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РАЗВИТИЕ ЦИФРОВЫХ ТЕХНОЛОГИЙ И ПРОИЗВОДИТЕЛЬНОСТИ ТРУДА СРЕДНИХ ПРЕДПРИЯТИЙ РОССИИ

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Аннотация: В экономически развитых странах разрабатываются пилотные проекты, целью которых является развитие предпринимательства и повышение производительности труда за счет использования современных технологий. В связи с этим нацеленность государственной политики на решение проблемы роста производительности труда и ликвидацию технологического отставания страны от передовых экономик мира актуализировало как на государственном, так и региональном уровнях задачу поиска новых направлений и ресурсов повышения производительности труда в России. Цель данной работы – выявление зависимостей цифровых технологий и производительности труда средних предприятий в России и ее регионах. В ходе исследования были подтверждены следующие гипотезы: существует корреляционная зависимость между долей организаций, использующих Интернет и производительностью труда средних предприятий в России. Затраты на ИКТ в России оказывают достаточно сильное влияние на производительность труда средних предприятий. Результаты исследования могут быть использованы для выявления тех индикаторов ИКТ, которые имеют наибольшее влияние на рост производительности труда средних предприятий, что может быть использовано для совершенствования региональных аспектов инновационного развития экономики страны.

Ключевые слова: информационно-коммуникационные технологии, производительность труда, средние предприятия, цифровые технологии, эконометрический и факторный анализ, экономический рост, экономика региона

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THE DEVELOPMENT OF DIGITAL TECHNOLOGIES AND LABOR PRODUCTIVITY OF MEDIUM-SIZED ENTERPRISES IN RUSSIA

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Abstract: Economically developed countries develop pilot projects aimed at developing entrepreneurship and improving labor productivity through the use of modern technologies. In this regard, the state's policy focus on addressing the issue of labor productivity growth and bridging the technological gap between the country and advanced economies has brought attention to the need for discovering new avenues and resources to enhance labor productivity in Russia. The goal of this work is to identify the dependencies between the development of digital technologies and the labor productivity of medium-sized enterprises in Russia and its regions. The study confirmed the following hypotheses: there is a correlation between the share of companies using the Internet and labor productivity of medium-sized enterprises in Russia. ICT costs in Russia have a rather strong impact on the labor productivity of medium-sized enterprises. The study results can be used to identify those digital technologies indicators that have the greatest impact on labor productivity growth of medium-sized enterprises, which can be used to improve regional aspects of innovative development of the country's economy.

Keywords: digital technologies, econometric and factor analysis, economic growth, information and communication technologies, labor productivity, medium-sized enterprises, regional economics

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Introduction. Labor productivity is the most important indicator of economic development of the country and its regions. It has a direct link with economic growth, competitiveness, living standards and technological progress of the economy. Increasing labor productivity contributes to increasing corporate profits, saving labor force, and improving the competitiveness of enterprises in the country and its regions. The importance of labor productivity nowadays is due to the significant lag of the Russian economy behind the world leaders. In 2019 Russia ranked 6th place in PPP GDP, 35th place in labor productivity and 74th place in the Welfare Index. In addition, the country has lost its technological leadership, ranking 45th place in the ICT Development Index in 2017 and having a share of the digital economy in Russia's GDP of only 3.9%.

The state's policy focus on addressing the issue of labor productivity growth and bridging the technological gap between the country and advanced economies has brought attention to the need for discovering new avenues and resources to enhance labor productivity in Russia. This is crucial for promoting economic growth at the state and regional levels. According to S.I. Shanygin and E.I. Zuga, the labor productivity indicator provides valuable insights into the economic, technological, and social aspects, highlighting the capabilities of various sectors in terms of production and consumption [1].

The impact of digital transformation on a country's productivity and economic growth is recognized as one of the most significant contemporary challenges worldwide [2]. According to McKinsey Global Institute, there is a direct relationship between business digitalization, its profitability, and labor productivity due to the data-based business models [3]. In light of this, Russia and its various regions require a shift from the current export-focused approach to a novel model of economic advancement centered around the rapid growth of digital technologies in both social and economic spheres. The core idea of this model lies in the notion that the progress of digital technologies can serve as a critical driver for enhancing the competitiveness of the national economy, stimulating growth in labor productivity, and consequently impacting the enhancement of living standards, economic entities' profits, and the country and its regions' economic growth rate [4, 5].

The goal of this study is to analyze the relationship between the advancement of digital technologies and the labor productivity of medium-sized businesses in Russia and its regions. The research objectives include examining the linkages between digital technologies and labor productivity in these businesses, as well as identifying key correlations between digital indicators and labor productivity.

Literature review. Information and communication technologies are a crucial aspect of digitalization in various sectors of the economy. These technologies not only have a profound impact on people's lives but also bring about significant changes in the economic structure [6]. According to G.A. Kostin and I.V. Uporova, the level of development in digital technologies serves as a critical indicator of a state's economic and social well-being [7].

The proliferation of digitalization can create an environment in which the necessary data can be obtained on a continuous basis, which has a positive effect on the quality of the liquidity and solvency assessment of enterprises [8, p.16]. At the same time, V.A. Chereshnev, V.A., V.V. Chereshnev, D.N. Verzilin, and T.G. Maximova note that in order to develop innovative processes (including digital technologies), it is important not only to use direct government financing of innovative projects, but also to create conditions under which non-state investors will benefit from financing innovative developments [9, p.10].

Such researchers as C. Pissarides, S. Arvanitis, E. Lucis, R. Gordon, I.T. Ovchinnikova, Y.A. Salikov, A.V. Markov, and others supported the impact of information and communication technologies on labor productivity [10–13]. According to C. Pissarides, Nobel laureate in economics, sustainable development involves the use of technologies that ensure efficient output without

causing environmental problems in the future [10]. Studying the relationship between labor productivity growth and digital technologies in the USA, economist R. Gordon concluded that the acceleration of technological changes in the computer industry contributes to the decrease in prices and increase in demand for digital technologies, which later results in labor productivity growth in the national economy [12].

In their studies, R. Solow, T. Cowen and A. Porokhovsky mention the negative impact of digital technologies on labor productivity [14–16]. In 1987, Robert Solow, Nobel laureate in economics, has proposed a mathematical model that revealed a low impact of digital technologies on the productivity growth of companies and the economic system in general. This conclusion has been called the Solow paradox, according to which the signs of the computer industry are seen everywhere, but they are not observed in the labor productivity statistics [14].

Tyler Cowen from George Mason University has a similar opinion. According to him, the latest wave of scientific and technological progress, which was associated with digital technologies, has not had the same powerful impact on economic activities as the steam engine or electricity [15]. In the studies, A.A. Porokhovsky emphasizes that «while each previous industrial revolution resulted in labor productivity growth, with the beginning of the fourth industrial revolution and the deepening of global digitalization, productivity growth rates began to decline» [16].

Domestic scientists I.T. Ovchinnikova, Y.A. Salikov and A.V. Markov note both positive and negative impacts of digital technologies on the increase in labor productivity for regional industrial enterprises. According to the authors, this problem can be solved together with the introduction of innovations, as well as improvement of management quality and the qualifications of workers with appropriate labor incentives [13].

In the works, S. Arvanitis and E. Lucis conducted an empirical study of the impact of information and communication technologies on labor productivity in Greek and Swiss companies, which confirmed the hypothesis about the positive impact of digital technologies on labor productivity of enterprises. In their opinion, in most developed and developing countries, companies invest heavily to acquire and use new production factors, which has a great influence on the operation of companies [11].

Besides, economist Chad Syverson from the University of Chicago provides additional arguments to support the role of information technologies in economic development. In his study, he attempted to compare electricity and digital technologies in terms of their impact on labor productivity. It turned out to be that the labor productivity dynamics in the era of information technologies follows the same trajectory as in the late 19th and early 20th centuries, in the era of electricity [17].

V. Vishnevsky conducts an empirical analysis of the correlation between the digital economy and industry in 74 countries from 2014 to 2016 to explore the possibilities and restrictions of the digital economy during the fourth industrial revolution. The study reveals a strong relationship between the size of the digital economy and gross fixed capital formation.

Besides, the scientist's paper does not confirm R. Solow's opinion that the digital economy has no influence on productivity. The researcher asserts that the digital economy operates autonomously and produces distinct information products that are subject to distribution, exchange, and consumption. Furthermore, it evolves in accordance with distinctive economic principles [18].

In his work, V. Vishnevsky comes to the conclusion that the digital economy develops rapidly according to its own laws, is a significant sector, and already has macroeconomic effects. Digital technologies may cause problems, but at the same time find new ways to solve them: «smart» automatically imposed taxes, «smart» automated loans, «smart» regulation and management [17].

Methods of study. Method for calculating the indicator «Labor productivity of employees of workers at medium-sized enterprises in Russia»: labor productivity on one employee was calculated as the volume of output (turnover) in prices of 2010, produced by an employee per unit of time using the formula:

$$LP = O / W \ , \qquad (1)$$

where O – the turnover of medium-sized enterprises (in prices of 2010); W – average number of workers at medium-sized enterprises.

This method for calculating labor productivity is used by the International Labor Organization, and is presented in more detail on the official website [19].

In the course of the study, modeling techniques, along with structural-dynamical and correlation analysis, were applied utilizing retrospective data in its traditional form.

The study uses data available to a wide range of users: Federal State Statistics Service, International Labor Organization, and the Organization for Economic Cooperation and Development.

The study does not include the period from 2020–2022 to exclude distortions due to artificial factors. To conduct the analysis, we have used the statistical database for eight federal distrdigital technologies and Russia in general for the period from 2010 to 2019 of the Federal State Statistics Service, as well as the studies of the Higher School of Economics National Research University (HSE NRU) «Digital Economy Indicators».

All cost indicators were analyzed and given in constant prices of 2010; the GDP deflator index is used to exclude inflation [21].

When building regression models, possible lag shifts between dependent and independent indicators were not taken into account. This is due to the following reasons:

– most of the indicators in question are slow moving;

– most of the factors in the economy are interrelated and it is premature to say that there is a direct (non-transitory) relationship between the factors considered in this study. This is the subject of a separate study;

– similar studies carried out with said lagged shifts have shown a lower strength of relationship.

The econometric analysis takes into account the classical method of cointegration analysis of non-stationary time series, which includes several consecutive steps: checking for stationarity of time series using the Dickey-Fuller test or the ADF test; calculating the difference between two time series; checking for cointegration of data using the vector autoregression (VAR) method; estimating the parameters of cointegration of data using the least squares/maximum likelihood method; and checking for stability of the data.

The classical method of cointegration analysis of non-stationary time series allows us to identify and estimate the relationship between non-stationary series and draw conclusions about the long-run relationship between them. However, when analyzing economic data, it is not always appropriate to consider the trend (the long-term direction of change in the data) and fluctuations (short-term changes around the trend) separately. The reason is that trend and fluctuation are interrelated and looking at one aspect in isolation can lead to distorted conclusions and loss of meaning in the analysis. In order to get a completer and more correct picture, it is necessary to consider both aspects and their interaction when examining economic indicators.

Therefore, for a more complete understanding of economic data and obtaining accurate conclusions, it is advisable to consider the trend and fluctuations around it interconnectedly. This will help the expert, see the full picture and determine how trend and variability affect economic processes and phenomena. As a result, the expert will be able to make more informed decisions and more reliable forecasts based on the analysis of economic data.

Results of the research. To study the level of labor productivity in Russia and its regions, the analysis of changes in this indicator for 2010–2019 was conducted (Figure 1).

During the studied period, labor productivity in Russia decreased in 2015 and in 2017–2018; the same trend was maintained by the Southern, North Caucasian and Volga Federal Distrdigital technologies; in 2018-2019, labor productivity decreased in the Siberian Federal Distrdigital technologies.

A thorough econometric investigation was conducted to establish the correlation and evaluate the influence of digital technologies on the labor productivity of medium-sized enterprises operating within regions of the Russian Federation. Four indicators were selected as the influencing factors [19]:

1) The share of companies using the Internet, %.

2) The share of companies using personal computers, %.

3) The costs of information and communication technologies, million rubles.

4) The share of companies having a website on the Internet in the total number of companies, %.

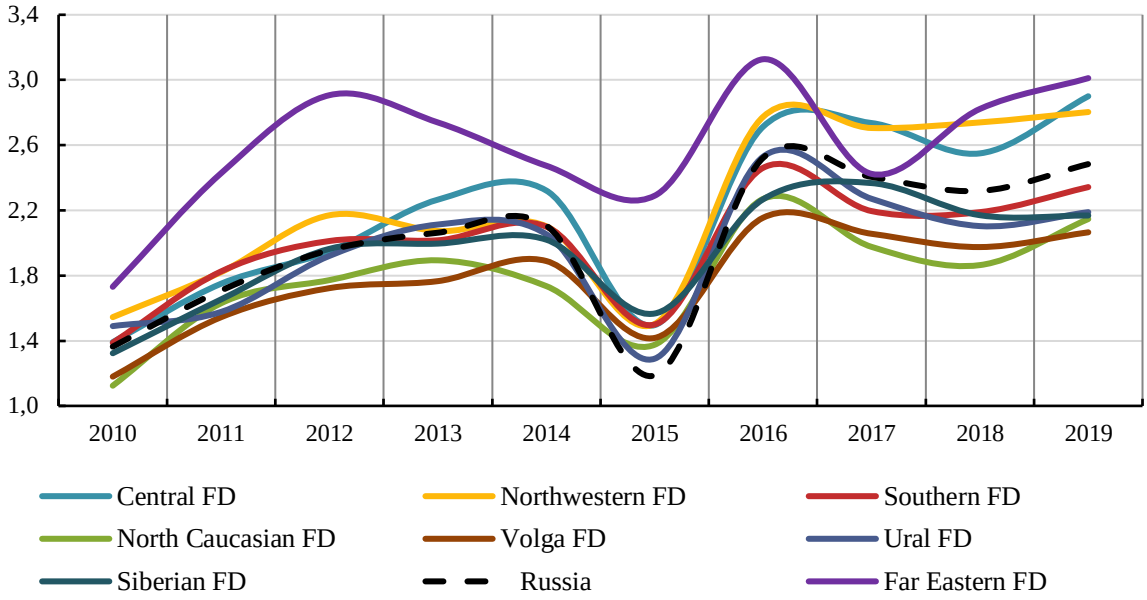


Figure 1 – Labor productivity in Russia and federal distrdigital technologies (in prices of 2010), million rubles/person

Source: calculated and prepared by the author based on [19]

Econometric analysis of the data was performed for 9 years (from 2010 to 2019), excluding data from 2015, due to the economic crisis, in order to avoid distortions of the data under study and to obtain more reliable estimates of the effects of other variables.

During the empirical study, the following hypotheses were made:

1) There is a functional relationship between the share of companies using the Internet and labor productivity of medium-sized enterprises in Russia and its regions.

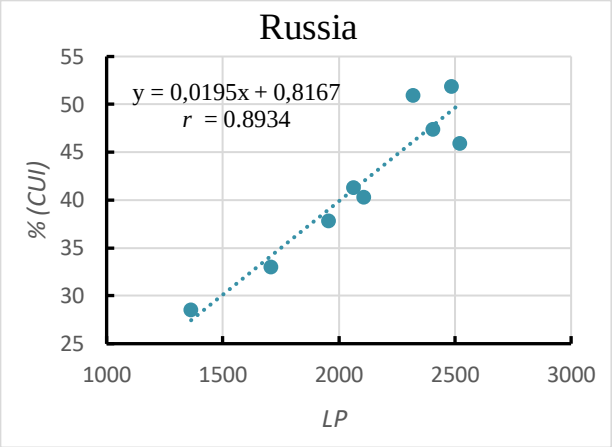
2) There is a significant relationship between the share of companies using personal computers and the productivity of medium-sized enterprises in Russia and its regions.

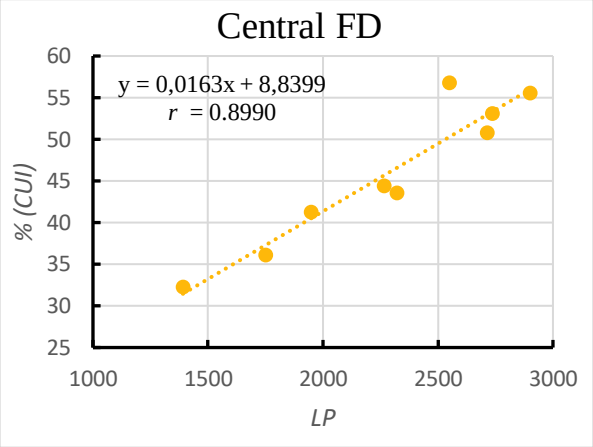
3) Information and communication technologies costs in Russia and its regions are interrelated with the labor productivity of medium-sized enterprises.

4) There is a strong linear relationship between the share of companies having a website on the Internet and labor productivity of medium-sized enterprises in Russia and its regions.

The graphic results of the test of the first hypothesis are shown in Figure 2. As we see, there is a significant correlation between the share of companies using the Internet and labor productivity of medium-sized enterprises in Russia (correlation coefficient $r = 0.89$). Here, we should note that the direct linear relationship was revealed only in the Central and Northwestern Federal Distrdigital technologies, where the correlation coefficients were 0.89 and 0.91, respectively; in other cases, no correlation between indicators was found.

According to testing of the second hypothesis, no relationship was found between the studied indicators; productivity of medium-sized enterprises in Russia is not characterized by the presence or absence of personal computers (correlation coefficient r = -0.09). A similar situation was found in the regions of the Russian Federation. The graphic results of the test of the third hypothesis are shown in Figure 3. As we see, information and communication costs in Russia have a sufficient impact on labor productivity of medium-sized enterprises (correlation coefficient $r = 0.79$). At the same time, a weak linear relationship was found in the Northwestern, North Caucasian, Southern, Ural, and Siberian regions, where the correlation coefficients were 0.22, 0.11, 0.24, 0.44 and 0.39, respectively. The Central Federal District exhibited the strongest correlation (0.74) among all regions, highlighting the significant variance in investment in Information and Communication Technologies (ICT) across Russian regions. This finding can be attributed to the fact that the Central FD bears the highest proportion of ICT expenditures.





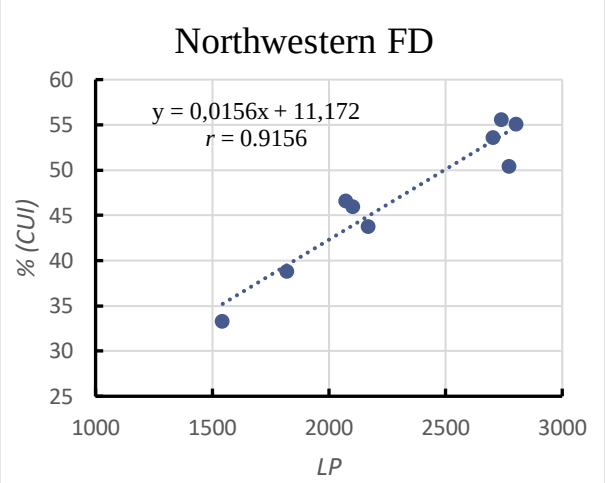
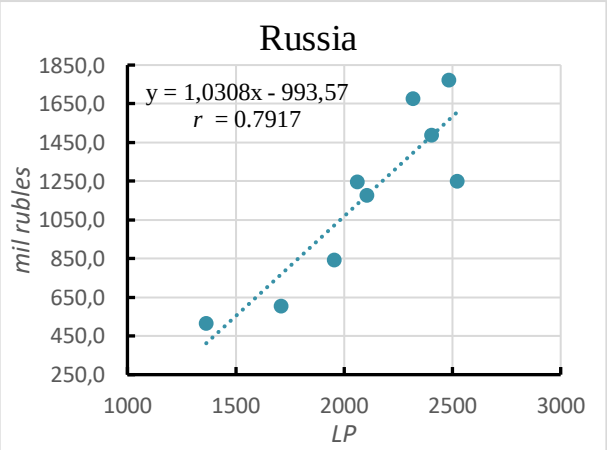


Figure 2 – Relationship between the share of companies using the Internet and labor productivity of medium-sized enterprises in Russia

Source: calculated and prepared by the author based on [21, 22]



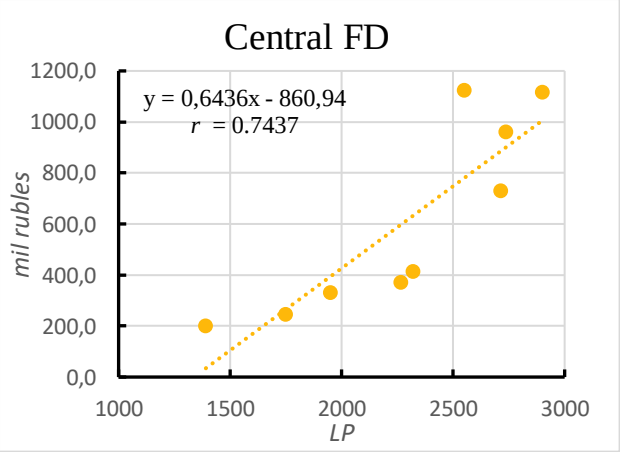


Figure 3 – Relationship between Information and communication technologies costs and labor productivity of medium-sized enterprises in Russia and its regions

Source: calculated and prepared by the author based on [21, 22]

The graphic results of the test of the fourth hypothesis are shown in Figure 4. As we see, there is a high correlation between the share of companies having a website on the Internet and labor productivity of medium-sized enterprises in Russia (correlation coefficient r = 0.89).

The results show a correlation of the indicators under discussion in all Russian regions, except for the North Caucasian and Southern Federal Distrdigital technologies, which may be due to the low development of Information and communication technologies in these regions

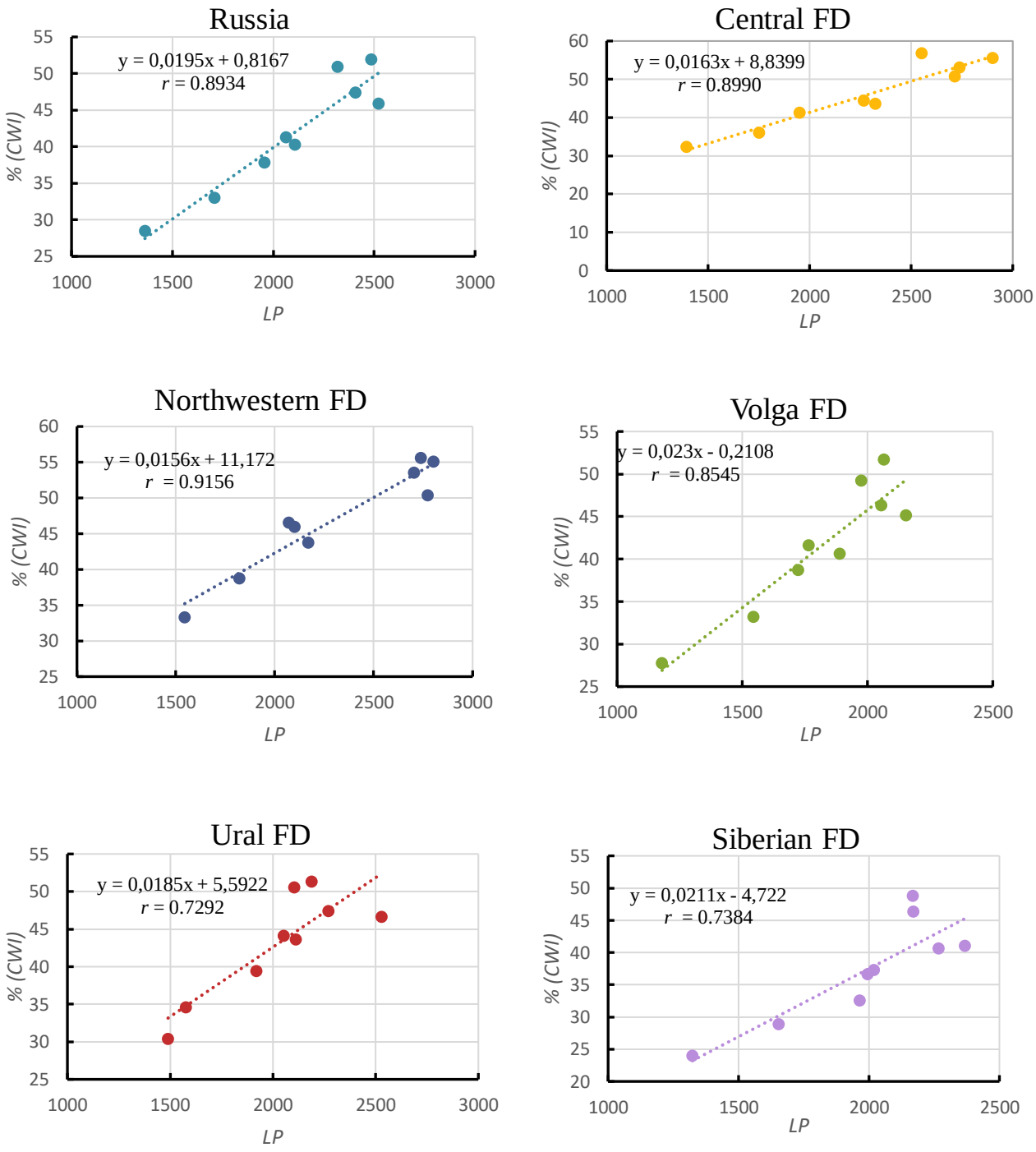


Figure 4 – Relationship between the share of companies having a website on the Internet and labor productivity of medium-sized enterprises in Russia and its regions

Source: Calculated and prepared by the author based on [21, 22]

Conclusion. The focus of state policy on solving the problem of labor productivity growth and eliminating the technological lag of the country from the advanced economies has actualized the problem of finding new directions and reserves of increasing labor productivity in Russia to ensure the economic growth of the country and its regions both at the state and regional levels. Currently, there is no stable growth in labor productivity in Russia, which is confirmed by the trend of the recent years, when the periods of productivity growth alternated with periods of a decline in the studied indicator.

During the studied period, labor productivity in Russia decreased in 2015 and in 2017–2018; the same trend was maintained by the Southern, North Caucasian and Volga Federal Distrdigital technologies; in 2018–2019, labor productivity decreased in the Siberian Federal Distrdigital technologies.

According to the obtained results, quantitative digital technologies indicators, in fact, have an impact on labor productivity of medium-sized enterprises. Factors such as the percentage of companies utilizing the Internet, expenses related to ICT, and the proportion of companies with an online presence played a significant role in shaping labor productivity in the majority of Russian regions.

Thus, the center of the digital economy growth is access to Internet data, the penetration of digitalization into the business environment, as well as the creation of websites of organizations that can serve to ensure the availability of services and brand awareness of the company. An assessment of the relationship between investment in digital technology and the productivity of medium-sized enterprises suggests that investment in modern technology can contribute to enterprise production and economic growth, as well as the development of new markets and business opportunities and increased innovation activity that will generate new ideas and innovative business solutions. The study results can be used to identify those digital technologies indicators that have the greatest impact on labor productivity growth of medium-sized enterprises, which can be used for the transition to innovative development of the country's economy and regions. This strategy provides an opportunity to improve the competitiveness, efficiency and profitability of enterprises, to promote the development of a technology cluster or attract investment, and to increase labor productivity and job creation.

In addition, the findings identify key areas where digital technologies can bring the greatest benefits and improve labor productivity. This could be, for example, the introduction of new production management systems, the automation of work processes, the use of data analytics for decision-making or the development of new technological solutions, as well as contributing to the development of pilot projects to support SMEs.

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