Abstract. Based on the materials of the Rosstat Monitoring of the Development of the Information Society in the Russian Federation for the period 2011-2020, the article analyzes the indicators characterizing the development of information and communication technologies. The purpose of the study is to assess the dynamics of business digitalization in Russian regions and digital divides. The main method of analysis is descriptive statistics. Based on the study of the indicators dynamics, the authors identified leading and outsider regions for various indicators of digitalization and built consolidated ratings of regions digitalization for 2011 and 2020. The study assessed the stability/mobility of the list of leading and outsider regions for the period under review, and considered the concentration of inequality and the relationship between business digitalization and the level of labor productivity in the region. Based on the results of the study, there was concluded that the mobility of the group of regions-leaders of digitalization is higher than those of the regions-outsiders. There is a fairly high concentration of low digitalization indicators in outsider regions, which, however, is stable over time. There is no significant relationship between the indicators of business digitalization and the level of labor productivity in the region, which to a certain extent confirms the productivity paradox known in the economic literature. On the other hand, the accelerated development of digitalization in regions with low levels of productivity and labor can be seen as an investment in the development of the region and in increasing labor productivity.

Keywords: digitalization, labor productivity, Russia, regions.

1 Introduction

Digitalization processes are currently in the focus of attention of scientists and practitioners. Numerous studies analyze the impact of digitalization on economic development and various areas of people’s lives. One of the objectives of the socio-economic development of the country at the present stage is to reduce the uneven development of Russian regions. In this terms, digital technologies contain a huge potential for economic development and increasing labor productivity, reducing socio-economic inequality [1-3].

The impact of digitalization on socio-economic development is controversial. As early as 1987, R. Solow noted: “You can see the computer age all around you, but not in terms of
productivity growth” [4]. A number of studies in the 1990s and early 2000s fixed the disappearance of the previously noted performance paradox [5, 6]. However, studies in recent years have raised one more time the problem of the existence of the “performance paradox 2.0” [7, 8]. An explanation for the contradiction between the growing pace of digitalization and a decrease in the growth rate of labor productivity can be both overestimated expectations from digitalization, as well as errors in measuring the effects of digitalization, the presence of time lags between the introduction of technology and the effect, as well as the pace of digitalization of individual sectors of the economy.

The economic literature presents a number of approaches to assessing the digital divide, based on the construction of ratings of regions according to various digitalization metrics. The Digital Economy and Society Index (DESI), Digital Evolution Index, and other indices that characterize digitalization processes are often used [9, 10]. For example, the DESI index contains detailed assessments of human capital, connectivity, digital technology integration, and digital society [11].

Russian statistics use different indicators compared to EU countries. The assessment of the digitalization of Russian regions is based on different approaches and methods, however, all of them highlight significant regional gaps in the levels of digitalization of regions and territories. Thus, N. Novikova and E. Stroganova, using the example of the Ural Federal District, revealed a significant differentiation in the level of digitalization by subjects of the federation and the unequal potential for the development of the digital economy in the regions [12]. The digital life index proposed by the staff of the Moscow School of Management Skolkovo, which includes primary indicators of the development of the digital environment, fixes a five-fold digital gap between large Russian cities [13].

Despite the most interesting approaches presented in these works, the information base on which they are performed covers limited periods of time and allows you to fully assess the dynamics of the development of digitalization.

The second issue is related to the assessment of the consequences of digitalization and its impact on the development of the region. Some aspects of this problem are disclosed by V. Dementiev [14], who analyzed the dynamics of labor productivity and the cost of technological innovation. In general, the conclusions of his study do not contradict the performance paradox noted above. The study by N. Abramova and N. Grishchenko [15], which was performed using a production function and contains averaged data that does not allow drawing conclusions about the change in gaps between regions.

Thus, nowadays, the literature presents a wide range of works aimed at assessing the level of digitalization of regions and, to a lesser extent, assessing the impact of digitalization on the results of economic development. At the same time, they are not works aimed at assessing the results of digitalization, as a rule, they are of a generalized nature and do not contain estimates of changes in gaps between regions.

In this paper, the authors attempt to assess the consequences of digitalization in the context of the economic development of regions, proposing an assessment methodology, identifying leading and outsider regions in terms of digitalization and labor productivity, and analyzing the change in these groups over time.

2 Materials and methods

The purpose of this study is to assess the dynamics, features and consequences of the digitalization of regions in the context of economic development and the reduction of inequality.

The objectives of the study are related to finding answers to the following questions:
1. How variable are the indicators of inequality in the digital development of business in Russian regions, how stable is the list of leading and outsider regions over time? Are the outsider regions likely to overcome the existing gap over time?

2. How concentrated are the indicators of inequality, and does this concentration change over time? Can the outsider regions be such only in terms of a relatively small list of indicators, or, on the contrary, do these regions form a digital lag in terms of a whole range of indicators? Does this characteristic change over time?

3. Do the dynamics in the digital development of Russian regions correlate with the dynamics of labor productivity?

The analysis was performed on the data of regional statistics of Rosstat and Monitoring of the Information Society Development in the Russian Federation (Section 2.2. – E-Business, hereinafter – Monitoring) [16]. These data make it possible to evaluate the annual dynamics of various indicators, followed by a comparison of the results in dynamics for a comparable range of indicators. To answer the questions posed, the use of a database for a relatively long period of time for a comparable range of indicators is required. For the study, a ten-year interval was chosen for the analysis of indicators for the following monitoring components:

- the use of computers and computer networks by organizations;
- the use of the Internet;
- application of information and communication technologies (ICT) by employees of organizations;
- integration of internal information systems (IS) and shared access to information within the organization;
- integration of the organization’s IS with the counterparties’ IS;
- e-commerce.

For each indicator, the ranks of the regions for 2011 and 2020 were determined (the extreme boundaries of the studied time interval) and 10 leading and outsider regions were identified to assess the dynamics of changes. The total number of indicators of the development of digital technologies in business according to monitoring indicators for 2011 and 2020 is 22. Research methods: descriptive statistics, grouping regions into groups of leaders and outsiders according to individual indicators of the development of digitalization of business, followed by comparison of groups.

### 3 Results

In 2011, the leading regions in at least one of the 22 indicators of business digitalization included 53 Russian regions, including 4 regions (Moscow, St. Petersburg, Tomsk Region and the Republic of Karelia) in 10 or more indicators. At the same time, the first three regions were among the leaders 20 times or more. 45 regions were among the outsider regions for at least one indicator over the same period, including 8 regions where this group was registered 10 times or more (the Republic of Tyva, the Chechen Republic, the Bryansk region, the Karachay-Cherkess Republic, the Republic of Sakha (Yakutia), Republic of Ingushetia, Amur Region).

In 2020, 54 Russian regions were among the leading regions in at least one indicator, while the composition of the leaders has completely changed. Belgorod, Yaroslavl and Vladimir regions entered the TOP-10 regions in terms of 10 or more indicators of business digitalization. For the same period, 47 regions were among the outsider regions in at least one indicator, in eight of which falling into the list of outsiders in terms of the indicators under consideration was recorded 10 or more times. (Republic of Dagestan, Republic of Tyva, Republic of Buryatia, Chukotka Autonomous Okrug, Jewish Autonomous Region, Republic of Crimea, Sevastopol, Nenets Autonomous Okrug).
In general, over the decade under review, the top ten regions have undergone significant changes. Only two leading regions in 2011 remained in this group in 2020 (St. Petersburg and Stavropol Territory). At the same time, the top ten outsiders turned out to be more stable. 4 regions out of 10 could not leave this group (Republic of Tyva, Chechen Republic, Republic of Ingusheniya, Karachay-Cherkess Republic).

Analysis by indicators shows that, on average, in both groups, 3 out of 10 regions after 10 years retained their positions. However, in terms of business digitalization components, the situation looks heterogeneous (Table 1).

Table 1. The average number of leading and outsider regions in terms of individual indicators of business digitalization in 2011, which retained their positions in 2020

<table>
<thead>
<tr>
<th>Components of digitalization</th>
<th>Regions remaining in the top ten in terms of the digitalization component</th>
<th>Regions remaining in the top ten outsiders in terms of the digitalization component</th>
</tr>
</thead>
<tbody>
<tr>
<td>The use of computers and computer networks by organizations</td>
<td>3.9</td>
<td>3.3</td>
</tr>
<tr>
<td>The use of the Internet</td>
<td>3.0</td>
<td>2.4</td>
</tr>
<tr>
<td>The use of ICT by employees of organizations</td>
<td>3.7</td>
<td>2.0</td>
</tr>
<tr>
<td>Integration of internal IS and sharing of information within the organization</td>
<td>2.3</td>
<td>4.5</td>
</tr>
<tr>
<td>Integration of the IS of the organization with the IS of counterparties</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>E-commerce</td>
<td>3.5</td>
<td>2.5</td>
</tr>
</tbody>
</table>

*Source: calculated by the authors.*

The analysis of the regions that retained the status of an outsider in 2020 for any indicator shows that low indicators tend to be concentrated in the same regions. The most difficult situation is in the Republic of Tyva, the Karachay-Cherkess Republic, the Republic of Kalmykia, the Chechen Republic, and the Chukotka Autonomous Okrug.

The Pearson correlation coefficient between the level of labor productivity (hereinafter referred to as PT), calculated as the ratio of gross regional product at current prices to the average annual number of employees, and digitalization indicators in most cases is statistically insignificant. In 2011, the average degree of connection was noted between labor productivity and the share of organizations using wireless local area networks ($r=0.42$, $p<0.01$), the share of organizations using the Extranet ($r=0.36$, $p=0.01$), the share of organizations that used resource planning systems (ERP systems, $r=0.45$, $p<0.01$). In 2020, all correlation coefficients are below $|0.3|$.

As follows from Table 2, the assumption of a relation between digitalization and the reduction of economic inequality is not confirmed.

Table 2. Rating of regions-leaders and outsiders of digitalization in terms of labor productivity

<table>
<thead>
<tr>
<th>Leading regions in terms of digitalization</th>
<th>Rating of the region by the level of digitalization</th>
<th>Outsider regions in terms of digitalization</th>
<th>Rating of the region by the level of digitalization</th>
<th>Rating by PT level</th>
</tr>
</thead>
</table>

As follows from Table 2, the assumption of a relation between digitalization and the reduction of economic inequality is not confirmed.
Components of digitalization

In 2011 the leading regions of digitalization had high and medium ratings in terms of labor productivity, with rare exceptions, while in 2020 the situation changed. The leaders of digitalization have become regions with labor productivity indicators at the average and below average levels.

### 4 Discussion

The data obtained show the existence of conditions for overcoming the digital divide of regions, especially in the top part of the ranking of regions, and at the same time, do not contradict the productivity paradox. The group of digitalization and productivity outsiders became much more homogeneous in 2020. Among the digitalization outsiders, most regions also have low labor productivity indicators, which may negatively affect their further development.

Assessing the results obtained, the authors note that they may indicate that investments in the digitalization of regions with an average level of labor productivity are a prerequisite for its increase.

At the same time, it is unexpected that in 2020 Moscow did not make it into the top ten leading regions of digitalization. This is probably due to the peculiarities of the data used,
most of which characterize the initial stages of digitalization and do not assess the level of human capital and intangible assets.

5 Conclusion

The findings demonstrate the presence of a number of features of the digitalization of Russian regions.

Primarily, over the past decade, there has been a rather high mobility of the leading regions, indicating a decrease in the digital divide and creating conditions for business development in this group of regions.

Secondly, we can observe a significantly lower mobility of digitalization outsider regions. Combined with low productivity scores for most of these regions, this could signal a risk of growing digital age and diminished economic development opportunities in these regions.

Thirdly, getting into the group of outsiders of digitalization of regions with extreme places in the productivity rating shows that digitalization is not yet a factor in increasing the efficiency of activities for many of them.

The study was supported by the Russian Science Foundation grant No. 22-28-20336, https://rscf.ru/project/22-28-20336/. The reported study was funded by the Russian Science Foundation project number 22-28-20336.

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