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Digital Divide in Russia's Regions: Assessment and Priorities in the Context of Achieving National Development Goals

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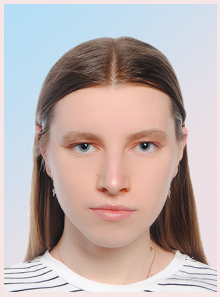

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Abstract. The persistent spatial differentiation in digitalization levels across Russian regions underscores the urgent need to identify the determinants of the digital divide to inform effective state policy. This study aims to identify and econometrically assess the key determinants shaping this divide across three structural levels – inequality in access, quality of use, and the ability to derive benefits – for three primary stakeholders: households, businesses, and the state. The scientific novelty of this research lies in its comprehensive, panel-data analysis of determinants across these three user groups and its identification of paradoxical relationships within the digitalization adoption. Employing fixed effects models on data from 82 Russian regions for the period 2017–2023, the analysis reveals a stable and significant influence of economic factors on all levels of the digital divide. Specifically, rising Internet service provider (ISP) charges and an increased share of the population in poverty are found to significantly reduce household access and digital

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activity. For the business sector, however, the analysis uncovers paradoxical relationships, which are likely attributable to the structure of official statistical data. The study also establishes that elderly populations demonstrate high digital activity, potentially as a means to compensate for offline limitations, while satisfaction with digital public services is unexpectedly higher in more depressed regions, a phenomenon explained by adapted expectations. The findings confirm the sector-specific nature of the determinants, necessitating differentiated policy measures. Furthermore, spatial analysis indicates a poor diffusion of innovations from digitalization centers to peripheral regions, highlighting a critical challenge for equitable development.

Key words: digital divide, digital inequality, households, business, public sector, fixed effects models, regional economy, Russian regions.

Acknowledgment

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Introduction

The digital transformation of society, heralded as the fourth industrial revolution, promises not only unprecedented opportunities for economic growth, social inclusion, and access to knowledge but also new forms of social stratification. Traditional constraints are gradually being replaced by digital inequality – a complex issue involving differentiation in access to information and communication technologies (ICT), as well as in their use and benefits derived from them. However, a static understanding of inequality as just internet access is becoming irrelevant to a rapidly changing technological environment. Today, the focus shifts to the dynamic and multidimensional concept of the digital divide, reflecting differences in infrastructure availability, as well as a growing gap in skills, quality of use, and the ability to derive capital from the digital environment.

The term "digital divide" was coined in academic discourse in a 1995 report by the U.S. National Telecommunications and Information Administration, which highlighted the differentiation in access to telecommunications technologies among various socio-geographic groups[1]. Although the phenomenon had been discussed earlier in public discourse, this report provided a systematic definition, framing it as inequality in possessing information resources due to differences in the availability of telephony, computers, and the internet between residents of rural and urban areas, low-income groups, racial minorities, and the rest of the population. U.S. President Bill Clinton played a significant role in popularizing the term, using it in public speeches and expanding its meaning to highlight the gap between those included in and excluded from the digital economy[2]. He emphasized the need to overcome this inequality, identifying its key parameters: income level, education, geographic location, and race.

[1] United States. National Telecommunications and Information Administration. Falling Through the Net: Defining the Digital Divide: A Report on the Telecommunications and Information Technology Gap in America. US Department of Commerce, National Telecommunications and Information Administration, 1999.

[2] Remarks to the National Academy Foundation Conference in Anaheim, California. Available at: https://www.presidency.ucsb.edu/documents/remarks-the-national-academy-foundation-conference-anaheim-california (accessed: 15.04.2025).

The term gained further academic grounding in the work of sociologist Pippa Norris (Norris, 2003), who defined it as inequality in access to digital technologies between socially vulnerable and advantaged population groups. Norris proposed a multi-level concept, distinguishing a global dimension (the disparity between developed and developing countries), a social dimension (internal differences based on income, education, age, and race), and a democratic dimension (inequality in the use of digital resources for political participation). In 2001, the Organization for Economic Co-operation and Development (OECD) brought the term into the international policy agenda, cementing it in the report "Understanding the Digital Divide". According to the OECD, the digital divide characterizes the imbalance between different socio-economic entities not only in opportunities to access ICT but also in the intensity of their use for a wide range of tasks, including commercial activity[3]. So, the emphasis has shifted to the comprehensive use of ICT, a broader issue than just internet access.

The modern concept of digital inequality is structured across three levels. The first level involves inequality in access to ICT, driven by differences in infrastructure availability, economic affordability of equipment and access for socially vulnerable groups and remote areas (Attewell, 2001). The second level is characterized by inequality in the quality of use of digital technologies, where the key factor is the differentiation of digital competencies. The effectiveness of technology use varies depending on the socio-economic context – from educational practices to professional application (Zhuravlev, Chaadaev, 2024). Even with technical skills, the problem of inefficient use of ICT potential persists, for example, when passive content consumption predominates over its creation (Gladkova et al., 2019).

The third, most complex level of inequality is related to the opportunities to derive benefits from using digital technologies and "digital capital" concept. Following the Weberian approach of Ragnedda, digital capital represents a set of resources (infrastructural and cognitive) that allow transforming technological opportunities into positive changes in quality of life (Ragnedda, 2017). This level integrates the previous ones, as deriving benefits is impossible without basic access and developed competencies (Rastvortseva, Panasiuk, 2025). The third level is particularly significant for regional economies, as the concentration of digital capital in developed regions leads to deepening disparities in labor productivity (Zhuravlev, 2018), increased dependence of peripheral territories on federal digital platforms (Uskova, Kozhevnikov, 2013), and out-migration of highly qualified personnel to digital clusters, limiting the economic potential of depressed regions (Derevtsova et al., 2021).

A digital divide is evident among Russian regions (Basova, 2021; Kozhevnikov, 2019). For instance, according to Rosstat data for 2023, in leading regions (Moscow, Saint Petersburg, Republic of Tatarstan) the share of households with broadband internet access exceeds 90%, while in a number of other regions (Novgorod, Tver, Orel, Tambov, Kostroma regions) this figure remains below 80%, and the gap can be even more significant for organizations. This differentiation directly affects the quality of life of citizens, business competitiveness, and public administration efficiency, creating "digital peripheries" with limited development opportunities.

Research on social inequality between urban and rural populations has shown the need for state support for socially vulnerable families and low-income households in organizing access to ICT (Kostyaev, 2024). A study by A.I. Ivanova identified key factors of digital inequality for three stakeholder groups – households (internet access is influenced

[3] Understanding the Digital Divide. OECD Digital Economy Papers. No. 49. Paris: OECD Publishing. DOI: http://dx.doi.org/10.1787/236405667766

by age, education level, and ICT subsidies, while quality of use is influenced by regional ICT expenditures), the state (the share of the elderly constrains development, while digitalization subsidies stimulate both access and use of services), and business (digitalization is slower in densely populated southern regions due to cultural specifics, demand for e-commerce depends on education, and business subsidies showed no significant effect) (Ivanova, 2023).

We think that the levels of the digital divide may manifest differently for each group of Russia's constituent entities (*Fig. 1*). Understanding the factors shaping its key components across three levels for different economic sectors will enable more targeted and effective digitalization policies in the regions.

Addressing digital inequality is key to achieving Russia's national development goals formulated in strategic documents. Primarily, this includes the "Strategy for the Development of the Information Society in the Russian Federation for 2017–2030"[4], which sets the task of eliminating digital inequality and ensuring across-the-board access to reliable and fast internet networking. Its implementation is detailed in the national program "Digital Economy of the Russian Federation", where one of the priorities is overcoming gaps in digital infrastructure between regions.

Furthermore, tasks to reduce digital inequality are integrated into the Presidential Decree "On National Development Goals until 2030"[5], particularly the issues of ensuring "digital transformation" and improving citizen well-being.

The goal of this study is to identify and conduct an econometric assessment of the key determinants shaping the digital divide in Russian regions across three structural levels (inequality in access, quality of use, and opportunities to derive benefits) for three key stakeholder groups – households, business, and the state.

Figure 1. Indicators of the three levels of the digital divide for different economic sectors in Russian regions

	Digital divide Level I	Digital divide Level II	Digital divide Level III
Households	Share of households with broadband internet	Level of daily internet use among population	Prevalence of online shopping among population
Business	Share of organizations with broadband internet	Prevalence of cloud services among organizations	Share of e-commerce in retail turnover
State	Share of state and local authorities with internet speed of at least 2 Mbps	Population engagement in interaction with authorities	Satisfaction with quality of electronic services

Source: own compilation.

[4] On the Strategy for the Development of the Information Society in the Russian Federation for 2017–2030: Presidential Decree 203, dated May 9, 2017. Available at: https://base.garant.ru/71670570 (accessed: 14.12.2025).

[5] On the national development goals of the Russian Federation for the period up to 2030 and for the future until 2036: Presidential Decree 309, dated May 7, 2024. Available at: https://www.consultant.ru/law/hotdocs/84648.html (accessed: 14.12.2025).

Research methodology and rationale for its selection

The primary method was panel data econometric analysis. Three approaches were used for model building: pooled regression, random effects regression, and fixed effects regression. The correct model specification was determined using the Breusch – Pagan and the Hausman statistical tests. Gretl econometrics package was used for the analysis. It was found that in all cases, fixed effects regression models performed best.

The criteria for qualitative assessment of econometric models in panel data research include theoretical justification of variables, statistical significance of coefficients (*p-value*), coefficient of determination (R^2), fulfillment of key assumptions (absence of multicollinearity and autocorrelation of residuals), and testing for heteroskedasticity using robust standard errors. In this work, the choice of the fixed effects (*FE*) model was statistically and substantively justified. First, the Breusch – Pagan test rejected the null hypothesis of no individual regional effects, indicating the inadequacy of the pooled *OLS* regression. Then, the Hausman test, showing statistical significance, rejected the assumption of the random effects (*RE*) model about the non-correlation of individual effects with regressors. Since such constant but unobserved regional characteristics (e.g., geographic location, historically formed institutional environment) almost certainly affect both the level of digitalization and economic-demographic indicators, the *FE* model is appropriate. It allows eliminating the influence of time-invariant regional characteristics and estimating effects solely based on intraregional dynamics over the 2017–2023 period, providing consistent estimates of the correlation between regressors and levels of the digital divide.

The dependent variables were defined as indicators of the three levels of the digital divide for different stakeholder groups, presented in *Figure 1*.

Independent variables in the models:

1) *Pop_urbaniz* – share of urban population in the total population, % (+ a positive impact on indicators is assumed) (Shabunova et al., 2020; Kostyaev, 2024; Fong, 2009; Rastvortseva, Manaeva, 2022);

2) *Pop_women* – share of women in the total population, % (- a negative impact) (Antonio, Tuffley, 2014; Acilar, Sæbø, 2023);

3) *Pop_pension* – share of population aged 65 and over, % (-) (Gruzdeva, 2022a; Van Dijk, 2013; Krueger et al., 2018);

4) *Empl_educ* – share of the employed with higher education, % (+) (Cruz-Jesus et al., 2016; Soomro et al., 2020);

5) *Inst_inform* – share of employment in the informal sector, % (-) (Anakpo et al., 2023; Dutta et al., 2023);

6) *Inst_small_bus* – share of micro and small enterprises in the total number of enterprises, % (+) (Duncombe, Heeks, 2002; Arendt, 2008);

7) *Econ_paym* – share of ISP charges in average income, % (-) (Martin, Robinson, 2007);

8) *Econ_Inequal* – Gini index, % (-) (Fidan, 2016);

9) *Econ_food* – share of food expenditures in total expenditures, % (-) (Nanthikesan, 2000; Zhang, 2013);

10) *Econ_poverty* – population with income below the poverty line, % (-) (Gruzdeva, 2022b; Norris, Inglehart, 2013; Wamuyu, 2017).

Data source: open statistical data from the annual publications "Regions of Russia" for 2018–2024 and the Rosstat statistical survey[6]. Research objects: 82 constituent entities of the Russian Federation, period: 2017–2023[7]. The sample comprises 574 observations.

[6] Selective federal statistical monitoring of the use of ICT networks by the population. Federal State Statistics Service. Available at: https://rosstat.gov.ru/free_doc/new_site/business/it/ikt24/index.html (accessed: 30.08.2025).

[7] In 2017, the Russian Federation adopted the Information Society Development Strategy until 2030.

Research results

Let us consider the distribution of digital divide indicators across all three levels for households in Russian regions (*Fig. 2–4*).

Analysis of the share of households with broadband internet showed that in 2023, 87.3% of households had access to it. The highest growth in this indicator is demonstrated by regions with major

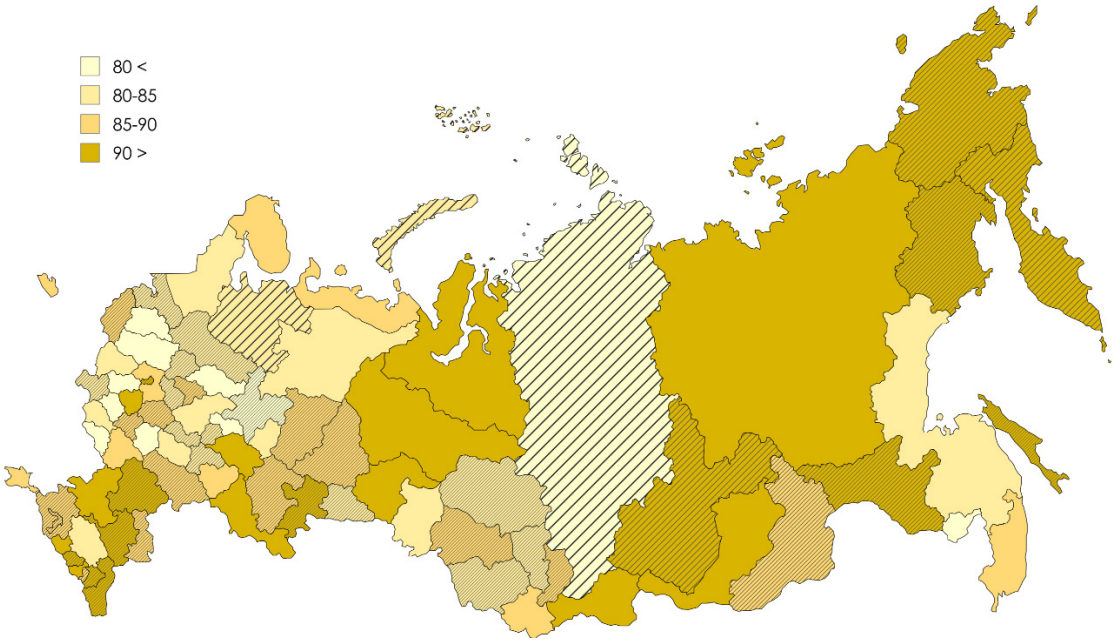

Figure 2. Share of households with broadband internet, 2023, %

Note: regions with growth rates above average in 2017–2023 are shaded.

Source: own compilation.

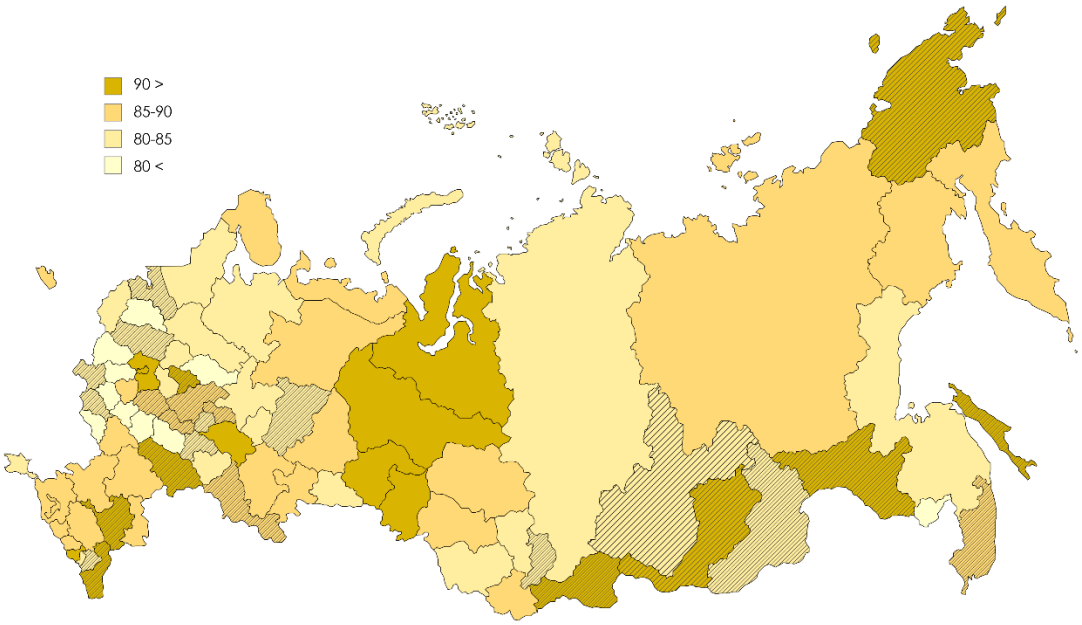

Figure 3. Level of daily internet use among the population in Russian regions, 2023, %

Note: regions with growth rates above average in 2017–2023 are shaded.

Source: own compilation.

investment projects and support for innovative business (Republic of Tatarstan, Moscow, Chechen Republic) and northern territories, where digital infrastructure compensates for geographic remoteness. Notably, high indicators are also observed in southern regions stimulated by tourism sector development and in sparsely populated regions where it is easier to achieve full coverage. Conversely, agricultural regions lag behind due to the predominance of the elderly whose professional activities are not related to the online environment. Even active digitalization in some of these regions has not yet overcome the general lag.

The highest level of daily internet use is characteristic of developing regions (Republic of North Ossetia-Alania, Republic of Dagestan, Republic of Kalmykia) and remote territories (Chukotka Autonomous Area, Amur and Sakhalin regions). This is explained by the compensatory role of digital technologies: in conditions of limited access to offline opportunities for entertainment, education, professional activity, and communication (especially in mountainous and remote areas), the internet becomes a key channel. In this context, high internet activity becomes a consequence of unfavorable socio-economic conditions.

The assumption that innovations diffuse from the center to neighboring regions can also be rejected. For example, the southeastern semi-circle around Moscow shows a lag in the adoption of IT. Constraining factors include the aging rural population and low resource availability, which is typical for northwestern territories, where high connection costs and relatively low incomes hinder the acquisition of devices and payment for high-speed access. This suggests that digital skills can form even under conditions of resource scarcity.

The spatial differentiation in the spread of online shopping in Russia demonstrates a pronounced dependence on the socio-economic characteristics of regions. The leadership of capital agglomerations and the innovation center (e.g., Republic of Tatarstan), as well as the influence of the neighborhood effect, confirms the role of economic development and infrastructural proximity as drivers of growth. In remote regions (Republic of Kalmykia, Republic of Buryatia, northern autonomous areas), e-commerce compensates for

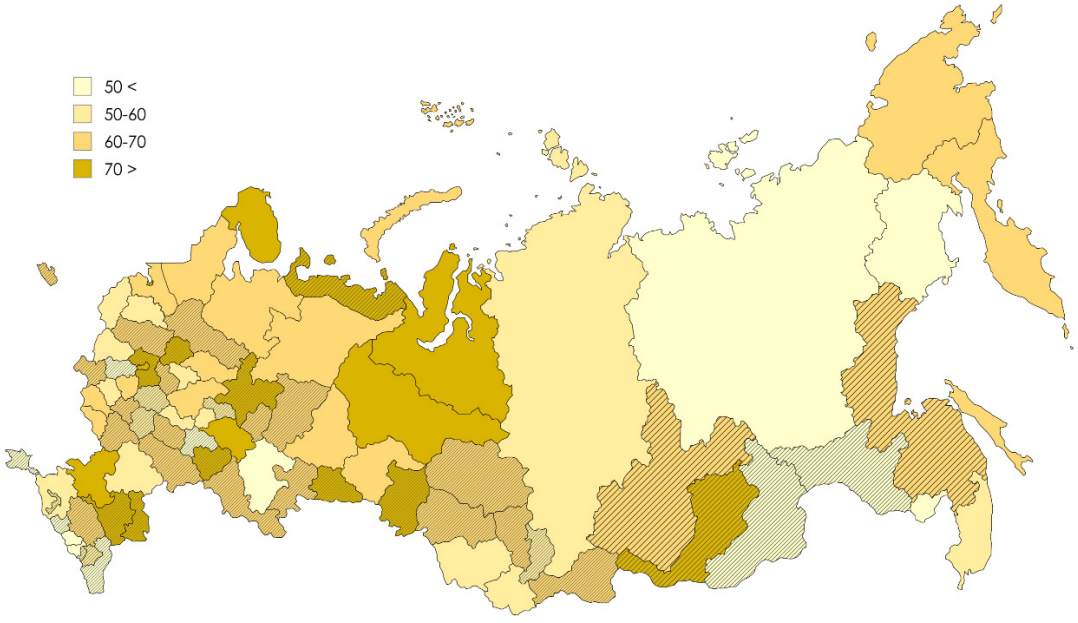

Figure 4. Prevalence of online shopping among the population in Russian regions, 2023, %

Note: regions with growth rates above average in 2017–2023 are shaded.

Source: own compilation.

offline trade, while low activity in other peripheral constituent entities is associated with remoteness, a high share of elderly people, and limited incentives for business diversification, indicating significant potential for further industry growth.

Three built models of factor influence on these three indicators are presented in *Table 1*.

The analysis revealed a statistically significant negative relationship between the share of ISP charges in income and the prevalence of broadband internet access: a 1% increase in ISP charges leads to a 5.87% decrease in the share of households with internet access. Digital accessibility is negatively related to the share of those with incomes below the poverty line: an increase in this indicator reduces broadband access by 2.9%. A positive correlation with the share of food expenditures was found, likely mediated by a general increase in income and welfare stimulating online consumption (Olumekor et al., 2024). An increase in the share of the informal economy reduces household internet access by 0.33%, reflecting regional economic distress[8]. Among demographic factors, the share of women has a positive influence: a 1% increase raises accessibility by 0.01%, which is associated with their higher internet activity[9].

Table 1. Models of factor influence on the digital divide in Russian regions for households

Variable	Model 1		Model 2		Model 3	
	Values of coefficients	HDE	Values of coefficients	HDE	Values of coefficients	HDE
Dependent variable	Share of households with broadband internet		Level of daily internet use among population		Prevalence of online shopping among population	
const	103.022		206.246		190.357	
Econ_paym	–5.86872*** (<0.0001)	–	–6.72647*** (<0.0001)	–	–6.49025*** (<0.0001)	–
Econ_food	0.577059*** (<0.0001)	–	0.286635*** (0.0069)	–		
Econ_poverty	–2.08662*** (<0.0001)	–	–3.15031*** (<0.0001)	–	–3.51617*** (<0.0001)	–
Econ_Inequal			–2.53034*** (<0.0001)	–	–2.35555*** (<0.0001)	–
Pop_pension			0.303511*** (<0.0001)	–	0.335796*** (<0.0001)	–
Pop_women	0.00972588*** (0.0046)	–				
Inst_inform	–0.330099*** (0.0031)	–			–0.47624*** (0.0037)	–
Inst_small_bus					0.06118*** (0.0041)	+
R-squared	0.723586		0.765169		0.736065	
Standard error of model	5.402668		5.552066		7.898893	
Number of observations	574		574		574	

*p < 0.1;
**p < 0.05;
***p < 0.01.
Note: p-values are in parentheses; HDE – hypothesized direction of effect.
Source: own compilation.

[8] Informal employment is growing along with the economy. Available at: https://www.vedomosti.ru/economics/articles/2021/09/14/886678-tenevaya-zanyatost (accessed: 04.05.2025).

[9] Women are the most active internet users. Available at: https://rapsinews.ru/digital_law_news/20231207/309451985.html (accessed: 04.05.2025).

Lack of high income limits the possibility of high-speed connections with large data traffic, forcing reduced usage. The Gini coefficient shows a negative correlation: a high level of economic inequality, meaning income concentration in a small group, leads to a 2.5% reduction in daily internet use due to its inaccessibility for broader segments. Low accessibility fosters weak digital competence due to a lack of conditions for acquiring and practicing relevant skills. A paradoxical positive relationship was identified with the share of the elderly: its increase raises the frequency of internet use by 0.3%, explained by this user group's specific digital skills for solving practical tasks and the need to maintain social connections (Kochetkov, Melnikova, 2024).

The conducted econometric analysis confirms the relationship of the third level of digital inequality, manifested in using the internet for online shopping, with factors from the first and second levels, such as access and competencies. The population's ability to derive advantages from digitalization is seriously undermined by a set of unfavorable economic factors. At the same time, a positive correlation between the share of online shopping and the share of the elderly was identified: a 1% increase raises the indicator by 0.33%, explained by the online environment's function of providing access to goods in conditions of limited physical mobility. Furthermore, this indicator is positively connected with the density of micro and small organizations: their increase per thousand people raises the level of online shopping by 0.06%, as this sector provides competitive local supply, stimulating service use.

Let us consider the distribution of Russian regions by digital divide indicators among organizations (*Fig. 5–7*).

Digital inequality in the business sector, as for households, is largely due to differences in the broadband internet access. Analysis shows that in recent years, the share of organizations with broadband internet access has been declining in most regions.

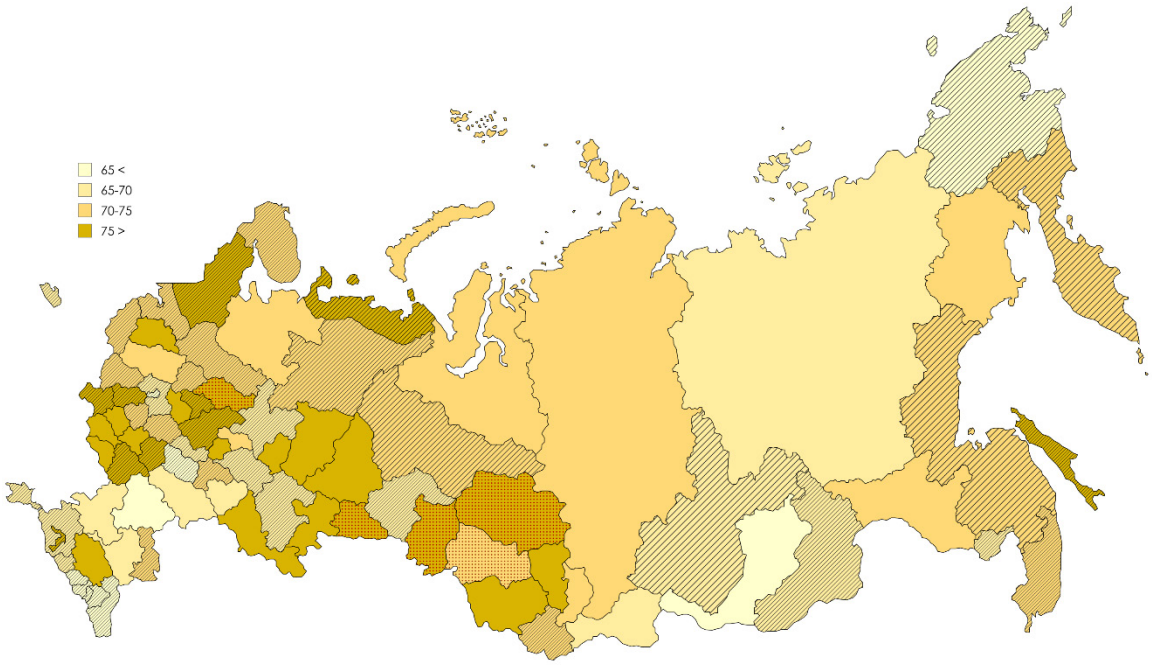

Figure 5. Share of organizations with broadband internet in Russian regions, 2023, %

Note: regions with growth rates above average in 2017–2023 are shaded.

Source: own compilation.

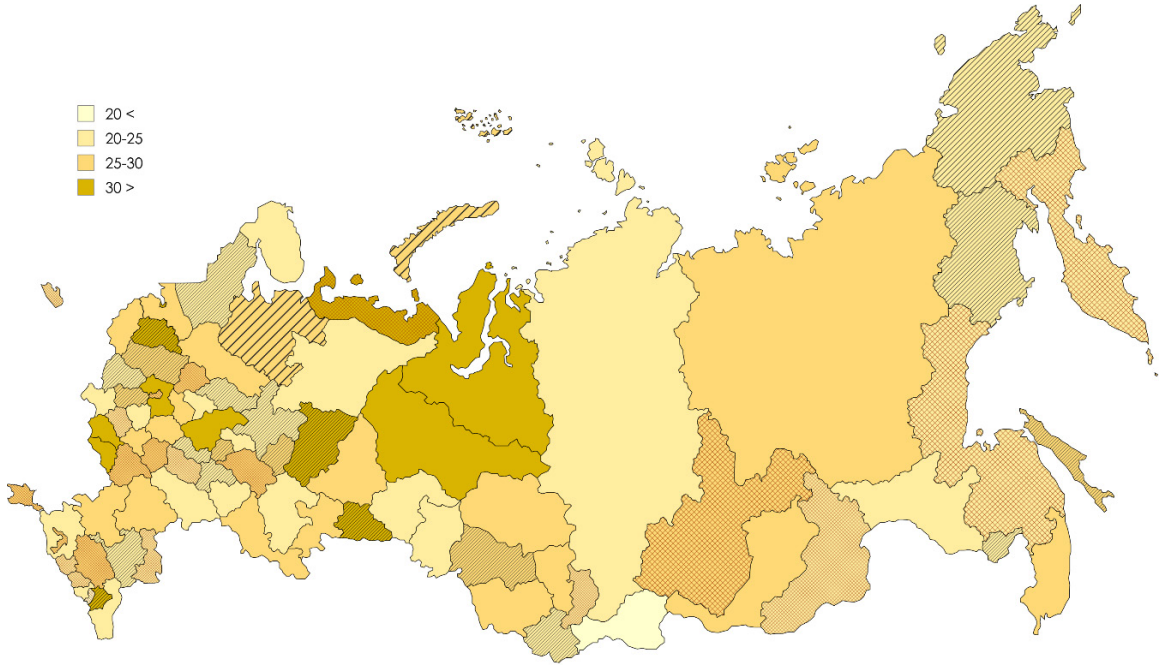

Figure 6. Prevalence of cloud services among organizations in Russian regions, 2023, %

Note: regions with growth rates above average in 2017–2023 are shaded.

Source: own compilation.

A negative relationship between internet access of households and organizations is observed in a number of leading regions, such as Orenburg, Kaluga, Orel, Belgorod regions, Republic of Udmurtia, Altai Territory and Kemerovo Region, where broadband internet access of organizations likely acts as a factor for entering new markets and developing. The Tomsk Region's growth is associated with the implementation of the federal project "Information Infrastructure" and the presence of knowledge-intensive structures requiring stable connectivity[10]. Meanwhile, the decrease in internet provision for organizations in southern regions, Moscow, Saint Petersburg, and Republic of Tatarstan may be explained by the spread of informal connection schemes through individuals, as well as the post-pandemic shift to remote work, where employees use personal connections accounted for in household statistics.

The observed increase in the share of organizations using cloud services, from 20.5% in 2017 to 26.7% in 2023, is characterized by significant interregional differentiation. The leadership of constituent entities such as the Novgorod Region is linked to the implementation of targeted IT business support programs[11], while in the Chechen Republic, adoption is driven by the needs of key economic sectors – trade and construction. High indicators in a number of other regions are explained by the presence of large IT companies expanding interregional interaction. However, after 2022, in some regions, including the Republic of Tatarstan, growth rates have slowed or turned negative, possibly due to the

[10] Another 15 small villages in the Tomsk Region will have internet access in 2023. Available at: https://www.tvtomsk.ru/news/84182-esche-15-malyh-sel-v-tomskoj-oblasti-podkljuchat-k-internetu-v-2023-godu.html (accessed: 29.04.2025).

[11] New measures to support IT specialists are implemented in the Novgorod Region. Available at: https://mindigital.novreg.ru/medianews/news/836 (accessed: 29.04.2025).

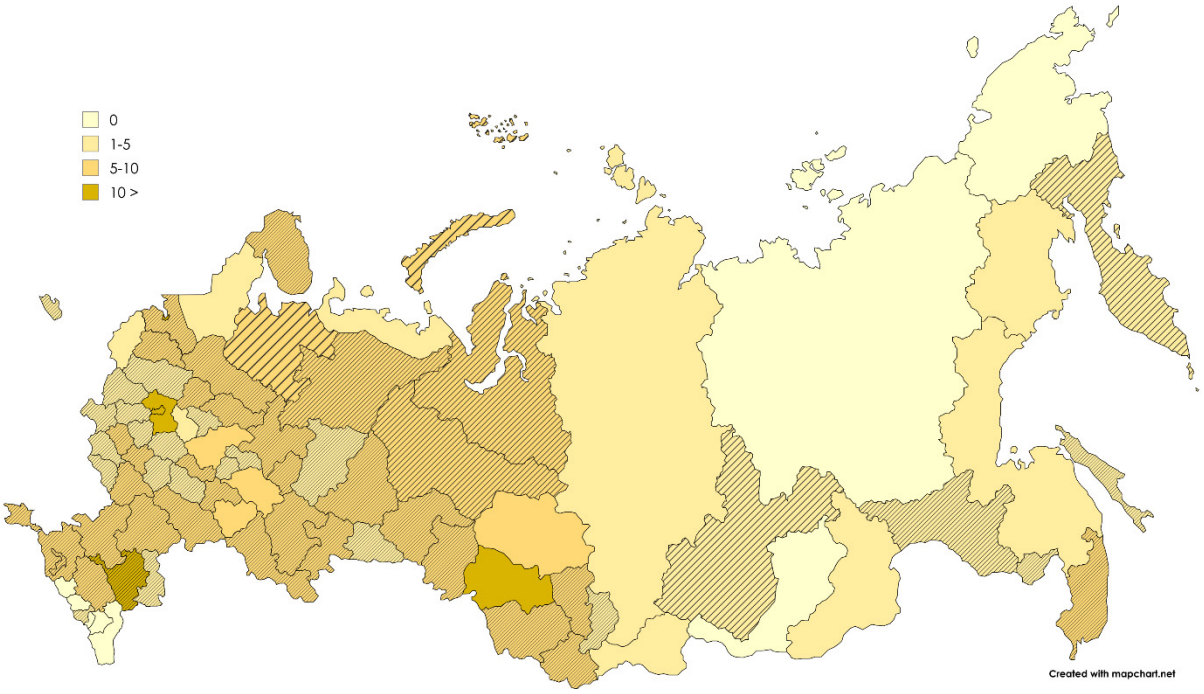

Figure 7. Share of e-commerce in retail turnover in Russian regions, 2023, %

Note: regions with growth rates above average in 2017–2023 are shaded.

Source: own compilation.

departure of international IT companies and the transition of some organizations to domestic or proprietary technological solutions during the adaptation period, which may impact the level of digital competencies in professional activity in the future.

The third level of differentiation among organizations is determined by the share of online sales in total retail turnover. At the national level in 2023, this indicator reached 8.1%, which is more than a six-fold increase from 2017 and reflects the overall trend. The Republic of Kalmykia demonstrates exceptional dynamics: its share of online sales increased several-fold in 2022–2023, correlating with the growth in the number of online stores by one-third. Traditionally high indicators are characteristic of Moscow, Moscow Region, and Saint Petersburg, where solvent consumer demand and a focus on time saving stimulate the development of online services. Expansion of e-commerce is observed eastward from these innovation clusters, accompanied by the development of regional logistics infrastructure and the launch of delivery services by local offline stores, facilitated by low initial competition. High growth rates are also noted in Far Eastern border regions, where re-export activities using foreign goods are developed. Meanwhile, low online sales values in regions adjacent to the Moscow agglomeration are explained by the availability of more competitive goods from the central cluster, limiting incentives for developing local internet platforms.

Let us define the factors shaping the digital divide for business across three levels (*Tab. 2*).

Table 2. Models of factor influence on the digital divide for business in Russian regions

Variable	Model 4		Model 5		Model 6	
	Values of coefficients	HDE	Values of coefficients	HDE	Values of coefficients	HDE
Dependent variable	Share of organizations with broadband internet		Prevalence of cloud services among organizations		Share of e-commerce in retail turnover	
const	41.0952		–11.8994		7.82935	
Econ_paym	4.33742*** (0.0026)	–				
Econ_food	–0.641560*** (0.0002)	–				
Econ_poverty	1.06756*** (0.0009)	–	–0.550377*** (<0.0001)	–	–0.77296*** (<0.0001)	–
Econ_Inequal	2.00355*** (0.0009)	–	–2.53034*** (<0.0001)	–		
Pop_urbaniz			1.00442*** (<0.0001)	+		
Pop_pension	–0.486757*** (<0.0001)	–			0.137196*** (<0.0001)	–
Empl_educ	–0.862195*** (<0.0001)	+				
Inst_ small_bus					0.022634*** (0.0002)	+
R-squared	0.454307		0.677729		0.612755	
Standard error of model	8.904748		3.112697		1.956002	
Number of observations	574		574		574	

*p < 0,1;
**p < 0,05;
***p < 0,01.
Note: p-values are in parentheses; HDE – hypothesized direction of effect.
Source: own compilation.

The analysis revealed a paradoxical positive correlation between the relative cost of internet services and their availability for organizations. Rising costs are associated with infrastructure development. Meanwhile, the greatest availability is noted in economically lagging regions, whereas in developed Russian regions the share of connected organizations declines. This may be explained by incomplete statistical data on connections for individual entrepreneurs and small enterprises, and the concentration of large internet consumers in wealthy regions.

At the second level of digital inequality, the use of cloud technologies shows an inverse relationship with regional economic well-being. A 1% increase in the share of the population with incomes below the poverty line reduces the adoption of cloud solutions by 0.55%. The main consumers of these services are large companies in developed regions, where urbanization, not education level, is the key adoption factor.

At the third level, it was established that the share of online sales positively correlates with the activity of micro and small enterprises and the presence of the elderly people as a target audience, despite the overall decrease in the use of online channels in regions with high poverty shares. E-commerce allows small enterprises to expand their sales geography and increase operational efficiency.

Let us consider the development of the digital divide across three levels for the public sector in Russian regions (*Fig. 8–10*).

The first level of digital inequality in the public sector is characterized by the share of state authorities and local government bodies provided with the data transfer speed of at least 2 Mbps. By 2023, this indicator reached 72.6%, 12.5 p.p. higher than six years before. The most significant growth was recorded in 2020, when coronavirus pandemic countermeasures catalyzed the transition of interaction between state and local authorities, as well as communication with the population, to online formats, including rapid information dissemination via social networks. This leap was possible due to accelerated digitalization, supported in part by targeted state subsidies directed to specific regions.

Analysis of digitalization processes in public administration across Russian regions reveals significant differentiation. Undisputed leaders are Moscow and Saint Petersburg, the first to actively implement IT solutions in government processes. Among other regions, the Omsk Region stands out, achieving leading positions in the share of state and municipal authorities with internet access. There, the GIS "Unified Budget Process Management System" functions successfully, and the regional Ministry of Economy is integrated into the digital platform MSP.ru (SMEs) with prospects for its use by municipalities.

The Perm Territory demonstrates active development of digital infrastructure, possessing over 200 state information systems, 62 of which are key for the region. Its municipalities digital transformation is based on regular assessments by

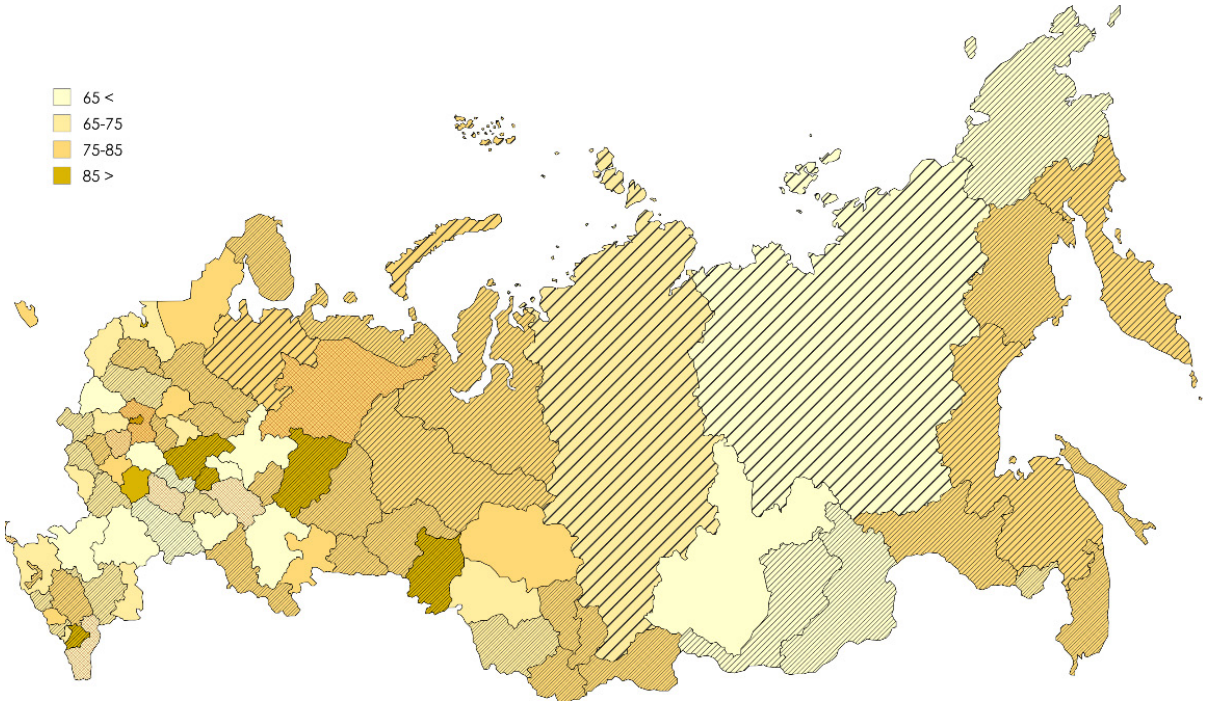

Figure 8. Share of state authorities and local government bodies with internet speed of at least 2 Mbps in Russian regions, 2023, %

Note: regions with growth rates above average in 2017–2023 are shaded.
Source: own compilation.

seven target indicators, and business digitalization is supported[12]. Significant progress is observed in the Chechen Republic, where the level of digitalization has grown due to the implementation of a republican program[13].

At the same time, in a number of regions, such as the Irkutsk, Ryazan, Volgograd, and Rostov regions, where socio-economic problems persist, digitalization is at around 60%, showing no substantial growth. The Republic of Tatarstan, a pioneer in providing the full range of 319 state and municipal services in digital form, faces the problem of high-speed internet accessibility. The most challenging situation is characteristic of the Chukotka Autonomous Area, the Penza Region, and the Republic of Buryatia, where digital technologies in the public administration system are in the early stages of development.

According to 2023 data, the national average for population engagement in interaction with authorities reached 74.6%, indicating growth of over one-third in the six-year period in the intensity of citizen interaction with state and municipal authorities via the internet. This trend is also observed across Russian regions. The highest values are reached in the Krasnodar Territory, Voronezh and Ivanovo regions, and republics of Bashkortostan and Tyva. In these regions, the "Gosuslugi" platform is actively used mainly by low-income population groups to obtain information in the

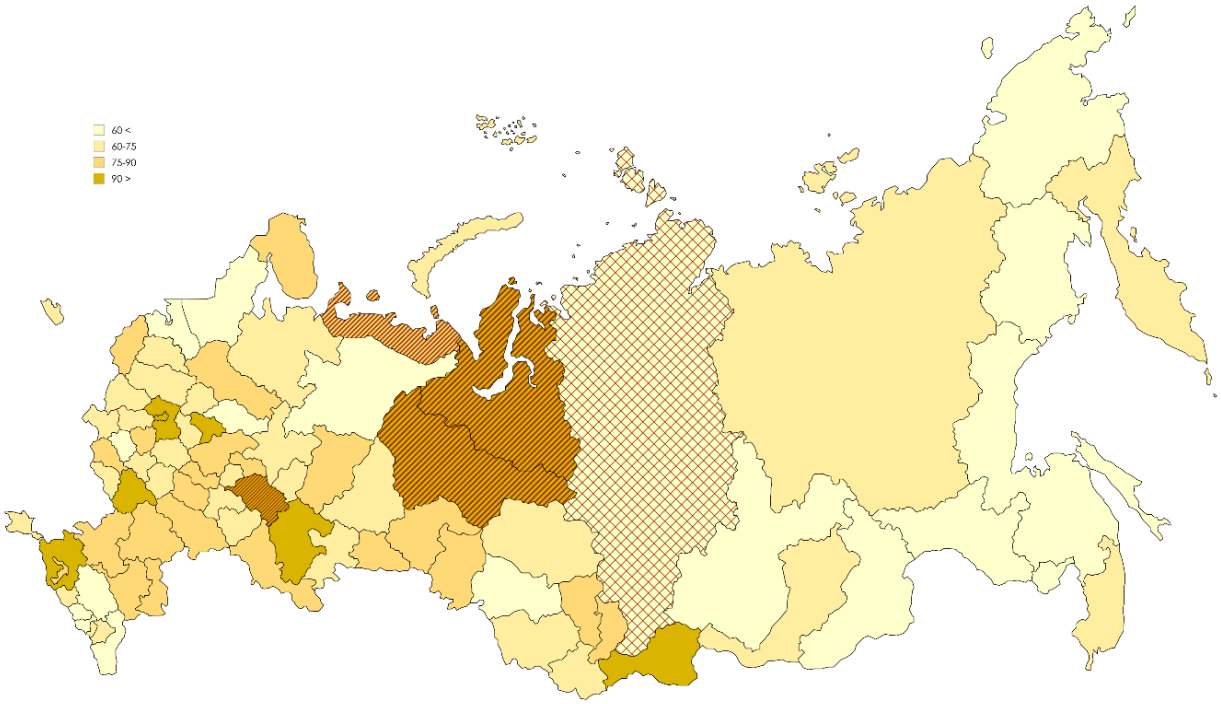

Figure 9. Population engagement in interaction with authorities in Russian regions, 2023, %

Note: regions with growth rates above average in 2017–2023 are shaded; cross-hatched regions show negative growth.
Source: own compilation.

[12] Khinshtein A. Perm Territory's progress in digitalization is significant at the federal level. Available at: https://permkrai.ru/news/aleksandr-khinshteyn-uspekhi-permskogo-kraya-po-tsifrovizatsii-znachimy-na-obshchefederalnom-urovne/ (accessed: 30.04.2025).

[13] Available at: https://mtischr.ru/index.php?option=com_content&view=article&id=%201719&Itemid=1720 (accessed: 30.04.2025).

Figure 10. Satisfaction with the quality of electronic services in Russian regions, 2023, %

Note: regions with growth rates above average in 2017–2023 are shaded; cross-hatched regions show negative growth.
Source: own compilation.

social sphere[14]. Meanwhile, the most significant lag is noted in regions of the South and Far East, where interaction with authorities is either underdeveloped or largely conducted in the traditional form of in-person visits, due to both cultural characteristics and insufficient development of civil society institutions.

The indicator of citizen satisfaction with the quality of public e-services reflects the third level of inequality in the public sector. By 2023, the share of satisfied users was 49.8%, 20% lower than 2017 values. This trend is predominant for most regions.

The greatest lag in satisfaction with the quality of public electronic services is recorded in the Pskov, Voronezh, Kaluga, Magadan, and Amur regions, as well as the republics of Altai and Mari El, where digitalization processes are implemented less intensively compared to other Russian regions. The consequence is limited availability of socially significant services, especially those in high demand in depressed regions. According to Rosstat data, in the Pskov Region, 12.1% of the population marked this reason as the main factor for refusing to use electronic public services.

An additional factor exacerbating the situation is the low socio-economic development of these regions, where elderly people predominate, preferring in-person interaction through multi-functional public services centers (MPSCs) not only for resolving administrative issues but also for satisfying the need for social communication.

[14] 98% of residents of the Ivanovo Region are registered on Gosuslugi. Available at: https://i3vestno.ru/news/2024/01/25/na_gosuslugah_est_98_zhiteley_ivanovskoy_oblastiт (accessed: 30.04.2025).

The leading group in terms of satisfaction includes the Samara and Leningrad regions, the Rostov Region, the Republic of Tatarstan, and the Kabardino-Balkarian Republic. These regions are characterized by relatively high economic development within their federal districts, contributing to the formation of a more financially secure and educated population possessing the necessary skills, opportunities, and resources to effectively use digital public services.

Let us define the influence of factors on the formation of the digital divide in the public sector (*Tab. 3*).

The econometric analysis allowed determining broadband internet accessibility for authorities, where the growth of ISP charges reduce connections by 5.89%. Socio-economic factors show multidirectional influence: improved financial well-being (increase in the share of food expenditures as a welfare indicator) increases internet accessibility for the public sector by 0.92%, while rising poverty and social inequality reduce it by 1.4 and 2.94% respectively. The educational level of the population positively correlates with digital infrastructure development (increase of 0.7%), and the presence of the informal sector stimulates public administration digitalization by 0.63% for enhanced control purposes. Electronic interaction between citizens and authorities intensifies with lower internet costs (increase of 6.11%) and rises in regions with significant shares of elderly (0.45%) and female populations

Table 3. Models of factor influence on the digital divide in Russian regions for the public sector

Variable	Model 7		Model 8		Model 9	
	Values of coefficients	HDE	Values of coefficients	HDE	Values of coefficients	HDE
Dependent variable	Share of state and local authorities with internet speed of at least 2 Mbps		Population engagement in interaction with authorities		Satisfaction with quality of electronic services	
const	140.919		183.443		–92.9155	
Econ_paym	–5.89839*** (0.0002)	–	–6.11085*** (<0.0001)	–		
Econ_food	0.921734*** (<0.0001)	–			–0.84133*** (0.0017)	–
Econ_poverty	–1.40137*** (<0.0001)	–	–4.18377*** (<0.0001)	–	6.27475*** (<0.0001)	–
Econ_Inequal	–2.94431*** (<0.0001)	–	–1.95192*** (0.0007)	–	2.87417*** (0.0021)	–
Pop_women			0.0157516*** (0.0083)	–		
Pop_pension			0.449120*** (<0.0001)	–	–0.4633*** (0.0010)	–
Empl_educ	0.707953*** (0.0020)	+				
Inst_inform	0.624537*** (0.0024)	–				
R-squared	0.537785		0.782276		0.577240	
Standard error of model	9.832942		9.368695		14.08579	
Number of observations	574		574		574	

*p < 0.1;
**p < 0.05;
***p < 0.01.
Note: p-values are in parentheses; HDE – hypothesized direction of effect.
Source: own compilation.

(0.02%), but decreases with rising poverty (-4.18%) and inequality (-1.95%). Satisfaction with digital public services decreases with higher expenditures on basic needs (-0.84%) and in the older age group (-0.46%), but increases in depressed regions with high poverty (+6.27%) and social segregation (+2.87%), which is explained by the population's adapted expectations.

The conducted research revealed persistent spatial differentiation of Russian regions by levels of digitalization. The key problem is three-tiered inequality, manifested in internet access, its use, and derived advantages. Despite high average household internet access rates (87.3%), significant lag persists in depressed and rural regions, due to infrastructure limitations and low demand. In the business environment, a paradoxical situation is recorded: a decline in formal access to 72.9% in the context of growing cloud service use (26.7%), indicating a structural transformation of digital practices.

The most acute problem in the public sector is the decline in satisfaction with the quality of electronic services to 49.8%, explained by the non-simultaneous technological and social adaptation, especially in regions with a predominant elderly population. Spatial analysis confirms the poor innovation diffusion from digitalization centers to peripheral regions, forming persistent clusters of the digital lag.

All three levels of digital inequality in the household, business, and public sectors are determined by economic conditions, particularly the share of the population with incomes below the poverty line, but the impact of these factors is sector-specific. For households, key constraints are the high relative cost of internet services and low incomes, while the elderly and women turned out to be active users due to needs for communication, online shopping, and solving everyday tasks. In the business sector, the prevalence of digital technologies is positively linked to urbanization and small business development, though in less developed regions limitations arise from high connection costs and low purchasing power of demand. The public sector demonstrates dependence on budgetary constraints and regional economic well-being, while satisfaction with electronic services is higher among low-income groups, likely due to lowered expectations, whereas elderly citizens more often expressed dissatisfaction, stemming from a deficit of digital competencies.

Conclusions

Based on the conducted econometric analysis of the determinants of digital inequality in Russian regions for households, business, and the public sector, some conclusions and policy recommendations can be formulated. The study confirms the persistent and multidimensional nature of digital inequality in Russian regions, which persists across three interconnected levels: access to infrastructure, quality of use, and the ability to derive benefits. A key systemic conclusion is the dominant role of economic factors, particularly population income levels and the relative cost of internet services, which significantly negatively impact all sectors and levels of digitalization. This indicates that measures focused solely on infrastructure development, without considering purchasing power and the overall economic well-being of territories, have limited effectiveness. State digitalization policy should be comprehensive, integrating with regional socio-economic development programs.

For the household sector, the priority is reducing financial barriers to access. The strong negative relationship between internet cost and its prevalence necessitates mechanisms for charges regulation or targeted subsidies for low-income groups and residents of remote territories. Simultaneously, it is important to develop digital literacy programs focused not only on basic skills but also on the effective use of online services for solving daily tasks, employment, and entrepreneurship. The identified

high digital activity of the elderly and women should be considered in inclusion programs, transforming from a forced compensation for offline deficits into a tool for improving quality of life.

In the business environment, policy should be sharply differentiated depending on company size and region. For micro and small enterprises, which are drivers of e-commerce, support is needed in the form of consulting services, preferential access to digital platforms, and support for solving logistics issues, especially in regions lagging in online sales share. For large businesses and organizations, where paradoxical statistics show declining formal connectivity alongside growing cloud service use, it is important to improve statistical accounting methodologies to adequately reflect real digital practices. A common priority is stimulating the adoption of cloud technologies and digital solutions in regions with low economic development through special investment programs and the creation of IT infrastructure hubs.

Digitalization of the public sector requires a shift from quantitative coverage indicators to service quality and user satisfaction. The critical decline in citizen satisfaction with electronic public services signals a gap between the technical possibility of providing a service and its real value to the user. Deep user adaptation of interfaces, simplification of procedures, and provision of technical support are needed, especially for elderly citizens. The positive link between satisfaction and poverty levels in regions reflects an effect of low expectations, which is an unsustainable basis for assessment. Therefore, the focus should shift toward improving the objective quality, speed, and transparency of services. Simultaneously, it is important to continue eliminating infrastructure gaps in providing high-speed internet to government bodies, especially at the municipal level.

A crucial strategic conclusion is the confirmation of poor spatial diffusion of digital innovations from leading central regions to the periphery. Accordingly, persistent clusters of digital lag are formed and this requires targeted leveling policies, including the creation of regional digital competence centers, development of interregional IT partnerships, and implementation of infrastructure projects focused on territorial connectivity. Thus, overcoming digital inequality in Russia should become not a separate technological direction but a key element of comprehensive regional policy aimed at reducing socio-economic disparities and creating conditions for the inclusive development of all Russian territories.

Debate on the results

The results obtained in the study are representative and statistically significant but allow for alternative interpretations and reveal several debatable points. For example, the positive relationship between the share of the elderly and the level of daily internet use and the prevalence of online shopping may not be an indicator of successful digital inclusion so much as a reflection of structural imbalances in regional development. High internet activity in depressed and remote regions may signal not the overcoming but the reproduction of digital inequality, where the digital environment becomes a forced substitute for inaccessible offline services and does not necessarily translate into improved quality of life or digital capital.

The identified positive correlation between the cost of internet services and their availability for organizations contradicts basic postulates of economic theory and requires cautious interpretation. This result may be due to imperfect accounting of connection channels (use of employees' personal accounts) in developed regions, where actual business digitalization outpaces formal statistics. Consequently, the observed "decline" in access may reflect not a real regression but a shift in technological consumption models.

Debatable is also the conclusion about increased satisfaction with the quality of electronic public services in regions with a high share of poor

population. While this may be explained by adapted expectations, it cannot be ruled out that this effect is temporary and related to the initial positive perception of the very possibility of remote access to services. In the long term, as population demands grow and services become more complex, satisfaction may decline if formal service provision is not followed by a real increase in their quality, transparency, and convenience.

We believe that the conducted analysis, focusing on quantifiable determinants, has further development prospects for including qualitative aspects of the digital divide, such as user motivation, cultural barriers, and subjective perception of technologies. Further research requires the integration of mixed methods for a deeper understanding of the causal mechanisms behind the identified statistical patterns.

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