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Modeling the Development of E-Commerce in Russia in the Context of Regional Inequality and Digital Transformation

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Abstract: The article examines the development of e-commerce in Russia in the context of regional inequality and digital transformation. It analyzes current market trends, the characteristics of e-commerce distribution in different regions of the country, and the impact of income inequality and internet access on the industry's dynamics. Particular attention is paid to the role of artificial intelligence in stimulating the growth of e-commerce. A comparative analysis of the Russian and global e-commerce markets is conducted. To assess the impact of socio-economic and digital factors on e-commerce volumes, regression models are constructed to forecast the further development of the industry, taking into account regional differences.

1 INTRODUCTION

At present, it is impossible to imagine modern society without information technology. Information and communication technologies (ICT) and artificial intelligence (AI) are being implemented and used in virtually all areas of human life. In the context of active informatization and the widespread use of the Internet, sectors such as education, healthcare, trade, and many others have received a major boost to their development. E-commerce, as one of the most important types of economic relations, is currently a very widespread and popular type of economic activity. Thanks to ever-new digital technologies and the Internet, it is developing and growing in volume. However, it should be noted that access to and use of ICTs is not the same everywhere, which gives rise to the phenomenon of digital inequality, which poses a serious problem for the information society at both the national and international levels.

The Organization for Economic Cooperation and Development (OECD) provides the following definition of this term. Digital inequality is the gap between individuals, households, businesses, and geographic areas at different socioeconomic levels in terms of their ability to access information and communication technologies (ICT) and the Internet (OECD, 2001).

While digital inequality was initially viewed solely as inequality in access to ICT, it has since become the subject of interdisciplinary research (Revenko & Revenko, 2022). Some researchers have concluded that, in addition to differences in access to technology, the digital divide includes forms of inequality such as social, cultural, economic, and others. Later, researchers confirmed the assumption that digital inequality is not static. It is constantly changing under the influence of various socio-economic and social processes. For example, such as the spread of the Internet in different regions of the world, the growth of e-commerce, the level of education and digital literacy in different countries, etc. (Vartanova & Gladkova, 2021). Thus, it is impossible to identify a single cause of digital inequality. It is influenced by a huge number of factors that must be constantly analyzed and evaluated in order to develop measures to reduce the level of digital inequality (Revinova & Kaisarova, 2022). The digital divide is becoming a key obstacle for developing countries. It leads to income inequality, which in turn leads to polarization of the population within and between countries. It is worth noting that digital inequality can manifest itself both between different regions of the world and countries,

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as well as between regions or districts within a single country (Ledneva, 2021).

Nevertheless, the growth in e-commerce has been widespread in recent years. This is influenced by many factors: increased digital literacy and user loyalty, improvements in digital technologies, and the emergence of new convenient services. The development of e-commerce is also closely linked to income inequality (Ma & Komatsu, 2024). E-commerce contributes to national development by creating jobs and generating import duties. However, developing countries are lagging behind in adopting e-commerce due to problems with the Internet, trust, and security issues regarding online payments (Hendricks & Mwapwele, 2023).

At the present stage, the use of artificial intelligence is having an increasing impact on the growth of e-commerce. Artificial intelligence technologies are used to improve work in the following areas: in working with users (smart prompts, smart search, etc.); in the work of logistics centers for supply chain management; for effective pricing and merchandising, etc. Most researchers agree that artificial intelligence has a positive impact on consumer purchasing behavior, and the integration of artificial intelligence increases consumers' intention to make a purchase (Bhagat et al., 2022). For the vast majority of consumers, the ease of use and usefulness of intelligent customer service are very high, and they can greatly facilitate purchasing and contribute to consumer behavior (Xue, 2023). Artificial intelligence helps companies gain insight into customer needs very quickly and efficiently, which increases their sales and revenues (Khatri, 2021). Artificial intelligence technologies can provide important and direct benefits to consumers through better quality and more accessible information (Abrardi et al., 2021). For e-commerce companies, AI is very beneficial, and it is in their interest to attract as many users as possible to the process (Ratner et al., 2025).

This paper presents an attempt to model the further development of e-commerce in Russia.

2 MATERIALS AND METHODS

The study uses materials from scientific articles and official data from Rosstat, the Association of Internet Trading Companies (AKIT), Data Insight, as well as publicly available international comparative studies on e-commerce for 2010–2023.

Regression analysis was used as the main method to identify the impact of socio-economic and digital inequality on the development of e-commerce in Russia and to substantiate forecasts for the further growth of the industry, taking into account regional differences and the introduction of new technologies, including artificial intelligence. As a result, econometric models were constructed to identify the impact of key factors (income level, share of Internet users, digital infrastructure) on e-commerce volumes in Russia as a whole and by region. The total volume of e-commerce and per capita volume were considered as dependent variables; average monthly wages, average per capita income, and the share of the population using the Internet daily were considered as independent variables. A comparative analysis method was also used to identify differences between Russian regions in terms of ICT penetration, income, and e-commerce volumes. Maps and rankings of regions were constructed based on key metrics, and indicators of e-commerce development in Russia, China, the US, and other leading countries were compared.3 Results and discussion

E-commerce in Russia is growing rapidly, although it still lags behind the leading countries by a considerable margin (Table 1).

Table 1: Comparison of e-commerce markets by country, 2023.

Country	Internet penetration rate, %	E-commerce share of GDP, %	B2C e-commerce volume, billion dollars	GDP per capita, thousand dollars	B2C e-commerce volume per capita, dollars
China	76	17,1	3020	13,2	2119
United States	92	6,6	1160	83,1	3463
United Kingdom	97	5,9	196	52,4	2925
Japan	83	4,6	193	34,6	1556
South Korea	97	8,6	147	34,7	2827
India	46	3,2	119	2,9	83
Germany	92	2,2	97	54	1155
Russia	90	4,6	92	13,7	639
France	85	2,6	79	48,2	1162

Source: compiled by the authors, (Data Insight, 2024).

Based on data for 2023, Russia has a fairly high internet penetration rate (90%), but its B2C e-commerce volume is small compared to the other countries under consideration – $92 billion, which is only 4.6% of its GDP. The volume of e-commerce per capita is also small – $639. China has the highest e-

commerce volume ($3.02 trillion). At the same time, the country does not have the highest Internet penetration rate (76%) and has a fairly low GDP per capita (US$13,200). It can be said that the high e-commerce volume in China is due to its large population (1.425 billion people). The US has the highest per capita e-commerce volume at $3,463. It is also worth noting that China and the US are home to the most famous e-commerce platforms today, such as Alibaba and Amazon.

Speaking of the Russian e-commerce market, it is worth noting that Russia is one of the leaders in terms of sales growth in this sector in 2023. The country's growth was 36% (Fig. 1).

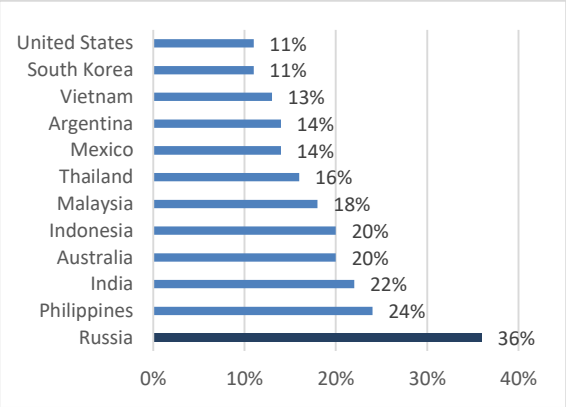

Figure 1: Top countries by growth in online retail sales in 2023, %.

Source: compiled by the authors, (Data Insight, 2024).

In 2023, for the first time, two of the largest universal Russian marketplaces, Wildberries and Ozon, entered the top 10 most popular marketplaces in the world in terms of number of visits (Data Insight, 2024).

When talking about the global e-commerce market, it is important to remember the existence of digital inequality. Online sales volumes, number of orders, average check, and other e-commerce indicators vary for each country depending on its level of development, ICT infrastructure, internet accessibility, digital literacy of the population, etc.

The volume of Russian e-commerce in 2023 amounted to 6,359 billion rubles, in 2022 – 4,986 billion rubles, and in 2021 – 3,921 billion rubles (Fig. 2). These figures clearly reflect the trend of gradual growth in e-commerce in the country (Sviridova, 2023).

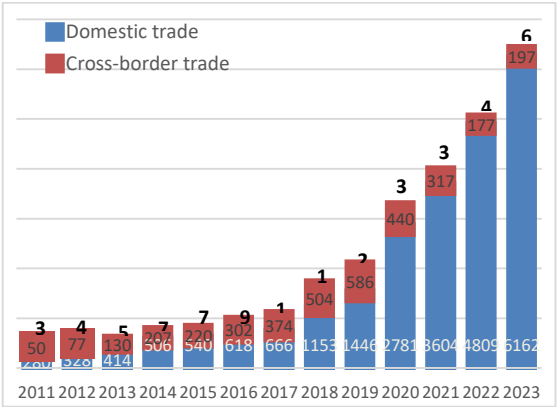

Figure 2: Russian e-commerce market, billion rubles. Source: compiled by the authors, (AKIT, 2024).

The number of orders placed in online stores is also constantly growing. In 2023, Russian e-commerce customers placed 5,150 orders, which is 80% more than in the previous year (2,860 orders). At the same time, there has been a decrease in the average check. In 2023, the average check for the market as a whole was 1,520 rubles, which is 18% less than in the previous year (1,850 rubles) (Data Insight, 2024). There are a few reasons for this. First, the economic situation in the country has changed, making some consumers more careful with their spending. Second, competition has increased. As competition in the market grows, new players appear, offering more affordable goods, which increases the share of inexpensive goods and can lead to a decrease in the average check.

Changes in the average check and the number of orders are closely related. Russia is characterized by a gradual increase in the number of orders and a decrease in the average check. It can be assumed that these trends are related to changes in consumer behavior and a smooth transition to small purchases. Thus, modern consumers may prefer to make more frequent but smaller purchases because the purchasing process is much faster in this case, and the fact that online stores are available 24/7 makes online shopping as convenient as possible. The growth of mobile commerce also encourages users to make quick and small purchases. Another explanation may be the growing popularity of subscription services offered by stores to their customers. This may lead to a decrease in the average check per transaction, but an increase in the number of transactions.

If we delve deeper into the analysis of the e-commerce market in Russia, we can safely say that marketplaces occupy the leading positions in the market. They account for 57.1% of the entire domestic market, while classic online stores account

for only about 10% (AKIT, 2025). This fact can be explained by the fact that universal, cross-functional marketplaces are more convenient for consumers, as their assortment includes goods from various categories, groups, and brands. The Wildberries and Ozon marketplaces occupy the largest market shares (35% and 31%, respectively).

It should be noted that e-commerce may develop differently in various regions of the Russian Federation due to their individual characteristics.

The Russian Federation is a country that includes eight federal districts and 89 constituent entities, whose indicators in various spheres of life can differ significantly from one another. This is explained by the location of Russian regions, differences in population size, industry specialization, level of infrastructure development, etc. The same is true for indicators related to information and communication technologies (Shkiotov & Markin, 2022).

The development of e-commerce requires infrastructure: personal computers, Internet access, and high-quality communications.

Overall, in 2023, all federal districts of the Russian Federation (FD) have fairly high indicators (Table 2).

Table 2: Comparison of Russian federal districts by household ICT availability, %, 2020–2023.

	Percentage of households (%) with								
	personal computer			Internet access			broadband Internet access		
	2020	2022	2023	2020	2022	2023	2020	2022	2023
Russian Federation	72,1	73	71,2	80	86,6	87,9	77	85,5	87,3
Central Federal District	76,2	78,7	75,9	81,7	87,9	88,5	79,6	87	88
Northwestern Federal District	77,7	76,1	74,6	81,3	84,2	85,7	79,3	83,5	84,8
Southern Federal District	72,4	74	74,8	80	88	90,6	76,6	86,9	89,4
North Caucasus Federal District	63,5	64	63,7	82,4	89,7	89,5	75,8	87,7	88,5
Volga Federal District	69,4	70,2	68	77,7	85,1	87,5	75,1	83,7	86,9
Ural Federal District	72,7	72,6	71,1	80,8	86,7	89	78,3	86,1	88,8
Siberian Federal District	67,3	66,8	65,8	77,4	84,8	85,1	72,8	84,3	84,5
Far Eastern Federal District	67,3	69,8	66	81,3	88,1	88,6	75,7	85,7	88,3

Source: compiled by the authors, (Rosstat, 2025).

Figure 3 shows a heat map of the proportion of households with Internet access by region in Russia, based on data for 2023. All constituent entities of the Russian Federation were divided into four groups depending on the values of the indicator in question. Regions with a lower percentage of households with Internet access are highlighted in lighter colors on the map. It can be said that most regions of the Russian Federation are fairly well provided with Internet access and there are no significant fluctuations between the values of the indicator, which indicates a high level of ICT provision across the country as a whole.

Figure 3: Heat map of the share of households with Internet access by region in Russia, %, 2023. Source: compiled by the authors, (Rosstat, 2025).

According to Rosstat data, the leading positions in terms of the share of the population using the Internet

in 2023 were occupied by the Chukotka Autonomous Okrug (99.7%), the Yamalo-Nenets Autonomous Okrug (99.5%), the city of Moscow (99.3%), Khanty-Mansi Autonomous Okrug (99.1%), and the Republic of Tatarstan (99.1%). The regions with the lowest indicators include Oryol Oblast (82.5%), Kirov Oblast (86.7%), Novgorod Oblast (87%), Chuvash Republic (87.3%), and Jewish Autonomous Region (87.6%) (Rosstat. 2025). At the regional level, the differences are not very noticeable, as they are smoothed out by the varying population sizes in the regions.

In terms of the number of active mobile broadband Internet subscribers per 100 people, the top five regions are: Saint Petersburg (including data for the Leningrad Region) – 145.4 people; Yamalo-Nenets Autonomous Okrug – 143 people; Moscow (including data for the Moscow Region) – 142.5 people; Nizhny Novgorod Region – 139.7 people; Khabarovsk Krai – 139.6 people. The regions lagging behind are: Sevastopol – 1.2 people; Republic of Adygea – 53.8 people; Republic of Ingushetia – 57.2 people; Republic of Dagestan – 62.6 people; and Republic of Tyva – 66.8 people.

When considering indicators at a lower level (not in general by region, but by region per 100 people), the difference in the values of digital development and ICT availability indicators becomes much more noticeable.

Thus, all regions of the Russian Federation are subject to digitalization, and the indicators of ICT accessibility and availability are improving (Abdrakhmanova et al., 2023). However, differences still exist, and since the spread of e-commerce depends on the level of digitalization, these differences also affect the volume of e-commerce in the regions.

E-commerce is spreading unevenly across the regions of the Russian Federation. The largest share (17.7%) and volume of e-commerce (1,123 billion rubles) is accounted for by the country's capital, Moscow, which has traditionally topped the list of regions for several years. It is followed by the Moscow Region with a share of 9.2% and a volume of approximately 585.5 billion rubles, and St. Petersburg (6.1% and 387.8 billion rubles). Further down the ranking are regions such as Krasnodar Krai (5.3%), Rostov Oblast (3%), Sverdlovsk Oblast (2.6%), Nizhny Novgorod Oblast (2.2%), Samara Oblast (2%), the Republic of Tatarstan (1.9%), and Krasnoyarsk Krai (1.8%). There is a noticeable difference between the leading regions and the rest, which can largely be explained by the large population and higher income levels in Moscow, St. Petersburg, and the Moscow Region. The lagging regions include the Chukotka Autonomous Okrug, the Yamalo-Nenets Autonomous Okrug, the Jewish Autonomous Region, the Republic of Tyva, the Republic of Altai, and some regions of the North Caucasus Federal District. This lag in e-commerce volumes for the above-mentioned regions can be explained by the complexity of delivering goods due to their remote location or lower incomes of the population.

Rosstat data on the share of online sales in the total retail trade turnover by federal districts of the Russian Federation, presented in Table 3, also confirm the lag of regions belonging to the North Caucasus Federal District and the Far Eastern Federal District. An analysis of the dynamics of this indicator shows an annual increase in the share of online sales, characteristic of all federal districts, which is associated with the growing role of the Internet in trade and the constant development and active introduction of information and communication technologies into people's lives.

It is important to note that there are quite significant differences in the volume of e-commerce both at the level of the federal districts of the Russian Federation and at the level of individual constituent entities of Russia, which create regional inequality in this area.

Table 3: Share of online sales in total retail trade turnover by federal district, %, 2021–2023.

	2021	**2022**	**2023**
Russian Federation	5,1	6,0	8,1
Central Federal District	7,0	7,9	10,7
Northwestern Federal District	6,0	8,7	12,3
Southern Federal District	4,9	5,2	6,3
North Caucasus Federal District	0,9	1,3	1,9
Volga Federal District	3,5	4,5	6,0
Ural Federal District	4,8	6,2	8,1
Siberian Federal District	4,0	5,1	6,4
Far Eastern Federal District	1,6	1,8	3,6

Source: compiled by the authors, (Rosstat, 2025).

As for the indicator of e-commerce volume per capita, shown in Figure 4, no representative of the North Caucasus and Far Eastern Federal Districts is a leader here either. The top 10 regions of the Russian Federation in terms of e-commerce volume per capita in 2023 is led by St. Petersburg with an indicator of almost 86,000 rubles. In 2022, it surpassed the

absolute leader, the Russian capital, for the first time, which ranked only third in 2023 (78,136 rubles). This phenomenon may be due to the constantly growing population in Moscow, which reduces the per capita indicator accordingly. The Republic of Kalmykia, which had rather low indicators until 2023, took second place among the leaders. The significant jump in the indicator was due, firstly, to the historically low population and, secondly, to the opening of a large number of online stores in the region, which was stimulated by low taxes and subsidies from local authorities. The number of online stores in Kalmykia tripled in 2023 (Shoppers.media, 2024).

Thus, the volume of e-commerce per capita in this region amounted to just over 82,000 rubles. Next, with a fairly significant lag behind the top three, comes the Moscow Region (almost 47,000 rubles), followed by the Sverdlovsk Region, Novosibirsk Region, Murmansk Region, Arkhangelsk Region, Rostov Region, and the Republic of Tatarstan, whose indicators are approximately at the level of 25,000–30,000 rubles. Many of these regions are regional centers with developed infrastructure, logistics, a large number of warehouses, and a fairly high level of average per capita income within their federal districts.

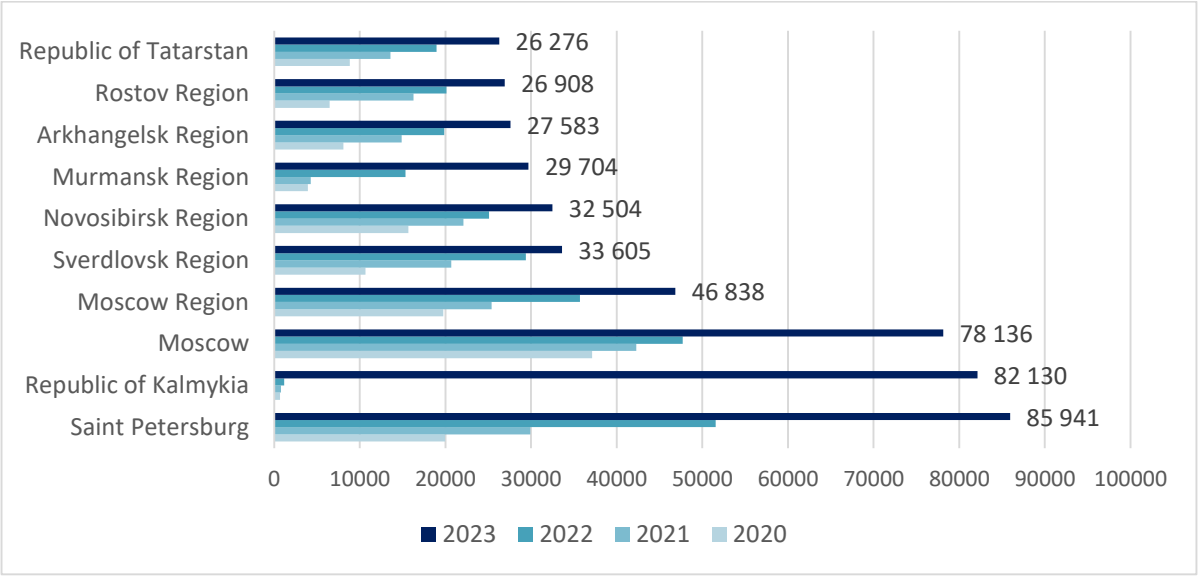

Figure 4: Top 10 Russian regions by e-commerce volume per capita, rubles, 2020–2023. Source: compiled by the authors, (Rosstat, 2025).

Nevertheless, the dynamics of various indicators confirm the main trend, which is the multidirectional development of Russian regions in the e-commerce market. For example, the Republic of Tatarstan, Rostov Region, Nizhny Novgorod Region, Chelyabinsk Region, and Krasnodar Krai showed the largest absolute increase in the share of online orders. The development of regions in this area is due to the development of infrastructure, migration processes, and the redistribution of cash flows in favor of regions with intensive industrial and agricultural production. The prospects for active development of e-commerce are characteristic of those regions in which there is a parallel increase in the share of online orders and economic activity. As can be seen from the data in Table 4, the shares of the three largest regions (Moscow, Moscow Region, and St. Petersburg) are rapidly declining, while the shares of other regions are growing. However, despite the decline in their share of the total volume, the absolute number of online orders in Moscow, the Moscow Region, and St. Petersburg continues to grow, and these regions remain the leaders.

Table 4: Top 10 regions with the largest shares in the structure of online order delivery, 2021–2023.

Region	Share of total online orders (in %) in 2021	Share of total online orders (in %) in 2022	Share of total online orders (in %) in 2023
Moscow	25,45%	19,56%	17,63%
Moscow Region	10,93%	10,72%	9,50%
Saint Petersburg	10,93%	9,22%	7,65%

Krasnodar Krai	3,91%	4,32%	4,40%
Rostov Region	2,29%	2,71%	2,85%
Sverdlovsk Region	2,78%	3,19%	2,85%
Republic of Tatarstan	1,93%	2,17%	2,56%
Nizhny Novgorod Region	1,86%	2,61%	2,37%
Samara Region	1,97%	2,25%	2,28%
Chelyabinsk Region	1,68%	2,11%	2,24%

Source: compiled by the authors, (Data Insight, 2024).

Thus, it can be concluded that the main features of e-commerce for Russian regions are significant differences in total e-commerce volumes and e-commerce volumes per capita between regions, due to their socio-economic inequality, as well as the growth in the share of regions that makes them attractive for the development of e-commerce.

As mentioned earlier, Russian regions are facing the problem of inequality in the field of e-commerce: the difference in e-commerce volumes between the leading regions (Moscow, St. Petersburg, Moscow Region, etc.) and the lagging regions is very significant, which negatively affects the lives of the population, since this type of trade has recently increased its role in this area and, one might say, has become indispensable. , etc.) and lagging regions is very significant, which negatively affects the lives of the population, since this type of trade has recently increased its role in this sphere and, one might say, has become commonplace, which should be accessible to everyone.

The main reasons for this problem may be:

1) Differences in the level of income of the population. Since the purchasing power of the population directly depends on the funds it has at its disposal, this factor is of paramount importance for the trade sector as a whole. Low incomes in a number of regions force residents to give preference to essential goods and refuse to purchase more expensive ones. This is typical for regions with low wages or high unemployment rates. However, the correlation between higher per capita income and higher e-commerce volumes does not apply to all regions of the Russian Federation. The Yamalo-Nenets Autonomous Okrug, Nenets Autonomous Okrug, Magadan Oblast, Sakhalin Oblast, and Kamchatka Krai stand out significantly. In these regions, the average per capita income is high (80,000–140,000 rubles), but the volume of e-commerce per capita is very low. This is because e-commerce volumes are influenced by a large number of factors other than population income. In this case, factors such as the location of the region, infrastructure, and logistics issues play an important role.

Moscow, St. Petersburg, and the Republic of Kalmykia also stand out. However, while the relationship between the indicators under consideration is still characteristic of the two aforementioned cities of federal significance, and they stand out only because of their high values, the situation is different for the Republic of Kalmykia. Here, low average per capita incomes are accompanied by high indicators of e-commerce per capita. It can be assumed that this situation is explained by the low population density in the region, low taxes, and subsidies from local authorities.

2) Differences in logistics infrastructure. E-commerce logistics in Russia is a complex and rapidly developing system that plays a key role in the field of e-commerce (Raj et al., 2023). It covers all stages: from storing goods in a warehouse to delivering them to the buyer. The key players in the logistics market are delivery services (Russian Post, SDEK, DPD, Boxberry), logistics companies (PEK, Delovye Linii), transport companies that transport goods between cities and regions, and the logistics networks of large marketplaces (Wildberries, Ozon, Yandex.Market).

Russian regions face the following problems: first, increased costs and delivery times to remote regions due to the country's large territory and uneven population distribution. Second, the underdevelopment of transport infrastructure in some regions also complicates delivery and causes delays. Another problem is seasonal factors that complicate the delivery process. It is also worth paying attention to the specifics of warehouse logistics. For example, according to data for 2023, the largest Russian marketplaces, Wildberries and Ozon, own 2.16 million square meters and 1.32 million square meters in the regions and 756,000 square meters and 1.12 million square meters in Moscow, respectively (Logistics of Internet Trade in Russia in 2023. Opinions and Expectations, 2025). The next important aspect of logistics infrastructure is the delivery of goods directly to the consumer. Recently, consumers have been receiving almost 80% of goods through order pickup points (OPPs) by self-delivery. The success of marketplaces is largely due to the convenience of this delivery model for consumers. Nevertheless, 2023 saw a revival of courier delivery. This is explained by the emergence and development of so-called “last mile” delivery, carried out using

couriers on bicycles, electric bicycles, cars, and other types of transport (Table 5).

Table 5: Relative shares of courier delivery and pickup at parcel terminals in Russia, 2021, 2023.

Region	Share of courier deliveries, 2021	Share of deliveries via pickup points and parcel lockers, 2021	Share of courier deliveries, 2023	Share of deliveries via pickup points and parcel lockers, 2023
Moscow	36,63%	63,37%	44,48%	55,52%
Moscow Region	21,22%	78,78%	24,28%	75,72%
Saint Petersburg	24,54%	75,46%	31,04%	68,96%
Krasnodar Krai	20,37%	79,63%	23,53%	76,47%
Rostov Region	16,34%	83,66%	19,41%	80,59%
Sverdlovsk Region	13,83%	86,17%	21,67%	78,33%
Republic of Tatarstan	19,92%	80,08%	28,80%	71,20%
Nizhny Novgorod Region	17,12%	82,88%	20,06%	79,94%
Samara Region	15,38%	84,62%	25,23%	74,77%
Chelyabinsk Region	15,09%	84,91%	25,79%	74,21%

Source: compiled by the authors, (Data Insight, 2024).

Top 5 regions in terms of the prevalence of deliveries via pickup points in 2023: Murmansk Region – 85.41%; Jewish Autonomous Region – 84.21%; Novgorod Region – 84.17%; Arkhangelsk Region – 84.00%; Republic of Mari El – 83.60%. These regions have relatively small populations and low average incomes, so PVZs are chosen as a more economical delivery option.

Top 5 regions by prevalence of courier delivery in 2023: Republic of Ingushetia – 58.75%; Chechen Republic – 52.20%; Moscow – 44.48%; Republic of Tyva – 38.31%; Republic of Buryatia – 38.16%. Here we can see two groups: Moscow, with its high income, developed infrastructure, and fast pace of life, and the other regions, with their lack of infrastructure (not enough pickup points, or existing pickup points unable to cope with demand).

3) Differences in digital infrastructure. In remote and rural regions, access to high-speed internet is still limited, which hinders the development of e-commerce in these areas. In addition, insufficient network coverage and higher tariffs create barriers to participation in e-commerce for both buyers and sellers.

This also includes differences in the level of digital literacy among the population. Low digital literacy is characteristic of regions where rural areas predominate, where residents have a low level of education, or where the older generation predominates, who find it more difficult to adapt to rapidly changing conditions and may therefore experience difficulties in making online purchases.

4) Differences in local government support for business development. In regions with a less favorable business climate and insufficient support for small and medium-sized businesses, there are fewer entrepreneurs willing to develop online commerce.

All these factors influence the level of development of regions in the field of e-commerce. Eliminating regional inequality in this area is an important task for the state, business, and consumers.

Regression models were constructed to analyze and forecast e-commerce volumes in Russia in the context of digital inequality. The dependent variables considered were: the total volume of e-commerce in the Russian Federation (billion rubles, 2010–2023) and the volume of e-commerce per capita by region (rubles/person, 2016–2023).

The key factors used were: average monthly nominal accrued wages (for the whole of the Russian Federation) and average per capita cash income and the share of the population using the Internet daily (for regional analysis).

The results of the model constructed for Russia as a whole (Model 1) are as follows.

The correlation coefficient between the volume of e-commerce and the average monthly wage was 0.9727, which indicates a direct and close relationship between these indicators. For the constructed power model, the coefficient of determination $R^2 = 0.9942$, which indicates the high quality of the approximation and the predictive power of the model. Key metrics: RSS = 0.0816; SE = 0.0861; MSE = 0.0058; RMSE = 0.0764; MAPE = 0.93% (within 10–15% — the forecast is considered accurate); Theil's U1 = 0.0053 (close to 0 — high accuracy), Theil's U2 = 0.2807 (better than a naive forecast). All model coefficients are statistically significant ($p < 0.01$).

Final equation:

$$\ln(Y^) = 18.557 + 2.419 * \ln(X) + 0.289 * d,$$

where X is the average monthly salary, d is a dummy variable (0 for 2010–2019, 1 for 2020–2023).

The model's forecast for 2024–2027 shows that the growth trend in e-commerce volumes will continue, with minimal deviations from actual values (Fig. 5).

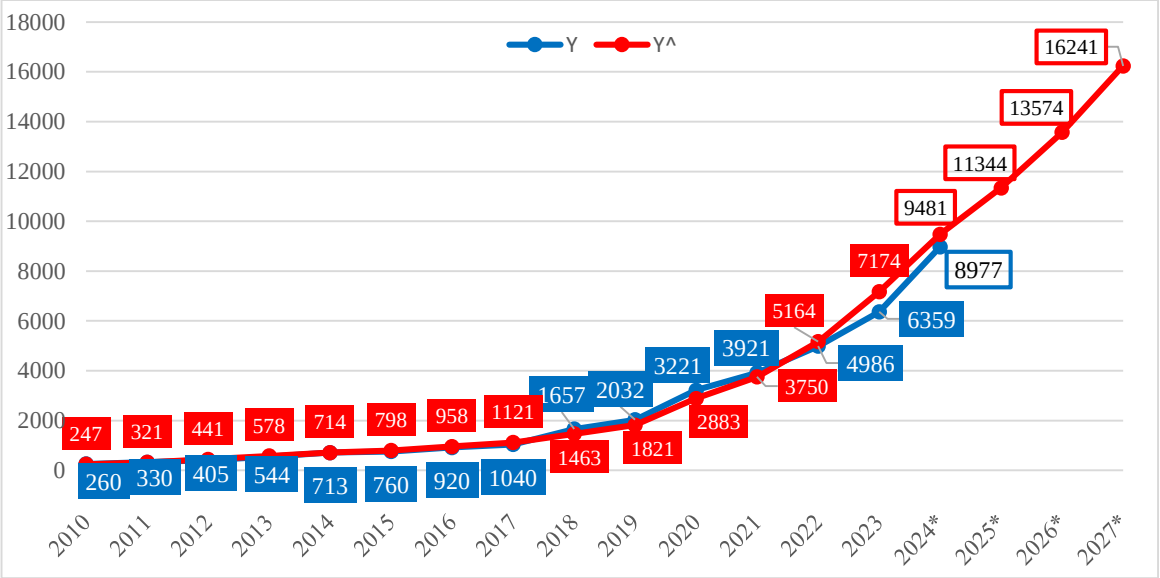

Figure 5: Comparison of actual and forecast e-commerce volumes in Russia, billion rubles, 2010–2027.Source: compiled by the authors.

Two models were constructed to analyze regional differences: Model 2: the dependence of e-commerce volume per capita on average per capita income and the share of the population using the Internet daily, and Model 3: dependence only on average per capita income.

The following results were obtained.

The coefficients of determination for Model 2 were $R^2 = 0.7665$ and for Model 3, $R^2 = 0.75461$.

Fisher's test was performed to compare the data from these models (Table 6).

Table 6: F stat and F crit values for Fisher's test for Model 2 and Model 3.

Values	Model 2	Model 3
F stat	153,21	216,83
F crit (10%)	1,24	2,34
F crit (5%)	1,32	3,06
F crit (1%)	1,48	4,76

Since Fstat > Fcrit at all significance levels, the obtained equations are significant at all levels.

The calculation of indicators and comparison of model quality showed that both models have a sufficiently high forecast accuracy, but the indicator values for Model 2 are slightly better than those for Model 3 (Table 7).

Table 7:Assessment of the forecast accuracy of Model 2 and Model 3.

	Model 2	Model 3
MSE	0,3483	0,3661
RMSE	0,5902	0,6050
MAPE	5,036%	5,348%
Theil's U1	0,0336	0,0344
Theil's U2	0,7301	0,7293
Bias proportion	0,0000	0,0000
Variance proportion	0,0664	0,0703
Covariance proportion	0,9336	0,9297

Final equation Model 2:

$$\ln(Y^*) = -19{,}52+2{,}04*\ln(X_1)+1{,}49*\ln(X_2)+0{,}78*d,$$

where X_1 is per capita income, X_2 is the share of the population using the internet daily, and d is a dummy variable (0 for 2016–2019, 1 for 2020–2023).

When per capita income increases by 1%, e-commerce per capita increases by an average of 2.04%; when the share of Internet users increases by 1%, it increases by 1.49%.

In most regions, the model forecast corresponds to actual data, except for Moscow (overestimation of the forecast due to high incomes) and St. Petersburg (underestimation of the forecast in 2023 due to additional unaccounted factors). The forecast for 2024 indicates further growth in e-commerce volumes per capita in all regions analyzed (Fig. 6).

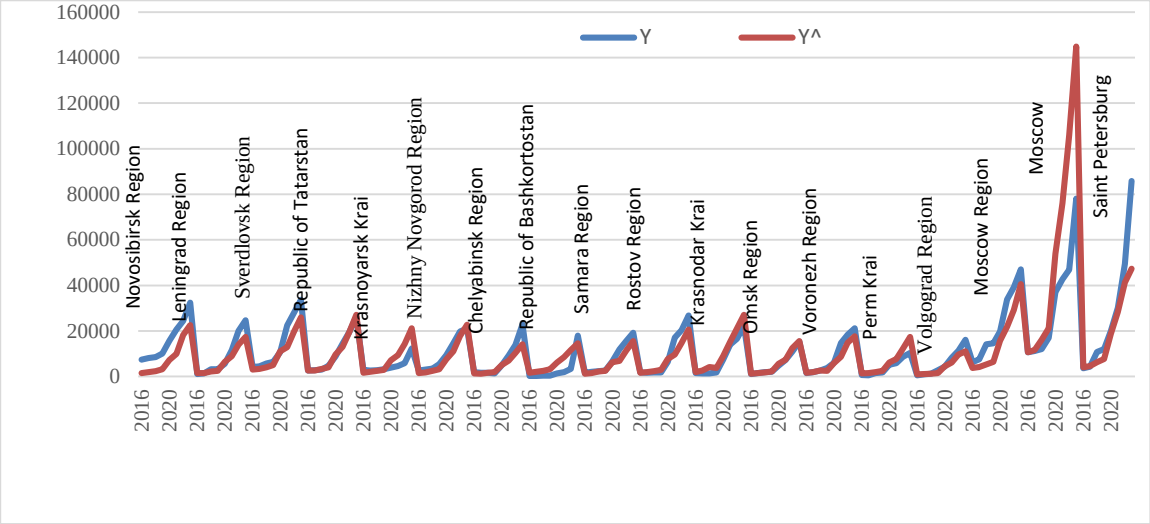

Figure 6: Comparison of actual and forecast e-commerce volumes per capita by region in Russia, rubles, 2016–2023. Source: compiled by the authors.

The models developed are highly accurate and enable reliable forecasting of the development of e-commerce in Russia. The main factor driving market growth is the level of household income; the impact of digital inequality (the proportion of Internet users) is statistically significant but significantly lower than that of income. The models reveal regional differences and confirm the continued growth of e-commerce at both the federal and regional levels.

4 CONCLUSIONS

Russia can increase the volume of e-commerce mainly through the growth of online sales in the domestic market, which will be possible provided that the use of the Internet and ICT expands, the popularity of e-commerce and demand for it grows, and the population is ready and able to use online stores and marketplaces, i.e., the growth of all factors capable of reducing digital inequality. The analysis and models constructed showed that e-commerce will continue to grow and develop. The main driver will be the growth of household income (a socio-economic factor). Digitalization, the development of mobile commerce and AI, and the development of logistics infrastructure will also play an important role in the development of e-commerce. An important factor for the further growth of e-commerce is the improvement of shopping services through the use of new technologies, such as artificial intelligence and virtual reality.

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