CLUSTERING OF RUSSIAN REGIONS BY SOCIALLY IMPORTANT INDICATORS OF TRADE DEVELOPMENT

AGRUPAMENTO DAS REGIÕES RUSSAS POR INDICADORES SOCIALMENTE IMPORTANTES DO DESENVOLVIMENTO DO COMÉRCIO

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Abstract

The article aims at forming clusters of Russian regions based on socially significant indicators of trade development. Clustering was conducted using the k-means method based on statistical data from 85 regions. As a result, five clusters were identified. The first cluster is characterized by a high share of chain retail turnover in the total retail trade volume. The second cluster shows no extreme values and is defined as average. The third cluster stands out for its well-developed market and fair trade. The distinctive feature of the fourth cluster is high consumer prices. The fifth cluster is marked by many retail facilities. In the context of fulfilling the social functions of trade, the most challenging is the fourth cluster, which includes four regions in the Far Eastern Federal District. To increase the social impact of trade in this cluster, it is advisable to develop foreign trade with neighboring Asian countries, including China, and to promote the expansion of Russian and cross-border e-commerce. The value of the results lies in the fact that clustering based on indicators reflecting the social significance of trade enables the adaptation of trade

Resumo

O artigo tem como objetivo formar clusters de regiões russas com base em indicadores socialmente significativos do desenvolvimento do comércio. O agrupamento foi realizado utilizando o método k-means com base em dados estatísticos de 85 regiões. Como resultado, foram identificados cinco clusters. O primeiro cluster é caracterizado por uma elevada percentagem do volume de negócios do comércio a retalho em cadeia no volume total do comércio a retalho. O segundo cluster não apresenta valores extremos e é definido como médio. O terceiro cluster destaca-se pelo seu mercado bem desenvolvido e comércio justo. A característica distintiva do quarto agrupamento são os altos preços ao consumidor. O quinto agrupamento é marcado por muitas instalações de varejo. No contexto do cumprimento das funções sociais do comércio, o mais desafiador é o quarto agrupamento, que inclui quatro regiões no Distrito Federal do Extremo Oriente. Para aumentar o impacto social do comércio neste agrupamento, é aconselhável desenvolver o comércio exterior com os países asiáticos

development policies to the specific characteristics of each region. This will contribute to a more comprehensive realization of trade's social functions and help mitigate regional socioeconomic disparities.

Keywords: Trade. Social Functions. Clustering. Region. Trade Network. Market. Price. E-Commerce.

vizinhos, incluindo a China, e promover a expansão do comércio eletrônico russo e transfronteiriço. O valor dos resultados reside no fato de que o agrupamento com base em indicadores que refletem a importância social do comércio permite a adaptação das políticas de desenvolvimento comercial às características específicas de cada região. Isso contribuirá para uma realização mais abrangente das funções sociais do comércio e ajudará a mitigar as disparidades socioeconômicas regionais.

Palavras-chave: *Comércio. Funções Sociais. Agrupamento. Região. Rede Comercial. Mercado. Preço. Comércio Eletrônico.*

1 INTRODUCTION

Trade provides the population with direct access to consumer goods, including those of social importance, thereby influencing public health and quality of life (Arynova *et al*., 2025). As a commercial activity, trade encompasses entrepreneurial and social interests (Akshalova *et al*., 2025; Kamysbayev *et al*., 2025). Addressing social issues and aligning as closely as possible with public needs contribute to enhancing the efficiency of trading companies in the consumer market (Ivanov, Orlov, 2013; Fedchenko *et al*., 2025). In this context, analyzing the social aspects of trade is relevant to both the state and the commercial sector.

The social role of trade is associated with its primary function — ensuring access to consumer goods for the population (in a preferred assortment, at optimal prices, with minimal time spent on making purchases). However, the social functions of trade with regard to consumers go beyond simply delivering goods from the producer to the retail shelf. Specifically, scholars have analyzed the influence of retailers on the health and well-being of citizens (Rinaldi *et al*., 2024; Watt *et al*., 2022; Wolgast *et al*., 2022), the consumption of health-beneficial fruits and vegetables by low-income populations (Hollis-Hansen *et al*., 2019), and issues such as excess weight and obesity (Zhang *et al*., 2012).

Retailers also act as organizers of leisure and meet the social and communicative needs of the population (Guiry, 2012; Kazakevičiūtė; Banytė, 2012), typical of shopping

centers (Baghaee *et al*., 2021). Shopping is one of the most common ways to demonstrate social status, which is why trade is considered to have a stratifying function (Aborvalova, 2012; Ahmed *et al*., 2022; Barkalova, 2022). Alongside performing social functions, trade provides a means of assessing the quality of life of the population, for which retail turnover and its macrostructure are analyzed.

Trade holds social significance as a sphere of employment. In Russia, trade leads among economic activities in terms of the number of workers, with their share, according to the Federal State Statistics Service, accounting for 18.6%. By providing jobs, trade creates working conditions, opportunities for development and self-realization, income generation, and the well-being of workers and their families. However, despite its undeniable contribution to employment, the functions related to working conditions are often insufficiently addressed. In this regard, studies are conducted on the work-life balance of retail workers (Zulich *et al*., 2012), work stress, technological changes, job insecurity in the retail organization (Ghani *et al*., 2022), and healthy eating behaviors and food consumption frequencies of retail workers (Dost, Uner, 2024; Mokhov *et al*., 2025).

Among other social functions of trade are stimulating the activity of producers, which also has social significance, socio-cultural exchange, and the mitigation of cultural differences, promoting sustainable and responsible consumption, contributing to the state budget, and influencing the development of regions and urban areas (Nikishin *et al*., 2025; Poluyan *et al*., 2025).

This research focuses specifically on the Russian context, where trade plays a vital role in both economic activity and social stability across regions. Given the country's vast geographical size and diverse regional conditions, understanding the social functions of trade within Russia requires detailed spatial analysis. Studying these internal variations is essential for shaping regionally sensitive trade policies (Batrakova, 2021). However, the social significance of trade in Russian regional studies is rarely addressed. Differences in the development of domestic trade across federal districts have been analyzed (Karashchuk and Boldyassov, 2022), as well as regional network trade (Mayorova *et al*., 2019) and regional e-commerce (Krasilnikova, 2019). In all cases, regional disparities were noted, with a need for their smoothing and a differentiated approach to industry development, considering the specific features of the regions.

The socially significant indicators of trade development in Russian regions were previously analyzed (Ivanov *et al.*, 2016). Three groups of indicators were considered: those characterizing the interaction between trade and consumers, the interaction between trade and the state, and the role of trade in employment. Based on these, an integrated indicator of the social effectiveness of trade in each region was calculated. The results confirmed regional differentiation.

The understanding of regional trade development differences can be expanded through cluster analysis. Cluster analysis methods have been successfully applied in regional studies, particularly in the clustering of Russian regions by overall socioeconomic development level (Ketova *et al.*, 2021), innovation activity (Mariev, Pushkarev, 2019; Valinurova, Tlyavlin, 2022), industrial focus (Kirillova *et al.*, 2024), food security (Zhilina, Khanova, 2023), population incomes (Ilyasov *et al.*, 2019), etc.

There are two main approaches to addressing this issue: first, reducing regional disparities; second, applying a differentiated strategy that considers the specifics of each region. Both approaches require a clear understanding of how regions are grouped and the criteria used for this classification. Since regional differentiation also extends to trade, clustering regions based on trade development indicators becomes a viable option. Clustering is essential for the subsequent adaptation of trade development policies to regional characteristics and for a more comprehensive realization of trade's social functions.

Particular attention in the development of regional trade in Russia should be given to the cluster characterized by high consumer prices, including four regions of the Far Eastern Federal District. The main directions for this cluster involve expanding foreign trade with nearby Asian countries (China) and promoting domestic and cross-border e-commerce.

The purpose of this article was to form clusters of Russian regions based on socially significant indicators of trade development, in order to adapt trade policy measures to regional characteristics and enhance the social effectiveness of trade.

2 METHODS

2.1 Research design

This study adopts a quantitative cross-sectional design using regional-level statistical data from 85 Russian regions for the year 2023. The research focuses on clustering regions based on selected socially significant indicators of trade development. The design integrates both descriptive and exploratory elements to identify meaningful patterns and regional groupings that can inform differentiated trade policies.

The formation of clusters of Russian regions based on indicators characterizing the social significance of trade will allow the adaptation of trade development policies to regional characteristics. This will contribute to the better realization of trade's social functions.

2.2 Data source and selection

The initial data used in this study were collected by the Federal State Statistics Service of Russia (n.d.). A preliminary selection identified nine indicators that reflect the social significance of trade.

1. Retail trade turnover per capita by region, rubles (x1). This indicator reflects realized demand or consumer spending not covered by subsistence farming. The volume and structure of retail trade turnover are commonly used as indicators of quality of life, which emphasizes its social relevance.

2. The share of retail trade turnover accounted for by chain retail stores in the total retail trade volume, % (x2). The social role of chain retail lies in its ability to curb inflation, generate a significant number of jobs, and contribute substantial tax revenues to the state budget. It also stimulates production and small retail businesses (through franchising) and plays a key role in building social capital (Belyakova, Mordvinova, 2017; Mayorova *et al*., 2019).

3. The share of online sales in total retail turnover, % (x3). E-commerce increases the accessibility of goods for consumers, expands the options available, enhances

the speed of purchase, and contributes to employment, lowering barriers to starting a retail business.

4. The share of retail markets and fairs in total retail turnover, % (x4). The social role of markets and fairs is reflected in the opportunity to buy and sell products from farms and handmade goods, providing low-income populations with a wide range of products at affordable prices, as well as offering employment opportunities.

5. The availability of modern retail space per 1,000 people, m2 (x5). When collecting statistical data, the modern format refers to a self-service store larger than 400 m2, with a wide assortment, at least one counter for fresh products, and additional services for customers.

6. The number of retail trade objects (stores) as of December 31, units (x6). A greater number of stores increases the accessibility of goods for consumers and stimulates competition, which helps to control prices and improve the quality of service.

7. The average annual cost of a conditional (minimum) food basket, rubles (x7). This indicator reflects consumer prices for a basket that includes 33 types of food products and characterizes the price accessibility of essential food items for the population.

8. The consumer price index for goods and services, at the end of December, % change from the previous month (x8). The index reflects the dynamics of consumer prices, and in conditions of high inflation, it is one of the most important socioeconomic indicators.

9. The share of the average annual number of employees in trade (wholesale and retail, as well as in motor vehicle and motorcycle repair) in the total average annual number of employed, % (x9). This indicator reflects the contribution of trade to employment in the region.

10. Data for 2023 were used for 85 regions of Russia, with a total of 765 values (Table 1).

Table 1

Indicators of descriptive statistics

| Indicator	x1	x2	x3	x4	x5	x6	x7	x8	x9
count	85	85	85	85	85	85	85	85	85
mean	289,417.5	34.0	5.6	4.7	263.5	10,601.1	6,117.7	100.8	16.7
std	71,301.5	11.1	4.6	8.7	134.1	10,336.4	1,402.6	0.3	3.3
min	92,894.0	1.6	0.2	0.0	35.8	370.0	4,741.3	100.2	5.4
25%	247,102.0	28.6	3.7	0.9	172.9	4,747.0	5,271.0	100.6	15.4
50%	280,885.0	36.6	5.1	2.4	237.9	7,436.0	5,710.1	100.8	17.0
75%	337,066.0	42.6	6.6	5.1	345.2	14,113.0	6,358.5	101.0	18.7
max	504,105.0	48.9	36.5	52.5	600.4	58,188.0	14,591.0	101.5	23.4

Source: calculated by the authors based on the data from the Federal State Statistics Service

Seven missing values (or 0.9%) were filled in with the average values from neighboring regions. An exception was made for the Nenets Autonomous Okrug, where the share of retail markets and fairs in the retail turnover was equated to the indicator for the entire Arkhangelsk Region, to which it is integrated.

Indicators that also characterize the social significance of trade and are collected by the Federal State Statistics Service but are closely related to the ones being analyzed were excluded to avoid multicollinearity. Their absence is evident in Figure 1.

Figure 1

Correlation matrix between indicators of socially significant aspects of trade development in Russian regions
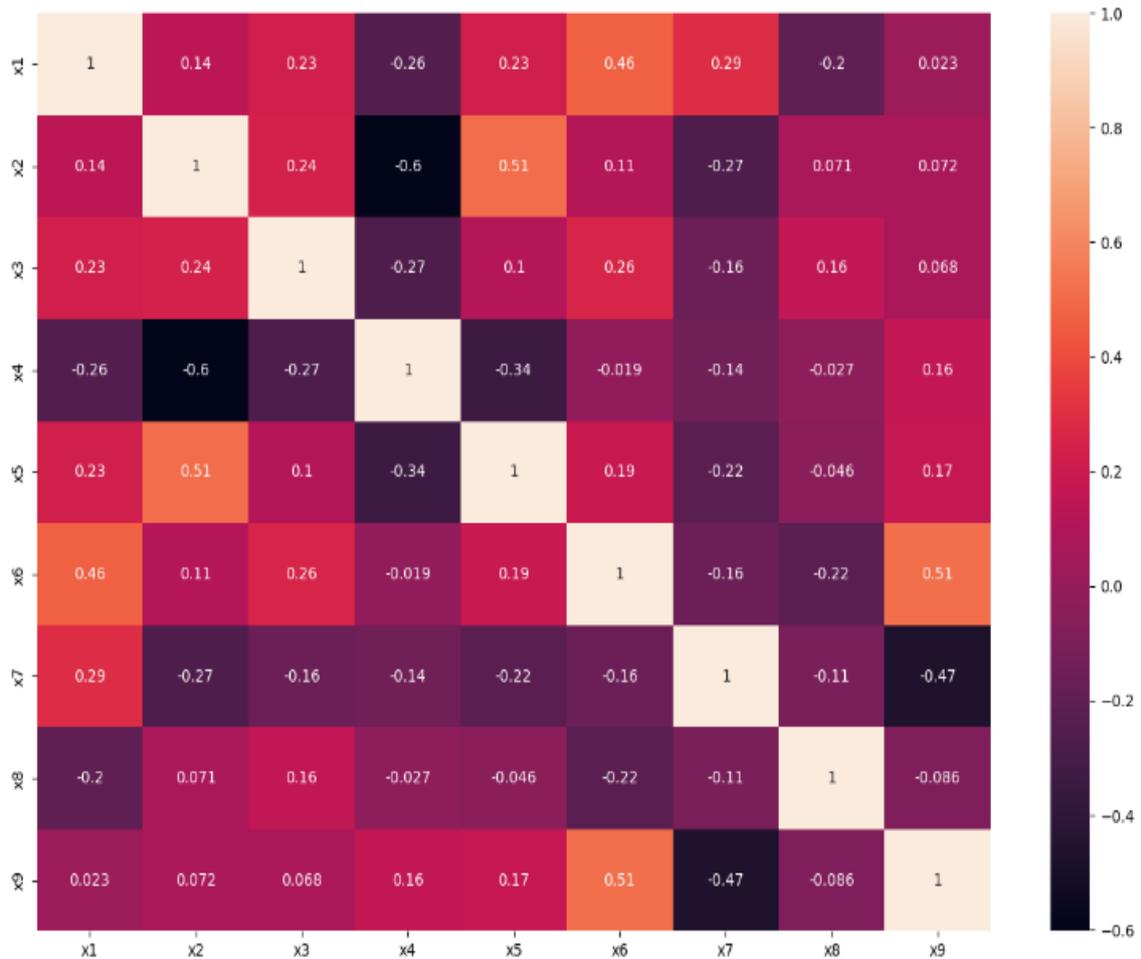
Source: compiled by the authors based on the data from the Federal State Statistics Service

2.3 Data preparation and standardization

Pairwise scatter plots and histograms (Figure 2) showed no strong correlations, but distributions deviated significantly from normality. Additionally, the indicators varied in units and scales, which could bias the clustering results. Therefore, all original data were standardized prior to analysis.

Figure 2

Scatter fields between socially important indicators of trade development and their histograms (compiled by the authors based on the data from the Federal State Statistics Service)

2.4 Data analysis: clustering procedure and tools

Clustering was performed using the k-means method with the following parameters: the initialization method – KMeans++; the number of initialization runs – 150; the maximum number of iterations – 1,000; the distance function – Euclidean. To determine the optimal number of clusters, the "elbow method" was applied. This method involves plotting the relationship between the target variable and the number of clusters. The share of the between-cluster sum of squares (BCSS) in the total sum of squares (TSS)

was used as the target variable. The closer this share is to 100%, the smaller the within-cluster deviations and the higher the clustering quality. The software used for the analysis included Python and GeoDa.

3 RESULTS

Based on the dependence of the BCSS share in the TSS on the number of clusters (Figure 3), it was decided to divide the regions of the Russian Federation into five clusters. After the fifth cluster, the curve begins to flatten, indicating that the addition of more clusters does not lead to a significant improvement in the evaluated metric.

Figure 3

Illustration of the elbow method for determining the optimal number of clusters

BCSS – between-cluster sum of squares
TSS – total sum of squares
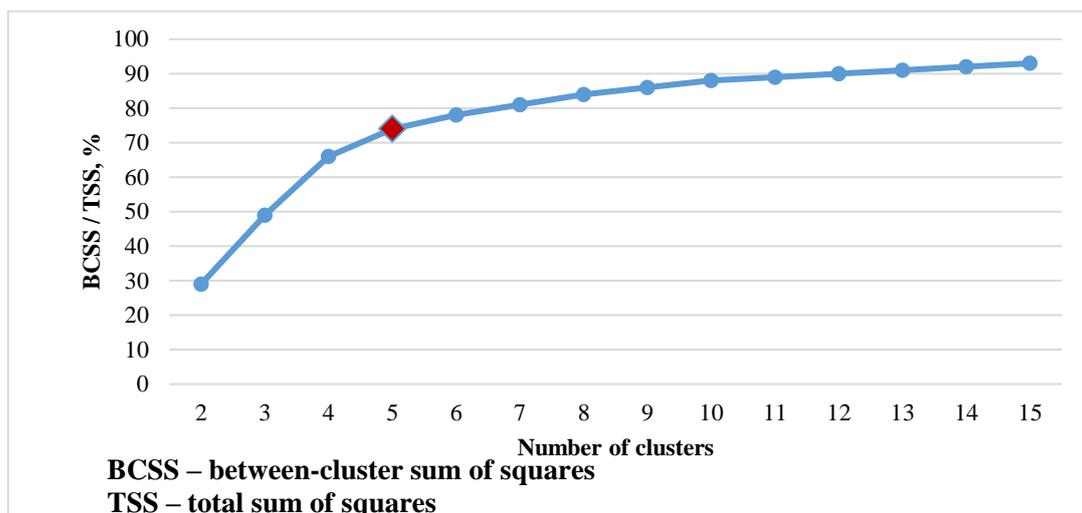
Source: compiled by the authors

The sequential exclusion of variables from the analysis and the comparison of results demonstrated that the most effective clustering is achieved using four indicators: the share of retail trade turnover accounted for by retail chains in the total retail trade turnover, the share of retail markets and fairs in retail trade turnover, the number of retail trade outlets (stores), and the average annual cost of a conditional (minimum) set of food products. Accordingly, these indicators were selected for further regional clustering.

The composition of each cluster is presented in Table 2.

Table 2

Clusters of Russian regions by socially important indicators of trade development

Cluster	Regions	Number of regions
1	Altai Territory, Sverdlovsk Region, Tambov Region, Astrakhan Region, Republic of Bashkortostan, Belgorod Region, Bryansk Region, Republic of Tatarstan, Tomsk Region, Kaliningrad Region, Tula Region, Chuvash Republic, City of Saint Petersburg, Tver Region, Altai Republic, Tyumen Region, Irkutsk Region, Ivanovo Region, Udmurt Republic, Ulyanovsk Region, Vladimir Region, Kaluga Region, Volgograd Region, Vologda Region, Republic of Karelia, Kemerovo Region, Voronezh Region, Yaroslavl Region, Khanty-Mansi Autonomous Okrug, Kirov Region, Komi Republic, Kostroma Region, Jewish Autonomous Region, Krasnoyarsk Territory, Kurgan Region, Kursk Region, Leningrad Region, Lipetsk Region, City of Sevastopol, Republic of Mari El, Republic of Mordovia, Orenburg Region, Murmansk Region, Nizhny Novgorod Region, Novgorod Region, Novosibirsk Region, Omsk Region, Oryol Region, Penza Region, Perm Territory, Pskov Region, Ryazan Region, Samara Region, Saratov Region, Smolensk Region, Stavropol Territory, Chelyabinsk Region	57
2	Amur Region, Arkhangelsk Region, Republic of Buryatia, Chechen Republic, Republic of Adygea, Republic of Kalmykia, Khabarovsk Territory, Republic of Khakassia, Nenets Autonomous Okrug, Republic of Sakha (Yakutia), Sakhalin Region, Yamalo-Nenets Autonomous Okrug, Republic of Tuva, Republic of Crimea, Primorsky Krai	15
3	Republic of Dagestan, Republic of Ingushetia, Kabardino-Balkarian Republic, Karachay-Cherkess Republic, Republic of North Ossetia–Alania	5
4	Chukotka Autonomous Okrug, Kamchatka Territory, Magadan Region, Zabaykalsky Krai	4
5	Krasnodar Territory, Rostov Region, City of Moscow, Moscow Region	4

Source: compiled by the authors

The first cluster turned out to be the largest, comprising 57 regions. As shown in Figure 4, most of the regions in this cluster are located in the European part of Russia. This includes the federal city of Saint Petersburg and the Leningrad Region. The main distinguishing feature of this cluster is the high share of retail chain turnover in the total retail trade turnover.

Figure 4

Map of clusters of Russian regions by socially important indicators of trade development

Source: compiled by the authors

The second cluster includes 15 regions. It can be described as an average cluster since it does not have distinctive characteristics compared to the other clusters. Regions in this cluster are found in all federal districts except the Central and Volga Federal Districts. Notably, it includes the Republic of Sakha (Yakutia), the largest constituent entity of Russia by territory.

The third cluster consists of five regions, all in the southern part of Russia within the North Caucasian Federal District. The main distinguishing feature of this cluster is the high share of retail markets and fairs in the total retail trade turnover.

The fourth cluster comprises four regions, all of which are part of the Far Eastern Federal District. The distinguishing characteristic of this cluster lies in the higher consumer prices. Within the clustering framework, this is reflected by the cost of a basic (minimum) food basket.

The fifth cluster includes four regions: Moscow and the Moscow Region, as well as the Rostov Region and the Krasnodar Territory, which are located in the Southern Federal District. Despite their relatively small territory, these regions stand out due to the large number of retail facilities. In addition, they are characterized by well-developed chain retail trade.

Table 3 presents the average values of indicators that characterize the specific features of each cluster.

Table 3

Average values of socially significant indicators of trade development by clusters

Indicator/cluster	1	2	3	4	5
Share of retail trade turnover of retail trade networks in total retail trade turnover, %	39.85	23.69	10.08	20.85	34.83
Share of retail markets and fairs in retail trade turnover, %	2.57	2.89	36.08	2.28	4.7
Number of retail trade objects (stores), as of December 31, units	9,818	5,795	6,501	2,745	49,448
Average annual cost of a conditional (minimum) set of food products, rubles	5,652.39	6,776.61	5,555.5	10,892.2	6,127.93

Source: compiled by the authors

The share of chain retail in total retail turnover is particularly high in the regions of the first cluster (around 40%) and the fifth cluster (approximately 35%). It is lowest in the third cluster, which includes most regions of the North Caucasus Federal District. The third cluster leads in the development of retail markets and fairs, where their share exceeds 36%, while in all other clusters, this figure remains below 5%. In terms of the number of retail outlets (stores), the fifth cluster stands out, with nearly 50,000 units. The first cluster holds second place, although the number of stores there is five times lower. The fourth cluster is notable for the highest cost of a basic food basket, which exceeds 10,000 rubles in its regions.

4 DISCUSSION

4.1 Clustering, socioeconomic differentiation, and trade formats

The possibility of clustering regions based on socially significant characteristics of trade aligns with the widely discussed issue of regional differentiation in terms of socioeconomic development (Batrakova, 2021; Shatalova, 2023).

The distinctive features of the first, third, and fifth clusters are associated with different trade formats. The popularity of markets and fairs in the North Caucasus Federal District, which make up the third cluster, can be attributed to historically rooted trade traditions and the active trade in vegetables, fruits, and berries. These products are grown in large quantities due to favorable natural and climatic conditions and are often sold in open markets. Their widespread consumption is also embedded in the dietary habits of the population in this cluster.

In contrast, the regions of the Northwestern Federal District (particularly the city of Saint Petersburg and the Leningrad Region), which belong to the first cluster, are known for their dominance of chain retail. This is often linked to consumer preferences for shopping in a single location, driven by the cold climate, as well as the presence of headquarters of several major retail chains (Mayorova *et al*., 2019).

All trade formats are socially significant and develop according to the priorities of specific social groups (Ivanov, Orlov, 2013), in this case, the preferences and purchasing habits of regional populations.

The densely populated capital region, in addition to its well-developed chain retail sector, is also characterized by a large number of retail facilities of various types and formats. This diversity fosters competition and provides consumers with a wide range of choices, thus enabling trade to effectively fulfill its social functions.

4.2 Challenges in the fourth cluster

The most problematic of the identified clusters is the fourth, whose defining feature is high consumer prices. It includes four regions (approximately 5% of all Russia's constituent entities), all located in the Far Eastern Federal District. Elevated prices in this cluster are primarily due to high logistical costs resulting from the regions' remoteness from the country's central areas, as well as unfavorable natural and climatic conditions for agriculture, which necessitates the importation of goods.

To ensure the better fulfillment of trade's social functions in the regions belonging to the fourth cluster, it is advisable to focus on two key areas of development. First, the import of goods from nearby Asian countries (particularly China) is highly relevant. Second, there is a pressing need to promote the development of online retail. In areas with

low population density and geographically remote regions, the operation of numerous traditional retail enterprises is often economically inefficient. Consumers in these areas have access to a limited range of goods. On the one hand, e-commerce offers consumers an almost unlimited choice of products. On the other hand, it requires lower costs and is more economically viable for retail businesses. The expansion of online marketplaces, accompanied by an increase in the number of pickup points, seems especially promising.

4.3 Role of E-commerce in regional trade development

The development of e-commerce is also viewed as relevant for regions in the second cluster that do not have any extreme characteristics. Even in regions belonging to the other clusters and despite the dominance of certain trade formats, the intensification of online retail could help expand the range of available goods and enhance convenience for consumers, including through price comparisons and reduced shopping time. There is evidence suggesting that e-commerce contributes to curbing consumer prices (Grebenkina *et al*., 2023; Jo *et al*., 2024), which is particularly important for Russian regions at present. While a few years ago, e-commerce in Russia was concentrated in Moscow, Saint Petersburg, and other major cities, a clear trend has emerged indicating its gradual expansion into other regions.

4.4 Summary of clustering results

Among the socially significant indicators of trade development, the following are suitable for clustering Russian regions: the share of retail trade turnover generated by chain retailers in total retail turnover; the share of retail markets and fairs in retail trade turnover; the number of retail outlets (stores); and the average annual cost of a basic (minimum) food basket. Based on these indicators, five clusters were identified.

The first cluster (57 regions) is characterized by a high share of chain retail turnover in total retail trade. The second cluster (15 regions) does not exhibit extreme values and is designated as average. The third cluster (five regions) stands out for its well-developed trade in markets and fairs. The defining feature of the fourth cluster (four

regions) is high consumer prices. The fifth cluster (four regions) is distinguished by many retail outlets.

4.5 Policy implications

The fourth cluster is the most problematic in terms of fulfilling the social functions of trade. It includes the Chukotka Autonomous Okrug, the Kamchatka Territory, the Magadan Region and Zabaykalsky Krai, i.e., regions that are geographically remote from the central part of Russia and characterized by natural and climatic conditions unfavorable for the development of agriculture. To enhance the social impact of trade in the specified cluster, it is advisable to develop foreign trade with nearby Asian countries, including China, and to intensify the spread of e-commerce (both domestic and cross-border). E-commerce will expand the range of goods and improve shopping convenience, including through price comparisons and time savings. Given the observed trend of reducing interregional disparities in Russia's e-commerce sector due to regional development, the necessary prerequisites for implementing these proposals have already been established.

4.6 Directions for further research

The main direction for further research is seen in the analysis of the potential for the development of e-commerce in Russian regions, including those located in the Far Eastern Federal District. To attain this end, it is necessary to examine the population's access to the Internet, consumers' attitudes toward the advantages and risks of making online purchases, the use of mobile devices, and other regional factors. It is essential to develop mechanisms that would make it possible to apply online technologies in trade in a way that maximizes their social effect.

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Authors' Contribution

All authors contributed equally to the development of this article.

Data availability

All datasets relevant to this study's findings are fully available within the article.

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