RESEARCH PAPER

REGIONAL PATTERNS OF THIRD-LEVEL DIGITAL INEQUALITY IN RUSSIA: AN ANALYSIS OF GOOGLE TRENDS DATA

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ABSTRACT. Digital inequality extends beyond mere access to technology. This study explores the concept of third-level digital inequality, which describes the situation where individuals or communities have access to technology and the Internet, have required skills, but still struggle to use it effectively. However, there is currently a lack of data and methods for assessing third-level digital inequality. To address this gap, this study aimed to evaluate it on a regional scale by analyzing the popularity of Google search queries. In proposed method, the data are categorized into three groups: everyday services, education, science, and technology, and entertainment. On this basis authors calculated the index of Internet usage efficiency. The study's findings revealed the territorial patterns of digital inequality in the constituent entities of the Russian Federation. Regions in North Caucasus and Siberia showed low Internet usage efficiency, while regions in the Urals and Central Russia had high Internet usage efficiency. The study's methodology is quick, cost-effective, and easy to implement, but it also has limitations. The method only considers the popularity of certain search queries and does not consider the frequency or duration of internet usage, or the specific websites or services accessed, and does not consider individual-level factors that may influence internet usage patterns. The authors emphasize the importance of addressing not only differences in Internet access but also the lack of technology skills, digital literacy, and motivation among certain groups. They conclude that public policies aimed at enhancing internet skills can reduce digital inequality and improve the quality of life of the population.

KEYWORDS: digital inequality, digital divide, Google Trends, Russian regions

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INTRODUCTION

Data in digital form has become a critical factor in the production of goods and services across all sectors of society, including economic, cultural, and other human activities. According to the International Telecommunication Union (2019) and Internet World Stats (2022), the number of Internet users has increased fivefold in the last 17 years, from 1 billion in 2005 to 5.1 billion in early 2022.

At first, it was considered that the Internet would bridge the inequalities between people in accessing information and would eventually allow it to be distributed without restriction, thereby ensuring equal access to education and new opportunities for every segment of the world's population. However, the problem of uneven access to digital technologies by different social groups remains. Research on this subject was made at the end of the 1990s. Researchers found that in the United States, the highest degree of Internet accessibility was observed among groups that had access to better education and higher incomes (Hoffman and Novak 1998; Strover 1999). As information technology has become ubiquitous, the problem of unequal access has become more pronounced. The adoption of new digital technologies is often not evenly distributed across social groups or geographic areas. The spread of new technologies, including digital ones, between countries and regions, generally follows the classical laws of innovation diffusion (Zemtsov and Baburin 2017). Unequal distribution of technology infrastructure, such as access to the Internet, computers, and other digital devices was called Digital divide.

According to the Organization for Economic Development (OECD), "Digital divide" refers to the gap between individuals, households, businesses, and geographic areas at different socio-economic levels regarding their opportunities to access information and communication technologies (ICTs) and use them for a variety of activities (OECD, 2001). That is, the digital divide is "the inequality between the 'haves' and the 'have-nots', differentiated through dichotomous measures of access to information technology. This is the interpretation that most researchers rely on, e.g. (Novak and Hoffman 2000; Wilhelm and Thierer 2000; Norris 2001).

Digital inequality, on the other hand, is a broader concept. It encompasses the digital divide and complements it with other factors affecting the use of technologies by people who have formal access to them. Inequality manifests itself in, for example, unequal distribution of Internet skills (e.g.

ability to search for information), and in the use of the Internet not only for entertainment or social networking (Van Deursen and Helsper 2015). Current research identifies three levels of digital inequality:

• The first level is the inequality in physical or economic access to technology;

• The second level is the inequality of usage skills;

• The third level is the unequal distribution of opportunities for tangible outcomes in real life (employment, education, political participation, etc.) due to patterns of technology use (Du et al. 2021; Van Dijk 2012).

Third-level digital inequality refers to a situation where an individual or community has access to technology and the internet, as well as the necessary skills and knowledge to use it, but is still unable to effectively use it to access useful services and resources. Third-level digital inequality can have several different causes, including social and cultural factors, such as a lack of awareness or understanding of the benefits of using technology, or a lack of support or guidance in using it. It may also be caused by technological or infrastructure issues, such as slow or unreliable internet connections, or a lack of relevant content or resources.

Overall, third-level digital inequality represents a deeper and more complex challenge than first- or second-level digital inequality, as it requires addressing not just access and skills, but also attitudes, behaviors, and the design and delivery of services.

The digital inequality can persist even after the digital divide has been bridged and there is almost equal access to technology. This is a problem in both high-income countries (Hargittai and Hinnant 2008; Peter and Valkenburg 2006) and low-income ones (Drori 2010; ITU 2011).

Digital inequality can have significant consequences for sustainable development, as it can limit individuals' and communities' ability to access information, communicate, and participate in economic, social, and cultural activities. This can lead to a range of negative outcomes, including reduced economic opportunities, social isolation, and limited access to education and health services. Digital inequality is a key consideration in several of the United Nations Sustainable Development Goals (SDGs), including Goal 9 (Industry, Innovation, and Infrastructure), Goal 10 (Reduced Inequalities), and Goal 17 (Partnerships for the Goals). Efforts to reduce digital inequality and promote sustainable development therefore require a multi-faceted approach that involves both the public and private sectors, as well as civil society and international organizations.

Research on the first-level digital inequality (the digital divide itself) and the second-level digital inequality is nowadays often published not only abroad but also in Russia (Avraamova and Vershinskaya 2001; Yudina 2020; Gladkova et al. 2020).

Most papers on the digital divide in Russia approach the topic mainly from a technological perspective, i.e. the gap between those who have and those who do not have access to digital technologies, and analyze the many factors that influence this divide. There is enough statistical information to estimate the first two levels of inequality, but it should be acknowledged that methodological approaches to collecting federal statistical data on the specifics of ICT use in Russia do not allow a full assessment of the third level of digital inequality. The problem of a lack of data is also described in the work (Zemtsov et al. 2022) in which the authors studied the issue of digital inequality through the prism of the diffusion of innovations concept. To assess the third level of digital inequality, the authors were able to select only one indicator - the share of the online sector in trade.

The authors estimate that Russia has a high level of Internet connectivity, but relatively low indicators of digital skills and use of Internet technology to improve living standards and quality of life. At the same time, evaluating the effectiveness of the use of the Internet by the public as a crucial information and communication network is becoming increasingly important. "Those who function better digitally and participate more fully in digital social life enjoy a competitive advantage" (Robinson et al. 2015), which can lead to increasing social inequalities.

Markers of social status, such as income and education, are found to affect the quality of Internet use. People with higher social status are more likely to have access to the Internet and use it more effectively (Witte and Mannon 2010). Educated and affluent users will become even better at realising their potential, while people with low income and education will fall further and further behind in using digital technology effectively, falling victim to fraud, cybercrime, receiving unfavourable or imposed services, etc. According to Hargittai and Hsieh (2013), social inequalities would decrease if people with lower social status used the Internet in more useful ways.

In this paper, the authors set out to develop and test a methodology for measuring the third level of the digital inequality, suitable for research at the regional level, namely the use of the Internet to produce tangible results in real life through access to technology.

There is currently no generally accepted methodology for assessing the third level of the digital inequality. While official statistics, such as broadband access or the proportion of the population using the Internet to interact with public authorities, are collected for the first and second level assessments, difficulties arise in assessing the effectiveness of digital technologies in improving quality of life. The main question before us, then, is not whether people use the Internet, but how people use it and, ultimately, with what benefit to real life.

Most of the existing studies on the third level of the digital inequality use a sociological approach. Surveys investigate existing factors such as education, interests or social connections, determine how people interpret new technologies such as the Internet (Zillien 2009) and how they integrate them into their daily lives. However, the more common internet-based surveys are affected by the digital inequality. Representativeness is a key issue: differences in connectivity, skills and use of social media are directly linked to the level of digital inequality (Robinson et al. 2015).

For country-level studies, a computerized telephone survey is currently considered the most reliable. For example, the Media Change and Innovation Division of the Institute of Mass Communication and Media Research at the University of Zurich conducted three nationally representative surveys — in 2011 (Latzer et al. 2012), 2013 (Latzer et al. 2013) and 2015 (Latzer et al. 2015). The surveys used telephone interviews, which also made it possible to interview non-Internet users. Samples were drawn based on age, gender, region and employment. However, these kinds of surveys are complicated by the complexity of their organization and the cost of conducting the survey. There is little comparability with other countries, as survey standards may differ.

With the development of communication studies, the use of techniques such as text mining and network analysis in the study of the digital inequality is spreading (Berry et al. 2011).

Traditional survey-based analysis remains fundamental to research on the digital inequality, and new methods of big data analysis face many challenges, but nevertheless they promise valuable additional information and are likely to be used more frequently in future research. Internet services, including search engines and social media, have made vast amounts of previously unavailable or unrecorded data available to researchers (Boyd and Crawford 2012). New possibilities for content analysis of Internet resources, search engine analysis and social media analysis have emerged. However, working with such data still has several limitations. Major platforms whose data analysis would be as representative as possible (e.g., Facebook and Twitter) restrict access to their data. Their user agreements limit content collection and transactional data is rarely shared with researchers (Boyd and Crawford 2012).

As can be seen from the papers examples, there is currently an acute lack of methodologies that can quickly, inexpensively (social surveys are one of the most expensive methods of researching the digital inequality) and consistently portray a spatial picture of the third-level digital inequality.

MATERIALS AND METHODS

In this paper, we demonstrate the testing of our developed method for spatial estimation of the third level of digital inequality on a regional scale by analyzing the popularity of Google search queries. We have chosen this search engine because it is the most popular in the world (92% of market in September 2020 according to Search Engine Market Share Worldwide (2022) and in Russia (55,5% according to LiveInternet Site Rating (2022). Tools for analyzing and visualizing search engine statistics are provided by the free online service Google Trends. Data from this service is increasingly being used in various fields of science. In recent years, many papers have been published that use Google Trends to explore public interest in certain socially relevant topics. For example, environmental protection (McCallum and Bury 2014) or unemployment (Yurevich and Akhmadeyev 2021). The service is also used to make predictions ranging from the spread of epidemics (Sulyok et al. 2021) to the results of presidential elections (Granka 2013).

Google Trends works as follows: entering a query (a single word or a group of words) into the search bar, the service generates a report on the search activity in Google for this query, which includes information on the dynamics of popularity of the query in the world or in the selected country during a selected period of time since 2004, as well as the rating of countries or regions of the selected country by the level of popularity of the query. The popularity of a query in Google Trends is a relative value that describes the share of a given query among all search queries for a selected period in a selected territory.

Some queries are recognized by Google Trends as topics. According to the service's support description (https://support.google.com/trends/), topics are the result of an automated classification of thematically related queries in all languages. For example, the most closely related queries to the topic of State Services in Russia are "gosuslugi", "гос услуги", "услуги", "госуслуги". Information on queries related to a given topic is also contained in the report. The State Services topic report for the period 2016 to 2020 is shown as an example in Figure 1. For each element of the report, tables with data on the constituent entities of the Russian Federation are available for downloading in CSV format (except for the Republic of Crimea and Sevastopol, as they are attributed to Ukraine in the Google database). The language of the report can be any language and depends on the user settings. In our case, English is selected, and the topic names are also in English, although, as mentioned above, they include queries in all the languages available on Google.

For the purposes of this study, we identified three categories of search query topics corresponding to users' areas of interest associated with different types of digital use and impact on quality of life. It is assumed that users' search queries reflect their main patterns of Internet use. People with higher education and income are more likely to use information technology for information, education, work and career purposes, while people with lower education and income mainly use apps for entertainment, chatting, social networking or simple communication (Zillien and Hargittai 2009; Tsetsi and Reins 2017). Van Deursen and Helsper (2015) analyzed papers on Internet use and identified the main categories of positive use:

- economic use associated with trade;
- economic use associated with labour;
- social use;
- use for educational purposes;
- use for political purposes;
- use of public institutions;
- use of medical facilities.

Other data supports this assumption, for example showing that people with higher levels of education benefit more economically, institutionally, and educationally from the Internet than less educated users.

Based on the research described above, we have divided Google users' search queries into conditionally positive and conditionally negative queries. The former reflect the effective use of digital technologies with a positive impact on the quality of life of the population. The latter point out that the use of the Internet does not have a tangible positive effect in real life (Hargittai and Hsieh 2013). For example, people who use modern technology only for entertainment purposes do not get any additional opportunities to improve their education and quality of life. Three categories of searches are thus distinguished:

- Category 1 Everyday Services describes the ability to use the Internet to access popular services such as banking, transport, government services, shopping and delivery of goods. It can be assumed that the higher the search interest of the queries in this category, the higher the effectiveness of the use of the Internet in this field.
- Category 2 Education, Science and Technology, describes the possibility of using the Internet for education and new knowledge, primarily in the fields of science and technology. We assume that the higher the search interest of the queries in this category, the higher the effectiveness of the use of the Internet in this field.
- Category 3 Entertainment describes the ability to use the Internet for recreational purposes: searching for films and TV series, music, video games. According to our assumption, the higher effectiveness of Internet usage may be indicated by lower values of the level of search interest in the topics of this category of queries. We have treated this category of queries as conditionally negative, as research (Van Deursen and Helsper 2018; Van Dijk, 2020) suggest that a high proportion of time on the Internet spent on entertainment reduces the effectiveness of users' use of the Internet.

Table 1 presents the query topics that we have included in the highlighted categories. Each category is made up of four component topics. In doing so, the Marketplace topic includes 4 search topics relating to popular goods delivery services. The topics were selected primarily according to their meaning, considering which are the most popular

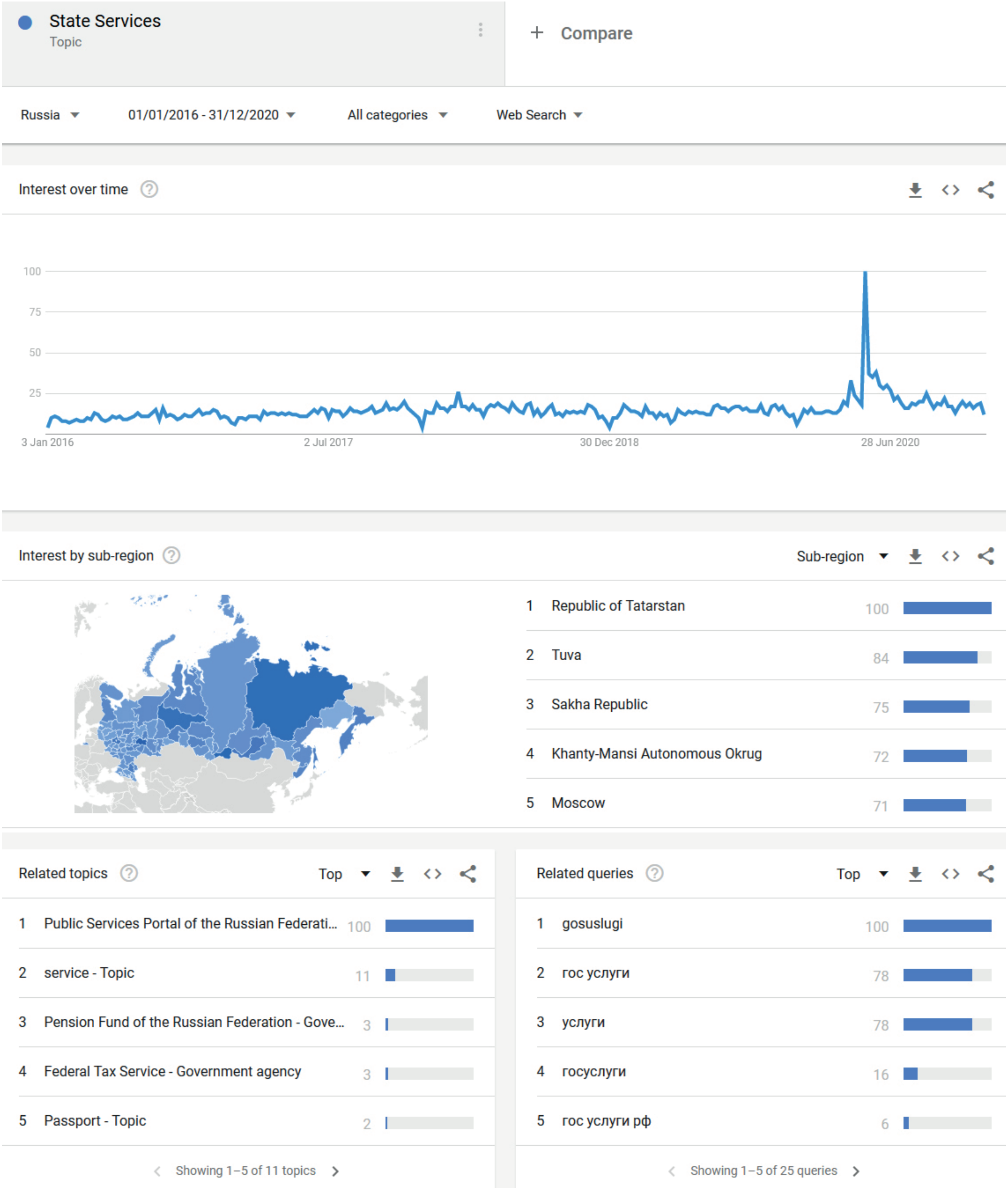

Fig. 1. Screenshot of Google Trends report on "State Services" topic

queries related to the topic, as well as the level of popularity of the topic. If the number of queries from a region is too low, statistics for that region are not calculated in Google Trends — as, for example, for the Nenets and Chukotka regions in Figure 1.

The data on search interest in all the selected topics is consolidated into a table which forms the basis for further calculations. The rows of the table correspond to the names of the constituent entities of the Russian Federation and the columns to the values of the search interest, ranging from 0 to 1. The data is collected for 2016 to 2020. Where the Google Trends report does not include data for a region due to a low number of queries, it was manually assigned the lowest available search interest value for that topic.

Three indices of search interest in each of the three thematic categories, as well as an overall index of Internet usage efficiency, were calculated based on the values obtained.

To calculate the indices of search interest in each of the three thematic categories, as well as an overall index of Internet usage efficiency, normalization (Tikunov 1997, p. 83-85) of the values obtained was carried out using formula (1):

$$\widehat{X}ij = \frac{\left| x_{ij} - \overset{o}{x}_j \right|}{\left| {}_{max/min}x_j - \overset{o}{x}_j \right|} \qquad (1)$$

$$i = 1, 2, 3, \ldots, n;$$

$$j = 1, 2, 3, \ldots, m$$

where $\overset{o}{x}$ are the worst of all encountered values (for each indicator), i.e. the lowest values of search interest for category 1 and 2 topics and the highest for category 3 topics; ${}_{max/min}x$ are the values of the indicators that are most different from $\overset{o}{x}$; n is the number of territorial units (regions of Russia) under study; *m* is the number of indicators (search topics) used for the calculations (m = 4). The purpose of this normalization is translating each search interest indicator from the Google Trends report into a deviation from a given best or worst value. The resulting normalization values are restricted to a range of 0 to 1. The evaluation indices for each query category are calculated as the arithmetic average of the four normalized values included in the respective categories.

The resulting indices of search interest by thematic category were also reduced to an overall integral index of Internet usage efficiency by calculating a simple average.

RESULTS

Table 2 lists the constituent entities of the Russian Federation with maximum and minimum values of the revealed level of search interest in the studied thematic categories (let us remind that the calculations were carried out for 83 constituent entities of the Russian Federation without the Republic of Crimea and Sevastopol). Some regions appear in this table more than once. Thus, the Republic of Tatarstan is in the top 5 for search interest in "Everyday Services" and "Education, Science and Technology", while the Republics of Ingushetia and Dagestan were outsiders in the same categories, but leaders in category No. 3 "Entertainment". Moscow was among the leaders in terms of searches for services and facilities, but in last place in terms of search interest in entertainment.

In order to illustrate the results of the calculation, we also made a map illustrating the values of the integral index of Internet usage efficiency by users from different regions (Figure 2).

Table 1. Google Trends query categories selected for regional analysis of the digital inequality

Query categories	Topics in Google Trends		Popular requests from Russian users
1. Everyday Services	State Services		gosuslugi, гос услуги, услуги, госуслуги, гос услуги рф, гос услуги личный кабинет, мфц
	Transport		транспорт, транспорт онлайн, общественный транспорт, яндекс транспорт, transport, транспортные компании, как доехать
	Bank		банк, банки, сбербанк, онлайн банк
	Marketplace	Delivery	доставка, доставка еды, доставка цветов, доставка суши, пицца, delivery
		Ozon.ru	озон, ozon, озон ру, озон магазин, азон, промокод озон
		Wildberries	вайлдберриз, wildberries, вайлдберис
		AliExpress	алиэкспресс, aliexpress, алиэкспресс на русском, али
2. Education, Science and Technology	Education		образование, сетевой город образование, веб образование, электронное образование
	Technology		технологии, технология, technology, информационные технологии, новые технологии
	Research		исследования, исследование, research, методы исследования, исследовать, маркетинговые исследования, научные исследования, клинические исследования
	Science		наука, science, философия, научные статьи, экономика, министерство науки
3. Entertainment	Film		фильм, фильмы, смотреть фильм, кино, фильм онлайн, смотреть фильм онлайн, скачать фильм
	Game		игры, игра, играть, скачать игру, онлайн игры, играть онлайн, игры бесплатно
	Television series		сериал, сериалы, смотреть сериал, турецкий сериал, сериалы онлайн, русские сериалы
	Music		музыка, скачать музыку, слушать музыку, music, скачать музыку бесплатно

Table 2. Constituent entities of the Russian Federation with the highest and lowest levels of search interest on Google for topics in the selected categories

Query categories	Highest level of search interest	Lowest level of search interest
1. Everyday Services	1. Republic of Tatarstan 2. Perm Krai 3. Moscow 4. Republic of Karelia 5. Udmurt Republic	79. Republic of Dagestan 80. Primorsky Krai 81. Chechen Republic 82. Karachay-Cherkessia Republic 83. Republic of Ingushetia
2. Education, Science and Technology	1. Republic of Sakha (Yakutia) 2. Republic of Tatarstan 3. Tyumen region 4. Republic of Komi 5. Republic of Tyva	79. Krasnodar Krai 80. Republic of Dagestan 81. Karachay-Cherkessia Republic 82. Murmansk region 83. Republic of Ingushetia
3.Entertainment	1. Chechen Republic 2. Republic of Ingushetia 3. Republic of Dagestan 4. Kabardino-Balkaria Republic 5. Republic of North Ossetia-Alania	79. Moscow region 80. Nizhny Novgorod region 81. Leningrad region 82. Saint-Petersburg 83. Moscow

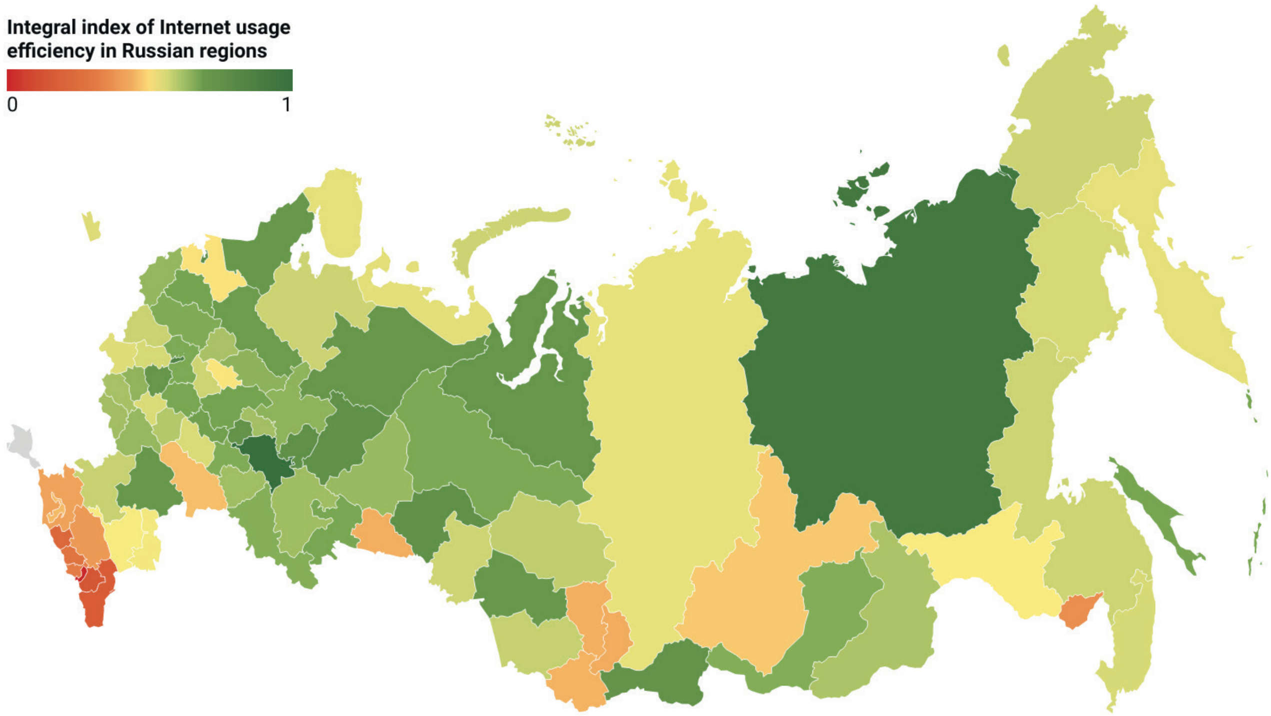

Fig. 2. Integral Index of Internet usage efficiency in Russian regions

As can be seen from the map, there are some geographical patterns in the people's use of the Internet. First of all, we see the regions in the North Caucasus for which the lowest Internet usage efficiency was identified. Search queries in this group of regions gravitate mainly towards the entertainment topics, which indirectly indicates that the Internet is little used for economically and socially useful activities.

We also found rather low Internet usage efficiency in the Siberian regions. Here, users are mostly uninterested in education and science topics and do not demonstrate a high level of use of online services. At the same time, the entertainments search rate is above average.

The Far East regions are the most diverse in terms of the resulting integral index. Here are regions with both very low (Jewish Autonomous Region) and very high (Yakutia) Internet usage efficiency.

The regions of the Urals and Central Russia demonstrate high Internet usage efficiency. Here people most often search for useful services, information for education and science. The only exception is the Kurgan region.

To verify the validity of the methodology developed, it was necessary to assess whether it reflected the correlation between Internet usage efficiency and educational attainment and income levels found in other studies of digital inequality listed before. To do this, we built two scatter diagrams. The first (Figure 3) shows on the vertical axis the share of the population with higher education (based on the 2010 census, as newer data is not available) and the second (Figure 4) shows the average per capita income for 2016-2020. Source of data in both cases was the Rosstat website rosstat.gov.ru. The horizontal axis in both diagrams shows the calculated integral index of Internet usage efficiency. The size of the circles, each corresponding to a constituent entity of the Russian Federation, is proportional to the population size.

As we can see, in both cases the scatter diagrams appear to extend from the lower left to the upper right corner of the diagram, indicating a possible direct correlation between the indicators under investigation.

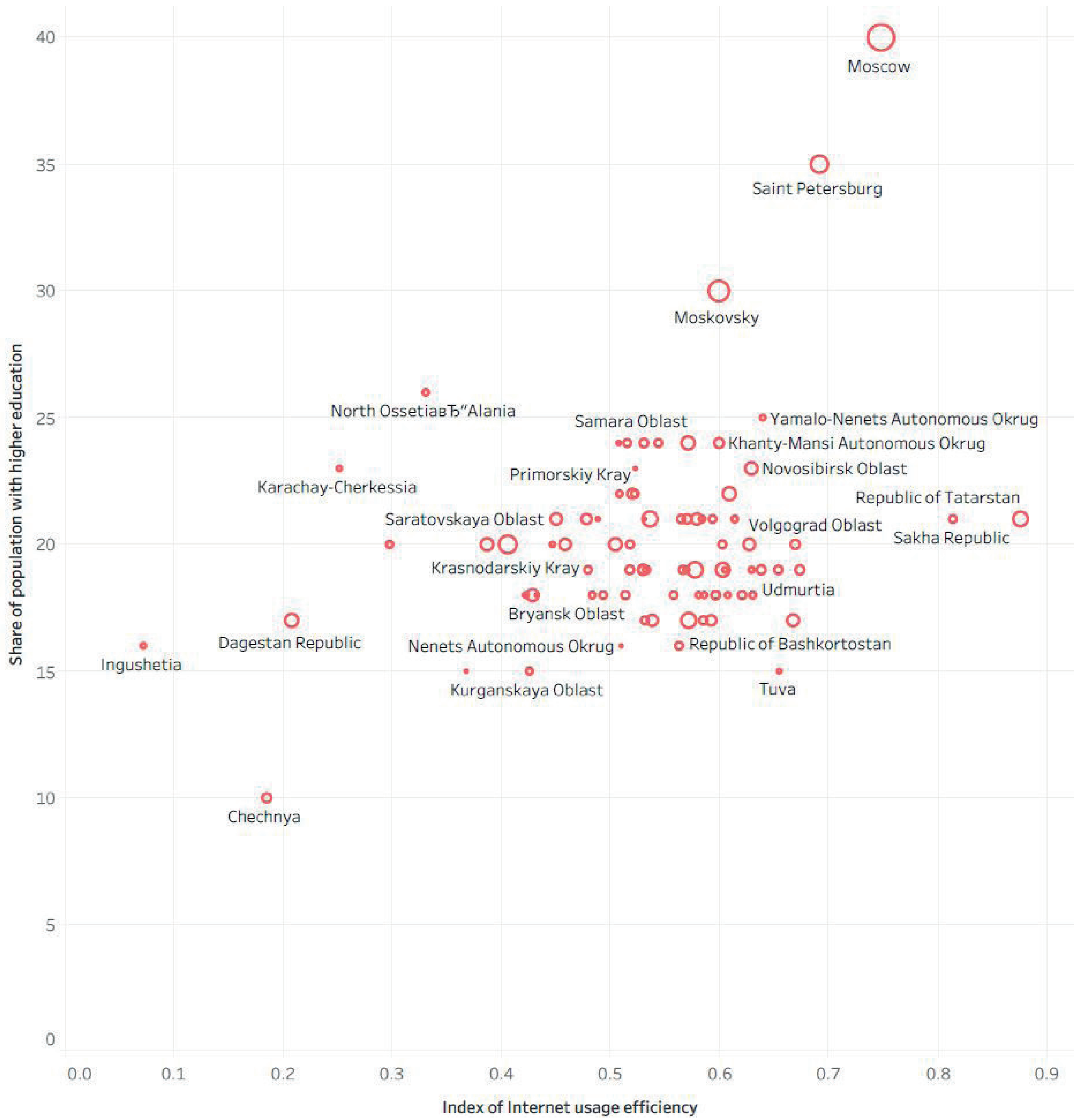

Fig. 3. Distribution of Internet usage efficiency and share of population with higher education by constituent entities of the Russian Federation

The uppermost points in Figure 3 (Moscow, Moscow region and St. Petersburg) are characterized by high levels of educational attainment and Internet usage efficiency. The Republics of Ingushetia, Chechnya, and Dagestan, on the other hand, are characterized by low Internet usage efficiency, combined with a low proportion of people with higher education.

Figure 4 highlights the sparsely populated oil and gas producing regions with high average per capita incomes: Yamalo-Nenets, Nenets, and Chukotka Autonomous Districts. They combine very high revenues with medium Internet usage efficiency. Another group of locations is in the Far East: Sakhalin Region, Magadan Region, and Kamchatka Krai. Here higher average per capita income is combined with a high cost of living, and the Internet usage efficiency index is medium. The Republics of Tatarstan and Sakha (Yakutia) have high rates of Internet usage efficiency and medium level of income. The republics of the North Caucasus are characterized by both low income and low Internet usage efficiency.

DISCUSSION

Research on the geography of digital inequality is currently limited and in need of further methodological development. The study of digital inequality cannot be limited to simply examining differences in Internet access between different population groups. It is also important to consider the inequalities caused by certain groups' lack of skills in using modern technology and applying it to improve their standard of living and quality of life. Digital inequality can have significant consequences for social and economic mobility, as well as for social cohesion and democratic participation. It is crucial for policy makers, businesses, and other stakeholders to address these issues and work towards reducing digital inequality.

Differences in specific online activities — learning, receiving services, having fun — are mainly explained by users' interests, as well as available online skills, which, in turn, depend on social standing. Differences in the purposes

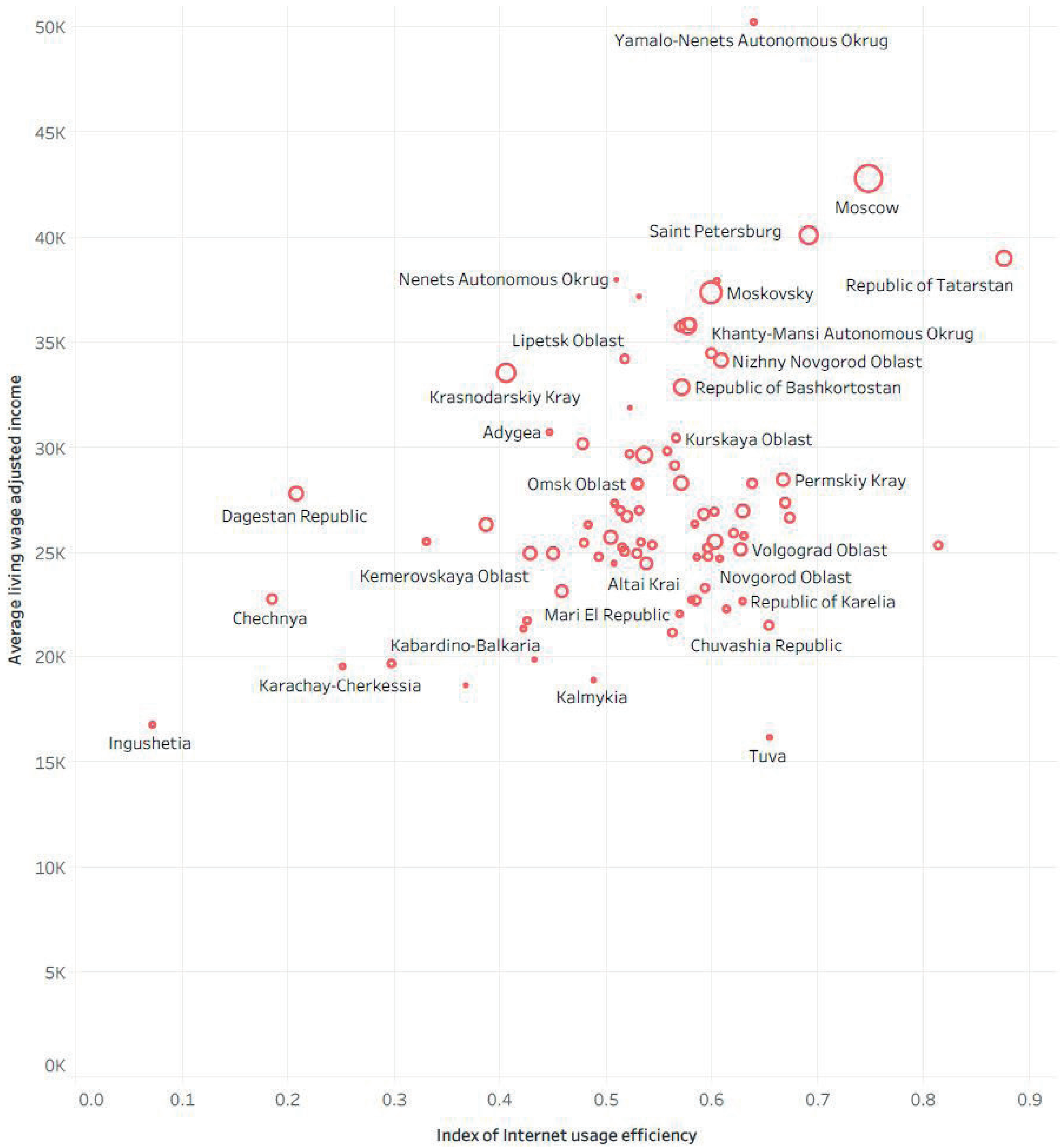

Fig. 4. Distribution of Internet usage efficiency average living wage adjusted income by constituent entities of the Russian Federation

for which the Internet is used tend to further exacerbate social inequalities. People who use modern technology only for entertainment purposes do not get any additional opportunities to improve their education and quality of life (e.g., to improve their health by getting timely medical advice online, which is especially relevant in a pandemic). The study reveals territorial aspects of Internet usage patterns at the level of constituent entities of the Russian Federation, expressed in differences in Google search interest in the topics we selected as digital inequality markers.

The values of the calculated integral index of Internet usage efficiency were mapped. We demonstrated that the Internet usage efficiency indicator is likely to have a direct correlation with the income level of the population and the level of education, which is consistent with the known global research on the digital inequality.

This method has several benefits. First, it is quick and easy to implement. By using Google Trends, researchers can easily access and analyze large amounts of data on internet search patterns. Second, it is cost-effective, as it does not require expensive phone surveys or other resources to collect data. Finally, it can be used to compare internet usage patterns across different regions, making it useful for international comparisons. However, it is important to note that this method does have limitations.

Relying on Google Trends data may introduce bias, as not all internet users use Google as their search engine. This means that the results may not accurately represent the internet usage patterns of the entire population. The method only considers the popularity of certain search queries and does not consider the frequency or duration of internet usage, or the specific websites or services accessed. The method only considers internet usage at a regional level and does not consider individual-level factors that may influence internet usage patterns, such as age, education, or income.

CONCLUSIONS

The study demonstrates the potential for spatial estimation of third-level digital inequality by analyzing Google search queries. The results revealed geographical patterns in Internet usage efficiency in the constituent entities of the Russian Federation, with regions in North Caucasus and Siberia showing low efficiency and regions in the Urals and Central Russia showing high efficiency. The study highlights the importance of not only considering differences in Internet access, but also the lack of skills in using technology among certain groups.

The method used in this study has several benefits, including its speed, cost-effectiveness, and ease of implementation. However, it is important to note that the method has limitations and may introduce bias by relying on Google Trends data.

The findings of this study have important implications for public policy, businesses, and other stakeholders in addressing digital inequality. The study recommends that efforts to reduce digital inequality should not be limited to providing equal access to the Internet but should also include measures to improve digital literacy and the potential for users to realize their full potential online.

The study's results and methodology can contribute to the development of the Russian scientific community's understanding of digital inequality and its spatial characteristics. Further research is needed to refine the methodology and expand its application to other regions and countries. The study provides valuable insights into the geography of digital inequality and can inform the development of targeted interventions to reduce this inequality and promote digital inclusion for all. ■

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