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## *Оригинальные статьи*

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# Exploring Local Labor Markets and Knowledge Spillover from a Spatial Perspective

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**ABSTRACT**

**Relevance.** Cities serve as vital hubs for socioeconomic activities, fostering convergence in local labor markets characterized by high productivity, premium wages, and knowledge spillover. Jakarta Metropolitan, as Indonesia's economic center, embodies these advantages, prompting the need for a spatial investigation of their regional association.

**Research Objective.** This study examines the unique attributes of the labor market in the Jakarta Metropolitan Area. The analysis encompasses anomalies such as the impact of premium wages on local labor productivity and the influence of education levels, as a proxy for knowledge spillover, on urban labor productivity.

**Data and Methods.** Utilizing microdata from Sakernas and macrodata from BPS for 2017-2019, this study offers a comprehensive analysis of the Jakarta Metropolitan Area. By synthesizing cross-level data, the intricate interplay between productivity, wages, and area size becomes evident, particularly the tendency for skilled individuals to gravitate toward larger urban centers. Employing spatial regression, the analysis takes into account local characteristics in regions.

**Results.** Density and education have a positive correlation, while the number of holders of bachelor's degrees has a surprisingly negative impact on productivity. Notably, higher aggregate education levels enhance regional productivity throughout the Jakarta Metropolitan Area, except for highly educated individuals. The level of education influences the minimum wage in a region, driven by spatial disparities in the educational infrastructure and quality. The number of educated people also influences wages in and across regions, prompting migration to regions with higher salaries.

**Conclusions.** By integrating microdata and macrodata and employing spatial regression techniques, this study shows the connection between education, productivity, and regional dynamics, particularly in the Jakarta Metropolitan Area. These findings challenge the assumption that possessing a high level of education guarantees higher productivity and remuneration, demonstrating the need for education reforms that align with labor market demands and bolster the economy.

**KEYWORDS**
local labor market; knowledge spillover; urban area; wage premium; productivity; Indonesia

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# Анализ локальных рынков труда и эффекта перетока знаний: пространственный аспект

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**АННОТАЦИЯ**

**Актуальность.** Города служат жизненно важными центрами социально-экономической активности, способствуя конвергенции локальных рынков труда, характеризующихся высокой производительностью, премиальной заработной платой и наличием эффекта перетока знаний. Столичный регион Джакарта, как экономический центр Индонезии, воплощает в себе эти преимущества, что вызывает необходимость исследования специфики их пространственного проявления.

**КЛЮЧЕВЫЕ СЛОВА**
локальный рынок труда; эффект перетока знаний; городская территория; надбавка к заработной плате; производительность; Индонезия





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**Цель исследования.** В исследовании рассматриваются уникальные особенности рынка труда в столичном регионе Джакарта. Анализ охватывает такие явления, как влияние премиальной заработной платы на производительность труда на локальном уровне и влияние уровня образования, как показателя распространения знаний, на производительность труда в городах.
**Данные и методы.** На основе микроданных Национального обследования рабочей силы (Sakernas) и макроданных Государственной службы статистики Индонезии (BPS) за 2017-2019 годы, в исследовании выполнен всесторонний анализ рынка труда столичного региона Джакарта. При обобщении перекрестных данных становится очевидной сложная взаимосвязь между производительностью, заработной платой и размером территории, а также тенденция к тому, что квалифицированные специалисты тяготеют к более крупным городским центрам. Использование пространственной регрессии позволяет учесть локальные особенности исследуемых регионов.
**Результаты.** Плотность населения и образование имеют положительную корреляцию, в то время как количество обладателей степеней бакалавра оказывает, как ни парадоксально, негативное влияние на производительность труда. Примечательно, что более высокий совокупный уровень образования повышает региональную производительность во всем столичном регионе Джакарты, за исключением высокообразованных людей. Уровень образования влияет на минимальную заработную плату в регионе, что обусловлено пространственными различиями в инфраструктуре и качестве образования. Количество образованных людей также влияет на ситуацию внутри региона и характер взаимовлияния регионов, стимулируя миграцию в регионы с более высокими зарплатами.
**Выводы.** Интегрируя микроданные и макроданные и используя методы пространственной регрессии, это исследование показывает связь между образованием, производительностью и региональной динамикой, фокусируясь на примере столичного региона Джакарта. Эти результаты ставят под сомнение предположение о том, что обладание высоким уровнем образования гарантирует более высокую производительность и оплату труда; демонстрируют необходимость реформ образования, которые обеспечили бы соответствие образования требованиям рынка труда и укрепили бы экономику.

**БЛАГОДАРНОСТИ**
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# 地方劳动力市场和知识溢出效应分析：空间视角

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**摘要**
**现实性**：城市是社会和经济活动的重要中心，促进了高生产率、高工资和知识溢出为特征的当地劳动力市场的融合。雅加达首都地区作为印度尼西亚的经济中心，体现了这些优势，因此有必要研究其空间表现的具体情况。
**研究目标**：该研究探讨了雅加达首都地区劳动力市场的独特特征。分析涵盖了工资溢价对地方劳动生产率的影响，以及作为知识传播指标的教育水平对城市劳动生产率的影响等现象。
**数据与方法**：该研究基于2017-2019年国家劳动力调查（Sakernas）的微观数据和印度尼西亚国家统计局（BPS）的宏观数据，并对雅加达首都地区的劳动力市场进行了全面分析。当汇总横截面数据时，生产力、工资和地区规模之间的复杂关系变得显而易见，技术专业人员倾向于向较大的城市中心倾斜。而空间回归的使用使我们能够考虑到所研究地区的地方特点。
**研究结果：**人口密度和教育程度呈正相关，而矛盾的是，拥有学士学位的人数却对劳动生产率产生负面影响。值得注意的是，在整个雅加达首都地区，除了受过高等教育的人之外，总体教育水平越高，地区生产率就越高。由于基础设施和教育质量的空间差异，教育水平会影响地区最低工资。受教育人口的数量也会影响区域内的情况和区域间的性质，鼓励人口向工资较高的区域迁移。
**结论**：通过整合微观和宏观数据并使用空间回归技术，本研究以雅加达首都地区为例，展示了教育、生产力和地区动态之间的关系。这些结果挑战了“高水平的教育可以保证更高的生产率和工资”的假设。表明有必要进行教育改革，使教育与劳动力市场需求相一致，并加强经济发展。

**关键词**
当地劳动力市场、知识溢出效应、城市、工资溢价、生产率、印度尼西亚

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## Introduction

The city is renowned as a hub for the exchange of information and the transaction of goods and services, serving as a focal point for socio-economic activities. Given its grandeur, the city naturally demands high productivity, competitive wages, top-tier education, and quality healthcare services, among others. However, the array of conveniences provided by urban environments contributes to congestion and density, leading to concentrated labor forces and subsequently, elevated living costs.

The primary incentive for individuals to relocate to urban areas is the allure of higher wages. Gould (2007), Glaeser and Maré (2001), for instance, found that the basic urban wage premium for smaller cities surpasses 21%, while for moderately-sized cities with over a million residents, the wage premium exceeds 30% compared to areas outside this territory. Similar evidence was presented by Combes et al. (2007) for France, and Díaz-Dapena et al. (2017) for Spain.

The urban wage premium prevalent in cosmopolitan areas can stem from either heightened labor productivity in downtown regions or the inclination of workers to pursue more promising careers and live in a metropolitan environment. Consequently, the premium salary aligns with higher levels of education; without a doubt, cities boast an ample supply of skilled and well-educated labor. This phenomenon is observable in Indonesia as well, where education correlates with higher earnings (as illustrated in Figure 1). Figure 1 demonstrates that obtaining a university degree correlates with higher wages. In contrast, the earnings of those with only an elementary school education are approximately half the salary of university graduates. Theoretically, education levels show a positive correlation with income. Indonesia's system of compulsory education comprises primary school (Sekolah Dasar – SD) (6 years), junior high school (Sekolah Menegah Pertama – SMP) (3 years), and high school divided in senior high school (Sekolah Menengah Atas – SMA) and vocational high school (Sekolah Menegah Kejuruan – SMK) (3 years). After completing compulsory education, students can enter an institution of higher education, which can be roughly divided into institutions of higher vocational education (Diploma 1 (D1), Diploma 2 (D2), Diploma 3 (D3), Diploma 4 (D4)) and those of academic education (bachelor, master, and doctoral degrees). However, after 2021, the salaries of high school graduates (SMA/SMK) have shown a slight decline, while those of people with primary school education (SD) and junior high school (SMP) levels have remained relatively stable. This shift has contributed to the evolution of Indonesia's labor market dynamics.

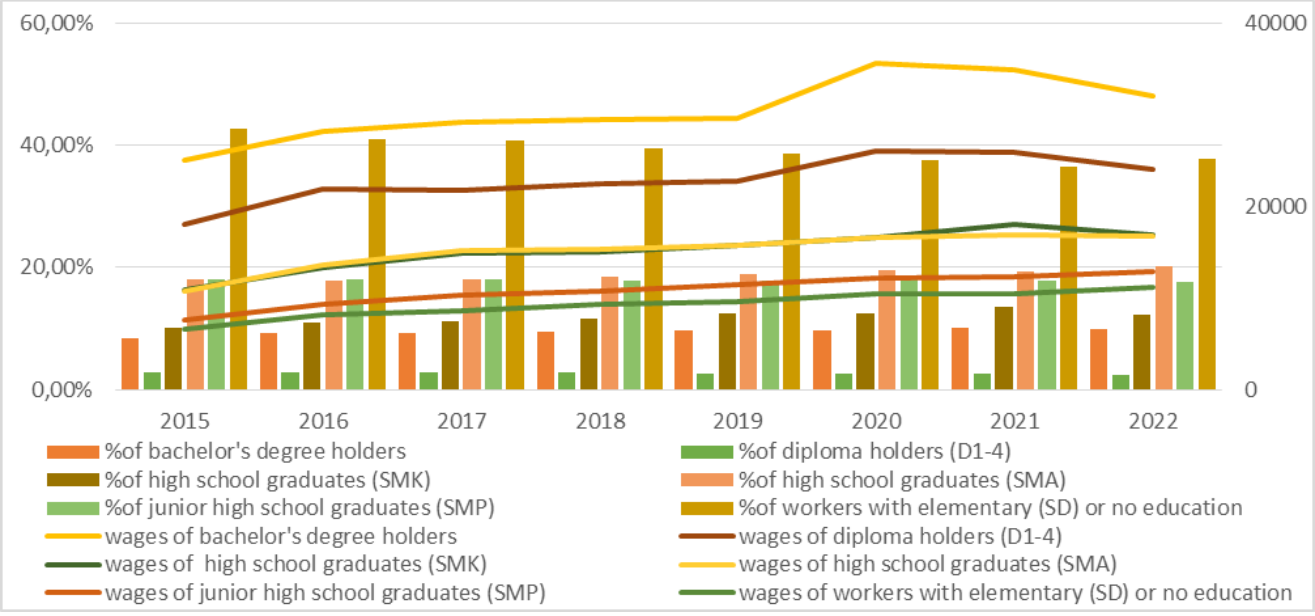


***Figure 1.*** *Average wage per hour (Rupiah/Hour) and workers with different levels of education (%) in Indonesia*
*Source: Compiled by the authors based on the data from the labor section of Badan Pusat Statistik Indonesia. Retrieved from:* https://www.bps.go.id/indicator/19/1175/1/upah-rata---rata-per-jam-pekerja-menurut-tingkat-pendidikan.html;https://www.bps.go.id/statictable/2016/04/05/1909/penduduk-berumur-15-tahun-ke-atas-menurut-pendidikan-tertinggi-yang-di-tamatkan-dan-jenis-kegiatan-selama-seminggu-yang-lalu-2008-2022.html (Date of access: 16 June 2023)


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Furthermore, delving into Indonesia's labor market structure based on education levels, it becomes apparent that the labor force predominantly consists of individuals with elementary education, constituting 37.88%. These workers received less than 15,000 rupiahs per hour in 2022 (Figure 1). In 2022, the average wage for Indonesian laborers hovered around 18,973 rupiahs per hour, and a significant 87.88% of those with education ranging from primary school (SD) to high school diploma (SMA/SMK) earn an average wage of less than 15,000 rupiahs per hour.

Additionally, the labor segmentation in Indonesia's cosmopolitan centers also attracts those with lower levels of education. Allen et al. (2016) showed that unskilled laborers earning lower wages are predominantly concentrated in urban areas, likely due to the fact that 50% of the labor force resides in cities. Consequently, this attraction can both stimulate urban productivity and economic growth, while also generating challenges such as poverty and the emergence of slum areas.

The high level of productivity and attractive wages naturally lead to a substantial influx of highly skilled labor. Urban environments offer exceptional amenities that encourage swift interactions among individuals possessing top-tier education and advanced skills. Consequently, metropolises become hubs attracting individuals with excellent education and sought-after skills. This convergence of educated individuals, along with their ability to adapt to new challenges, fuels Indonesia's sustainable economic growth, especially in urban zones such as the Jakarta Metropolitan Area.

However, there is a certain disparity in the distribution of education in Jakarta (Muhaimin et al., 2022), which generates varying productivity levels across different locations within the Jakarta Metropolitan Area. Imagine a scenario where all individuals in urban areas have access to proper education to confront the challenges of the new industrial revolution; as a result, other areas could also influence the enhancement of urban regions. This phenomenon of knowledge dissemination in cities is termed knowledge spillover, a mechanism that amplifies city productivity and fosters sustainable economic growth.

The above-described situation in Jakarta has determined the purpose of this study, which aims to gain an understanding of the interconnection of productivity, wages, knowledge spillover, and labor market conditions in Indonesia's metropolises, with a particular focus on the Jakarta Metropolitan Area.

Furthermore, the Jakarta Metropolitan Area, encompassing 13 municipalities/cities, exhibits distinct characteristics. Consequently, a spatial model framework proves to be an invaluable tool for dissecting these unique attributes and interactions. By integrating spatial elements, such as geographic proximity, into the analysis, a deeper understanding of the impacts of agglomeration and knowledge spillover on labor market outcomes can be gained. The prime focus of this paper is on the anomalies in the local labor market of urban areas, particularly the Jakarta Metropolitan Area, which is Indonesia's capital city and a sprawling metropolis. These anomalies include the impact of wages on the productivity of the local labor market and the influence of different education levels in the local labor market, which act as proxies for knowledge spillover, on urban labor productivity. Achieving these objectives could confirm that dense urban areas foster knowledge spillover, which in turn boosts productivity and contributes to the enhancement of the national economy through higher salaries in cities.

## Theoretical framework

*Urban Labor Market and Productivity*

The city is an area with a high concentration of diverse professionals. Unquestionably, this pool of people creates a city that becomes a tremendously big labor market. Combes et al. (2012) remarked that agglomeration economies in larger cities encourage interchanges that enhance productivity, conceivably strengthened by localized natural benefits. In other words, urban agglomeration means that the local labor market's size can yield productivity gains (Ciccone, 2002; de la Roca & Puga, 2017; Glaeser &Resseger, 2010; Groot & de Groot, 2020; Lee et al., 2017; Prasertsoong&Puttanapong, 2022; Venhorst, 2017). The higher productivity observed in a dense labor market could be influenced by preferences that arise due to increased competition in that market (Ciccone, 2002; Di Giacinto et al., 2020; Gould, 2007; Henderson & Turner, 2020; Moretti, 2010; Shi et al., 2022; Sveikauskas, 1975; Tadjoeddin& Mercer-Blackman, 2018). Moretti (2010) contends that the size of the labor market is correlated with reduced unemployment risk for employees and the presence of job vacancies for companies, both of which reflect wage differences.


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The urban environment's external effects on productivity are associated with the fact that the more prominent and denser accommodations imply a robust positive relationship between urbanization and economic development (Di Giacinto et al., 2020; Henderson & Turner, 2020; Moretti, 2010; Sveikauskas, 1975; Tadjoeddin& Mercer-Blackman, 2018). Prasertsoong and Puttanapong (2022) proved that a higher population thickness in Thailand increases labor productivity due to a high agglomeration pressure yielded by density. According to Tadjoeddin and Mercer-Blackman(2018), urban economies produced by agglomeration economies have better worker productivity, as the case of the Jakarta Metropolitan Area illustrates. Moreover, Di Giacinto et al. (2020) stated that density plays a significant role in metropolitan productivity; for instance, doubling density increases productivity by 2-4%. Kuswardana et al. (2021) conducted a primary investigation of the relationship between job density and productivity. They found that as an agglomeration increases in size, the impact on productivity remains consistently around 2-6%. This result is in line with previous studies, such as Ciccone (2002).

Furthermore, Lee et al. (2017) showed the significance of population density driven by localization and urbanization economies. Similarly, de la Roca and Puga (2017) discuss the fundamental queries of urban economics: evaluating the productive advantages of metropolises and understanding their essence. The advantages of urban areas' productivity are exemplified by the increased productivity of firms operating in them (de la Roca & Puga, 2017; Glaeser & Xiong, 2017; Henderson & Turner, 2020; Lee et al., 2017), highlighting the crucial role cities play in national economic development.

The assertion that cities are labor markets is fundamentally accurate. The undeniable allure of metropolitan amenities must also be acknowledged (Glaeser & Xiong, 2017; Gould, 2007; Henderson & Turner, 2020). Thus, at its core, the overarching dynamic centers on cities assuming the role of hubs wherein companies actively recruit employees while individuals seek to secure employment opportunities. Chen et al. (2020) noted that workers in large firms tend to be more productive due to heightened labor competition. A parallel logic applies to employees in large cities, where higher effectiveness and productivity are observed (Henrekson, 2020). The convergence of firms and workers in a single location enhances productivity (Combes et al., 2012), thereby stimulating the city's development.

Previous studies confirm strong and positive connections between productivity, agglomeration, and premium earnings in urban areas (Combes et al., 2007; Díaz-Dapena et al., 2017; Glaeser & Maré, 2001; Gould, 2007; Lee et al., 2017; Moretti, 2010; Prasertsoong & Puttanapong, 2022; Tadjoeddin & Mercer-Blackman, 2018). The interplay between regional size, productivity, and wage offerings per sector in cities influences residential choices (de la Roca & Puga, 2017; Glaeser & Resseger, 2010; Gould, 2007; Lee et al., 2017; Venhorst, 2017). Li et al. (2021) concluded that high wages determine the quality of the workforce, reinforcing the idea that cities are zones of productivity with substantial paychecks and progressive technology.

As for education, both public and private, it tends to be higher in urban areas. Moreover, human capital accumulation is accelerated in metropolises through in-person interactions (Glaeser & Maré, 2001; Glaeser & Resseger, 2010). Concerning firms' spatial sorting, the concept suggests that as businesses grow, labor market competition intensifies, allowing only the most productive firms to thrive. This dynamic enables firms to attract higher-quality workers, contributing to their expansion or enhanced productivity (Glaeser & Resseger, 2010; Lee et al., 2017).

Multiple studies investigating the correlation between premium pay and urbanization imply that higher productivity in a metropolitan area positively affects individual incomes, even when considering different timeframes and datasets (de la Roca & Puga, 2017). Furthermore, it's accurate to state that cities fundamentally operate as labor markets. Certainly, we cannot disregard the attractiveness of urban amenities. Di Giacinto (2020) demonstrated a strong correlation between the labor productivity component of urban productivity and demographic factors, serving as a proxy for labor market density. Notably, productivity increases alongside density (Glaeser & Resseger, 2010; Glaeser & Xiong, 2017; Tadjoeddin & Mercer-Blackman, 2018).

Moreover, there is a tendency for uneven growth in productivity across different sectors (Manning & Pratomo, 2018; Sugiyarto et al., 2006). To a certain extent, the shift from agriculture to manufacturing and services is a response to low productivity in the agricultural sector. However, despite this broader economic adjustment, a significant portion of the population remains engaged in low-productivity industries. This phenomenon isn't exclusive to agriculture but also prevails in urban areas where


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industries exhibit a low rate of labor absorption, particularly during the industrial revolution era. Consequently, local urban labor is required to possess high skills and productivity. The compensation for their heightened efficiency and productivity is the high wages offered by urban areas.

*Local Labor Market, Wages, and Knowledge Spillover*

Higher earnings consistently lead workers to contemplate moving, especially to cities. According to the widely accepted view, agglomeration economies come into play as productivity increases alongside higher population density, resulting in larger rewards for local workers (Di Giacinto et al., 2020; Henderson & Turner, 2020; Tadjoeddin & Mercer-Blackman, 2018). Glaeser & Maré (2001) cite Max Weber, who reported a 50% wage disparity between rural and urban areas in Germany. This gap proved significant for taxing purposes and roughly equivalent to the daily earnings of unskilled urban labor (Halfdanarson et al., 2008). Acar (2003) showed that in developing countries, agricultural wages were approximately 41% lower than the nominal urban wages for full-time unskilled labor. In the 1830s, England witnessed a more pronounced wage gap of around 73%, while the USA experienced a 50% gap in the mid-1890s (Acar, 2003).

Gould (2007) and Glaeser and Maré (2001) showed that locations with over 1 million residents exhibit an average wage approximately 30% higher than smaller areas, the latter enjoying a basic urban wage premium of about 21%. Glaeser and Resseger (2010) concluded that real wages rise in tandem with city population. Similar findings were reported by Combes et al. (2007) for France and Diaz-Dapena et al. (2017) for Spain. In Thailand, higher population density translates to increased labor productivity: Prasertsoong and Puttanapong (2022) demonstrate a concentrated high wage pattern in Bangkok and its environs, a result of strong agglomeration forces due to higher population density. Thus, it may be concluded that the higher wages offered by cities are the main factor that attracts labor to these areas.

According to Zgarrick et al. (2020), the wage premium serves as a critical tool for assessing the labor market, essential for maintaining and supporting the labor force. Furthermore, Li et al. (2021) emphasize that wages fundamentally reflect the economic standing of workers and serve as a critical gauge of the quality of their employment.

Glaeser and Xiong (2017) show the key role of the relationship between productivity, earnings per worker, and the size of the area in urban economics. They hypothesize that this connection reflects the preference of more skilled professionals to establish themselves in non-rural areas, driven by urban prominence as a market access point that attracts educated labor with higher earnings (de la Roca & Puga, 2017; Di Giacinto et al., 2020; Glaeser & Maré, 2001; Glaeser & Xiong, 2017; Groot & de Groot, 2020; Henderson & Turner, 2020; Lee et al., 2017; Moretti, 2010; Prasertsoong & Puttanapong, 2022; Shi et al., 2022; Tadjoeddin & Mercer-Blackman, 2018; Venhorst, 2017). This convergence of educated labor in urban areas is highlighted by Duranton & Puga (2020), Glaeser & Maré (2001), Lamorgese et al. (2019), Lu (2022), Moretti (2010), Shi et al. (2022), and Tadjoeddin & Mercer-Blackman (2018). Consequently, urban spillovers encompass both premium wages and knowledge sharing.

Gould (2007) contends that higher productivity, which leads to an increased presence of skilled workers in cities and ideal conditions for human capital development, drives higher earnings in urban areas. Additionally, Di Giacinto et al. (2020) find that the availability of local human capital is closely tied to the benefits of increased urban productivity due to the depth of the labor market and recognized indicators of agglomeration economies. Prasertsoong and Puttanapong (2022) assert that labor skill is compounded by localized productivity and wages. Tadjoeddin and Mercer-Blackman (2018) highlight that cities foster efficiency through proximity, facilitating the exchange of ideas, knowledge dissemination, and creativity. Glaeser and Xiong (2017) add that higher firm density in specific locations fosters the exchange of ideas and job matching, reducing search costs and promoting flexibility. Since well-educated individuals tend to live in highly productive urban areas, this solidifies the recognition of cities as productive hubs, offering competitive wages and advanced technology.

The research literature predominantly focuses on the positive effects of urban labor markets and knowledge spillover in developed countries while the implications for developing countries remain a question, particularly the effectiveness of local knowledge spillovers. Kesidou and Romjin (2008) and Kesidou and Szirmai (2008) conducted research among software firms in Uruguay and found that local knowledge spillovers enhance firm performance. Their findings are further sup-


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plemented by Chen et al. (2020), who utilized a probit model to explore knowledge distribution across urban areas in various developing Asian countries, including Indonesia. Chen et al. (2020) argue that larger city populations correlate with a higher propensity for innovation. However, their study covered Jakarta as a province rather than a specific metropolitan area.

Taniguchi et al. (2018) noted that Indonesia's labor productivity still has room for improvement, and educational investments should be aligned with market demands. Consequently, delving into the Jakarta Metropolitan Area, a pivotal hub in Indonesia, could yield us valuable insights into this issue. Jakarta serves as both the cornerstone of Java's economic corridor and the capital city of Indonesia. Setyawan et al. (2020) showed Jakarta's significance in offering ample job opportunities for individuals with higher education levels, leading to commuter activities that influence economic development in their respective regions. This effect reverberates in terms of economic activities and the regional minimum wage (Setyawan et al., 2020). As far as education is concerned, Muhaimin et al. (2022) showed that achieving educational equity through the school zoning system in Jakarta hinges on the existence of spatial justice. Concurrently, Kuswardana et al. (2021) discovered that in Indonesia, inter-sectoral knowledge spillover has a positive impact on productivity, especially in capital-intensive industries. This underscores the need for comprehensive research on the intricate interplay between urban economies, labor markets, and knowledge diffusion within the spatial confines of the Jakarta Metropolitan Area. Such studies hold the potential to enrich analyses related to this matter, especially within the context of developing countries.

## Method and data

Numerous empirical studies on agglomeration have centered around using urban and industrial size as indicators of productivity, with premium wages often serving as a motivating factor for agglomeration economies. Additionally, the concept of knowledge spillovers is highlighted as a benefit stemming from agglomeration. Furthermore, considering the inevitable interaction between regions, this can be reflected through a spatial weight matrix with a weight structure expressed mathematically as follows:

$$\begin{bmatrix} w_{11} & \cdots & w_{1N} \\ \vdots & \ddots & \vdots \\ w_{N1} & \cdots & w_{NN} \end{bmatrix}, \quad (1)$$

A spatial weights matrix ($W$) is an $N$ by $N$ positive and symmetric matrix that identifies, for each observation (row), the positions (columns) with non-zero elements, determined by their neighborhood relationships (Anselin & Bera, 1998). Specifically, wij= 1 when i and j are neighbors, and wij = 0 otherwise. The diagonal elements of the weight matrix are set to zero, and the sum of each row is equal to one. This results in components of the row-standardized weights matrix being uniform. In the context of geography, the construction of W is based on either adjacency connections or the closest k neighbors, determined through Euclidean distance measurements.

Indonesia employs a five-tiered geographic system consisting of national, provincial, district/municipality (*kabupaten*) and city (*kota*), sub-district (*kecamatan*), and village (*desa*) levels. In this study, the focus is on the kabupaten/kota level, which represents the third tier in this system. The study specifically centers on the Jakarta Metropolitan Area, encompassing the following areas: Central Jakarta, East Jakarta, West Jakarta, North Jakarta, South Jakarta, Bekasi City, Bekasi Municipality, Depok City, Bogor City, Bogor Municipality, Tangerang City, Tangerang Municipality, and Kepulauan Seribu. It's worth noting that the areas with water boundaries may lack neighboring areas. The data used in this research is sourced from the National Labor Force Survey (Sakernas) and Statistics Indonesia (BPS). BPS offers open-access data, collected annually up to the third-tier level. As a result, data on various variables such as productivity, wages, population, density, localization economy, human development index, and education rate are gathered. On the other hand, Sakernas provides detailed household-level microdata, though access is limited. Data regarding educated individuals, specifically those holding bachelor's degrees, is sourced from Sakernas. Therefore, this study employs aggregated data from Sakernas and BPS for 2017-2019, covering 13 kabupaten/kota in the Jakarta Metropolitan Area.

The spatial lag or spatial autoregressive model (SAR) is applicable to assess the existence and strength of spatial interaction. The SAR model is formalized as follows (Anselin& Bera, 1998; Elhorst, 2014b):


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$$Y_{nt} = \rho_0 WY_{nt} + X_{nt}\beta_0 + U_{nt} \quad (2)$$

where $Y_{nt}$ represents the dependent variable, $\rho$ stands for the coefficient of spatial autoregression, and $\varepsilon$ represents a vector of error terms. $WY_{nt}$ signifies the spatial lag for y at i. Another approach is the spatial error model (SEM), which arises when error terms are correlated across observations, meaning that an observation's error affects the errors of its neighbors, hence defined as:

$$\begin{aligned} Y_{nt} &= X_{nt}\beta_0 + U_{nt} \\ U_{nt} &= \lambda W_u + \varepsilon \end{aligned} \quad (3)$$

where $W_u$ is the spatial lag in errors and $\varepsilon$ is a vector of error terms. Further, the Spatial Durbin Model (SDM) is a model that can support both spatially lagged dependent and independent variables (Elhorst, 2014b; LeSage& Pace, 2009a). Anselin and Bera (1998) stated that SDM solves the similarity between spatial lag and error models and imposes a spillover effect for different explanatory variables. The SDM equation is as follows (Elhorst, 2014a):

$$\begin{aligned} Y_{nt} &= \rho_0 WY_{nt} + X_{nt}\beta_0 + WX\theta_{nt} + U_{nt} \\ U_{nt} &= \lambda W_u + \varepsilon \end{aligned} \quad (4)$$

where $WY_{nt}$ is the spatial lag of dependent variable, $WX$ is the spatial lag of independent variables, and $W_u$ is the spatial lag error term.

Moreover, incorporating the region into the spatial model introduces a distinct interpretation of the effects of changing variables. In a spatial context, spillovers are often described as changes in one location influencing changes in other regions. If we look at the SDM from equation (4), it can be rewritten in vector form as:

$$Y_i = (I - \rho W)^{-1}\alpha I_n + (I - \rho W)^{-1}(X_t\beta + WX_t\theta) + (I - \rho W)^{-1}\varepsilon_t \quad (5)$$

$$Y_i = \sum_{k=1}^{n} S_k(W)X_k + V(W)\alpha + V(W)\varepsilon, \quad (6)$$

where $V(W)=(I-\rho W)^{-1}$ degenerates to the identity matrix, $\alpha I_n$ is a vector constant parameter where vector $y$ does not have mean value of zero (Golgher& Voss, 2016; LeSage& Pace, 2009b). Moreover, $S_k(W)=(I-\rho W)^{-1}[I_N\beta_k+W\theta_k]$ presents as a "multiplier" which transforms $X_k$ into a matrix with higher-order adjacent relations (LeSage& Pace, 2009b). Let's expand the expected value to illustrate the function of $S_k(W)$ for a single dependent variable. This will lead to the following equation (6) (Elhorst, 2014b; LeSage& Pace, 2009b):

$$Y_i = \sum_{k=1}^{n}[S_k(W)_{i1}X_{1k} + \cdots + S_k(W)_{in}X_{nk}] + V(W)\alpha + V(W)\varepsilon \quad (7)$$

Moreover, the derivative $\partial y_i/\partial x_j$ can be used to represent the idea of spillover mathematically (Golgher& Voss, 2016). The dependent variable in area $j \neq i$ is affected by changes to the explanatory factors in region i. Lesage and Pace (LeSage& Pace, 2009b) clarified the complexity of the derivative of $y_i$ with respect to $X_{ik}$ in models with spatial lags of a dependent variable, where $i$ and $j$ stand for two different observations. Therefore, the impact of the expected value of area i, given a change in a particular variable for the same region or called direct effect (Golgher& Voss, 2016; LeSage& Pace, 2009b), is determined by:

$$\frac{\partial y_i}{\partial x_{ik}} = S_k(W)_{ii}, \quad (8)$$

where $S_k(W)_{ii}$ represents the i element of the matrix $S_k(W)$. The expected value of the dependent variable in i will change in response to a change in $x_{ik}$ and then pass via neighbors of i before returning to the origin area (Golgher& Voss, 2016; LeSage& Pace, 2009b). Meanwhile, the indirect effect is the impact of a unit increase in xj in a region on y in all other areas collectively. Considering equation (8) and modifying the explanatory variable $x_k$ in location $j$, the effect on the anticipated value of location $i$ is:

$$\frac{\partial y_i}{\partial x_{ik}} = S_k(W)_{ij} \quad (9)$$

where $S_k(W)_{ij}$ represents the $i$ and $j$ element of the matrix $S_k(W)$.

In theory, Sveikauskas (1975) proposed that the potential labor productivity gains in larger areas could be analyzed through regressions between value-added divided by labor in the city ($(V/L)_c$) and the city's population ($Pop_c$). However, as the quality of laborers tends to increase along with the urbanization rate, the equation examined by Sveikauskas is as follows:

$$\log(V/L)_c = \alpha + \beta_1 \log Pop_c + \beta_1 \log Edu_c + \varepsilon_{ct} \quad (10)$$

Following Sveikauskas' model and using the sector's industrial concentration or market share as a proxy for localization economies (Díaz-Dapena et al., 2017), we introduce an additional variable, referred to as Localization Economy (LE), into equation (10). As stated by Glaeser and Maré (2001), knowledge spillover or human externality could be approximated using the human development index and the proportion of bachelor's degree holders in the population. Extending this notion to comprehend productivity and education in the urban context, our variables for the initial model are as follows:

$$prod_c = f(D, HI, LE, BA, Pop) \quad (11)$$


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Here, c represents the specific region, and the dependent variable, 'prod,' pertains to the productivity of that region, calculated as the ratio of GDP to the labor force. The independent variables include density (D), the population size in the region (Pop), the human development index (HI), the education index (Edu) which signifies the literacy rate in the region, and localization economic (LE) which proxies the proportion of industrial sector share in the region's GDP. These data are sourced from BPS at the kabupaten/kota level within the Jakarta Metropolitan Area. Meanwhile, the percentage of holders of bachelor's degrees in the population (BA) is derived from the Sakernas microdata. This model aims to uncover how the influence of educated individuals, represented by the share of bachelor's degrees (BA), impacts the enhancement of urban productivity.

Therefore, the next step involves showing the existence of premium salaries and knowledge spillover, employing a composite framework built upon the work of Combes et al. (2007) and Lee et al. (2017). In this context, the minimum wage ($w_c$) will serve as the dependent variable and will be regressed against independent variables, similar to the previous equation. Additionally, productivity will be introduced as another independent variable (Díaz-Dapena et al., 2017). Thus, the formulation of the second model is as follows:

$$w_c = f(prod, D, HI, LE, BA, Pop) \quad (12)$$

Furthermore, while regional productivity and wages have garnered significant attention, it's essential to acknowledge that local attributes also play a pivotal role in shaping employment choices and corporate placements. It could be supposed that the correlation between productivity and urban scale signifies a preference of highly skilled individuals for larger metropolitan areas. Therefore, this approach aims to reveal the interplay between urban agglomeration, labor motivation (represented by wages), and knowledge spillover, while taking into account the nuances of local characteristics.

## Results

The structure of Indonesia's labor market features a substantial workforce supply, particularly owing to favorable demographic conditions, with the majority of the population concentrated in urban areas. These factors present an important opportunity for Indonesia's economy. However, as illustrated in Figure 1, the current state of the labor market structure is unsatisfactory primarily due to the fact that nearly 45% of the labor force has limited education (no education or primary school), and middle-level education (junior and senior high school). In contrast, the proportion of individuals with higher education (diploma of institutions of higher vocational education and academic degrees) is only around 10%. As a result, Indonesia's labor market faces a paradoxical situation, often linked to uneducated or low-skilled labor migration (Wijayanti & Turgel, 2021). This situation, combined with the benefits of the demographic dividend and rapid technological advancement, could potentially place Indonesia in a precarious position. This concern is particularly relevant in densely populated areas, such as urban centers, which play a crucial role in a country's economy. Hence, megacities such as Jakarta could be disproportionately affected by these challenges.

Jakarta, as Indonesia's capital city, has transformed into a metropolitan region known as Jabodetabek (Jakarta, Bogor, Depok, Tangerang, and Bekasi) due to agglomeration effects. Jakarta comprises distinct areas: Central Jakarta, East Jakarta, West Jakarta, North Jakarta, South Jakarta, and KepulauanSeribu. The cluster map shows that these areas can be grouped into four spatial clusters based on productivity and wages—high-high, low-low, high-low, and low-high (refer to Figure 2). This classification signifies that Central Jakarta and its surroundings exhibit both high productivity and wages, denoting its status as the core of Jakarta metropolitan (indicated by the red color in Figure 2). Central Jakarta functions as the administrative hub and has a high number of trading and service enterprises.

On the contrary, West Jakarta demonstrates high productivity but is encircled by areas with lower wage levels (indicated by the purple color in Figure 2). This phenomenon is explained by the influence of agglomeration, which boosts West Jakarta's productivity due to its proximity to key centers like Soekarno-Hatta International Airport. On the other hand, Bekasi City showcases high productivity within a region surrounded by lower wage areas. This can be attributed to East Jakarta's reputation as a less economically active area, resulting in similar low minimum wage levels for Bekasi Regency. Moreover, the concentration of factories in Bekasi City contributes to its higher productivity compared to East Jakarta and Bekasi Regency.

In contrast, Bogor Regency (indicated by the blue color in Figure 2) exhibits lower productiv-


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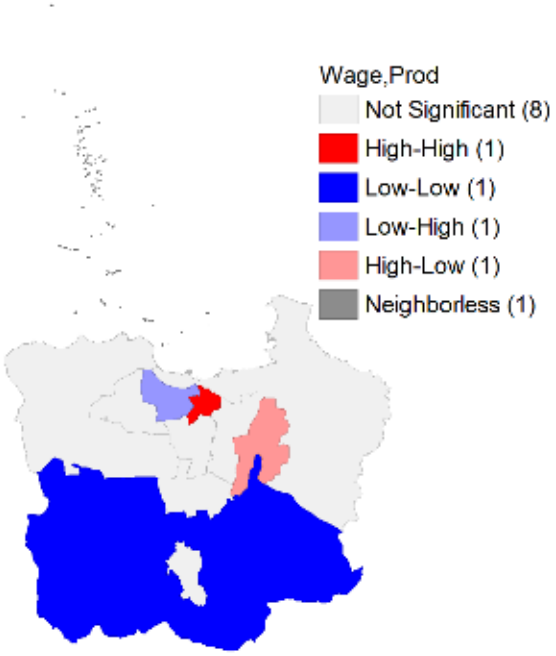


***Figure 2.*** *Cluster map of Jakarta Metropolitan*
*Source: compiled by the author*

Table 1

**AIC value for SAR, SEM, and SDM**

| | Model | SAR | SEM | SDM |
|---|---|---|---|---|
| Model 1 | AIC | 320.7514 | 317.3909 | 318.678 |
| Model 2 | AIC | 725.17 | 718.4942 | 717.6291 |

*Source: calculated by the author*

ity and wages compared to its neighboring areas. This disparity arises from its distant location from the economic core, reduced consumption and investment levels, and a lower human capital base, particularly in terms of education, compared to other regions.

Firstly, we employ the Akaike Information Criterion (AIC) test to assess the goodness of fit for these spatial models. The AIC test is commonly employed as an information criterion for comparing different model specifications (Darmofal, 2015). Table 1 indicates that the SEM exhibits the lowest AIC value for the first model, while the SDM has the lowest AIC value for the second model.

Moving forward, the Glaeser and Mare's equation yields intriguing results. This equation seeks to show how the presence of highly educated individuals with bachelor's degrees (BA) influences cities' productivity through minimum wage policies. Notably, the connection between the number of holders of bachelor's degrees and productivity exhibits a negative correlation. At the ASEAN level, hiring young workers with higher education is seen as more productive than hiring older workers (Wijayanti, 2018). Nevertheless, as can be seen from Table 2 and 4, a higher number of bachelor's degrees negatively affects productivity and wages. In essence, higher education, as a proxy for knowledge spillover in Jakarta, does not guarantee higher salaries and productivity. Recently, the perception of higher education in Indonesia has taken a negative turn, exacerbated by the pandemic. In the present scenario, many individuals are exploring alternative avenues, such as investment and programming courses offered by informal institutions.

However, in terms of spatial influence, the education rate in Jakarta has a positive impact on both productivity and wages (see Table 2 and Table 4). If we look at the direct effect on productivity, the education level in similar regions has a positive influence (Table 3). Meanwhile, the direct effect on wages indicates that the education level in a specific region affects the minimum wage level in that same region rather than neighboring ones (Table 5). This pattern is attributed to the concentration of education in Central and South Jakarta and the unequal distribution of schools across the Jakarta Metropolitan Area, as highlighted by Muhaimin et al. (2022).


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Table 2

**Primary analysis of productivity and knowledge spillover in the Jakarta Metropolitan Area**

| Prod | D | HI | LE | BA | Edu | Pop |
|---|---|---|---|---|---|---|
| OLS | 0.0064568 | 19.57861 | -3.064477 | -0.0011996 | -2.424324 | 3.26e-06 |
| | (0.0129569) | (20.41899) | (2.516236) | (0.0005642) | (8.582651) | (0.0000503) |
| SAR | 0.0350725*** | -6.782217 | 2.952632* | -0.0010612*** | -3.144468 | 7.34e-07 |
| | (0.0071625) | (11.20958) | (1.546813) | (0.0002734) | (28.97395) | (0.0000318) |
| SEM | 0.0323243*** | -8.986515 | 1.689443 | -.0009656*** | 85.39174** | -.0000179 |
| | (0.0062846) | (9.506901) | (1.507335) | (0.0002315) | (38.94964) | (0.0000262) |
| SDM | 0.0278014*** | -5.181213 | 0.6277514 | -0.0009916*** | 96.69396** | -0.0000138 |
| | (0.0076685) | (8.726163) | (2.05945) | (0.000234) | (43.15497) | (0.0000327) |

*Note: ***, **, and * represent significance at the 1%, 5% and 10% levels, respectively.*

*Source: calculated by the author*

Table 3

**Impact of the local labor market and educated workforce on the productivity of the Jakarta Metropolitan Area**

| Prod | | D | HI | LE | BA | Edu | Pop |
|---|---|---|---|---|---|---|---|
| SAR | DE | 0.0371396*** | -7.181951 | 3.126656* | -0.0011237*** | -3.329798 | 7.77e-07 |
| | | (0.0080486) | (12.02442) | (1.674515) | (0.0002805) | (30.59125) | (0.0000336) |
| | IE | 0.0384286 | -7.431205 | 3.235169 | -0.0011627 | -3.445361 | 8.04e-07 |
| | | (0.0313655) | (15.25365) | (3.220884) | (0.0008779) | (30.62066) | (0.0000345) |
| | TE | 0.0755682** | -14.61316 | 6.361824 | -0.0022864** | -6.775159 | 1.58e-06 |
| | | (0.0365192) | (26.91345) | (4.572995) | (0.0010024) | (61.1722) | (0.0000681) |
| SEM | DE | 0.0279518*** | -5.57644 | 0.6206622 | -0.0009874*** | 97.14964** | -0.0000144 |
| | | (0.0087529) | (10.91545) | (2.037261) | (0.0002381) | (42.41329) | (0.0000306) |
| | IE | -0.0490447 | 128.8298 | 2.310806 | -0.0013667 | -148.536** | 0.0002068*** |
| | | (0.0549612) | (102.6092) | (7.468917) | (0.0018078) | (64.62192) | (0.0000599) |
| | TE | -.0210929 | 123.2534 | 2.931468 | -0.0023541 | -51.38634 | 0.0001924*** |
| | | (0.0613009) | (106.7022) | (7.691653) | (0.0018648) | (50.93131) | (0.0000528) |
| SDM | DE | 0.0327375*** | -9.101392 | 1.711039 | -0.0009779*** | 86.48333** | -0.0000181 |
| | | (0.0058899) | (9.565377) | (1.495487) | (0.0002337) | (39.51695) | (0.0000264) |
| | IE | -0.0089122 | 2.477705 | -.4658024 | 0.0002662 | -23.54367 | 4.93e-06 |
| | | (0.0105611) | (3.658785) | (0.5260764) | (0.0003359) | (31.40571) | (8.37e-06) |
| | TE | 0.0238252 | -6.623687 | 1.245237 | -0.0007117 | 62.93966 | -0.0000132 |
| | | (0.0128391) | (8.039688) | (1.443478) | (0.0003587) | (39.43096) | (0.0000213) |

*Note: ***, **, and * represent significance at the 1%, 5% and 10% levels, respectively*

*Source: calculated by the author*

Table 3 presents the outcomes of the analysis regarding the impact of the local labor market and educated workforce on the productivity of the Jakarta Metropolitan Area. As indicated in Table 3, results from SAR, SEM, and SDM demonstrate that density and the education index exhibit a significant positive correlation, while the number of holders of bachelor's degrees displays a significant negative association with productivity. The direct effect size of 0.0327375 for density implies that a 1% increase in productivity corresponds to a 0.0327% enhancement in density. The influence of density on productivity suggests that regions with higher population density are more likely to attract individuals, contributing to increased density in those areas. This connection between denser living environments and heightened economic activity, competitiveness, and productivity aligns with various studies on the correlation between density and productivity (Di Giacinto et al., 2020; Gould, 2007; Henderson & Turner, 2020; Moretti, 2010; Prasertsoong & Puttanapong, 2022; Sveikauskas, 1975; Tadjoeddin & Mercer-Blackman, 2018).

Meanwhile, high population concentration has a negative impact on productivity in both approaches. Evidently, in Jakarta, this creates vari-



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ous challenges such as crime, poverty, and underdeveloped zones. Additionally, Jakarta's role as a hub for economic activity and migration contributes to the clustering of both people and businesses in the region. Nonetheless, Jakarta's localization economy, represented by the proxy of the manufacturing sector, shows no relevance to productivity. This outcome contradicts the findings of Combes et al. and several other studies that emphasize higher firm productivity in larger areas (P. Combes et al., 2012; de la Roca & Puga, 2017; Di Giacinto et al., 2020; Glaeser & Resseger, 2010; Groot & de Groot, 2020; Lee et al., 2017; Moretti, 2010; Prasertsoong & Puttanapong, 2022; Tadjoeddin & Mercer-Blackman, 2018; Venhorst, 2017). This outcome might be attributed to the proxy used for the localization economy, which primarily represents industrial sectors. Another possible interpretation is that it signifies a shift in the economic structure of Jakarta towards other sectors. Consequently, among the three variables analyzed, the education level of the region emerges as a key determinant of Jakarta's metropolitan productivity within a spatial context.

To explore the presence of productivity and human capital externalities, we examine the impact of the human development index on productivity in the Jakarta Metropolitan Area. The human development index is a composite measure of health, education, and living standards, serving as an indicator of regional welfare levels. Despite Jakarta's substantial population concentration, the dense and productive environment does not ensure uniformly high life expectancy, education, and per capita income. Consequently, the human development index exhibits a spatially negative relationship with productivity, registering a value of -9.101392. While cities offer numerous benefits, they also carry disadvantages, particularly in terms of managing a sizable population (de la Roca & Puga, 2017; Duranton & Puga, 2020).

The direct impacts of the number of holders of bachelor's degrees and the education index in a district are -0.0009779 and 86.4833, respectively (see Table 3). This result showcases the negative correlation between higher education and productivity, juxtaposed with the positive correlation between education levels and productivity in the Jakarta Metropolitan Area. Plausibly, higher education quality contributes to higher productivity in similar regions. However, the number of highly educated individuals has a negative impact on productivity, albeit relatively small. Hypothetically, such individuals may not contribute significantly to their region, potentially migrating to other areas or countries. Consequently, while aggregate-level education can drive productivity in each region of the Jakarta Metropolitan Area, the impact of highly educated individuals is different. This result disagrees with a number of studies that emphasize the value of high human capital in densely populated areas or cities (de la Roca & Puga, 2017; Di Giacinto et al., 2020; Duranton & Puga, 2020; Glaeser & Maré, 2001; Glaeser & Resseger, 2010; Glaeser & Xiong, 2017; Groot & de Groot, 2020; Halfdanarson et al., 2008; Henrekson, 2020; Kijek & Kijek, 2019; Lamorgese et al., 2019; Lee et al., 2017; Lu, 2022; Moretti, 2010; Shi et al., 2022; Tadjoeddin & Mercer-Blackman, 2018; Venhorst, 2017; Yin et al., 2022; Zgarrick et al., 2020). Presumably, this outcome stems from various factors, including: 1) the limited share of highly educated individuals in the labor market; 2) a mismatch between tertiary education curricula and labor market demands; 3) Indonesia's status as a developing country rather than a developed one; 4) disparities in school distribution in the Jakarta metropolitan area; and 5) the migration of highly educated individuals to other regions or countries. Consequently, the high level of education in the Jakarta Metropolitan Area does not necessarily align with the skill demands of the local labor market.

Meanwhile, the presence of educated individuals seems to decrease productivity in their respective regions, while also impacting the minimum wage in those regions and neighboring areas (see Table 5). This suggests that higher wages in certain regions attract educated individuals, prompting them to migrate, as noted by Setyawan et al. (2020). It's likely that firms or labor demand prefer locations with high education rates as an incentive for offering higher salaries. It could be supposed that while a high urban education rate could generally elevate wages, in the specific case of holders of bachelor's degrees, there seems to be no significant effect on productivity and wage. This phenomenon could be caused by such factors as limited job opportunities, a majority of the labor market being composed of lower-educated workers, or even the migration patterns of educated individuals.

More specifically, the components of the minimum wage structure do not seem to account for education, despite the high competitiveness in the metropolitan area; consequently, possessing


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Table 4

**Primary analysis of wages, productivity, and knowledge spillover in the Jakarta Metropolitan Area**

| Wage | Prod | D | HI | LE | BA | Edu | Pop |
|---|---|---|---|---|---|---|---|
| OLS | 433.0241 | 12.04379 | 45123.39 | 6629.431 | -1.31036 | -4820.967 | .1096157 |
| | (276.5905) | (20.35137) | (32403.9) | (4027.191) | (0.943041) | (13445.42) | (0.0787449) |
| SAR | 1913.316*** | 0.8693918 | 66204.27** | 7119.918** | -0.0915953 | 108875.3* | 0.1971435** |
| | (458.0517) | (22.79237) | (28437.6) | (3728.719) | (0.8016353) | (62736.03) | (0.0775362) |
| SEM | 2068.811*** | -3.873147 | 101215.3*** | 5534.871*** | -0.6434435** | 112599.1*** | 0.3352907*** |
| | (353.3042) | (18.06969) | (22287.3) | (2881.077) | (0.6439398) | (35049.16) | (0.0700849) |
| SDM | 1916.646*** | -28.71461 | 123768.3*** | 7409.1* | -1.61645*** | 425104.9 *** | 0.1630168** |
| | (365.9361) | (18.8779) | (16922.35) | (4160.121) | (0.5893733) | (121861) | (0.0766741) |

*Note: ***, **, and * represent significance at the 1%, 5% and 10% levels, respectively*

*Source: calculated by the author*

Table 5

**Impact of productivity and knowledge spillover on the wage level in the Jakarta Metropolitan Area**

| Wage | | Prod | D | HI | LE | BA | Edu | Pop |
|---|---|---|---|---|---|---|---|---|
| SAR | DE | 1915.216*** | 0.8702551 | 66270.01** | 7126.988** | -0.0916863 | 108983.4* | 0.1973393** |
| | | (454.2106) | (22.81633) | (28308.93) | (3734.476) | (0.8024122) | (62832.07) | (0.0771738) |
| | IE | 185.1628 | 0.0841361 | 6406.975 | 689.0362 | -0.0088642 | 10536.5 | 0.0190787 |
| | | (460.7156) | (2.283548) | (15440.7) | (1840.739) | (0.0799508) | (28319.03) | (0.0464522) |
| | TE | 2100.378** | 0.9543912 | 72676.99*** | 7816.025** | -0.1005505 | 119519.9 | 0.216418*** |
| | | (511.6332) | (25.09137) | (27259.51) | (4569.461) | (0.8793101) | (75796.98) | (0.07631) |
| SDM | DE | 1790.399*** | -13.51877 | 102279.1** | 5830.467 | -1.338017* | 415680.7*** | 0.1786886** |
| | | (430.5677) | (31.43816) | (39863.84) | (5022.434) | (0.7355338) | (120822.5) | (0.0773673) |
| | IE | 3424.399 | -412.1823* | 582886.6** | 42819.91** | -7.552426* | 255630.7 | -0.4250934 |
| | | (2854.48) | (239.4008) | (262832.7) | (19081.64) | (4.138607) | (385494.6) | (0.4470071) |
| | TE | 5214.799* | -425.701 | 685165.7** | 48650.38** | -8.890443** | 671311.4 | -.2464048 |
| | | (2957.687) | (262.2839) | (291206.2) | (20989.87) | (4.348735) | (417253) | 0.4916601 |
| SEM | DE | 2069.657*** | -3.87473 | 101256.6*** | 5537.133** | -.6437065 | 112645.2*** | .3354277*** |
| | | (355.5597) | (18.07829) | (22396.52) | (2881.029) | (.6443458) | (35104.41) | (.0704838) |
| | IE | -117.6631 | .2202842 | -5756.594 | -314.7944 | .0365957 | -6404.048 | -.0190696 |
| | | (255.1772) | (1.195992) | (12645.54) | (649.6527) | (.0880414) | (13772.98) | .0420043 |
| | TE | 1951.994*** | -3.654445 | 95500.06*** | 5222.339* | -0.6071108 | 106241.1*** | 0.3163581*** |
| | | (275.1301) | (16.97492) | (17369.09) | (2871.795) | (0.6027197) | (32959.17) | 0.0514384 |

*Note: ***, **, and * represent significance at the 1%, 5% and 10% levels, respectively*

*Source: calculated by the author*

a bachelor's degree doesn't guarantee higher salaries and increased productivity. It's likely that the education system in Indonesia falls short of meeting the skill demands of the labor market. This contrasts with the findings of Glaeser and Maré (2001), who argue that cities accumulate human capital, leading to increased productivity and higher salaries in urban areas. Therefore, the government should prioritize further investment in the education sector.

Based on Table 5 and the results of SDM, the most influential factors affecting salary in Jakarta are the education index in the region, the human development index (HI), productivity (Prod), and population. The direct positive impacts of Edu, HI, productivity, and population are 415680.7, 102279.1, 1790.399, and 0.1786886, respectively, while the number of holders of bachelor's degrees has a negative effect. HI stands as a significant factor contributing to higher salaries in the region, particularly in Jakarta. The combined direct and indirect effects, spanning both the region itself and its neighbors, emphasize the importance of the human development index in the Jakarta Metropolitan Area. It has a substantial and positive impact on the minimum wage, surpassing the


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impact of other variables (as shown in Table 5). Given that the HI is closely linked to the dimensions of education, health, and living standards, it plays a pivotal role in determining the workforce's capabilities. The abundant facilities offered by cities contribute to a decent quality of life for their inhabitants (Glaeser & Xiong, 2017; Gould, 2007; Halfdanarson et al., 2008; Henderson & Turner, 2020), ultimately affecting the quality of the future workforce. This includes the birth of skilled and educated workers with longer life expectancies, subsequently leading to higher wages and better compensation for workers.

In the Jakarta Metropolitan Area, density has a negative indirect effect on the salary rate. This implies that densely populated neighborhoods contribute to a decrease in the minimum wage in certain regions. In contrast, the localization economy, represented by the share of industrial activity, has a positive effect on neighboring regions by increasing the minimum wage. The varying industry structures across regions can account for some of the differences in regional salary levels. For instance, the densest area in the Jakarta Metropolitan Area is Central Jakarta, while the highest minimum wage is found in Bekasi City. Therefore, discrepancies in salary between regions can be attributed to differences in the local industry structure (Chen et al., 2020; Sveikauskas, 1975).

Based on the outcomes of these models' indirect effects (Table 3 and 5), it can be speculated that when considering spatial dependence in the region itself, a significant spatial spillover effect is observed in comparison to other regions within the Jakarta Metropolitan Area, particularly with regard to salaries. This finding indicates that the process of agglomeration is already underway, and the economic interactions in each region are crucial for harnessing the benefits of localization. However, it's imperative to address the state of education in densely populated areas in Indonesia. This is essential to mitigate the risk of significant unemployment arising from the new era of technology and the burgeoning working-age population in Indonesia.

In response, the Ministry of Education, Culture, Research, and Technology has initiated a comprehensive strategy named "Kampus Merdeka" (Independent Campus). This strategic plan aims to foster integration between universities and the professional field, enabling graduating students to acquire not only theoretical knowledge but also practical skills. This program helps students gain a diverse range of experiences, including professional internships, international study opportunities, laboratory involvement, and cross-university collaboration both in Indonesia and abroad. This initiative holds the potential to mark a significant step toward producing high-quality graduates with bachelor's degrees who can effectively contribute to productivity. These outcomes align with findings from various studies, including those by Glaeser and Maré (2001), Glaeser and Resseger (2010), Duranton and Puga (2020), and others in the field.

## Conclusion

The novelty of this study lies in the fact that it amalgamates microdata from the Sakernas survey and macrodata from BPS within the timeframe of 2017-2019, focusing on the Jakarta Metropolitan Area. By seamlessly integrating individual-level data on highly educated individuals from Sakernas with regional-level data from BPS, the study achieves a holistic comprehension of the distinctive attributes prevalent across different regions. This harmonization of data across varying levels empowers a more intricate analysis of the correlation between productivity and area dimensions, offering insights into the trend of skilled individuals gravitating toward larger urban centers. This spatial exploration adds depth and complexity to the investigation, showing how the presence of skilled individuals in one area influences the neighboring regions. This spatial lens adds a layer of intricacy and authenticity to the study's findings.

Regarding productivity, it becomes evident that Jakarta's productivity is affected by its density. Additionally, localization economy, the human development index, and population size exhibit a positive yet statistically insignificant influence on productivity. Intriguingly, a negative association is observed between high education and productivity, contrasting the common assumption that education drives productivity. On a broader scale, the education rate at the aggregate level demonstrates the potential to increase productivity in its respective region. As such, it becomes apparent that density has a more pronounced impact on productivity than the sheer number of individuals in a region. The quality of education is also under scrutiny for its alignment with and contribution to Jakarta's productivity. This highlights a nuanced knowledge spillover scenario in Jakarta, deviating slightly from the common theoretical expectations and the notion of brain drain.

With respect to wages, the study reveals that productivity, the human development index, education rate, localization economy, and population


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collectively exert a positive influence on salary increments. Conversely, the population density of a region appears to have a dampening effect on wages, which might be explained by the presence of both prosperous and struggling areas in denser regions. Furthermore, the concentration of highly educated individuals in specific regional clusters seems to reduce minimum wages. This finding raises questions and suggests potential limitations in the study's scope. Basically, the study demonstrates that possessing a high level of education does not guarantee higher productivity and remuneration in Jakarta. Consequently, the need for reforming the education system emerges as a crucial priority in urban areas.

These findings suggest that relying solely on increased productivity as a measure of a nation's economic performance or progress could lead to inaccurate interpretations. Short-term development strategies that exhaust finite resources, such as natural reserves, may yield short-lived growth while undermining long-term progress. It is therefore imperative for Indonesia to focus on investing in human capital for sustained growth and prosperity. Despite the study's limitations—such as time frame constraints, the utilization of education rate and bachelor's degrees as proxies for knowledge spillover, and the localization proxy via industrial share in GDP—future research avenues are clear. These could encompass comparative analyses of multiple Indonesian metropolitan areas, a more nuanced exploration of knowledge spillover involving work experience as a proxy, or a focus on IT graduates as a driving force in Indonesia's evolving landscape. Additionally, studying variations in localization economies could enrich our understanding of local labor markets. Moreover, a more comprehensive assessment of human development factors is required to obtain a more accurate picture of urban well-being. Therefore, it's important for future studies to investigate well-being metrics, as they play a vital role in incorporating human and social capital values into sustainable development initiatives, particularly in densely populated areas such as urban environments.

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# Impact of Social Spending and Inter-Regional Migration on Employment Rates in Russian Regions

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**ABSTRACT**

**Relevance.** The employment level in Russia plays a crucial role in the social and economic development of regions. The federal policy of Russia is geared towards bolstering regional employment through targeted social spending and fostering balanced inter-regional migration. Analyzing the contribution of these policies to employment outcomes offers insights for shaping effective regional strategies across the Russian Federation's entities.

**Research Objective.** This study aims to uncover the key relationships and assess the impact of inter-regional migration and social policy spending on employment dynamics in Russian regions.

**Methods and Data.** Our research is based on a dataset encompassing 83 Russian regions spanning from 2000 to 2021. The study relies on the data sourced from the Treasury of the Russian Federation, the Ministry of Finance, and the Federal State Statistics Service. To model these dynamics, we employ simultaneous quantile regression with bootstrapped standard error.

**Results.** Inter-regional migration tends to exert a negative influence on regional employment rates in most cases. Public spending on social policy, on the other hand, contributes to employment gains in regions with relatively healthier employment rates, while exhibiting less efficacy in regions dealing with more significant employment challenges. Western regions, characterized by more favorable employment situations and higher economic development, tend to be more attractive to migrants.

**Conclusion.** Current trends in inter-regional migration demonstrate diminished effectiveness in stimulating regional employment. Social policies generally boost employment in most regions, although there's still potential for improvement in areas with job disparities. Based on our findings, we propose several policy implications for both federal and regional governments to enhance employment policies in Russia.

**KEYWORDS**
employment, public spending, social policy, inter-regional migration, Russian regions

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# Влияние социальных расходов и межрегиональной миграции на занятость в субъектах Российской Федерации

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**АННОТАЦИЯ**

**Актуальность.** Уровень занятости в России является одним из ключевых факторов, определяющих социально-экономическое развитие регионов. Федеральная политика России направлена на содействие занятости в регионах за счет выделения расходов на социальную поддержку и обеспечение сбалансированной межрегиональной миграции. Анализ роли указанной политики в увеличении занятости позволит определить направления региональных стратегий развития в субъектах Российской Федерации.

**Цель исследования.** Целью данного исследования является выявление ключевых взаимосвязей и изучение влияния межрегиональной миграции и расходов на социальную политику на занятость в регионах России.

**КЛЮЧЕВЫЕ СЛОВА**
занятость, государственные расходы, социальная политика, межрегиональная миграция, регионы России





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**Методы и данные.** Исследовательскую базу составила выборка по 83 регионам России за период 2000-2021г. Информационным обеспечением исследования послужили базы данных Казначейства РФ, Министерства финансов и Федеральной службы государственной статистики. Для эконометрического моделирования применен метод одновременной квантильной регрессии с коррекцией стандартных ошибок.
**Результаты.** Результаты эконометрического моделирования демонстрируют, что в большинстве случаев межрегиональная миграция снижает уровень занятости в регионах. Государственные расходы на социальную политику стимулируют занятость в регионах, где ее уровень выше относительно других субъектов, в то время как данная политика менее эффективна в регионах с более выраженной проблемой занятости. Западные регионы отличаются более благоприятной ситуацией в сфере занятости и высокими темпами экономического развития, что привлекает мигрантов.
**Вывод.** Межрегиональная миграция имеет низкую эффективность в увеличении занятости в регионах РФ. Социальная политика стимулирует занятость в большинстве регионов, однако требует некоторой корректировки для менее развитых субъектов. На основе результатов исследования сформированы предложения по совершенствованию федеральной и региональной политики в области содействия занятости в России.

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**ДЛЯ ЦИТИРОВАНИЯ**
Vasilyeva R.I., Ampenova D.M. (2023). Impact of Social Spending and Inter-Regional Migration on Employment Rates in Russian Regions. *R-Economy*, 9(3), 269–280. doi: 10.15826/recon.2023.9.3.016

# 社会政策支出和区域间移民对俄罗斯联邦主体就业的影响

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**摘要**
**现实性：**俄罗斯的就业水平是决定地区社会经济发展的关键因素之一。俄罗斯联邦的政策旨在通过分配社会支出和确保地区间的均衡移民来促进各地区的就业。分析上述政策在增加就业方面的作用将有助于确定俄罗斯联邦各主体地区发展战略的方向。
研究目**标：**本研究的目的是确定关键联系，并研究地区间移民和社会政策支出对俄罗斯各地区就业的影响。
数据与方法：本研究基础是 2000-2021 年期间俄罗斯 83 个地区的样本。研究得到了俄罗斯联邦国库、联邦国家财政部与统计局数据库的支持。计量经济学建模采用了修正标准误差的分位数回归法。
研究**结果：**计量经济学模型的结果表明，在大多数情况下，地区间移民会降低地区的就业水平。国家在社会政策方面的支出刺激了就业水平相对较高地区的就业，而在就业问题较为严重的地区，这一政策的效果则较差。西部地区的特点是就业形势较好，经济发展速度较快，因此吸引了移民前来。
**结论：**地区间移民在增加俄罗斯联邦各地区就业方面效率较低。社会政策对大多数地区的就业有促进作用，但欠发达地区的社会政策需要进行一定的调整。根据研究结果，我们提出了完善俄罗斯联邦和地区就业领域政策的建议。

**关键词**
就业、政府支出、社会政策、地区间移民、俄罗斯地区

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## Introduction

The employment situation in Russia is a crucial topic in today's economic policy because it shapes social and economic progress across different areas. According to the Federal State Statistics Service, the employment level shows how many people within a certain age group are working compared to the total number of people in that age group[1]. Since 2018, the President of Russia has endorsed a number of national projects by issuing the decree "On the National Goals and Strategic Objectives for the Development of the Russian Federation up to 2024"[2]. The goal of protecting public health and well-being, along with the stateled "Demography" project that includes the federal initiative "Boosting Employment," is being pursued through coordinated financial strategies

[1] "On the National Goals and Strategic Objectives for the Development of the Russian Federation up to 2024", Decree of the President of the Russian Federation from 07.05.2018 N204. http://www.kremlin.ru/acts/news/57425 (Assessed on: 15.03.2023)

[2] Passport of the government program of Russian Federation "Sodeystvie zanyatosti naseleniya" (Eng. "Boosting Employment"), Decree of the Government of the Russian Federation of April 15, 2014 N 298 http://gov.garant.ru/SESSION/PILOT/main.htm (Accessed on: 20.02.2023)


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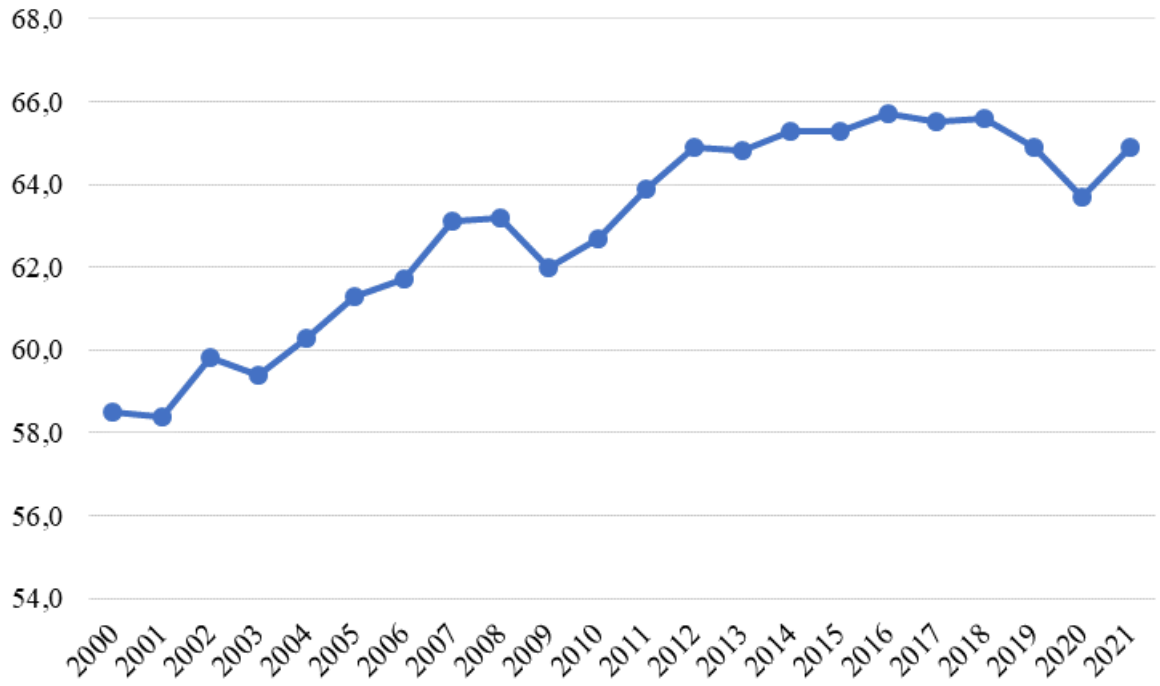


**Figure 1.** *Employment in Russia, 2000-2021.*
*Source: Compiled by the authors using data retrieved from EMISS (https://www.fedstat.ru/indicator/34027)*

at both the national and regional levels. This is accomplished by allocating federal funds to different regions. These programs aim to enhance the work of employment centers in various parts of Russia and help employers find workers. They are an important part of the regional plan to improve how people can move around for work.

As delineated by the Government of the Russian Federation, the main focus of the long-term state policy resides in fostering employment growth. This objective is pursued through the establishment of a multifaceted framework encompassing legal, economic, and institutional elements. Such a comprehensive approach is designed to stimulate the evolution of the labor market while concurrently enhancing the caliber and effectiveness of labor force participation[3]. Figure 1 illustrates a substantial growth in employment within Russia since the turn of the millennium. However, this upward trajectory was occasionally interrupted by significant events such as the Global Financial Crisis (2008-2010), geopolitical tensions (since 2014), and the recent disruptive influence of COVID-19, which lead to widespread business closures and workforce reductions.

According to the Federal State Statistics Service, the pinnacle of unemployment was reached in August 2020, with a recorded figure of 4.8 million jobless individuals. Concurrently, the overall labor force in Russia contracted from 75.7 million in August 2019 to 75.2 million by December 2020.

In 2021, a modest economic recovery, as acknowledged by the Ministry of Finance, brought about favorable outcomes for the labor market, signaling a gradual improvement. According to the recent statistical report, the labor force amounted to 75.3 million people in June 2021[4]. Unemployment returned to the 2019 level, receding from the August 2020 peak (6.4%) to 4.3%.

In the Russian context, it's crucial to give due regard to regional differences since they shape the unique aspects of the labor market. Factors like population density, environmental and climatic conditions, ethnic and demographic distinctions, infrastructure development, and more, can have a notable impact on employment rates (Chowdhury et al., 2022; Cui et al., 2012; Vermeulen & van Ommeren, 2009). The sparsely populated eastern and northern regions of Russia, along with struggling areas, face challenges in dealing with outward mi-

[3] Passport of the government program of Russian Federation "Sodeystvie zanyatosti naseleniya" (Eng. "Boosting Employment"), Decree of the Government of the Russian Federation of April 15, 2014 N 298 http://gov.garant.ru/SESSION/PILOT/main.htm (Accessed on: 20.02.2023).

[4] Employment and unemployment in Russian Federation // Federal Statistics Service URL: https://www.gks.ru/bgd/free/B04_03/IssWWW.exe/Stg/d02/17.htm (Accessed on: 10.03.2023).


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gration and declining employment opportunities (Mkrtchyan and Florinskaya, 2020). Specifically, the population of the Far East has notably dwindled over the last two decades, and this trend continues. This situation introduces fresh challenges for both the Russian labor market and migration policy. The national projects are designed to enhance employment opportunities by directing public social expenditures and fostering well-balanced and superior inter-regional migration patterns. According to Caponi (2017), Castillo et al. (2017) and Freedman (2015) the governmental policies impact the labor market and employment in the regions through increasing efficiency of labor market, which improves the quality of the workforce and spurs the employees' motivation. Their research results are supported in later studies (Agovino et al., 2019; Westerman, 2018).

The primary objective of this study is to assess how social public spending and inter-regional migration impact employment across Russian regions. To examine our hypotheses, we utilize a panel dataset encompassing Russian regions from 2000 to 2021. Given the considerable variation of variables across these regions and the substantial presence of heteroscedasticity, we employ a simultaneous quantile regression approach. This technique helps mitigate the influence of heteroscedasticity by segmenting the regions into quantiles based on employment levels. Moreover, the quantile approach enables the identification of regions with the highest and lowest employment rates within Russia.

This study adds to current research in several key ways. Firstly, we analyze the impact of a specific government expenditure category - social policy spending - on regional employment in Russia. This aligns with the President's decree to enhance employment across regions. Additionally, recent literature underscores the significant role of state policies in boosting regional employment rates (Azad et al., 2021; Carlino & Inman, 2013; Naraidoo et al., 2017). Secondly, we evaluate the impact of inter-regional migration on employment rates in Russian regions. According to the Spatial Development Strategy, enhanced labor mobility is expected to particularly boost employment in less populated areas, where employment challenges are most pronounced. Thirdly, we present policy recommendations for enhancing federal and regional employment strategies in Russia.

The article's structure is as follows: the subsequent section provides an empirical literature review. The Method and Data section outlines the dataset and econometric approach. The Results section presents key empirical findings and discussions. The concluding section contains final remarks and policy implications.

## Theoretical framework

*Exploring fiscal stimulus for employment: the role of public spending in social policy*

Previous research underscores the impact of public spending on social policy in driving employment and fostering economic activity (Antonelli & de Bonis, 2017). Rodríguez-Vives & Kezbere (2019) contend that the quantity and composition of social expenditures vary among nations and mirror social policy preferences. In the short term, government expenditures on social policy have a stimulating effect on the economy by bolstering GDP, private consumption, and employment. Murín (2016) found similar outcomes for EU countries. Furceri & Zdzienicka (2012) accentuate the importance of public spending on healthcare and unemployment benefits in propelling employment. While some scholars argue that short-term public spending on social policy yields equivocal results, ultimately becoming pro-cyclical in the long run (Effiom, 2019), Oyvat & Onaran (2022) offer evidence that public expenditures on social infrastructure invigorate both male and female employment. Moreover, Kopiec (2020) presents empirical evidence suggesting that fiscal stimulus augments the synergistic effects of fiscal and monetary policies, thereby fostering labor market growth and enhancing employment.

Veredyuk (2010), Giltman (2018), and Volovskaya (2016) offer empirical insights into how government spending and regional characteristics influence employment patterns in the Russian context. In the face of economic crises, some authors assert that active state intervention becomes crucial for maintaining employment rates (Gaidayenko, 2021; Kashepov, 2021). Balaev (2018; 2019) and Kamenskikh & Ivanova (2011) delve into the structure of Russian budget expenditures, noting that fiscal allocations can foster human capital development, employment, and overall economic growth. However, not much research has been done on how social spending boosts employment, which is why we intend to study how public money spent on social policies affects employment in Russia.

Public expenditures on social policy encompass a range of budget allocations that include pensions, social security and public services, family protection, research related to social policy, and


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other relevant aspects[5]. We believe that public expenditures on social policy contribute to heightened employment rates across Russian regions (H1). These social policy expenditures encompass unemployment benefits, pensions, scholarships, and various other social benefits. These incentives encourage economic agents to participate in the labor market and secure employment opportunities.

*Hypothesis 1:*

Public expenditures allocated to social policy have a stimulating effect on employment dynamics in Russian regions.

### *Connection between inter-regional migration and employment*

Inter-regional migration has the potential to enhance regional labor markets by promoting employment opportunities. The existing body of literature offers diverse interpretations of inter-regional migration. Troyanskaya (2021) defines it as the movement of people between administrative regions or territories within a state. Doroshenko (2022) argues that inter-regional migration in Russia addresses shortages in regional labor force and substantially bolsters employment in SMEs. Providing empirical support, Topilin & Maksimova (2020) demonstrate pronounced disparities in regional labor markets, attributed to the growing divide between less developed areas and more advanced regions. They contend that diverse forms of migration, necessitating greater governmental regulation, exert a considerable influence on the labor market. Furthermore, inter-regional migration in Russia contributes to the labor force and engenders elevated regional employment rates, underscoring the significance of heightened mobility within the labor market (Kozlova et al., 2015).

There is a view that inter-regional migration displaces local citizens' employment, thereby detrimentally affecting overall employment rates and increasing local unemployment. However, Wu et al. (2020) observe that in Chinese provinces, inter-regional migration does not exhibit a complete substitution effect for local workers. Specifically, empirical findings establish an employment substitution effect limited to low-skilled local workers, while inter-regional migration supplements employment in sectors demanding medium-skilled and highly skilled labor. Van Truong (2020) emphasizes the lesser appeal of lower-paid jobs to local workers, consequently leading to increased regional employment through migrant engagement in such positions. Intriguingly, a complementary employment effect surfaces in medium and higher-paid roles owing to economies of scale, skill complementarity, and the spill-over impact of consumption and human capital (Wu et al., 2020; Howard, 2020).

Furthermore, a scrutiny of the US labor market corroborates that inter-regional migration bears a favorable short-term impact on employment (Howard, 2020). However, there is evidence that these positive short-term effects often culminate in adverse long-term trends, necessitating robust and high-quality public management practices (Abdurakhmanova & Abdurakhmanov, 2019).

In the context of Russia, inter-regional migration exhibits an imbalance, with western regions drawing more migrants while eastern territories face human resource shortages. Consequently, the impact of inter-regional migration on employment in Russia becomes an empirical enigma, as it could either raise or lower employment rates. Hence, our objective is to assess the influence of inter-regional migration on employment rates, guided by the following hypothesis (H2):

*Hypothesis 2:*

Inter-regional migration exacerbates employment rates disparities among Russian regions.

Furthermore, Hypothesis 2 proposes that inter-regional migration enhances employment rates, incorporating both the initial employment rates and spatial aspects.

## Method and Data

We are going to test our assumptions by using a panel dataset encompassing annual observations from 2000 to 2021 across 83 Russian regions. The dependent variable under scrutiny is the employment rate, sourced from the Federal Statistics Service, calculated as the ratio of the employed individuals in a region to its total population.

Our principal research variable revolves around social spending per capita, serving as an indicator of the government's efforts to boost employment and inter-regional migration. As control variables, we use GRP per capita (in constant 2007 prices), inflation, the Central Bank key rate (Beetsma & Giuliodori, 2011; Carlino & Inman, 2016; Kato & Miyamoto, 2013), and regional dummies. A comprehensive description of these variables and their data sources are presented in Table 1.

[5] Fiscal Code of the Russian Federation of 31.07.1998 No. 145-Federal Law (adjusted in 14.04.2023). http://www.consultant.ru/document/cons_doc_LAW_19702/ (In Russian; accessed: 27.06.2023)


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Table 1

**Variables**

| Variable | Description | Unit | Source |
|---|---|---|---|
| Dependent variable | | | |
| Employment | Employment rate (number of employed to total number of populations of specific age) | % | Government Statistics Service |
| Independent variables | | | |
| Social spending | Per capita government expenditures on social policy | rub | Accounts Chamber of the Russian Federation |
| Migration | Coefficient of inter-regional migration (inter-regional migration growth to yearly average number of employment ratio) | % | Government Statistics Service |
| Regional dummy | Dummy variable indicating the spacing of the region (1 – western Russia; 0 – eastern Russia) | - | Constructed by the authors |
| GRP per capita | Gross regional product per capita (constant prices 2007) | rub | Calculated by the authors using the data of the Federal Statistics Service |
| Inflation | Inflation | % | Calculated by the authors by using the data of the Federal Statistics Service |
| Rate | Annual average key rate | % | Calculated by the authors by using the data of the Central Bank |

*Source: developed by the authors using the data retrieved from EMISS (https://www.fedstat.ru), the Federal State Statistics Service (https://gks.ru), and the Central Bank of Russia (https://cbr.ru).*

Table 2

**CD-test result**

| Variable | CD-test | p-value | average | mean ρ | mean |
|---|---|---|---|---|---|
| Employment | 155.408 | 0.000 | 20.98 | 0.58 | 0.60 |
| Social spending | 258.773 | 0.000 | 20.76 | 0.97 | 0.97 |
| Migration | 49.851 | 0.000 | 21.00 | 0.19 | 0.43 |
| GRP per capita | 240.871 | 0.000 | 19.69 | 0.93 | 0.93 |
| Inflation | 227.454 | 0.000 | 20.00 | 0.87 | 0.90 |
| Rate | 254.277 | 0.000 | 19.00 | 1.00 | 1.00 |

*Source: authors' calculations*

Table 3

**Slope homogeneity test result**

| | Delta | p-value |
|---|---|---|
| | 13.571 | 0.000 |
| adjusted | 17.928 | 0.000 |

*Source: authors' calculations*

At the preliminary stage, we conduct a series of tests on our dataset. Firstly, the outcomes of the cross-sectional dependency test (Pesaran, 2004, 2013), as displayed in Table 2, reveal a pronounced issue of cross-sectional dependency, given the considerable correlation among regional panels. To tackle this cross-sectional dependency concern, we augment our model specifications with spatial fixed-effects. These fixed-effects are computed as the average values for Russia in a particular year for each spatial-varying independent variable.

According to the results of the slope heteroscedasticity test (Pesaran & Yamagata, 2008) presented in Table 3, the high heterogeneity bias is found in the model specification.

To address the existing heterogeneity, we employ simultaneous quantile regression with bootstrapped standard errors. This quantile-based approach allows us to estimate the effects of various determinants on different employment quantiles, effectively accounting for the pronounced heteroscedasticity within the regional dataset (Koenker, 1978). The econometric model (Equation 1) is employed to gauge the influence of government expenditures on social policy and inter-regional migration on employment.


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$$Q_{Employment_{it}}(\tau|X_{it}) = \alpha(\tau) + \beta_{1i}(\tau)SocialSpending_{it} + \beta_{2i}(\tau)Migration_{it} + \beta_{3i}(\tau)RegionalDummy_i + \\ + \beta_{4i}(\tau)GRPpc_{it} + \beta_{5i}(\tau)Inflation_{it} + \beta_{6i}(\tau)Rate_t + \beta_{7i}(\tau)T - vars_t + \varepsilon_{it} \quad (1)$$

where $i$ = 1,…83 indicates the number of regions; t = 1,…21, the time periods; $Q_{Employment_{it}}$, quantiles of the dependent variable; $\tau$, the specific quantile (q10-q90); $\alpha$ is an intercept, $\beta_i(\tau)$ are slope coefficients for each variable at specific $\tau$ –quantile; $Migration_{it}$ indicates the inter-regional migration ratio; $SocialSpending_{it}$ is per capita social public spending; $GRPpc_{it}$ is per capita GRP in constant prices; $Inflation_{it}$ is the inflation rate; $Rate_t$ is the yearly average key rate of the Central Bank; $T - vars_t$ is the vector of cross-correlation effects (estimated for each indicator as the mean value for Russia during a specific period).

## Results and Discussion

Table 4 shows the results of our analysis using simultaneous quantile regression with bootstrapped standard errors. The upper quantiles represent regions with higher employment rates, while the lower quantiles include areas facing greater employment challenges. In the lower quantiles (Q10-Q30), the impact of migration is not significant, but it becomes negative and significant in the medium (Q40-Q60) and upper (Q70-Q90) quantiles.

Regions with higher employment rates tend to attract more migrants, which increases the ratio of arrivals to departures. However, this doesn't necessarily lead to more job opportunities for newcomers. Instead, it often results in a larger population and labor force, which can actually decrease employment rates. This negative impact of migration indirectly suggests that local residents and migrants don't replace each other in the job market.

Interestingly, we find that public spending on social policies stimulates employment in regions within the upper quantiles (Q50-Q90), which means that federal policies can help boost regional employment. These regions also tend to have higher economic development and employment rates. For example, the 90% quantile includes resource-rich areas like Kamchatka region, the Khanty-Mansyisk, Nenets and Yamalo-Nenets autonomous regions, as well as bustling economic hubs like Moscow region and the federal cities of Moscow and St. Petersburg. These regions offer better job prospects and higher wages, motivating residents to seek employment.

Moreover, in resource-rich areas such as Tyumen region, specialized educational and training programs are provided to prepare highly skilled workers for industries like resource extraction. Additionally, government spending on social policies includes support for maternity leave with job retention, which helps maintain employment rates.

Table 4

**Estimation results for simultaneous quantile regression analysis**

| Variable | Q10 | Q20 | Q30 | Q40 | Q50 | Q60 | Q70 | Q80 | Q90 |
|---|---|---|---|---|---|---|---|---|---|
| Migration | 1.175 | -1.054 | -0.793 | -1.042** | -1.228*** | -1.560*** | -1.652*** | -2.332*** | -2.677*** |
| | (1.480) | (0.972) | (0.597) | (0.478) | (0.362) | (0.324) | (0.377) | (0.574) | (0.547) |
| Social spending | -4.491*** | -1.656* | -0.0643 | 0.610 | 1.004** | 1.340*** | 1.739*** | 2.010*** | 1.818** |
| | (1.391) | (0.869) | (0.653) | (0.498) | (0.451) | (0.510) | (0.511) | (0.554) | (0.717) |
| Regional dummy | -0.179 | 0.925*** | 1.580*** | 1.816*** | 2.217*** | 2.514*** | 2.472*** | 2.857*** | 3.102*** |
| | (0.558) | (0.342) | (0.266) | (0.250) | (0.204) | (0.227) | (0.245) | (0.264) | (0.287) |
| GRP per capita | 7.139*** | 5.427*** | 4.605*** | 4.256*** | 4.069*** | 4.027*** | 3.954*** | 3.808*** | 4.388*** |
| | (0.693) | (0.529) | (0.373) | (0.302) | (0.329) | (0.424) | (0.426) | (0.465) | (0.495) |
| Inflation | -0.0102 | -0.00817 | -0.00942 | -0.0448 | 0.000309 | -0.0169 | 0.0359 | 0.0269 | 0.0357 |
| | (0.0974) | (0.0612) | (0.0418) | (0.0459) | (0.0435) | (0.0446) | (0.0348) | (0.0347) | (0.0357) |
| Rate | 0.0905 | 0.0513 | 0.0237 | 0.0348 | 0.0454 | 0.0242 | 0.0627 | 0.0245 | -0.0140 |
| | (0.161) | (0.0908) | (0.0757) | (0.0657) | (0.0596) | (0.0573) | (0.0550) | (0.0580) | (0.0592) |
| Constant | -8.687 | -35.66 | -34.00 | -42.23* | -54.83** | -48.48** | -57.82*** | -45.85* | -20.15 |
| | (60.60) | (28.55) | (22.11) | (21.67) | (23.80) | (24.29) | (20.63) | (24.64) | (29.49) |
| Common correlation effects | yes | yes | yes | yes | yes | yes | yes | yes | yes |
| Obs. | 1555 | 1555 | 1555 | 1555 | 1555 | 1555 | 1555 | 1555 | 1555 |

*Note: standard errors in parenthesis; level of significance: *** - p-val<1%, ** - p-val <5%, * - p-val<10%. Common correlation effects are included into the model specification to eliminate the CD-bias.*

*Source: authors' calculations*


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Contrarily, slope coefficients for social spending exhibit insignificance within the medium quantiles (Q30-Q40), while manifesting negative significance within the lower quantiles (Q10-Q20). These outcomes validate the inefficacy of social policy in incentivizing employment rates in regions facing more pronounced employment challenges. Our findings align with Fialová & Mysíková (2009), as government spending on social policy, encompassing benefits, subsidies, pensions, scholarships, and similar provisions, can potentially discourage economic agents from entering the labor market (van der Ploeg, 2006). For instance, increased scholarships may diminish students' motivation to seek employment until graduation. Furthermore, Hagedorn et al. (2015) contend that unemployment benefits can prolong joblessness and inadvertently hinder employment growth, as benefit recipients tend to rely on financial support throughout their unemployment period.

The impact of GRP per capita, on the other hand, exhibits consistent positivity and significance across all quantiles. Elevated economic development evidently contributes to employment among Russian regions, with the most pronounced slope coefficients observed at the 10% and 20% quantiles. Notably, economic development emerges as the predominant catalyst for stimulating employment in regions struggling with lower employment rates. Consequently, we recommend that effective government policy should involve the stimulation of business activity and regional economic development to foster labor demand and regional employment—a proposition supported by Saviotti & Pyka (2004) and corroborated by subsequent findings for Taiwan (Chen, 2014) and Algeria (Bouazza, 2015). Inflation and the key rate, as per the regression results, exhibit no significant impact on employment rates.

Continuing our exploration of the factors' impact on employment in Russian regions, we computed the contribution effects of the variables of interest. To this end, we calculated the difference between the mean value of each variable in 2021 and its corresponding mean value in 2000, based on descriptive statistics for the lowest (Q10), medium (Q50), and highest (Q90) quantiles (Table 5). The derivation of contribution effects involves the multiplication of the slope coefficients (Table 4) by the change in the independent variable relative to the change in the dependent variable (Equation 2).

$$Contribution\ effect = \beta_i(\tau) * \frac{\Delta X}{\Delta Y}, \quad (2)$$

where $\beta_i(\tau)$ indicates the slope coefficient for independent variable at specific quantile; $\Delta X$, the change in the independent variable (2021 compared to 2000); and $\Delta Y$, the change in the dependent variable (2021 compared to 2000).

The contribution effects reveal that at the lowest quantile, social policy has a negative impact on employment, decreasing it by 6.4%. On the other hand, economic development, represented by real GRP per capita, contributes to a 2.6% change in the dependent variable. Migration does not show significance in the econometric model. However, across all quantiles, we observe a negative shift, indicating a decrease in inter-regional migration during the given period. At the medium quantile, all indicators listed exhibit positive contribution effects. Public spending on social policy, inter-regional migration, and GDP per capita contribute, on average, 0.9%, 0.4%, and 1% respectively to the employment level. Interestingly, public spending on social policy demonstrates the highest contribution effect (1.4%) at the highest quantile, while inter-regional migration negatively affects employment rates by 0.4%.

Our analysis also confirms that spatial location impacts employment rates. Over the past three decades, eastern regions of Russia have experienced a population outflow towards western regions. Our study highlights significantly higher employment rates in western regions compared to their eastern counterparts at all quantiles Q20-Q90.

Table 5

**Contribution effects**

| | Change (2021 compared to 2000) | | | Contribution | | |
|---|---|---|---|---|---|---|
| Quantile | p10 | p50 | p90 | p10 | p50 | p90 |
| Employment | 3.00 | 4.40 | 5.10 | - | - | - |
| Social spending | 4.28 | 3.97 | 3.85 | -6.4 | 0.9 | 1.4 |
| Migration | -1.36 | -17.13 | -10.53 | -1.2 | 0.4 | -0.4 |
| GRP per capita | 1.08 | 1.09 | 1.30 | 2.6 | 1.0 | 1.1 |

*Source: authors' calculations*


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Table 6

**Estimation results for simultaneous quantile regression analysis**

| Q10 | Q20 | Q30 | Q40 | Q50 |
|---|---|---|---|---|
| Adygea Republic, Chechen Republic, Dagestan Republic, Ingushetia Republic, Tyva Republic | Altai Republic, Altai region, Buryatia Republic, Kurgan region, North Ossetia, Trans-Baikal region | Jewish Autonomous Region, Rostov region, Ryazan region, Tambov region | Krasnodar region, Bashkiria Republic, Saratov region, Volgograd region, Voronezh region | Kursk region, Novosibirsk region, Orenburg region, Omsk region, Perm region, |
| **Q60** | **Q70** | **Q80** | **Q90** | |
| Arkhangelsk region, Chuvash Republic, Ivanovo region, Smolensk region, Primorsky region | Kaliningrad region, Khabarovsk region, Lipetsk region, Sverdlovsk region, Vladimir region | Leningrad region, Nizhny Novgorod region, Samara region, Sakhalin region, Tatarstan Republic, Udmurtia Republic | Kamchatka region, Khanty-Mansi Autonomous Region, Moscow, Moscow region, Murmansk region, Nenets Autonomous Region, St. Petersburg, Tyumen region, Yamalo-Nenets Autonomous Region | |

*Source: authors' calculations*

Furthermore, considering regions with similar employment levels and GRP per capita, included in the same quantile, the disparity between western and eastern regions widens as the quantile increases.

Table 6 presents the regional distribution among quantiles. The upper quantiles (Q70-Q90) encompass regions with the highest employment rates from 2000 to 2021. Employment rates in these regions exceed 68% at the 90% quantile. Notably, the Chukotka Autonomous Region often boasts employment percentages surpassing 80% in most years.

Medium quantiles (Q40-Q60) encompass regions with employment rates spanning from 59.5% to 64.4%. Conversely, the lower quantiles (Q10-Q30) encompass regions facing significant employment challenges. Notably, the employment rates in the Chechen and Ingushetia republics fell below 20% throughout the given period.

## Conclusion

In this study, we sought to estimate the influence of government spending on social policy and inter-regional migration on employment rates across Russian regions, unraveling key relationships between these indicators. Our findings show the marked heterogeneity in employment rates among regions, prompting the adoption of simultaneous quantile regression with bootstrapped standard errors to alleviate any bias stemming from this variability.

Empirical evidence validates our primary hypothesis, affirming the positive contribution of public expenditures on social policy towards bolstering employment. However, our secondary hypothesis is rejected as we found a significant adverse effect of inter-regional migration in regions characterized by moderate to relatively high employment rates. Although regions grappling with pronounced employment challenges seem minimally impacted by inter-regional migration, the coefficient retains a negative sign.

Our study highlights the efficacy of government social spending in augmenting employment rates. Yet, our empirical study reveals that such spending exhibits counterproductivity in regions dealing with lower employment rates. Drawing from our estimation outcomes, we offer pertinent policy implications. Primarily, we recommend that government regional policies should focus on creating conducive conditions in regions with lower employment rates, especially in the eastern territories, to mitigate migration outflows and foster inter-regional equilibrium.

Furthermore, our study underscores the need for diversification in social policy, recognizing an incentive effect in regions characterized by higher employment rates. However, we have shown that government spending on social policy hampers employment growth in regions with lower employment levels. For these regions, the most important requirement is to boost economic development by increasing production and business activity. Such measures not only attract labor but also ameliorate employment prospects, aligning with initiatives like the "National Economy" national project and tailored place-based policies.

Our current findings may be used for future investigations into employment dynamics among Russian regions. Potential avenues for research include looking into the impact of international migration and the assessment of labor competition's influence on employment through the analysis of both internal and external migration patterns.


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# The role of reputation in cross-regional buyer-supplier cooperation in public procurement

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**ABSTRACT**

**Relevance.** The relevance of this study is determined by the growing trend of implementing approaches from the private sector in managing public procurement, such as suppliers' reputation assessment. Although the suppliers' reputation factor is a topic of current interest, both in research and in public procurement practice, there are ongoing discussions on the effects of the reputation criterion usage in public procurement, and some aspects have been insufficiently studied.

**Purpose of the study.** This study examines the role of suppliers' reputation factor in terms of interregional cooperation between public buyers and suppliers at the micro and regional levels.

**Data and methods.** The analysis is based on a survey of public buyers in Russia, revealing procurers' orientation on suppliers' reputation factor and their involvement in cross-regional cooperation for micro-level analysis. With the help of open data on public procurement contracts, a grouping of Russian regions by the share of suppliers from other regions is proposed. The combination of open data analysis and survey results is then used to explore the role of reputation in terms of interregional cooperation.

**Results.** The analysis shows that a suppliers' reputation factor is of particular importance when more than half of a buyers' suppliers are from other regions. Also, suppliers' reputation is of major significance for public buyers in regions that are more involved in contracting with suppliers from other regions. Thus, the importance of the suppliers' reputation factor, in terms of interregional cooperation, is confirmed both at the micro level of procurers' purchases and at the regional level.

**Conclusion.** For effective management of contractual relationships in public procurement, it is important to understand the effects and the role of considering the reputation of suppliers. The study focused on one of the insufficiently explored aspects of suppliers' reputation in public procurement. The results may be of interest both to regulators and direct procurement participants – public buyers and suppliers.

**KEYWORDS**

public procurement, suppliers' reputation, public procurement efficiency, interregional cooperation between procurers and suppliers, Russian regions

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# Роль репутации в межрегиональном взаимодействии заказчиков и поставщиков в государственных закупках

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**АННОТАЦИЯ**

**Актуальность.** В управлении государственными закупками наблюдается рост тренда на использование инструментов управления из частного сектора, в частности учет репутации поставщиков, что определяет актуальность данного исследования. Интерес к фактору репутации поставщиков растет как у исследователей, так и у практиков госзакупок, в дискуссиях по этой теме нет однозначного мнения относительно эффектов учета репутации поставщиков в госзакупках, а отдельные аспекты изучены в недостаточной степени.

**КЛЮЧЕВЫЕ СЛОВА**

государственные закупки, репутация поставщиков, эффективность госзакупок, межрегиональное взаимодействие заказчиков и поставщиков, регионы России





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**Цель исследования.** В статье рассматривается роль фактора репутации поставщиков в контексте межрегионального взаимодействия госзаказчиков и поставщиков на микроуровне и региональном уровне.
**Данные и методы.** В основу анализа положен опрос российских государственных заказчиков, с помощью которого выявляется ориентация заказчиков на фактор репутации поставщиков и вовлеченность заказчиков в межрегиональное взаимодействие. С помощью открытых данных о контрактах на госзакупки осуществлена группировка российских регионов по доле контрактов с поставщиками из других регионов. Комбинирование открытых и опросных данных позволяет определить роль фактора репутации в межрегиональном взаимодействии на уровне регионов.
**Результаты.** В результате анализа выявлено, что фактор репутации поставщиков особенно важен для госзаказчиков, когда более половины поставщиков являются представителями других регионов. Кроме того, наиболее ориентированы на репутацию поставщиков госзаказчики из регионов с высокой долей контрактов с поставщиками из других регионов. Таким образом, важность фактора репутации поставщиков в межрегиональном взаимодействии с госзаказчиками подтверждается как на микроуровне – закупки конкретного заказчика, так и на уровне регионов.
**Выводы.** Для эффективного управления контрактными взаимоотношениями в госзакупках важно понимать роль и эффекты учета репутации поставщиков. Статья посвящена малоизученному аспекту учета репутации поставщиков в госзакупках. Результаты исследования представляют интерес как для регуляторов, так и для непосредственных участников закупочного процесса – госзаказчиков и поставщиков.

**БЛАГОДАРНОСТИ**
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# 声誉在跨区域公共采购商与供应商互动中的作用

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**摘要**
**现实性：**在公共采购管理中，使用私营部门的管理工具，特别是供应商声誉管理工具的趋势日益明显，这也决定了本研究的相关性。公共采购研究人员和从业人员对供应商声誉因素的兴趣与日俱增，但在有关这一主题的讨论中，学界对于供应商声誉在公共采购中的影响并没有明确的观点，而且对某些方面的研究也不够充分。
**研究目标：**本文探讨了在微观和区域层面，供应商声誉因素在区域间公共采购商与供应商互动中的作用。
**数据与方法：**该分析基于对俄罗斯公共采购商的调查，揭示了采购商对供应商声誉因素的取向以及客户参与地区间合作的情况。利用公共采购合同的公开数据，我们按照其与其他地区供应商签订合同的比例对俄罗斯各地区进行了分组。结合公开数据和调查数据，我们可以确定声誉因素在地区间互动中的作用。
**研究结果：**分析表明，当一半以上的供应商来自其他地区时，供应商声誉因素对公共采购商尤为重要。此外，与其他地区供应商签订合同比例高的地区的采购商最注重声誉。因此，供应商声誉因素在与区域间公共采购商互动中的重要性在微观层面（特定客户的采购）和区域层面都得到了证实。
**结论：**要有效管理公共采购中的合同关系，就必须了解供应商声誉管理的作用和影响。本文专门讨论了供应商声誉管理，这一鲜有研究因素在公共采购中的作用。研究结果对监管者和采购过程的直接参与者--公共采购商和供应商都有意义。

**关键词**
公共采购、供应商声誉、公共采购效率、客户与供应商的地区间合作、俄罗斯地区

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## Introduction

Contractual relationships are associated with the principal-agent problem, which requires the principal to use various management tools. One of the ways to overcome the risks of uncertainty and opportunistic behaviour of the supplier (agent) is to consider the supplier's reputation, as it signals the reliability of the counterparty, and allows procurers to form expectations of the supplier's conscientious contract performance (Khalfan et al., 2007).

In public procurement, buyers also face a principal-agent problem, but the management of


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contractual relationships in this sphere is strictly regulated. In contrast to private procurement, the ability to consider suppliers' reputation at the selection stage in public procurement is limited by national regulations (Spagnolo, 2012). In Russia, reputation consideration is mandatory if the initial maximum contract price is equal or more than 20 million rubles[1], in other cases, it is at the discretion of the customer. Among the experience indicators, public buyers can consider the number and monetary volume of similar contracts executed[2], but not their performance indicators (for example, quality or delivery time). Procurement regulation for state-owned enterprises and natural monopolies provides more discretion in the choice of reputation indicators[3].

In discussions, an argument against the reputation factor is about barriers to entry for new suppliers or small firms (Kachour et al., 2016). In favour of reputation consideration in public procurement, various studies demonstrate the positive effects of reputation-based supplier selection (Decarolis et al., 2016; Spagnolo, 2012).

Still, some aspects of supplier's reputation considerations in public procurement remain insufficiently studied. The article focuses on the supplier's reputation factor and the aspects of its relevance in public procurement. The study is aimed to reveal the role of reputation in cross-regional buyer-supplier cooperation in public procurement by solving several tasks:

- Review the research about the effects of reputational considerations in public procurement and the areas of particular reputation importance, including the considerations of the reputation factor in cross-regional cooperation;
- Analyse the importance of suppliers' reputation factors for public buyers at the micro level, depending on their involvement in interregional cooperation, based on survey results;
- Analyse the distribution of Russian regions, depending on the share of contracts with suppliers from other regions in quantitative and value terms;
- Combine regional analysis with survey data to infer the role of reputation in inter-regional cooperation between procurers and suppliers.

The article is structured as follows: Section 2 presents the theoretical overview of research focused on the reputation factor in public procurement. Section 3 describes the data used and the methodology of the study. Section 4 focuses on the results of the empirical analysis carried out. Section 5 summarises the key findings and identifies possible directions for further research.

## Theoretical framework

Despite the similarities in many aspects of buyer-supplier interactions in private and public procurement, contract management in the public sector is associated with additional challenges (McCue et al., 2015). There are acute questions about the effectiveness of public procurement contracts (Karjalainen, 2011). Typically, the focus in public procurement has been on price criteria (Meehan et al., 2017), but now it is gradually shifting to quality assurance (Farr, 2016). In this regard, more attention is paid to the issue of considering the reputation of suppliers, which in private procurement is one of the key factors in interaction with customers (Manello & Calabrese, 2019).

Reputation makes it possible to infer the reliability of the supplier and form expectations about a supplier's future behaviour (Khalfan et al., 2007; Kramer, 1999). At the same time, reputation consideration mechanisms act as an informal tool for enforcing contracts (Banerjee & Duflo, 2000). Private procurement uses many reputation indicators (Yakimova, 2021). In public procurement, due to the need to ensure the measurability and objectivity of supplier evaluation criteria, the indicator of previous experience is most often used (Gomes et al., 2022; Mamavi et al., 2015; Spagnolo, 2012).

A number of studies show various positive effects of reputation considerations in public procurement. One of the key papers on this topic (Spagnolo, 2012) confirms the importance of suppliers' past performance measurement for improving public procurement management. Decarolis et al. (2016) have shown, through an experiment, how supplier reputation drives performance. Increasing the quality of supplied goods/services is one of the key effects of considering the reputation of suppliers (Koning & Van De Meerendonk, 2014; Spagnolo, 2012).

[1] Article 31 of the Federal Law №44-FZ "On the contract system in the procurement of goods, works and services to meet state and municipal needs"

[2] Decree of the Government of the Russian Federation of 31.12.2021 №2604.

[3] Article 3 of the Federal Law №223-FZ "On procurement of goods, works, services by certain types of legal entities".


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Bradshaw and Chang (2013), in their study, measured customer satisfaction based on the outcome of the contract execution. Consideration of previous experience has a positive effect on this indicator. Fiorino et al. (2018) highlight such positive effects of reputation consideration in public procurement as choosing the most qualified supplier, reducing the risks of opportunistic behaviour and cost overruns. Reputation measurement is an additional tool for monitoring supplier contract performance (Van Slyke, 2007).

In addition to the effects of reputation consideration described above, the reputation factor is the basis for building trust between buyers and suppliers (Lamothe & Lamothe, 2012; Dan et al., 2006; Zhao & Smith, 2006). Trust, in turn, also has a positive impact on supplier performance (Finne et al., 2015; Holma, 2012), reduces opportunism and improves the quality of deliveries (Gunawardane, 2012; Li & Choi, 2009).

The reputation factor plays a significant role in certain areas of procurement and in specific institutional settings. Thus, the factor of supplier reputation is of particular importance in areas with a high level of uncertainty (Chiou & Pate, 2018), for example, when concluding long-term contracts (Mamavi et al., 2015). Also, the reputation of suppliers is important in procurement, when many aspects of the supply are difficult to formalise (Board, 2011; Calzolari & Spagnolo, 2009). Beausoleil (2010) notes the importance of reputation in the procurements, which are characterised by performance issues, strict specifications and deadlines. In addition, reputation considerations are important when the judiciary is unable to verify certain aspects of a procurement outcome (Spagnolo, 2012).

Among the negative aspects of considering the reputation of suppliers in public procurement, the most frequently discussed risk is the formation of entry barriers for new players (Mamavi et al., 2015; Albano et al., 2006), which in turn, contradicts the principles of competition in public procurement (Kachour et al., 2016). Flynn (2017) also notes the advantage of large organisations due to their greater reputation resource, which small and medium-sized firms don't have. A recent study by Butler et al. (2020) focuses on this issue. The authors conclude that reputation can indeed be a barrier to entry, however, when certain reputation measurement mechanisms are formed, such an effect does not occur, and even vice versa, the entry of new players is growing.

Another concern about the usage of reputation criteria by EU regulators is that reputation considerations will lead to preferences for local suppliers, which will negatively impact cross-border procurement (Spagnolo, 2014). However, the stated concern is not supported by empirical evidence and contradicts the results of private sector research on this topic. In private procurement, two studies of inter-regional relationships in Chinese (Chintagunta & Chu, 2021) and United States markets (Elfenbein et al., 2019) note the importance of supplier reputation in inter-regional purchases.

As noted above, reputation, as an indicator of reliability and integrity of a supplier, is important in the conditions of uncertainty. Geographic range implies a greater level of uncertainty (Blum & Goldfarb 2006). In this context, it can be assumed that reputation is especially important in the interregional context - when procurers contract with suppliers from other regions. The proposed assumption has no empirical support in existing studies of public procurement. To fulfill this gap, the empirical part of the article is devoted to the analysis of the role of reputation in interregional interaction between public buyers and suppliers.

## Data and Methodology

The empirical part of the article is based on an online survey of Russian public buyers conducted in 2020. The survey covered a wide range of topics relevant to the public procurement system.

Qualitative analysis of the questions in the survey was carried out, prior to it being sent, with the involvement of experts from public procurement, to identify inappropriate or irrelevant questions. For the purposes of the study, it was important to focus on the opinions of experienced procurers. To form a sample, the email addresses of procurers who placed at least 5 applications between 2017-2019 were collected from the official public procurement website (www.zakupki.gov.ru). In total, there were more than 94,000 eligible public buyers. Overall, 611 responses were received.

Public buyers from a total of 74 different regions of Russia took part in the survey. The resulting distribution by federal districts as a whole reflects the distribution of budgetary organizations in Russia. Comparison of the sample and the general population is presented in Table 1.


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Table 1

**Comparison of the sample and general population by federal districts**

| Federal district | General population, % | Sample, % |
|---|---|---|
| Far East | 7.7 | 7.4 |
| Volga | 18.6 | 18.5 |
| North-West | 13.7 | 13.6 |
| North Caucasus | 4.0 | 1.3 |
| Siberia | 14.8 | 8.1 |
| Urals | 8.5 | 9.2 |
| Central | 22.9 | 30.7 |
| South | 9.3 | 11.2 |

*Source: author's calculations.*

In order to assess the orientation of procurers on the supplier reputation factor, they were asked the following question: "Please rate the role of the good business reputation factor in the public procurement market for suppliers (in their relations with procurers)." The measurement was carried out on a 7-point Likert scale, where 1 is very insignificant and 7 is very significant. The survey also included a question about the degree of customer interaction with suppliers from other regions: "Please indicate the approximate share of suppliers from outside your region of the total number of suppliers of your organization between 2018-2019". The procurer's region was then determined using a direct question with a drop-down list of the 85 official regions of the Russian Federation.

The survey data was supplemented by open data on public procurement in Russia between 2018-2019 (zakupki.gov.ru). By aggregating data on all concluded public procurement contracts, the index "share of contracts with suppliers from another region" was calculated in quantitative and cost terms for the official regions of the Russian Federation. The index, in quantitative terms, is calculated as the share of contracts concluded with suppliers from other regions out of the total number of contracts in the region. The index, in value terms, is calculated as the ratio of the monetary volume of contracts concluded with suppliers from other regions and the total monetary volume of contracts in the region.

The analysis was carried out for the regions whose customers responded to the survey - a total of 74 (the Nenets Autonomous Okrug was merged with the Arkhangelsk Region). The analysis did not include regions that were not represented by the results of the survey (10 regions: the Republic of Adygea, the Republic of Altai, the Republic of Ingushetia, the Kabardino-Balkarian Republic, the Karachay-Cherkess Republic, the Republic of North Ossetia-Alania, the Chechen Republic, the Kostroma Region, the Tambov Region, and the Chukotsky autonomous region). Using the data obtained, 74 regions were grouped depending on the level of interregional interaction between procurers and suppliers. Comparison of survey and regional data made it possible to draw conclusions about the importance of the reputation factor, depending on how actively contracts were concluded with suppliers from other regions of the Russian Federation.

## Results and Discussion

The survey results show that the supplier reputation factor is taken into account by the majority of public buyers. The average supplier reputation significance score is 5.1. A third of respondents rated the supplier reputation factor at 7 points (very significant).

To analyse the role of the supplier reputation factor, in the context of interregional interaction between customers and suppliers, the question about the share of suppliers from another region is used. Table 2 shows the distribution of procurers' responses to this question and the average scores for supplier reputation importance for different groups.


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Table 2

**Significance of supplier reputation for procurers with different shares of suppliers from another region**

| Shares of suppliers from another region | N | % | Average supplier reputation importance assessment |
|---|---|---|---|
| No | 39 | 6.5 | 4.9 |
| Up to 10% | 232 | 38.9 | 5.13 |
| 11-20% | 132 | 22.1 | 4.97 |
| 21-50% | 118 | 19.8 | 4.92 |
| More than 50% | 76 | 12.7 | 5.55 |

*Note: 14 procurers didn't mark the share of suppliers from another region.*
*Source: author's calculations.*

Table 3

**The relationship between the share of suppliers from another region and the assessment of suppliers' reputation importance (micro level analysis)**

| Variables | Dependent variable: Significance of supplier reputation |
|---|---|
| 11-20% suppliers from another region | 0.065<br>(0.210) |
| 21-50% suppliers from another region | -0.040<br>(0.221) |
| More than 50% suppliers from another region | 0.686***<br>(0.260) |
| Personal characteristics | Yes |
| Organisational characteristics | Yes |
| Location fixed effects | Yes |
| N | 575 |
| R-squared | 0.126 |

****p<0.01, **p<0.05, *p<0.1*
*Selected category: 0-10% suppliers from another region.*
*Control variables: gender, position, category (federal, regional, municipal), number of employees, federal district.*
*Source: author's calculations.*

As can be seen from Table 2, the share of procurers who work only with suppliers from their region is the smallest - 6.5%. Most respondents (38.9%) work with a relatively small number of suppliers from other regions - up to 10%. 12.7% of public buyers are distinguished by the fact that most of their suppliers are from another region. In the context of procurers' answers to the question about the significance of the reputation of suppliers, a category of procurers, in which more than 50% of suppliers were from another region, stands out. This category of procurers values the importance of suppliers' reputation significantly higher.

The regression presented in Table 3 confirms the significance of these differences. In the model, the dependent variable is an assessment of suppliers' reputation significance, and the explanatory variables are binary variables that reflect the share of suppliers from another region. The selected category is 0-10% of suppliers from another region. Here and below, several control variables are added to the regression - personal and organisational characteristics, as well as control on the federal district. Personal characteristics include the gender and position of the procurer, and organisational characteristics - the level of subordination of the


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Table 4

**Average estimates of the importance of suppliers' reputation by federal districts**

| Federal district | Average supplier reputation significance score | Share of customers, most of whose suppliers are from another region*, % |
|---|---|---|
| Far East | 5.30 | 11 |
| Volga | 5.11 | 13 |
| Northwest | 5.32 | 7 |
| North Caucasian | 4.88 | 13 |
| Siberian | 4.83 | 17 |
| Ural | 5.06 | 20 |
| Central | 5.08 | 10 |
| South | 4.95 | 16 |
| For the entire sample | 5.10 | 13 |
| *More than 50% | | |

*Source: author's calculations*

organisation (federal, regional, municipal) and the number of employees.

As can be seen from Table 3, in comparison with the selected category "0-10% of suppliers from another region", only the category "more than 50% of suppliers from another region" gives a statistically significant increase in the orientation of procurers to the supplier reputation factor. The size of the coefficient can be interpreted as follows: procurers, most of whose suppliers are from another region, rate the reputation factor higher by 0.69 (on a 7-point scale). The result obtained allows us to conclude that the reputation factor is of particular importance in the interregional interaction of procurers and suppliers. The survey data confirm this conclusion at the micro level - the purchases of a specific customer.

Further analysis is devoted to this effect at the regional level. There are certain differences in the distribution of the average estimates of the importance of suppliers' reputation by federal districts (table 4).

For example, procurers from the Far East and Northwest districts rate the reputation of suppliers above average, and the lowest reputation rating is in the Siberian Federal District. As can be seen from the column with indicators of the share of procurers, most of whose suppliers are from another region, at the level of federal districts, the significance of suppliers' reputation is not explained by individual purchases of the respondent. Thus, in the Ural Federal District, there are 20% of respondents, more than 50% of whose suppliers are from other regions, and the assessment of suppliers' reputation importance is at an average level. In the Northwest District, on the contrary, only 7% of respondents answered that more than half of their suppliers are from another region, and the reputation significance is the highest among all federal districts.

On the one hand, it was concluded that at the micro level (purchases of a specific public buyer), a high proportion of suppliers from another region leads to a higher assessment of reputation significance. On the other hand, the primary analysis shows that data on the importance of reputation, aggregated at the level of federal districts, are not explained by the peculiarities of the procurement of respondents. It can be assumed that the orientation of procurers to the reputation factor depends not only on their own interaction with suppliers from other regions, but also on the characteristics of the environment. Regions that are part of one federal district can differ greatly in certain aspects of public procurement. In this regard, further analysis was carried out at the level of regions (official regions of the Russian Federation).

The "Data and Methodology" section describes in detail the principle of calculating the regional index - the share of contracts with suppliers from other regions - in quantitative and cost terms. The lowest value for both indicators is in the Republic of Tatarstan - 12% of the number and 16% of the monetary volume of government contracts was concluded with suppliers from other regions. In the Leningrad region, the share of contracts with suppliers from other regions in quantitative terms


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**Figure 1.** *The distribution of Russian regions by the share of contracts with suppliers from other regions in quantitative and value terms*
*Source: authors calculations using data from zakupki.gov.ru*

is the largest (68%), and in value terms the leader is the Murmansk region - 81%. For the 74 regions included in the analysis, the average share of contracts with suppliers from other regions, in quantitative terms is 36%, and in value terms is 43%.

Figure 1 shows the distribution of 74 regions by the share of contracts with suppliers from other regions in quantitative and value terms. The figure shows region codes, a comparison of codes and names of regions is in the Appendix.

As can be seen from Figure 1, the regions are mainly located diagonally, i.e. with the increase in the share of contracts with suppliers from other regions in quantitative terms, the indicator in value terms also grows. However, there are regions where there are not so many contracts with suppliers from other regions, but these are large contracts, and in value terms, the share is significant. For example, in the Magadan region, 36% of the number of contracts is concluded with suppliers from other regions, and these contracts account for 68% in monetary terms of the total volume of contracts in the region. In several other regions, the situation is reversed - a large number of contracts that are not so big in monetary terms are concluded with suppliers from other regions. For instance, in the Republic of Tyva, 63% of state contracts fall on suppliers from other regions, but in


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monetary terms, these contracts account for 37% of the total volume of state contracts in the region.

Further, the 74 regions were divided into 4 groups depending on the indicators for these two indices. The division took place according to the average value of the indices (36% for quantitative terms and 43% for value terms). The lower group included regions with an indicator up to and including the average, and the upper group included regions with an indicator above the average. The grouping of regions is presented in Table 5.

Most of the regions (34) are characterised by the fact that up to 36% of the number of contracts and up to 43% of the volume of contracts are concluded with suppliers from other regions. Such regions include, for example, the Republic of Bashkortostan, Altai Territory, Krasnoyarsk Territory, Voronezh Region, Moscow.

16 regions are distinguished by high values of the share of contracts with suppliers from another region, both in terms of value and quantity. Examples of regions in this group: Republic of Karelia, Republic of Khakassia, Astrakhan region, St. Petersburg, Moscow region.

8 regions conclude many contracts with suppliers from other regions, but these contracts are not so large in terms of volume. Such a situation is, for example, in the Belgorod, Bryansk and Vladimir regions. 16 regions, on the contrary, do not conclude so many contracts with suppliers from other regions in quantitative terms, but the total volume of these contracts from the total volume of government contracts in the region is above average. This group includes, for example, the Republic of Buryatia, Krasnodar Territory, Khabarovsk Territory.

According to the average indicators of suppliers' reputation importance, it is noticeable that the highest ratings are in the regions with a high proportion of contracts with suppliers from other regions in quantitative terms. If we compare two groups for which the quantitative index is not higher than the average, the reputation score almost does not change from the indicator in value terms (5 vs 5.02). It can be assumed that the indicator of the share of suppliers from another region in value terms does not affect the orientation of procurers towards reputation, in contrast to the indicator in quantitative terms. To test this assumption, a regression model is presented in Table 6.

As can be seen from the table, estimates of suppliers' reputation importance are statistically significantly associated only with the share of contracts with suppliers from another region in quantitative terms. Thus, if a region has a large

Table 5

**The distribution of regions by the shares of contracts with suppliers from other regions and average reputation importance**

| Share of contracts with suppliers from other regions | | Value terms | |
|---|---|---|---|
| | | Up to 43% included | More than 43% |
| Quantitative terms | Up to 36% included | 34 regions<br>Reputation- 5.0 | 16 regions<br>Reputation- 5.02 |
| | More than 36% | 8 regions<br>Reputation- 5.21 | 16 regions<br>Reputation- 5.35 |

*Source: author's calculations*

Table 6

**Relationship between the share of suppliers from another region and the assessment of suppliers' reputation importance (regional level analysis)**

| Variables: | Dependent variable: Significance of supplier reputation | |
|---|---|---|
| | Quantitative terms | Value terms |
| The share of contracts with suppliers from another region is higher than the regional average | 0.402**<br>(0.194) | 0.086<br>(0.170) |
| Personal characteristics | Yes | Yes |
| Organisational characteristics | Yes | Yes |
| Location fixed effects | No | No |
| N | 570 | 570 |
| R-squared | 0.078 | 0.071 |

****p<0.01, **p<0.05, *p<0.1*
*Control variables: gender, position, category (federal, regional, municipal), number of employees.*
*Note: Control for federal district is not included because the explanatory variable varies by region.*
*Source: author's calculations*


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number of contracts with suppliers from other regions of the Russian Federation, the supplier reputation factor becomes more important.

This result complements the analysis at the level of individual contracts of public buyers. Together they show that the supplier reputation factor plays the most important role when a significant share of contracts is concluded with suppliers from other regions. This conclusion is confirmed, both at the micro level - the purchases of a specific customer, and at the regional level. The findings are especially important for managing contractual relationships in public procurement in Russia and other countries which are also characterised by a heterogeneous spatial structure and economic differentiation of regions. The findings may be of interest to public procurement regulators in such countries, as well as to direct market players actively involved in interregional interaction.

The research contributes to the literature in the following aspects. First, this article summarises the literature about the effects of suppliers' reputation consideration in public procurement. Second, this study adds to the understanding of areas where reputation factor is of particular importance. The research on this topic stresses the importance of reputation in areas with a high level of uncertainty (Chiou & Pate, 2018), in procurements with precise formulation characteristics (Calzolari & Spagnolo, 2009) or characterised by performance issues (Beausoleil, 2010). This study reveals the role of reputation in the context of interregional public procurement. The result is in line with the literature on the topic of reputation in cross-regional purchasing (Chintagunta & Chu, 2021; Elfenbein et al. 2019). The latter studies focus on private procurement, while the results of this paper cover the topic in the context of public procurement.

## Conclusion

Reputation is an important aspect of overcoming the principal-agent problem which is characteristic of contractual relationships. In public procurement, reputation considerations are limited by regulation. Emerging questions about the effectiveness of procurement operations management in the public sector (Karjalainen, 2011), as well as the growing role of the supply quality indicator (Farr, 2016), determine the relevance of research into the effects of reputation considerations in public procurement.

A review of studies showed that considering the reputation of suppliers by public buyers allows for increased productivity and quality of contract execution. This is also important from the point of view of the timing of the execution of contracts, together with the risks of cost overruns. The reputation factor is the basis for building trust between procurers and suppliers. Lack of research on reputation, in terms of interregional cooperation in public procurement, is revealed.

Based on the analysis of the survey of Russian public buyers, it has been shown that the reputation of suppliers is especially important for procurers who mostly work with suppliers from other regions. By aggregating open data on government contracts in Russian regions, the grouping of Russian regions is presented. Further combination of open and survey data confirms the role of reputation in interregional interaction between procurers and suppliers at the regional level. In regions where the share of contracts with suppliers from other regions in quantitative terms is higher than average, public buyers are more focused on the suppliers' reputation factor. Thus, in addition to the positive effects of the supplier reputation factor in public procurement considered in the theoretical part of the article, the empirical part demonstrates another, not so widely studied aspect.

The conclusion about the role of supplier reputation factor, in the context of interregional buyer-supplier interaction, both at the micro level and at the regional level, adds to the research on suppliers' reputation factor in public procurement. The importance of reputation in inter-regional economic relations has been confirmed in private sector studies (Chintagunta & Chu, 2021; Elfenbein et al., 2019), but has not previously been disclosed in the context of public procurement. An important direction for further research is to identify other regional features that affect the different levels of customer orientation on the reputation factor of suppliers by region. In addition, an important topic for research is the analysis of the role of reputation in interregional relationships between public buyers and suppliers in specific areas of procurement.

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Appendix
Table A1

**Comparison of codes and names of regions in the analysis**

| Code | Region Name | Code | Region Name | Code | Region Name | Code | Region Name | Code | Region Name |
|---|---|---|---|---|---|---|---|---|---|
| 2 | Republic of Bashkortostan | 23 | Krasnodar territory | 38 | Irkutsk region | 54 | Novosibirsk region | 70 | Tomsk region |
| 3 | Republic of Buryatia | 24 | Krasnoyarsk territory | 39 | Kaliningrad region | 55 | Omsk region | 71 | Tula region |
| 5 | Republic of Dagestan | 25 | Primorsky territory | 40 | Kaluga region | 56 | Orenburg region | 72 | Tyumen region |
| 8 | Republic of Kalmykia | 26 | Stavropol territory | 41 | Kamchatka territory | 57 | Oryol region | 73 | Ulyanovsk region |
| 10 | Republic of Karelia | 27 | Khabarovsk territory | 42 | Kemerovo region | 58 | Penza region | 74 | Chelyabinsk region |
| 11 | Republic of Komi | 28 | Amur region | 43 | Kirov region | 59 | Perm territory | 75 | Trans-Baikal Territory |
| 12 | Republic of Marij El | 29 | Arkhangelsk region | 45 | Kurgan region | 60 | Pskov region | 76 | Yaroslavl region |
| 13 | Republic of Mordovia | 30 | Astrakhan region | 46 | Kursk region | 61 | Rostov region | 77 | Moscow |
| 14 | Republic of Sakha (Yakutia) | 31 | Belgorod region | 47 | Leningrad region | 62 | Ryazan region | 78 | Sankt-Petersburg |
| 16 | Republic of Tatarstan | 32 | Bryansk region | 48 | Lipetzk region | 63 | Samara region | 79 | Jewish autonomous region |
| 17 | Republic of Tuva | 33 | Vladimir region | 49 | Magadan region | 64 | Saratov region | 86 | Khanty-Mansi Autonomous Area – Yugra |
| 18 | Udmurtian Republic | 34 | Volgograd region | 50 | Moscow region | 65 | Sakhalin region | 89 | Yamal-Nenets Autonomous Area |
| 19 | Republic of Khakasia | 35 | Vologda region | 51 | Murmansk region | 66 | Sverdlovsk region | 91 | Republic of Crimea |
| 21 | Chuvashi Republic | 36 | Voronezh region | 52 | Nizhni Novgorod region | 67 | Smolensk region | 92 | Sevastopol |
| 22 | Altai territory | 37 | Ivanovo region | 53 | Novgorod region | 69 | Tver region | | |

*Source: compiled by the author using "Region codes" directory. Retrieved from: https://www.nalog.gov.ru/rn77/fl/pay_taxes/income/get_help/4329723/*

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# Innovation-Driven Evolution of the Sharing Economy in a Russian Region: The Case of Sverdlovsk Region

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**ABSTRACT**

**Relevance**. The sharing economy, an emerging sector, encounters obstacles such as intricate regulations, insufficient funding, constraints in data collection infrastructure, and uncertainties in evaluation methodologies. For the best results, it is crucial to thoroughly examine risks and find effective ways for the sharing economy to grow in the region.

**Research objective**. This study aims to examine trends in sharing economy development in a major Russian area, using the case of Sverdlovsk region as an example.

**Data and Methods**. The study relies on scientific publications from Scopus, EBSCO, and RSCI databases, alongside proprietary indicators and websites of 19 representative companies. It introduces a methodology utilizing SimilarWeb and Yandex WordStat services to collect consumer behavior metrics from online sharing economy platforms in Russia and Sverdlovsk region.

**Results.** Results reveal escalating interest in sharing economy transportation services, suggesting potential funding reallocations in the public sector. Additionally, the popularity of freelance exchanges in Sverdlovsk region indicates a substantial remote work talent pool. Although the labor market's sharing economy is in its nascent stage, it demonstrates future growth potential. Notably, the rental of goods and equipment holds considerable promise for growth in Russia's industrial regions.

**Conclusion**. The study identifies a research challenge centered on the formulation of methodological principles for evaluating essential parameters within innovative sharing economy economic models at the regional level. Methodological guidelines are outlined, encompassing empirical assessments via SimilarWeb and Yandex WordStat services, with proposed indicators for analysis. Recommendations to support shared economy companies are also provided, serving as a potential blueprint for the government of Sverdlovsk region in their future planning endeavors.

**KEYWORDS**

sharing economy, regional economy, development trends, methodological tools, SimilarWeb, YandexWordstat

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# Инновационное развитие долевой экономики в регионе: опыт Свердловской области

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**АННОТАЦИЯ**

**Актуальность.** Долевая экономика является относительно новым сектором экономики, и ее развитие может столкнуться с различными препятствиями, включая законодательные и регуляторные проблемы, нехватку финансирования и слабую инфраструктуру сбора данных, а также отсутствие методологических рекомендаций по оценке долевой экономики. Однако, для достижения максимальных положительных результатов необходимо глубокое исследование данной темы, чтобы учесть все возможные риски и определить наилучшие способы развития долевой экономики в регионах. Исследование об инновационном развитии шеринг экономики может помочь определить тенденции и перспективы развития данного сектора экономики в конкретном регионе, выявить факторы, влияющие на ее развитие и оценить вклад в экономический рост и устойчивое развитие региона.

**КЛЮЧЕВЫЕ СЛОВА**

долевая экономика, региональная экономика, тенденции развития, методологический инструментарий, SimilarWeb, YandexWordstat





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**Цель исследования.** Целью данного исследования является систематизация тенденций развития долевой экономики в крупном российском регионе на примере анализа параметров деятельности компаний сферы услуг в Свердловской области.
**Данные и методы.** Информационной базой данного исследования стали научные публикации в открытом доступе баз данных Scopus, EBSCO, РИНЦ, авторские разработки по показателям развития долевой экономики, а также сайты 19 компаний, выбранных для репрезентации каждой из сфер. В данном исследовании предлагается способ сбора метрик поведения потребителей на онлайн - платформах долевой экономики в России и Свердловской области с помощью сервисов SimilarWeb и Yandex WordStat.
**Результаты.** Растущий интерес к долевой экономике в сфере транспортных услуг может привести к перераспределению финансирования в общественном секторе. Также, в Свердловской области пользуются популярностью фриланс-биржи, что говорит о большом количестве специалистов удаленных профессий. Долевая экономика в сфере рынка труда находится в начальной стадии развития, но имеет потенциал для роста в будущем. Сфера аренды товаров и оборудования имеет большой потенциал для роста в промышленных регионах России.
**Выводы.** Сформулирована научная проблема, заключающаяся в необходимости разработки методологических положений оценки базовых параметров экономических моделей инновационного развития долевой экономики в регионе. Разработаны методологические рекомендации оценки инновационного развития долевой экономики, такие как эмпирическая оценка результатов, полученных в результате компьютерной обработки данных с помощью сервисов SimilarWeb и Yandex Wordstat, предложены показатели для анализа. Предложены рекомендации мер поддержки компаний долевой экономики, которые могут быть использованы правительством Свердловской области при составлении дальнейших планов.

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**ДЛЯ ЦИТИРОВАНИЯ**
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# 地区共享经济的创新发展：以斯维尔德洛夫斯克州为例

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**摘要**
**现实性**：共享经济是一个相对较新的经济领域，其发展可能面临各种障碍：包括立法与监管问题、缺乏资金、数据收集系统薄弱，以及缺乏衡量共享经济的指南。然而，为了取得最大的积极成果，有必要对此主题进行深入研究。文章应考虑到所有可能的风险，并确定在该地区发展共享经济的最佳方式。研究共享经济创新发展，有助于判断特定地区经济领域的发展趋势和前景，识别影响其发展的因素，并评估共享经济对该地区经济增长和可持续发展的贡献。
**研究目标**：本研究的目的是通过对斯维尔德洛夫斯克州服务业公司活动参数的分析，系统阐述俄罗斯大型地区共享经济的发展趋势。
**数据与方法**：本研究信息基于开放数据库 Scopus、EBSCO、RSCI 中科学出版物中的关于共享经济发展指标的研究成果，以及被选中代表各领域的 19 家公司的官方网站。本研究提出了一种使用 SimilarWeb和Yandex WordStat服务来收集俄罗斯和斯维尔德洛夫斯克州在线共享经济平台消费者行为指标的方法。
**研究结果**：人们对交通服务领域的共享经济越来越感兴趣，这可能会导致公共部门资金的重新分配。此外，自由职业者市场在斯维尔德洛夫斯克州也很流行，这表明存在有大量远程工作专家。劳动力市场领域的共享经济正处于初步发展阶段，但未来仍有增长潜力。在俄罗斯工业地区，商品和设备租赁业具有巨大的发展潜力。
**结论**：文章建立了评估地区共享经济创新发展模式基本参数的方法。并提出了评估共享经济创新发展的建议，如利用 SimilarWeb 和 Yandex Wordstat 服务对计算机数据处理结果进行实证评估，还提出了分析指标。斯维尔德洛夫州政府在制定下一步计划时可以利用这些建议来支持共享经济公司的发展。

**关键词**
共享经济、区域经济、发展趋势、方法工具、SimilarWeb、YandexWordstat

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## Introduction

The innovation-driven development of the sharing economy in regional contexts plays a pivotal role in both augmenting economic growth and fostering sustainable advancements in regional economies. Innovative progression in the sharing economy entails the application of novel methodologies, technologies, and business paradigms to facilitate the exchange and dissemination of resources through digital platforms. This not only leads to a shift from traditional consumption patterns to more thoughtful resource use, but also stimulates the creation of new business models and collaborative frameworks. The sharing economy, as a systemic construct, facilitates the communal sharing of resources and amenities among individuals and enterprises, culminating in the optimization and streamlining of resource consumption, along with the mitigation of adverse ecological ramifications.

In the academic discourse, defining the precise boundaries of activities encompassed by the sharing economy remains an issue of contention. Various disciplines, including sociology, anthropology, business and management, and politics, use terms like "sharing consumption" and "access-based consumption" to define the area now commonly referred to as the "sharing economy". Furthermore, these activities are intricately interwoven with the concepts of the "circular economy" and the "collaborative economy", with discernible delineations between consumer-centric and production-related activities notably absent (Codagnone & Martens, 2016).

The sharing economy's trajectory continues to exhibit an accelerated momentum, permeating diverse spheres ranging from transportation to gastronomy. A salient advantage inherent in the sharing economy is its ability to alleviate issues related to excessive production and unnecessary consumption. Conventional market-driven economies often result in resource squandering and redundant purchases, thus engendering detrimental ecological and macroeconomic effects. On the other hand, the sharing economy enables the smart use of existing resources, reducing unnecessary consumption, promoting waste reduction, and preserving resources for future generations (Midgett et al., 2018).

Taking into account different perspectives, sharing economy business models that create lasting value can be sorted into environmental, societal, and economic benefits, that is, they lead to more efficient use of resources, prevent harm to society, and improve overall well-being. From an economic perspective, such business models concurrently enhance economic efficiency, bolster profits, and create new opportunities for businesses (Boar et al., 2020).

The sharing economy serves as a catalyst for the advancement of novel technologies and business models. Enterprises in the sharing economy perpetually seek fresh strategies to optimize their operations, thereby instigating a fertile milieu for pioneering advancements. Evident outcomes encompass the proliferation of online sharing platforms, the advent of innovative financial practices like crowdfunding and the rise of carsharing ventures. The sharing economy's growth has led to the emergence of different business approaches, which are ready to evolve alongside technological advancements and changing behaviors (Standing et al., 2019).

Moreover, the model of the sharing economy has the potential to bring about significant socioeconomic changes for regions. The adoption of sharing economy practices can particularly stimulate the growth of employment, thereby improving the economic situation in the region. At the same time, the gains in resource utilization efficiency resulting from sharing economy mechanisms offer the possibility of reducing inequality and enhancing the well-being of the population. This is especially relevant in countries dealing with issues like corruption and lack of social cohesion. In such contexts, sharing initiatives and the platforms that support their reputation can become promising strategies to coordinate efforts and reshape societal norms (Hira et al., 2017).

It is worth noting that the sharing economy is still a relatively new aspect of the economic landscape, which makes it susceptible to various challenges. These challenges include complex legislative and regulatory issues, limited funding, weaknesses in data collection infrastructure, and a lack of clear guidelines for measuring the extent of the sharing economy. Given this ever-changing environment, it's necessary for public policy to adapt alongside shifts in market conditions and the influence of emerging technologies or competitors that might render current regulations obsolete (Koopman et al., 2014). However, for the best possible outcomes, a thorough examination of this landscape is essential, taking into account potential risks and mapping out the most effective pathways for the growth of the sharing economy in specific regional contexts.


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An investigation into the progress of the sharing economy in specific regions help us unveil trends and potential for growth in this economic sector. Thus we are able to identify the factors that shape its evolution and assess its role in fostering economic expansion and sustainable development. Therefore, the aim of this study is to systematically analyze the trajectory of sharing economy development in a large Russian region, which will be shown by looking at how service companies in Sverdlovsk region are operating. To this end, several tasks need to be undertaken, including conducting a comprehensive review of existing research, the formulation of a methodology to evaluate economic models within the sharing economy framework, an appraisal of the sharing economy's progress in Sverdlovsk region, and the identification of emerging trends in various sectors of the sharing economy.

## Theoretical framework

The rise of the sharing economy has resulted from a combination of intricate changes across technology, economy, society, and the environment on a global scale. From a technological perspective, the progression of payment systems and the expansion of social networks have played a significant role. Societal factors include the increase in social inequality and a shift in consumption patterns. On an economic level, new business models have emerged, while the pandemic's impact on the economy has also been influential. Additionally, environmental considerations encompass heightened human-caused pressures and the initiation of a shift towards more responsible production and consumption practices (Lyaskovskaya et al., 2021).

The sharing economy is "a new consumption model that describes a marked trend in consumer values from ownership to access, in which individuals and communities around the world rent, borrow, trade, gift and share resources on a scale that was not previously possible" (McAlpine, 2014). Hamari, J et al. (2016) define the sharing economy as a peer-to-peer activity of obtaining, providing or exchanging access to goods and services, coordinated through community-based online services.

Currently, there is a lack of a universally agreed-upon definition for the sharing economy, which gives rise to various challenges when it comes to gauging the extent of this model and determining its regulatory framework. However, in order to anticipate the sharing economy's future trajectory, it becomes imperative to first evaluate its present scope. Notably, a comprehensive study conducted by R. Basselier et al. (2018) highlights the absence of a unified centralized database within statistical authorities, and the available administrative data falls short of facilitating thorough analysis. The ambiguity surrounding the terminology leads to estimation complexities; for instance, the Institute of National Accounts chose to exclude Airbnb from GDP estimations for now, awaiting guidance from the official Eurostat management for further direction.

Data for sharing economy research is often collected through a survey. For example, in the article by Hamari et al. (2016), the data consist of responses received from 168 registered users of the Sharetribe service, which were obtained through the official mailing list[1]. Hamari et al. (2016) used the data to investigate the motivation of people to participate in the sharing economy and showed that participation is motivated by many factors, such as sustainability, enjoyment of the activity, and economic benefits. However, survey data collection has a number of assumptions that can bias the results, including the subjectivity of the answers, the limited sample of respondents and questions.

Zervas et al. (2017) examine the impact of the Airbnb service on hotel stays, employing a regression analysis approach. They assembled a comprehensive dataset encompassing all Airbnb properties in Texas alongside a panel of quarterly tax revenue for all Texas hotels spanning a decade. Their findings unveil that a 1% surge in Airbnb listings in Texas corresponds to a 0.05% reduction in hotel quarterly revenue, an effect amplified by Airbnb's swift expansion. However, it's crucial to note the constraints of the presented data collection method, which limit the scalability and applicability of outcomes to a broader context. The study's sample pertains to one state, hence the results might not accurately represent other geographical regions.

Furthermore, the integration of sharing platforms can significantly impact the acquisition of durable goods. Gong et al. (2017) assess the influence of Uber adoption on new car ownership, employing an innovative dataset encompassing new car registrations in China spanning from 2010 to 2015. They sourced Uber activity data from the company's official blog and social media channels. In addition to macroeconomic and demographic indicators, they incorporated data from the Baidu

[1] Sharetribe Ltd. is a social business enterprise registered in Finland.


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index, a search volume metric provided by China's primary search engine, akin to Google Trends in the US, widely used as a demand proxy. Their findings indicate that Uber's emergence correlates with a notable upswing (8%) in new vehicle ownership, implying that consumers are proactively reallocating their accessible resources to capitalize on the surplus value offered by these platforms.

Examining the operational data of companies can improve the individual reputation of sellers on platforms, which in turn can result in increased revenue. Abrate and Viglia (2019) introduce a revenue model that factors in vendor and product reputations, alongside an upper boundary determined by total assets. This investigation focused on the Airbnb platform across five European cities, revealing that personal reputation profoundly influences revenue optimization. The dataset is sourced from the Airbnb website and encompasses details about room and apartment prices, availability, features, and reputation attributes. While revenues from specific properties are not directly stated, they are computed by multiplying the price by the average monthly occupancy.

A qualitative evaluation approach to assessing the sustainability of sharing economy business models is presented by Daunorienė et al. (2015). This methodology employs sustainability circles to pinpoint key sustainability facets. Using a peer-to-peer company assessment in Lithuania as an example, the study demonstrates how to gauge the present level of company stability and identify priority areas. Technological prospects and environmental impact are evaluated on a nine-point scale, where 1 signifies "critical" sustainability necessitating immediate alterations, while 9 indicates the highest level of sustainability. Nevertheless, it's essential to acknowledge that qualitative assessments can be heavily influenced by experts' subjective opinions, potentially yielding varying conclusions and introducing heterogeneity in assessment outcomes, thereby complicating decision-making.

Presently, there are several indicators for evaluating the growth of the sharing economy. The prominent Timbro Shared Economy Index relies on traffic data and web-scraped information. This index incorporates data from 286 services across 213 countries, albeit exclusively for 2018. It constitutes a staple in sharing economy research; for instance, Yin et al. (2021) explore the correlation between carbon emissions, the eco-efficiency index, and the Timbro index. Leveraging a Bayesian regression model, their findings indicate that a heightened sharing economy level corresponds to a negative correlation with carbon emissions and a positive association with overall environmental performance, thereby underscoring the environmentally considerate nature of the sharing economy.

Another indicator used to assess the development of the sharing economy is the number of users of the sharing economy from Statista[2]. This index is the number of U.S. adults who used a community-based online service that coordinates peer-to-peer access to property, goods, and services at least once during a calendar year. There is also an indicator from the statistical service of the European Union - the percentage of individuals who have used sharing economy projects. This indicator is presented in a database of 28 EU countries for the period from 2017 to 2019. The indicators of the statistical service of the European Union are actively used to study the sharing economy. Karobliene at al. (2021) proved the positive impact of the sharing economy on the economic sustainability of countries in terms of sustainable development goals using the above indicator. To determine the impact of the sharing economy, a cluster analysis of the EU countries was carried out. However, Timbro's Sharing Economy Index only has a single year result, Statista's Sharing Economy user count is limited to US residents, and sample limitations in the European Union Statistical Service database are also a problem.

Generally, two indicators are employed to examine the proliferation of the sharing economy on a regional scale. The first, the Sharing Economy Index, is used to measure the development level of the sharing economy in cities based on the availability of relevant services. This index was formulated by the Consumer Choice Center, an advocacy group for consumers. The second indicator is the Smart City Index, which assesses the accessibility of technological applications and structures for urban residents and gauges residents' perceptions of these aspects. This index is compiled by the Institute for Management Development, an independent academic institution headquartered in Switzerland. Baculakova (2020), for example, utilizes this index to assess the transport system's development and environmental concerns using the example of Bratislava.

Currently, the assessment of the sharing economy has the following primary challenges:

[2] Number of sharing economy users in the United States from 2016 to 2021 (in mln). Statista (2017). Source: //www.statista.com/statistics/289856/numbersharing-economy-users-us/


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a lack of universal metrics due to its diverse service spectrum, ranging from apartment rentals to carsharing, where evaluation might hinge on a chosen metric that isn't always universally applicable; and data inaccuracy — incomplete or imprecise data about sharing service usage hampers the assessment of economic activity and social benefits in the sharing economy. The absence of a standardized definition impedes the development of dependable statistical measurements for both financial value and participation in the sharing economy (Codagnone et al., 2016).

The path of sharing economy growth can differ from one region to another, influenced by factors such as how many people live there and their economic situation. For example, there are cases where the sharing economy has been successful in places with fewer minority residents, but it hasn't been as effective in areas where Black and Hispanic communities live (Thebault-Spieker et al., 2017).

Establishing methodological guidelines to assess key parameters within innovative sharing economy economic models in a given region is an important task for multiple reasons. Firstly, it fosters a standardized approach for evaluating and contrasting diverse segments of the sharing economy, which is especially crucial for governmental and municipal entities entrusted with regulating this domain. The evolution of policies and regulations concerning the sharing economy must progressively broaden to unlock its complete potential (Liu & Chen, 2020). Secondly, it enhances the quality of the data about the sharing economy, thereby augmenting decision-making and business strategy formulation for entrepreneurs and investors. Thirdly, these methodological provisions can establish safety and consumer protection standards and recommendations, benefiting all market participants. Furthermore, they contribute to a deeper comprehension of the sharing economy's scope and its overall impact on society and the economy.

## Method and data

The foundation of this study rests upon scientific publications available in open-access databases such as Scopus, EBSCO, and RSCI. Additionally, it encompasses the authors' own advancements regarding the indicators of shared economy development as well as an examination of selected companies' websites, chosen to represent distinct areas. Our approach is to gather consumer behavior metrics from online sharing economy platforms in Russia and Sverdlovsk region through the utilization of SimilarWeb and Yandex WordStat services.

The study's focus is on the economic interactions that foster the innovative development of the sharing economy.

SimilarWeb, a marketing analytics tool, employs a range of methodologies and technologies to collect and analyze data pertaining to web traffic and user interactions on internet resources. The service scrutinizes diverse data sources, encompassing partner data, public information, and statistics derived from user panels. What sets SimilarWeb apart is its extensive data collection capabilities, processing a billion digital signals daily, analyzing two terabytes of data each day, and engaging more than two hundred data scientists (Jansen et al., 2022). The outcomes of SimilarWeb's data processing culminate in statistical models, predictive trend analyses, and assessments of internet resource performance. The platform enables the examination of audience behavior on internet resources, including data on visitor demographics, interests, and site interactions. A more comprehensive overview of the practical applicability of chosen indicators is presented in Table 1. It should be noted that the resources from SimilarWeb were accessed within the timeframe of 01/03/2023 to 15/03/2023.

Yandex Wordstat functions as an accessible platform to retrieve search query statistics within the Yandex system. This platform enables prospective internet users to dissect queries based on their qualitative attributes (such as subject and word form) and quantitative aspects (like monthly query frequency and historical yearly query frequency) (Kazak et al., 2019). It facilitates the evaluation of demand for specific subjects and provides insights into the most frequently input queries by users. The procedure for utilizing Yandex Wordstat encompasses entering keywords, selecting a timeframe, acquiring data, analyzing findings, and leveraging the results. A notable advantage of Yandex Wordstat lies in its capacity to examine query frequencies across diverse Russian regions. Users can choose their region of interest to obtain data on keyword request frequencies in that specific area. The availability of such regional data enhances the precision of assessing demand for particular subjects in distinct geographical areas.


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Table 1

**Description of indicators**

| Indicators | Source | Content | Function |
|---|---|---|---|
| Rating in the country | SimilarWeb | This indicator reflects the company's position in the market in terms of user activity on the site. | This indicator facilitates the analysis and evaluation of the progression in specific sectors of the economy, including the shared economy. It aids in pinpointing prominent market participants and discerning overarching development patterns. |
| Traffic (mln visits per month) | Calculated by the authors based on SimilarWeb | The average number of users who visit the site per month. This indicator is alculated as an average based on the data for three months. | This indicator signifies the company's popularity and the efficacy of its business model. |
| Company marketing channels | SimilarWeb | Channels or means used by the company to reach its target audience and attract customers. | This indicator illustrates the promotional strategies employed by the company, offering an avenue for scrutinizing the competitive landscape. |
| Impressions per month | Yandex Wordstat | The number of times a certain search query was entered into the search box on the Yandex platform in a month. | This indicator enables the evaluation of the audience's engagement with specific services or products offered by these companies. It can be harnessed to ascertain the potential magnitude of demand for a particular product or service within a specific region. |
| Level of expressed interest | Calculated by the authors based on Yandex Wordstat | The number of people who show interest in a particular service or product in a particular region. It is the ratio of impressions per month to the total population of the region. | This indicator enables the assessment of the potential market for services and goods within a specific region. |
| Regional popularity | Yandex Wordstat | The percentage of queries in the Yandex search engine related to a certain region, relative to the total number of queries on this topic in Russia. | This indicator facilitates the identification of the region where a specific service or product enjoys the highest popularity. |

*Source: compiled by the authors.*

Table 2

**Analysis of companies in the field of transport services**

| Companies | BlaBlaCar | Delimobil | Whoosh |
|---|---|---|---|
| Rating in the country | 831 | 18678 | 78285 |
| Traffic (million visits per month) | 3,3 | 0,1 | 0,06 |
| Company marketing channels (in %) | Direct (43.69) and Organic Search (42.63) | Direct (43.90) and Organic Search (39.65) | Organic (72.94) and Direct (17.79) |
| Impressions per month in Sverdlovsk region (number of visits) | 26130 | 5423 | 554 |
| Level of expressed interest in Sverdlovsk region (in %) | 0,62 | 0,13 | 0,01 |
| Regional popularity in Sverdlovsk region (in %) | 127 | 158 | 102 |

*Source: compiled by the authors by using information from the official websites of digital platforms using SimilarWeb, retrieved from:* https://www.similarweb.com/ *(Accessed 01/03/2023); YandexWorstat, retrieved from:* https://wordstat.yandex.ru/ *(Accessed 08/03/2023).*

## Results

This section showcases the outcomes of a study concerning sharing economy companies across different sectors. The analysis was conducted using data from these companies' platforms, supplemented by SimilarWeb and Yandex Wordstat services, giving us insights into company performance. To study and juxtapose various sharing-focused companies, tables were assembled featuring pertinent indicators.

Table 2 shows that the BlaBlaCar application holds the dominant position in the transporta-


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Table 3

**Analysis of companies in the field of tourism and hotel business**

| Companies | Airbnb | Ostrovok |
|---|---|---|
| Rating in the country | 2478 | 176 |
| Traffic (million visits per month) | 1,5 | 8,8 |
| Company marketing channels (in %) | Direct (77.50) and Organic Search (16.68) | Referral (48.09) and direct (24.32) |
| Impressions per month in Sverdlovsk region (number of visits) | 955 | 17731 |
| Level of expressed interest in Sverdlovsk region (in %) | 0,02 | 0,42 |
| Regional popularity in Sverdlovsk region (in %) | 53 | 95 |

*Source: compiled by the authors by using information from the official websites of digital platforms using SimilarWeb, retrieved from:* https://www.similarweb.com/ *(Accessed 01/03/2023); YandexWorstat, retrieved from:* https://wordstat.yandex.ru/ *(Accessed 08/03/2023).*

tion services sector, significantly outpacing its competitors Delimobil and Whoosh by margins of nearly 30 and 55 times, respectively. Across the transportation industry, direct channels[3] and organic search[4] emerge as the prevailing marketing channels for all applications, signifying their primary role in attracting new users through advertising and search engine optimization. In Sverdlovsk region, the degree of expressed interest in various transportation service applications shows variations. Particularly noteworthy is the considerable percentage of interested users in the region for BlaBlaCar (0.62%), while Whoosh lags significantly behind, with the lowest percentage (0.01%). Furthermore, the popularity of these applications also diverges. Delimobil stands out as the most popular, with a popularity rate of 158%, while Whoosh exhibits the lowest rate (102%).

In a broader context, BlaBlaCar maintains its position as the most favored transportation service app throughout Russia. Meanwhile, Delimobil and Whoosh cater to more specific audiences, potentially targeting smaller regions or distinct consumer segments. In Sverdlovsk region, Delimobil stands out as the preferred car sharing service when compared to carpooling[5] and personal mobility equipment rental services. However, it should be noted that the user base relative to the region's population remains below 1%. Additionally, the relatively elevated regional popularity of online transport service platforms in Sverdlovsk region suggests that this percentage might even be lower in many other parts of Russia.

Analysis of the data presented in Table 3 reveals a substantial disparity in traffic between Ostrovok and Airbnb. Notably, Ostrovok experiences significantly higher traffic with 8.8 million monthly visitors, in contrast to Airbnb's 1.5 million visitors. In terms of marketing channels, Airbnb predominantly leverages direct channels and organic search, whereas Ostrovok finds its most effective channels to be referrals and direct access.[6]

Moreover, the level of expressed interest in Sverdlovsk region for both Airbnb and Ostrovok

[3] Direct traffic is a marketing channel that describes the flow of users who enter a website's URL directly into the browser's address bar or use bookmarks in their browser. Such traffic is considered "direct" because the user consciously chooses to visit a particular site, rather than going to it through a search engine, social networks or advertising campaigns. Users who access a site through direct traffic are often repeat customers or are already familiar with the brand. They may use bookmarks in their browser to quickly find the site or navigate to it through links in email or instant messengers.

[4] Organic search is a marketing channel that is based on the fact that users are looking for information in search engines such as Google or Yandex. The essence of organic search is that sites that rank high in the search results get a free source of traffic to their site. However, in order to appear on the first lines of search results, the site must meet certain requirements that are taken into account by search engines. Organic search has a number of advantages, among which there is a high efficiency in attracting targeted traffic to the site. However, its use requires time and effort to optimize the site for the requirements of search engines, as well as to analyze the results and adjust the promotion strategy.

[5] Carpooling is a form of travel in which several people travel in the same vehicle to save on fuel costs and reduce environmental pollution.

[6] A referral channel is a marketing channel in which users go to the site through unique links that are distributed by other users or partners of the company. When a user clicks on such a link and goes to the site, the analytics system records this transition as referral traffic. Referral traffic can come from various sources such as social networks, bloggers, affiliate programs, etc. This marketing channel allows you to attract targeted users who are already interested in a product or service and can become potential customers or partners.


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remains relatively modest, at 0.02% and 0.42% respectively. However, it's worth highlighting that Airbnb's popularity in Sverdlovsk region stands at 53%, while Ostrovok enjoys a higher level of 95%. This divergence could be attributed to Airbnb's international orientation, catering to a global audience, while Ostrovok, a Russian platform, concentrates on domestic accommodations.

Factors such as Ostrovok's broader regional advertising campaign, along with the presence of numerous hotel reviews and ratings on the platform, might also influence this discrepancy. It's important to acknowledge that these results could be skewed due to Airbnb's current lack of support for payments from Russian bank cards.

Looking at the popularity of online labor market platforms, it is evident that the leading role is played by Profi.ru, which outshines competitors like Toloka, YouDo, and FL in terms of traffic. A more in-depth examination of the level of expressed interest for each platform, particularly in Sverdlovsk region, shows FL's slight advantage over its rivals.

Direct channels and organic search stand as the prevailing marketing avenues for all these platforms, indicating that users predominantly seek out specific job-related information on these websites. In terms of popularity in Sverdlovsk region, FL and Toloka emerge as the preferred choices, while YouDo and Profi.ru lag behind in this regard. However, when accounting for the percentage of the interested population, it can be deduced that Profi.ru demonstrates a higher conversion rate of visitors into engaged users.

Table 4

**Analysis of companies in the labor market**

| Companies | FL | Toloka | YouDo | Profi.ru |
|---|---|---|---|---|
| Rating in the country | 1944 | 18368 | 2295 | 322 |
| Traffic (million visits per month) | 1,6 | 0,5 | 1 | 7 |
| Company marketing channels (in %) | Direct (66.82) and Organic Search (21.71) | Direct (42.53) and Organic Search (40.50) | Direct (53.47) and Organic Search (36.24) | Organic Search (42.73) and Direct (42.45) |
| Impressions per month in Sverdlovsk region (number of visits) | 25954 | 1290 | 2483 | 4930 |
| Level of expressed interest in Sverdlovsk region (in %) | 0,61 | 0,03 | 0,06 | 0,12 |
| Regional popularity in Sverdlovsk region (in %) | 114 | 94 | 78 | 74 |

*Source: compiled by the authors by using information from the official websites of digital platforms using SimilarWeb, retrieved from: https://www.similarweb.com/ (Accessed 01/03/2023); YandexWorstat, retrieved from: https://wordstat.yandex.ru/ (Accessed 08/03/2023).*

Table 5

**Analysis of companies in goods and equipment rental**

| Companies | Next2U.ru | Polka.rent |
|---|---|---|
| Rating in the country | 36810 | 58258 |
| Traffic (million visits per month) | 0,04 | 0,02 |
| Company marketing channels (in %) | Organic (81.95%) and Direct (15.74%) | Organic Search (51.04%) and Social Media (17.53%) |
| Impressions per month in Sverdlovsk region (number of visits) | 4 | 3 |
| Level of expressed interest in Sverdlovsk region (in %) | 0 | 0 |
| Regional popularity in Sverdlovsk region (in %) | 58 | 176 |

*Source: compiled by the authors by using information from the official websites of digital platforms using SimilarWeb, retrieved from: https://www.similarweb.com/ (Accessed 01/03/2023); YandexWorstat, retrieved from: https://wordstat.yandex.ru/ (Accessed 08/03/2023).*


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Table 6

**Analysis of resale companies**

| Companies | Basco Party | Avito | Youla |
|---|---|---|---|
| Rating in the country | 26035 | 11 | 170 |
| Traffic (million visits per month) | 0,3 | 355,3 | 17,0 |
| Company marketing channels (in %) | Direct (57.02) and Organic Search (38.94) | Direct (58.20) and Organic Search (28.01) | Direct (64.81) and Organic Search (25.10) |
| Impressions per month in Sverdlovsk region (number of visits) | 37035 | 1530327 | 103134 |
| Level of expressed interest in Sverdlovsk region (in %) | 0,87 | 36,1 | 2,43 |
| Regional popularity in Sverdlovsk region (in %) | 2606 | 87 | 172 |

*Source: compiled by the authors by using information from the official websites of digital platforms using SimilarWeb, retrieved from:* https://www.similarweb.com/ *(Accessed 01/03/2023); YandexWorstat, retrieved from:* https://wordstat.yandex.ru/ *(Accessed 08/03/2023).*

As Table 5 illustrates, in the sectors under consideration, the domain of goods and equipment rental garners the least attention from Russian internet users. The traffic observed on both platforms remains relatively modest, with user interest primarily directed towards seeking information about goods and services, rather than the rental offerings themselves.

However, it is important to emphasize the notably higher regional popularity of Polka.rent in Sverdlovsk region in comparison to Next2U.ru. This discrepancy can be explained by distinct regional demands, including an elevated requirement for construction materials and specialized equipment due to the region's active infrastructure development. Furthermore, distinct variations in marketing channels are noteworthy: organic search and direct channel dominate for Next2U.ru, whereas organic search and social networks[7] are prevalent for Polka.rent. This discrepancy might signify diverse promotional strategies and the necessity to tailor approaches to the distinct interests and behaviors of the audience on each platform.

If we look at the data in Table 6, we see that Basco Party has the least amount of traffic among the featured companies, with a monthly visitor count of 0.3 million. In contrast, its counterparts such as Avito and Youla draw significantly larger audiences, recording 355.3 million and 17 million monthly visitors, respectively. This means that Avito stands as the most favored resale service in Sverdlovsk region, engaging 36.1% of the local population.

However, both Basco Party and Youla have cultivated their own distinct audiences with interests specific to particular goods and services. Remarkably, Avito enjoys substantial traffic nationwide, which likely contributes to its heightened prevalence compared to other platforms in Sverdlovsk region. Additionally, Basco Party's exceptional regional popularity can be attributed to its geographic presence and the elevated interest in the resale sector in this specific region.

By looking at the data in Table 7, several notable insights come to the forefront. Kinopoisk boasts a substantial monthly user traffic of over 206 million, with Yandex.Music following suit by attracting more than 80 million visitors. Skillbox records a user count of 5.8 million, Getcourse registers 7 million, and Rutube garners a substantial audience of 61.8 million. In terms of marketing channels, direct access and organic search remain dominant avenues for all companies except Getcourse, which relies more on direct and referral channels. From these findings, we can conclude that Kinopoisk and Yandex.Music have established themselves as more popular choices among users in Sverdlovsk region. Despite lower interest percentages, platforms such as Skillbox, Getcourse, and Rutube cater to a specific user demographic due to their niche offerings. The regional popularity assessment, however, underscores the overarching demand for all these platforms in Sverdlovsk region.

[7] Social networks are platforms that allow people to communicate, share information, content and opinions in an online format. They are also a marketing channel that allows companies to connect with their target audience, increase brand awareness and promote their products or services. They provide the ability to create and distribute content, communicate with consumers, analyze their interests and preferences, and use paid advertising to increase audience reach.


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Table 7

**Analysis of information resource companies**

| Companies | Kinopoisk | Yandex.Music | Skillbox | Getcourse | Rutube |
|---|---|---|---|---|---|
| Rating in the country | 15 | 38 | 551 | 524 | 56 |
| Traffic (million visits per month) | 206,4 | 80,7 | 5,8 | 7,0 | 61,8 |
| Company marketing channels (in %) | Direct (51.11%) and Organic Search (32.10%) | Direct (72%) and Organic Search (13.40%) | Direct (46.89%) and Organic Search (37.83%) | Direct (56.45%) and Referral (13.67%) | Direct (54.68%) and Organic Search (27.31%) |
| Impressions per month in Sverdlovsk region (number of visits) | 115546 | 75805 | 2826 | 2982 | 31822 |
| Level of expressed interest in Sverdlovsk region (in %) | 2,73 | 1,79 | 0,07 | 0,07 | 0,75 |
| Regional popularity in Sverdlovsk region (in %) | 106 | 111 | 89 | 89 | 104 |

*Source: compiled by the authors by using information from the official websites of digital platforms using SimilarWeb, retrieved from:* https://www.similarweb.com/ *(Accessed 01/03/2023); YandexWorstat, retrieved from:* https://wordstat.yandex.ru/ *(Accessed 08/03/2023).*

## Trends in the development of the sharing economy

The development and popularity of the sharing economy in Sverdlovsk region exhibit variations across distinct sectors. In the domain of transport services, noteworthy trends emerge. BlaBlaCar, a carpooling service, garners substantial interest, reflecting a demand for budget-friendly travel, particularly for extended journeys. In contrast, Delimobil, a carsharing service, enjoys heightened popularity in the region, signaling elevated demand. On the other hand, the Whoosh app, which serves individual transportation needs, isn't catching on as much in the region, implying a subdued demand. Overall, the transportation services sector in the region shows a rising trend of interest in the sharing economy. This trend holds the potential to impact the allocation of public funds.

Conversely, the sphere of tourism and hospitality exhibits distinct dynamics. Ostrovok, a Russian firm specializing in hotel reservations, shows peak regional recognition, implying pronounced interest vis-à-vis other locales. However, global platforms like Airbnb have lower popularity in the region and attract fewer interested residents. This points to an ongoing preference for traditional hotel booking approaches and travel agency services. Nevertheless, as sharing services gain prominence through heightened awareness and user-friendliness, the sector's allure in the region might surge over time.

The nascent state of the labor market sharing economy in Sverdlovsk region has a unique landscape. FL, a service for finding short-term jobs, is particularly well-recognized in the local area and resonates with residents. On the national level, Profi.ru holds the top position, but its popularity is not as strong in Sverdlovsk region. Services such as Toloka and YouDo exhibit a modest percentage of interested inhabitants in this area. The particular makeup of the region's workforce, which might involve a significant number of remote professionals using freelance platforms, could explain why FL's services are popular. Even though the labor market sharing economy is just starting in the region, there is considerable potential for growth in the future.

The rental of goods and equipment in the sharing economy is still in its early stages of development in Sverdlovsk region. Companies like Next2u and Polka.rent have relatively low monthly impressions, indicating limited visibility. However, Polka.rent demonstrates high regional popularity, pointing to a growing market potential. The establishment of trust and potential demand from local industrial enterprises could contribute to the advancement of this sector within the sharing economy.

In the resale of goods sector, intriguing patterns emerge in the given region. Avito maintains its position as the leader in terms of the interested population, but its regional popularity is modest, hinting at market saturation. Conversely, Youla enjoys greater regional popularity, indicating its appeal to residents. Notably, Basco Party, a second-hand clothing store, stands out with high regional popularity despite a lower percentage of the interested population, mainly due to its physical presence. Overall, the resale of goods in the


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Table 8

**Analysis of company life cycle stages across various sectors in Sverdlovsk region**

| Spheres | Peculiarities | Development stage |
|---|---|---|
| Transport services | Stable interest in carsharing and carpooling services. Potential for the development of individual mobility services | Growth stage |
| Tourism and hospitality | Preference of domestic companies, traditional methods of booking prevail, travel agency services | Growth stage |
| Labor market | Increased interest in freelance exchanges, increase in the number of specialists in remote professions | Growth stage |
| Rental of goods and equipment | Potential for development, but no user response | Origin stage |
| Resale | Popularity of services among the audience, market saturation | Growth stage |
| Informational resources | Popularity of entertainment services, low interest in educational services, preference for traditional ways of acquiring knowledge | Growth stage |

*Source: compiled by the authors according to the model of Miller and Friesen (1984)*

sharing economy seems to be saturated, yet it remains popular among the region's residents.

An examination of trends in the development of the sharing economy in the information resources sector shows a preference for entertainment services among the region's audience. Kinopoisk and Yandex.Music demonstrate significant interest and regional popularity, highlighting a preference for consuming entertainment content. In contrast, educational services such as Skillbox and Getcourse exhibit lower interest and regional popularity, suggesting relatively reduced enthusiasm for online learning and a preference for alternative knowledge acquisition methods. Consequently, the region's audience tends to gravitate toward entertainment content, rendering online platforms providing such content highly favored.

To assess the current developmental stage in each sphere of the shared economy in Sverdlovsk region, the organizational life cycle model proposed by Miller and Friesen (1984) was employed. This model delineates distinct phases of an organization's evolution.

In the initial "birth" phase, firms strive to formulate a viable market strategy. As they progress into the "growth" stage, they expand in size, extend their market presence, and develop a more structured organizational framework. Subsequently, during the "maturity" stage, firms tend to be less innovative and refrain from significant alterations to their products and services. The "revival" phase is characterized by substantial changes in product strategy and heightened overall company innovativeness. Finally, organizations in the "decline" phase focus on conserving dwindling resources and often avoid innovation due to their outmoded product lines (Shirokova et al., 2006).

## Managing the development of the sharing economy

Considering the growth stage of companies operating in the sharing economy in the transport services sector, the government of Sverdlovsk region can implement supportive measures to foster their development. Collaborative efforts with companies to enhance and ensure the reliability of intercity and long-distance travel systems are crucial. We recommend that joint verification systems for drivers should be introduced through *gosuslugi.ru* - the Portal of Public Services of the Russian Federation - to enhance service reliability and security. To stimulate sectoral growth, the government could allocate grants for the study of transport route development and sectoral enhancement, positively influencing the progress of companies in the sharing economy. Moreover, facilitating financing for these companies could be considered. Government contracts can provide cities with more influence over sharing companies, enabling the enforcement of stronger consumer protection, enhanced economic redistribution, or other policy objectives (Rauch & Schleicher, 2015).

Sharing economy companies could contribute to the implementation of the region's development strategies until 2030 in the area "Development of Transport and Logistics Potential". A designated task is the establishment and advancement of an urban passenger traffic control center in Yekaterinburg. Sharing companies could aid in this endeavor by providing insights into route popularity, facilitating more efficient urban transportation planning. Additionally, focusing on modern transportation technologies and trends, such as electric and autonomous vehicles, and


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eco-friendly modes of transport is important. Encouraging innovative transport technologies can attract more sharing economy companies to the sector, ensuring its stable growth in the future.

For the advancement of sharing economy companies in the tourism and hotel business sector in Sverdlovsk region, it would make sense to foster collaboration between domestic services and local tourism companies to devise new tourist routes and promote domestic tourism. Organizing events like forums and conferences can facilitate the exchange of experiences and ideas among companies. A key objective of the region's development until 2030 is to present the region's tourism potential in international, national, and regional tourism exhibitions, conferences, and forums.

To support companies in the tourism and hotel business, the government could create favorable conditions such as tax rate reductions, preferential loans, or subsidies for business growth. Supporting the improvement of tourism infrastructure, including the construction of new hotels and renovation of existing facilities, can boost tourist numbers and satisfaction levels. Additionally, the creation of a dedicated website to aggregate all tourist routes and information about recreational areas in the region can address another goal of the region's strategic plan – promoting regional tourism products online. In the modern travel industry, the internet serves as a potent tool for promotion and sales, reaching millions of online users (Irgashevich et al., 2022).

The success of the labor market and information resources to a large extent hinges on the advancement of online education. Investments in this domain can yield positive outcomes such as skill improvement, process efficiency enhancement, and heightened company competitiveness. While some educational institutions remain wary of online learning models, there is a growing recognition of the potential of new technologies to enhance or replace more labor-intensive methods (Bishop, 2007). One strategy could involve companies placing educational orders with state universities for targeted training that meets labor market needs. Encouraging diverse forms of public-private partnerships in technical education and employment, including internships with local enterprises in Sverdlovsk region, aligns with government tasks outlined in the action plan for implementing the socio-economic development strategy until 2030. Ensuring widespread access to online education is essential for fostering sectoral growth. Additionally, the government can support local information resources like job portals, resumes, and innovative HR technology projects to enhance recruitment and personnel management efficiency.

To bolster companies in the sharing economy engaged in goods and equipment rental, issuing subsidized loans at their initial stages is recommended. This could be implemented as part of the above-mentioned action plan, addressing the tasks like establishing a system of state loan guarantees for SMEs and preferential lending systems for their investment projects. Notably, many startups, including high-tech ones in China, heavily rely on government funding for their successful launch (Chandra & Fealey, 2009). Marketing research support is crucial to identify market needs and ascertain the most sought-after types of goods and equipment in the region. Creating a startup incubator for this domain, potentially supported by the Sverdlovsk Regional Fund for Entrepreneurship, could provide budding entrepreneurs with essential resources and knowledge for successful business initiation and growth.

The sharing economy can significantly contribute to the sustainable environmental development of the region. By reducing the number of cars on the road, it can lower pollution levels and improve air quality. Additionally, the sharing economy can facilitate efficient municipal waste collection through optimal resource utilization and waste reduction. In sectors like personal services, sharing economy development can decrease waste volume by enhancing item utilization efficiency, consequently curbing production. However, alongside its benefits, the sharing economy raises concerns about negative impacts. The potential displacement of traditional workers is a notable concern, as sharing platforms might decrease demand for conventional employment, affecting job stability and income for those reliant on traditional jobs. Furthermore, the prevalence of part-time work in the sharing economy can lead to worker exploitation, with limited employment benefits, inadequate wages, and insufficient workplace safeguards. Inconsistent regulations in the sharing economy may exacerbate these issues, resulting in imbalanced power dynamics between workers and platforms, insufficient worker rights, and challenges in ensuring job security and fair treatment.

Our recommendations concerning sharing economy development in Sverdlovsk region can be applied to other regions. Proactive support and development of sharing economy sectors, such as transport, tourism, hotels, and equipment rental,


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are recommended. This can be achieved through financial and marketing aid to companies, alongside granting support for research and sectoral growth. Consideration should be given to tax rate reduction and startup incubator establishment to provide aspiring entrepreneurs with necessary resources for successful initiation and growth. Collaboration and partnerships between sharing economy entities and other local businesses or services are also highly encouraged. Such collaborations can lead to new business models, joint promotion of tourism routes and services, and overall sectoral advancement. Tailoring strategies to specific regional conditions and goals will pave the way for sustainable and inclusive sharing economy development across various regions.

## Conclusion

This study aimed to systematize the developmental trends in the sharing economy of a large Russian region, illustrated through an analysis of service company activities in Sverdlovsk region. The study yielded both theoretical and practical outcomes, outlined below.

Drawing from critical evaluations of prior research, the study identified the need to establish methodological guidelines for evaluating essential parameters in the innovative economic models driving shared economy development in a region. The existing methods for appraising shared economy parameters were systematically examined.

Methodological recommendations were formulated to assess the innovation-driven development of the shared economy. These encompassed empirical evaluations achieved through computer data processing using services such as SimilarWeb and Yandex Wordstat. Indicators for analysis were defined, including traffic and audience engagement metrics, the percentage of the region's population displaying interest, and the regional popularity relative to other parts of Russia. As part of our assessment of Sverdlovsk region's shared economy development, we identified trends and developmental stages in each given sector. Furthermore, recommendations were offered to support shared economy companies, potentially informing the future strategies of the region's government.

The study's novelty lies in the systematic delineation of the region's shared economy development, thus augmenting existing research on regional sharing economy.

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# Causal analysis of the interinfluence of workforce productivity and rail freight intensity in the regions of the Ural Federal District

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**ABSTRACT**

**Relevance.** The development of the railway industry has a significant positive impact on socio-economic dynamics at both the state and regional levels, which has been confirmed by numerous domestic and foreign studies. However, the issue of mutual influence of such categories as regional labour productivity and rail freight intensity has been little studied. At the same time, the most important task today is to find effective incentives for the growth of regional labour productivity.

**Research Objective.** This study aims to econometric analysis of the relationship between rail freight intensity and workforce productivity in the Ural Federal District (UFD).

**Data and Methods.** The study uses official statistical data on Russian regions provided by the Federal State Statistics Service. The methods of Vector Error Correction Models (VECM) and pooled mean group estimates (PMG method) formed the methodological basis of the study.

**Results.** The study has shown that there is a relationship between workforce productivity and rail freight intensity. At that point, in a short-term period growth of rail freight intensity leads to an increase in workforce productivity, which in a long-term period itself becomes an incentive to increase the shipped commodity mass and rail freight intensity.

**Conclusions.** The findings can be of interest to public authorities at the national and regional levels, for heads of industrial structures and functional institutions, representatives of business and scientific communities interested in the development and modernization of transport infrastructure, being a basic condition for the increased intensity of cargo transportation in the region.

**KEYWORDS**

regional development, regional transportation system, workforce productivity, rail freight intensity, vector error correction models (VECM), method of pooled mean group estimates (PMG method)

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# Причинно-следственный анализ взаимовлияния производительности труда и интенсивности железнодорожных грузоперевозок в регионах Уральского федерального округа

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**АННОТАЦИЯ**

**Актуальность.** Развитие железнодорожной отрасли оказывает существенное положительное влияние на социально-экономическую динамику как на уровне государства, так и на уровне регионов, что подтверждено многочисленными отечественными и зарубежными исследованиями. Однако мало изучен вопрос взаимовлияния таких категорий как региональная производительность труда и интенсивность грузовых перевозок. Вместе с тем сегодня в условиях необходимости наращивать производственно-технологический суверенитет важнейшей задачей является поиск эффективных стимулов для роста региональной производительности труда.

**Цель исследования.** Цель данного исследования – эконометрический анализ взаимосвязи между интенсивностью транспортных железнодорожных грузоперевозок и производительностью труда в Уральском федеральном округе (УрФО).

**КЛЮЧЕВЫЕ СЛОВА**

развитие региона, транспортная система региона, производительность труда, интенсивность железнодорожных грузоперевозок, векторные модели коррекции ошибок (VECM), метод объединенных средних групповых оценок (метод PMG)





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**Данные и методы**. В исследовании используются официальные статистические данные по российским регионам, предоставленные Федеральной службой государственной статистики. Методологическую основу исследования составили методы векторных моделей коррекции ошибок (VECM) и объединенных средних групповых оценок (метод PMG).
**Результаты.** Исследование показало наличие взаимосвязи между производительностью труда и интенсивностью грузоперевозок. Причем в краткосрочном периоде рост интенсивности грузоперевозок приводит к росту производительности труда, которая в долгосрочном периоде сама становится стимулом к наращиванию отгружаемой товарной массы и увеличению интенсивности грузоперевозок.
**Выводы.** Полученные результаты могут представлять интерес для органов государственной власти на национальном и региональном уровне, для руководителей отраслевых и функциональных органов, представителей бизнеса и научных сообществ, заинтересованных в развитии и модернизации транспортной инфраструктуры, как базовому условию наращивания интенсивности грузоперевозок в регионе.

**ДЛЯ ЦИТИРОВАНИЯ**
Petrov M.B., Serkov L.A. & Zavyalova K.A. (2023). Causal analysis of the interinfluence of workforce productivity and rail freight intensity in the regions of the Ural Federal District. *R-Economy*, 9(3), 310–324. doi: 10.15826/recon.2023.9.3.019

# 乌拉尔联邦区劳动生产率与铁路货运强度相互影响的因果分析

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**摘要**
**现实性：**铁路行业的发展对国家和地区层面的社会经济动态有着显著的积极影响，这一点已被国内外众多研究证实。然而，学界对于地区劳动生产率和货运强度等因素之间的相互影响问题却研究甚少。同时考虑到当今增加生产和技术主权的需要，找到区域劳动生产率增长的有效激励措施是最重要的任务。
**研究目标：**本研究的目的是对乌拉尔联邦区铁路货运强度与劳动生产率之间的关系进行计量分析。
**数据与方法：**研究使用了联邦国家统计局提供的俄罗斯各地区官方统计数据。研究使用了联邦国家统计局提供的俄罗斯各地区官方统计数据。研究的方法论基础是向量误差修正模型（VECM）和合并组均值法（PMG）。
**研究结果：**研究表明，劳动生产率与货运强度之间存在着某种关系。此外，在短期内，货运强度的增长会导致劳动生产率的提高，而在长期内，劳动生产率的提高本身又会成为增加货运强度的动力。
**结论：**研究结果可能会引起国家和地区各级政府、行业和职能机构负责人，以及对交通基础设施发展和现代化感兴趣的企业界和科学界代表的兴趣。研究可作为提高区域内货物运输强度的方法之一。

**关键词**
区域发展、区域交通系统、劳动生产率、铁路货运强度、向量误差修正模型（VECM）、合并组均值法（PMG）

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## Introduction

Transport freight contributes significantly to economic growth and thus to overall national and socio-economic development objectives. Transport freight can contribute to economic growth both directly and indirectly: they increase overall productivity; encourage technology diffusion between industries; and increase the profitability of transport-related businesses, either by increasing their sales volumes or by reducing production and delivery costs.

Transport freight has been the subject of detailed academic analysis, especially since the seminal works (Aschauer, 1989; Eisner, 1991). The central questions are whether the intensity of freight transport contributes to economic growth, whether economic growth increases the intensity of transport use, whether they reinforce each other, and whether they jointly influence other related processes.

Among freight transport, rail freight is particularly noteworthy as it is an important and integral part of the national economy and has a significant impact on society as a whole. At the same time, the share of rail transport in the total freight turnover of the Russian Federation (RF) is about 46-47%[1]. By comparison, the share of road transport in total freight turnover is about 5%. As noted in the paper (Petrov, et al, 2021) “the work of railway transport

[1] Transport in Russia. 2022: Statistical collection / Rosstat. - Moscow, 2022. - 101 c. - URL: https://rosstat.gov.ru/folder/210/document/13229.


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and the quality of transport services depends, firstly, on the investment attractiveness of territories and the transport mobility of the population. Secondly, railway transport stimulates other sectors of the economy through direct, indirect and induced effects. Thirdly, railway transport contributes to the formation of employment and income growth. Fourthly, rail transport generates positive economies of scale, helping to increase competitiveness, and finally, rail transport is an important factor for the dissemination of technical knowledge".

For a vast country such as Russia, the lack of mobility of critical production resources can be a major challenge and an obstacle to economic growth. Therefore, it is important to identify both short-term and long-term causes of freight demand response, depending on economic and technological determinants at the national level. The most important such determinant is the workforce productivity, which affects the growth of the commodity mass shipped.

The aim of this study is an econometric analysis of the relationship between railway freight transport intensity and workforce productivity in the Urals Federal District (UFD). In order to achieve the set goal, it is necessary to analyze the cause-and-effect relationships between labour productivity and intensity of transport railway freight traffic in the Urals Federal District. This is the research objective and scientific novelty of the work.

The choice of railway freight transportation in the Urals Federal District as an object of study is interesting because part of the territory of the Urals Federal District belongs to Siberia and the Arctic and the Northern Sea Route passes through this territory. The main objective of developing the transport system of the UFD is to form a unified transport space, the main tasks of which include, among others, forming a unified year-round accessible road network; renewing the rolling stock fleet with new, modern vehicles; increasing transport development of the Far North regions. The relevance of analyzing freight traffic intensity in the Urals Federal District is due to the fact that, according to the most pessimistic scenarios of minimum 2% annual economic growth in Russia, by 2030 the deficit of railway capacity on the Siberia-Ural route will amount to about 70 million tons (Kolomak, 2020).

Among all the regions of the Urals Federal District, two regions stand out – the Khanty-Mansi Autonomous Area (KhMAO) and the Yamal-Nenets Autonomous Area (YaNAO) - whose economies are based on oil and gas extraction. These regions are among Russia's leaders in terms of hydrocarbon reserves. In addition, for example, the Khanty-Mansi Autonomous Area ranks third in the "rating of the socio-economic situation of Russia's regions" and second in terms of economic size in Russia (second only to Moscow).

It should be noted that there are practically no publications on the direct impact of workforce productivity on the intensity of rail freight transport.[2] The bulk of publications are devoted to the analysis of the impact of railway transport infrastructure on regional economic performance. For example, A.N. Rahmangulov and O.A. Kopylova (Rakhmangulov, Kopylova, 2014) proposed an econometric model to assess the impact of these factors on the logistics infrastructure facilities in the regions. An interesting publication (Macheret, 2016) analyzes the dynamics of the main indicators of the railway network of different countries over a century period. The publication notes the positive results of economic reforms in railway transport. It concludes that the development of market mechanisms and their institutional framework (in particular, the removal of restrictions on attracting private capital into the development of the existing railway infrastructure) is necessary to successfully meet the challenges of developing the Russian railway industry and the country's entire economy.

A number of works are devoted to the application of a vector error correction model to analyses the causal relationship between transport performance and economic growth. Pradhan, et al (2013) found a bi-directional causal relationship between road transport intensity and economic growth. A unidirectional causal relationship was found between economic growth and rail transport. The authors believe that policies conducive to transport infrastructure development in India will contribute to sustainable economic growth in this country. In terms of the reciprocal impact of transport and economic growth, researchers from China in VECM (Liu, et al, 2006) found a one-way causal relationship between transport logistics and economic growth in China. It should be noted that there are very few studies related to the application of VECM for causal analysis in the transport industry. Meanwhile, this toolkit seems to be the most effective for analyzing this type of problems.

The paper (Mak, et al., 2015) uses an autoregressive model and establishes a causal relation-

[2] Bibliometric analysis using the VOSviewer software product was used in this paper.


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Table 1

**Indicators used in modelling**

| Indicator | Designations (logarithms) | Unit of measure |
|---|---|---|
| Rail freight intensity | lintens | tons/(km*person) |
| Real gross regional product (GRP) per capita employed (workforce productivity) | lvrp | Million rubles/person |

*Source: the authors' developed.*

ship between the following four variables: transport intensity, urbanization scale, emissions and economic growth in both the short and long term. The main conclusion is that passenger transport intensity in the G-20 countries should be increased in order to stimulate economic growth.

It should be noted that the method based on the estimation of Vector Error Correction Models (VECM) is also applied in other areas of analysis. For example, to study the financial sustainability of a number of countries (Canagarajah, et al, 2012; Afonso, et al, 2015; Quintos, et al, 1995; Payne, et al, 1997). Articles (Afonso, et al, 2016; Paniagua et al, 2017; Feld, et al, 2020; Seo, et al, 2016) have analyzed the fiscal sustainability of regions.

In addition to those mentioned above, various econometric methods have been used to investigate the impact of various factors on transport energy efficiency (Lv, et al, 2015; Shi, et al, 2013). The impact of carbon dioxide emissions has been analyzed in (Xu, et al, 2016; Liang, et al 2017). The decomposition of various factors affecting energy consumption in the transport sector is described in (Belloumi, 2016; Liu, et al, 2015; Yuan, et al, 2015).

## Methods and data

Econometric modelling is one approach to identify the interdependence and causality between different types of indicators. Since the time series of the indicators to be analyzed, as will be shown below, are non-stationary, standard classical methods such as the Ordinary Least Squares (OLS) method are not applicable for the estimation of regression parameters. Asymptotic distributions using classical model estimation methods such as OLS when dealing with non-stationary time series can lead to erroneous conclusions or false regressions. The solution to these problems is to test the time series of the variables under study for cointegration and to estimate Vector Error Correction Models (VECM) to distinguish short run and long run effects of intervening variables. The basic idea behind cointegration is that although each of two or more time series of variables may be non-stationary, their linear combination can have a stationary trend due to the mutual elimination of stochastic trends in the linear combination of variables. This linear combination between non-stationary variables is known as a cointegrating vector (cointegrating relationships). Thus, a cointegrating relationship between non-stationary series can be seen as a long-term steady state dynamic relationship, although there may be small short-term variations around long-term states. In order for the long-run relationship between the variables to be maintained, the variables must be corrected for bias, which is done in a vector error correction model.

Thus, at the first stage of the study the time series are checked for nonstationarity. At the second stage, the possibility of their cointegration is checked. At the third stage, VECM is estimated and causal relationships between the analyzed variables are established.

The peculiarity of the study is that it is carried out on panel data from six regions of the Ural Federal District for the period from 2000 to 2020. The choice of this rather compact data panel is due to the heterogeneity of empirical data describing the regions of the Ural Federal District in terms of industry.[3]

The analyzed indicators (Table 1) are obtained by calculation from the data available on the official website of Rosstat. All the regions of the Ural Federal District were studied: Kurgan and Sverdlovsk regions, the Khanty-Mansi (KhMAO) and the Yamal-Nenets (YaNAO) Autonomous Areas, Tyumen Region (without KhMAO and YaNAO) and the Chelyabinsk Region. The time series of indicators is annual data. The sample period is from 2000 to 2020[4]. Before the analysis, the time series of indicators are transformed into a natural logarithmic form (using the natural logarithm)[5].

[3] This choice is also due to the fact that in the absence of spatial autocorrelation between the variables under study, spatial econometric models cannot be applied.

[4] The use of annual data is due to the lack of official quarterly statistics for the indicators studied.

[5] Converting the data to logarithmic form is due to the fact that using them in their original form leads to heteroscedasticity in the residuals of the estimated equations.



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Rail freight intensity was calculated as the ratio of freight transported by rail per capita of the employed population to the operational length of public railway lines. Labour productivity was calculated as real gross regional product (GRP) per capita employed. Real GRP was determined in constant prices of 2000.

## Results

Table 2 shows the descriptive statistics of the indicators under study. The analyzed variables have positive asymmetry coefficient values, i.e., the statistical distributions of all these variables are positively skewed compared to the normal distribution. Thus, the time series of these variables may have a stochastic trend and be non-stationary. In order to verify this statement, a visual analysis of the data should be carried out and the time series under study should be tested for the presence of a unit root.

Visual data analysis allows us to analyze the validity of combining them into a panel and preliminarily assess some relationships between the studied variables. Figures 1 and 2 show the time dependencies of rail freight intensity and workforce productivity for individual regions of the Ural Federal District. From the above figures we see a rather uniform picture. On average, there are some stationary values for each region relative to which there are temporal fluctuations for the studied variables. This means that a panel model with a regionally heterogeneous constant may turn out to be quite adequate for the empirical data.

Table 2

**Descriptive statistics of the variables studied**

| Statistics indicators | lintens | lvrp |
|---|---|---|
| Average | 1.171 | 368.108 |
| Median | 0.362 | 135.876 |
| Maximum | 21.218 | 1275.112 |
| Minimum | 0.084 | 41.997 |
| Standard deviation | 0.431 | 12.085 |
| Asymmetry | 2.180 | 1.141 |
| Excess | 2.483 | 2.475 |

*Source: the authors' calculations are based on "Regions of Russia. Main Characteristics of the Constituent Entities of the Russian Federation. Retrieved from: https://rosstat.gov.ru/ (accessed 26.01.2023).*

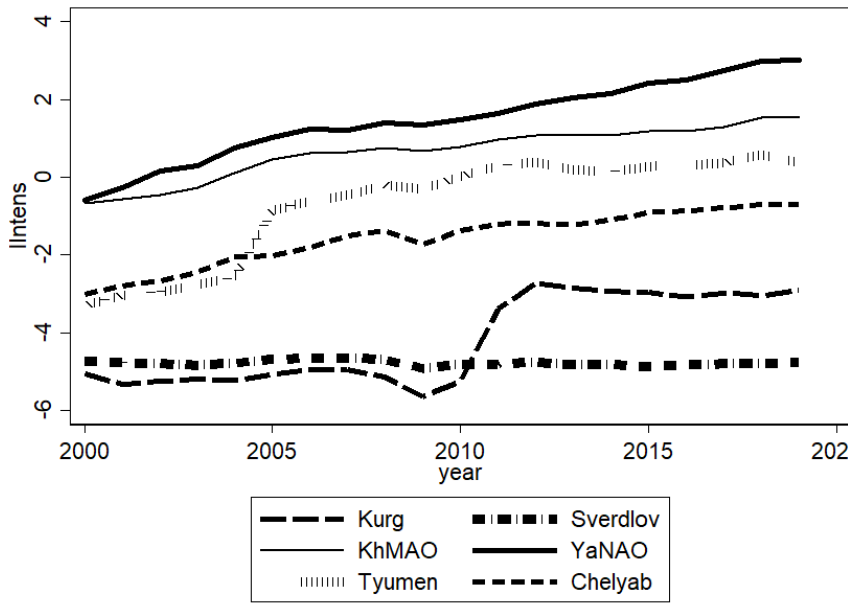


**Figure 1.** *Time dependence of the logarithm of the rail freight intensity for individual regions of the Ural Federal District*

*Source: Compiled by the authors are based on "Regions of Russia. Main Characteristics of the Constituent Entities of the Russian Federation. Retrieved from: https://rosstat.gov.ru/ (accessed 26.01.2023).*


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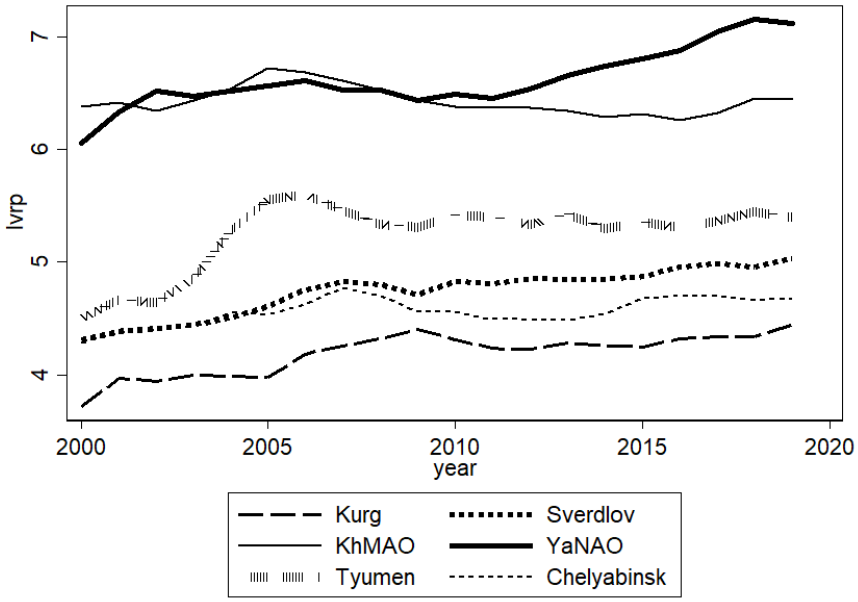


**Figure 2.** *Time dependence of the logarithm of workforce productivity for individual subjects of the Ural Federal District*

*Source: Compiled by the authors are based on "Regions of Russia. Main Characteristics of the Constituent Entities of the Russian Federation. Retrieved from:* https://rosstat.gov.ru/ *(accessed 26.01.2023).*

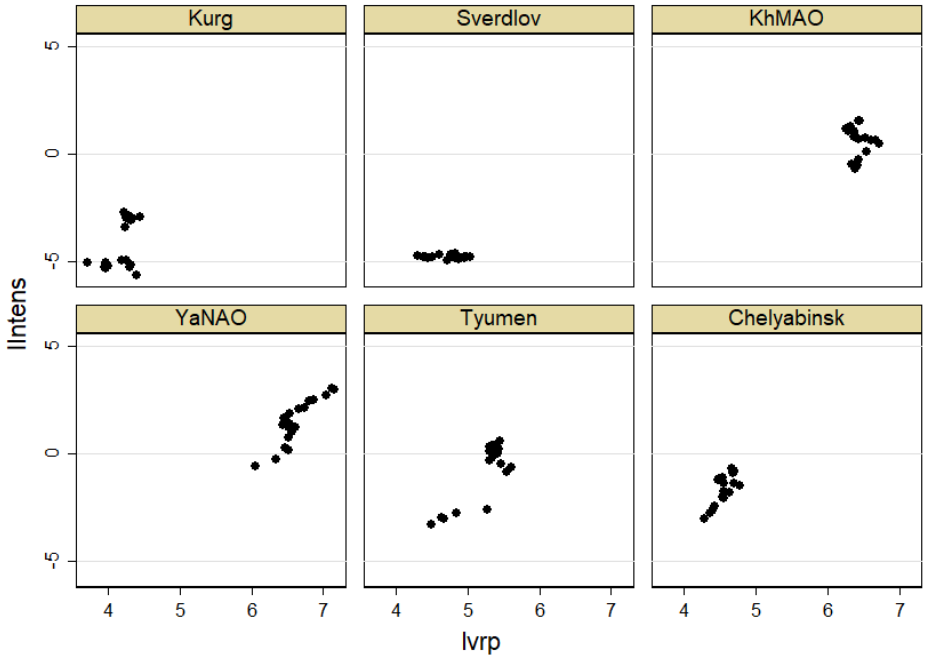


**Figure 3**. *Dependence of railway freight traffic intensity on workforce productivity for selected Ural Federal District subjects. Logarithmic values. Point diagrams.*

*Source: Compiled by the authors are based on "Regions of Russia. Main Characteristics of the Constituent Entities of the Russian Federation. Retrieved from:* https://rosstat.gov.ru/ *(accessed 26.01.2023).*

The test (Pesaran, 2007) confirms the cross-dependence of the studied series of panel data[6]. The CD (cross-dependence) test statistic is 2.624, the p-value is 0.0087 and the null hypothesis $H_0$ is no cross-dependence. The average value of the absolute correlation of the non-diagonal elements of the residual's matrix is 0.561, which confirms the specification of the fixed-effects model.

[6] A cross-dependence test for time series of individual variables showed that the time series under study are cross-dependent.


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It is noteworthy that rail freight intensity in the Sverdlovsk Region remained virtually unchanged over the study period (Figure 1), while the time dependencies for the Kurgan and Tyumen Regions are characterized by some positive jumps in intensity (especially for the Kurgan Region). It is precisely during these spikes that relatively strong productivity growth occurred for these regions (Figure 2).

Figure 3 shows the dependence of railway freight traffic intensity on workforce productivity for individual Ural Federal District subjects in the form of point diagrams. The diagrams show that a pronounced positive dependence of intensity on workforce productivity is observed for the KhMAO, YaNAO, Tyumen and Chelyabinsk regions. There is no such dependence for the Sverdlovsk Region. Finally, a rather contradictory picture is observed for the Kurgan Region, characterized by a jump and a negative dependence.

Panel data were tested for unit root using the Hadri and Pesaran tests (). The essence of the Hadri test (Hadri, 2000) is to test the statistical significance of model coefficients on time differences of the original time series data:

$$\Delta Y_{it} = \alpha_i + \beta_i Y_{t-1} + \gamma_i t + \varepsilon_{it}, \quad (1)$$

The test involves testing the null hypothesis that the process is stationary against the alternative hypothesis that it is non-stationary (the presence of unit roots). If for any number of cross sections is satisfied $\gamma_i \neq 0$ and $\beta_i < 0$, then the series of first-order differences is stationary, and hence the process is integrable of order I (1).

For the Hadri test, an estimated value of the Z-statistic

$$Z = \frac{\sqrt{N(LM - \mu)}}{\zeta} \to N(0,1),$$

is calculated using Lagrange multipliers:

$$LM = \frac{1}{N}\left\{\frac{\sum_{i=1}^{N}\left(\sum_{t=1}^{T}\left(\hat{Y}_{it} - Y_{it}\right)^2\right)}{T^2 \bar{f}_0}\right\}, \quad (2)$$

where $\bar{f}_0 = \frac{\sum_{i=1}^{N} f_{i0}}{N}$ – average estimation of spectral density of residuals of estimated model, $N$ – the number of observations, $T$ – the number of time periods, $\mu = 1/15, \sigma^2 = 11/6300$ if there is a trend and $\mu = 1/6,\ \sigma^2 = 1/45$ otherwise. The statistics are counted in Neuve-West estimates.

The results of the Hadri test are presented in Table 3. The Z-statistic and its corresponding significance level for rejecting the null hypothesis that the panel process is stationary are calculated for the test. In addition to the conventional Hadri statistic, statistics with possible heteroscedasticity, performed in Neuve-West estimates, are estimated.

The Pesaran test (Pesaran, 2007) is based on the assumption of cross-sectional dependence of series in a panel. In this case, a cross-sectional dependence statistic (CD-statistic) is calculated. Two model specifications were considered: with constant; with constant and trend. The test results are shown in Table 4.

Table 3

**Hadri panel test results for a single root**

| Model specification | lintens | lvrp |
|---|---|---|
| With a constant | | |
| Z - statistics | 6.293*** | 4.772*** |
| Z - statistics including possible heteroscedasticity | 5.272*** | 4.342*** |
| With constant and trend | | |
| Z - statistics | 3.834*** | 4.192*** |
| Z - statistics including possible heteroscedasticity | 3.542*** | 3.793*** |

*Note. H0 - the series is stationary (does not contain a unit root). * – the null hypothesis is rejected at 10%-level of significance; ** – the null hypothesis is rejected at 5%-level of significance; *** – the null hypothesis is rejected at 1%-level of significance.*

*Source: the authors' calculations.*


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Table 4

**Pesaran panel test results for a single root**

| Model specification | lintens | lvrp |
|---|---|---|
| Testing variables in levels | | |
| With a constant | -1.342 | -1.876 |
| With constant and trend | -2.232 | -2.765** |
| Testing variables in first differences | | |
| With a constant | -4.121*** | -4.654** |
| With constant and trend | -4.523*** | -4.854*** |

*Note. H0 - the series contains a unit root. Selection of lag length for each individual test regression was performed automatically based on the "general-to-specific" approach using the pooled F-test with maximum lag length equal to 3; * – null hypothesis rejected at 10%-level of significance; ** – null hypothesis rejected at 5%-level of significance; *** – null hypothesis rejected at 1%-level of significance.*

*Source: the authors' calculations.*

Table 5

**Results of Pedroni panel tests for cointegration**

| Alternative hypothesis: overall autoregressive coefficients (within-group significance) | | |
|---|---|---|
| | Statistic | p-value |
| Panel v-Statistic | 1.694*** | 0.001 |
| Panel rho-Statistic | 0.456 | 0.618 |
| Panel PP-Statistic | -3.216*** | 0.005 |
| Panel ADF-Statistic | -3.714*** | 0.003 |
| **Alternative hypothesis: individual autoregressive coefficients (intergroup significance)** | | |
| | Statistic | p-value |
| Group rho-Statistic | 1.760 | 0.355 |
| Group PP-Statistic | -7. 393*** | 0.001 |
| Group ADF-Statistic | -8.513*** | 0.001 |

*Note. H0 – no cointegration; The lag length is selected automatically using AIC criterion with maximum lag length equal to 3. Model specification includes individual constants and trends; *** – null hypothesis rejected at 1% significance level.*

*Source: the authors' calculations.*

Thus, based on the results of the tests performed, it is safe to conclude that all variables are first-order integrated I (1), hence a long-run relationship can exist between them.

Testing the long-run relationship between the variables under study is done for a regression equation:

$$\text{lintens}_{it} = \mu_i + b_i \text{trend}_t + \beta \text{lvrp}_{it} + \varepsilon_{it},\ \varepsilon_{it} \sim N(0, \sigma^2), \quad (3)$$

where $\mu_i, b_i$ – coefficients reflect the presence of spatial and temporal heterogeneity in the regions, respectively; index $i$ – the number of the region; *trend* – the trend of traffic intensity; $\varepsilon_{it}$ – error with zero mean and a finite constant variance. Equation (4) assumes that workforce productivity is the main factor affecting rail freight intensity. Since the variables under study are logarithmic, the coefficient estimate at the relevant variable can be interpreted as the elasticity of rail freight intensity at this indicator.

The cointegration of the variables in question means that there is a long-run effect of workforce productivity on regional rail freight intensity and that an equilibrium trajectory exists in their dynamics. To assess the presence of cointegration we will use the Pedroni panel test.

Table 5 presents the results of Pedroni's panel tests (Pedroni, 1999; Pedroni, 2004). Five tests out of seven reject the lack of cointegration between the variables. Thus, the results of the tests indicate that the variables in question are cointegrated,


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hence the relationship between the variables under investigation (equation 4) is characterized by the presence of long-run equilibrium dynamics.

Further analysis was carried out within the model described by Equation 4. The parameters of this cointegration equation were estimated using the method of pooled mean group estimates (PMG method).

PMG method (Pesaran, et al, 1999) allows simultaneously testing the presence of cointegration among variables, estimating parameters of their long-run relationship as well as the impact of these variables on the dependent variable in the short-run. It also allows for panel data to take into account existing differences in long-run and short-run dynamics between individual regions.

The initial model, as applied to our task in the PMG test, is an autoregressive dynamic model with a distributed lag $ARDL(p, q_1)$:

$$\text{lintens}_{it} = \mu_i + b_i \text{trend}_t + \sum_{j=1}^{p} \varphi_{ij}^{(1)} \text{lintens}_{i,t-j} + \sum_{j=0}^{q_1} \varphi_{ij}^{(2)} \text{lvrp}_{i,t-j} + \varepsilon_{it}, \quad (4)$$

Where $\phi_{ij}^{(1)}, \phi_{ij}^{(2)}$ – the coefficients are at lag variables. This model is reparametrized into an error correction model (VECM):

$$\Delta\text{lintens}_{it} = \tilde{\mu}_i + \sum_{j=1}^{p-1} \tilde{\varphi}_{ij}^{(1)} \Delta\text{lintens}_{i,t-j} + \sum_{j=0}^{q_1-1} \tilde{\varphi}_{ij}^{(2)} \Delta\text{lvrp}_{i,t-j} + \varphi_i^{ecm}(\text{lintens}_{i,t-1} - \beta_i \text{vrp}_{i,t-1} - \gamma_i \text{trend}_{t-1}) + \varepsilon_{it}, \quad (5)$$

where $\Delta$ – the operator of the first differences of the variables; $\phi_i^{ecm}$ – a coefficient describing the rate at which the system returns to an equilibrium state; the expression in brackets represents the equilibrium adjustment mechanism; $\beta_i$ – the coefficient of the long-run relationship between the variables; $\tilde{\phi}_{ij}^{(.)}$ – parameters characterizing the short-run dependencies of the regressors on the dependent variable, which are expressed through the coefficients $\phi_{ij}^{(1)}, \phi_{ij}^{(2)}$ of equation (4).

In equation (5), all terms are stationary. If cointegration is present, the coefficient $\phi_i^{ecm}$ should have a statistically significant negative value. If the parameter $\phi_i^{ecm} \approx 0$ and is insignificant, then variable under study does not adjust to long-run equilibrium.

In PMG estimation, short-term variation can vary across panels. PMG estimation constrains the long-run slope coefficient $\beta_i$, so that it remains homogeneous across panels, while the free terms, short-run coefficients $\tilde{\phi}_{ij}^{(.)}$ and error variances may vary by region. In addition, consistency and efficiency conditions are fulfilled when there is evidence of a long-run relationship between covariates. To do so, the covariates must be exogenous (i.e. they must not be consistently correlated). To satisfy these conditions, lags are included in both dependent and independent variables. Thus, the PMG method provides for uniform equilibrium long-run dynamics of the variables.

To select the length of the lag in the model, the information criteria AIC (Akaike criterion) and SIC (Schwartz criterion) were used. Testing using these criteria clearly led to the choice of the ARDL model specification (1,1).

Table 6 shows the results of the estimation of the long- and short-run relationship parameters (equation 5) using the PMG method. The parameters were estimated by the maximum likelihood method. The expression for the maximum likelihood function is the product of the similar functions for each panel.

Table 6

**Estimating the parameters of equation (5) by the PMG method**

| D.lIntens | Coefficient | statistical error | p-value |
|---|---|---|---|
| ec | | | |
| lvrp | 1.781*** | 0.097 | 0.000 |
| trend | 0.059** | 0.023 | 0.039 |
| SR | | | |
| ecm | **-0.213*** ** | 0.128 | 0.008 |
| D.lvrp | 0.108 | 0.613 | 0.860 |
| const | -2.151** | 0.726 | 0.003 |

*Note: The null hypothesis H0- parameter insignificance. * – the null hypothesis is rejected at 10% significance level; ** – null hypothesis rejected at 5% significance level; *** – null hypothesis rejected at 1% significance level. Model specification corresponds to ARDL (1,1)*

*Source: the authors' calculations.*


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For comparison, the parameters of the cointegration equation 3 were also estimated using the method of mean group estimates (MG method) (Table 3). In this method, the short-run coefficients and error variances are unweighted averages of the individual values, i.e., in particular the short-run coefficients $\bar{\phi}_j^{(\cdot)} = \frac{1}{N}\sum_{i=1}^{N}\phi_j^{(\cdot)}$. The validity of either PMG or MG method can be determined by using the Hausman test.

Given the strengths and weaknesses of the models compared, the Hausman test is used to examine significant differences between these models. The test assumes that there is no significant difference between PMG and MG in estimating long-run relationships. The absence of a significant difference indicates that the null hypothesis is valid and thus PMG is used. However, the alternative indicates that there is a significant difference between PMG and MG and hence the preferred use of the MG method. This process is used to test for differences between MG and PMG.

The Hausmann test indicates the preferred use of the PMG method for estimating short- and long-term relationships of the model 5 (statistic value $\chi^2 = 1.166$, $\Pr ob > \chi^2 = 0.688$, the null hypothesis of no significant difference between the long-run relationship coefficients is not rejected).

Table 6 shows that the long-run relationship coefficient $\beta$ is positive and statistically significant. This means that in the long run an increase in workforce productivity increases the intensity of trucking. (The intensity elasticity for this indicator is respectively 1.781). Since the coefficient $\phi_i^{ecm} = -0.213$ and is statistically significant, the railway transport intensity adjusts to long-run equilibrium, which confirms the existence of cointegration between the variables under study.

In the short run, the coefficient at the first difference of the productivity variable is statistically insignificant (Table 6) and has no effect on transport intensity.

It is of particular interest to compare the results shown in Table 6 for the Ural Federal District panel data with similar results for individual regions of the district. Table 8 shows estimation of short-run dependencies for individual regions by PMG method (the coefficient for all regions is determined by equation (3)). As can be seen from the table, the long-run equilibrium adjustment indicator for all regions is negative and statistically significant at 1% level, except for Kurgan Region, for which this indicator is statistically insignificant. This means that, in the long run, rail transport intensity in this region does not adjust to a long-term equilibrium condition in the event of any shocks. It should be noted that the rate of adjustment to the long-term equilibrium state of freight traffic intensity in the Ural Federal District is the highest for the Tyumen Region and relatively high for the YaNAO and the Chelyabinsk Region. For the Khanty-Mansi Autonomous Area and especially for the Sverdlovsk Region, the equilibrium adjustment rate is much lower. This result may indicate that the intensity of freight traffic in the Tyumen Region, Yamal-Nenets Autonomous Area and Chelyabinsk Region is closest to the long-term equilibrium value typical of the entire macro-region (the Urals Federal District). The result for the Sverdlovsk Region correlates with

Table 7

**Estimation of the parameters of equation (5) by the MG method**

| D.lIntens | Coefficient | statistical error | p-value |
|---|---|---|---|
| **ec** | | | |
| lvrp | 1.772** | 0.111 | 0.001 |
| trend | 0.053** | 0.019 | 0.036 |
| **SR** | | | |
| ecm | **-0.277**** | 0.141 | 0.035 |
| D.lvrp | 0.257 | 0.538 | 0.629 |
| const | 7.14 | 6.126 | 0.287 |

*Note: The null hypothesis H0 – parameter insignificance. * – the null hypothesis is rejected at 10% significance level; ** – the null hypothesis is rejected at 5% significance level; *** – the null hypothesis is rejected at 1% significance level. The model specification corresponds to ARDL (1,1)*

*Source: the authors' calculations.*


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Table 8

**Estimation of long-term and short-term dependencies for selected regions of the Ural Federal District using the PMG method**

| D.lIntens | Coefficient | statistical error | p-value |
|---|---|---|---|
| **ec** | | | |
| lvrp | 1.781*** | 0.067 | 0.000 |
| **Kurgan Region** | | | |
| ecm | -0.099 | 0.093 | 0.198 |
| D.lvrp | -2.509 | 1.185 | 0.34 |
| const | -1.560 | 1.391 | 0.262 |
| **Sverdlovsk Region** | | | |
| ecm | -0.090*** | 0.024 | 0.002 |
| D.lvrp | 0.910*** | 0.157 | 0.000 |
| const | -0.648** | 0.330 | 0.050 |
| **KhMAO** | | | |
| ecm | -0.172*** | 0.015 | 0.000 |
| D.lvrp | 1.046*** | 0.136 | 0.000 |
| const | -0.900*** | 0.339 | 0.000 |
| **YaNAO** | | | |
| ecm | -0.342*** | 0.054 | 0.000 |
| D.lvrp | 0.580** | 0.254 | 0.023 |
| const | -2.147** | 0.985 | 0.023 |
| **Tyumen Region** | | | |
| ecm | -0.853*** | 0.115 | 0.000 |
| Dlvrp. | 0.098 | 0.082 | 0.198 |
| const | -5.317*** | 0.144 | 0.000 |
| **Chelyabinsk Region** | | | |
| ecm | -0.297** | 0.113 | 0.048 |
| D.lvrp | 1.231*** | 0.396 | 0.002 |
| const | -1.715 | 0.995 | 0.121 |

*Note: The null hypothesis H0 – parameter insignificance; * – the null hypothesis is rejected at 10% significance level; ** – the null hypothesis is rejected at 5% significance level; *** – the null hypothesis is rejected at 1% significance level. Coefficient relationship for all regions is defined by equation (6).*

*Source: the authors' calculations.*

the visualization shown in Figures 1 and 3, from which it can be seen that the freight intensity and its dependence on workforce productivity remained virtually unchanged over the study period. In addition, in the period under study, the largest number of large investment projects was concentrated in the YaNAO, Chelyabinsk and Tyumen Regions, and was practically absent in the Kurgan Region

In the short run, changes in workforce productivity in all regions except Kurgan and Tyumen regions have a positive effect on changes in freight intensity in the short run (at the 5% significance level). For Kurgan and Tyumen regions, the indicator at this variable is statistically insignificant.

In equation 3 describing the long-run cointegration relationship between the variables, it is assumed that the regressor *lvrp* is exogenous and the dependent variable *lintens* is endogenous. Since the exogeneity of the variable *lvrp* is questionable, it is necessary to test the *lvrp* and *lintens* variables for long-run Granger causality (Granger,1969). The test was conducted according to the authors procedure (Dumitrescu, Hurlin, 2012), taking into account the panel data structure. The results of the Granger long-run causality test between the variables *lvrp* and *lintens* are shown in Table 9.


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Table 9

**Results of Granger long-term causality tests between the variables *lvrp* and *lintens***

| $lvrp \rightarrow l\,\text{int}\,ens$ |
|---|
| Optimal number of lags (BIC): 2 (tested number of lags: 1 to 4) |
| W-bar = 5.0287<br>Z-bar = 3.7094 (p-value = 0.0002)<br>Z-bar tilde = 2.2980 (p-value = 0.0216) |
| H0: *lvrp* cannot be the cause of a Granger change in the variable *lIntens*.<br>H1: *lvrp* can be the cause of a Granger change in the *lIntens* variable for at least one panel |
| $l\,\text{int}\,ens \rightarrow lvrp$ |
| Optimal number of lags (BIC): 1 (tested number of lags: 1 to 4) |
| W-bar = 0.9705<br>Z-bar = -0.0511 (p-value = 0.9593)<br>Z-bar tilde = -0.2336 (p-value = 0.8153) |
| H0: *lintens* cannot cause Granger variable *lvrp* to change.<br>H1:*lintens* can cause Granger variable *lvrp* to change for at least one panel |

*Source: the authors' calculations.*

Table 10

**Results of the Granger short-term causality test**

| D.lvrp | Coefficient | statistical error | p-value |
|---|---|---|---|
| **SR** | | | |
| ecm | - 0.002 | 0.002 | 0.331 |
| D.lintens | 0.298** | 0.128 | 0.021 |
| const | -0.339 | 0.320 | 0.345 |

*The null hypothesis H0 – parameter insignificance; * – null hypothesis rejected at 10% significance level; ** – null hypothesis rejected at 5% significance level; *** – null hypothesis rejected at 1% significance level.*


**Figure 4.** *Granger long-term causality diagram between the indicators under study (equation 3). The one-way arrows indicate a one-way relationship.*
*Source: Compiled by the authors.*

The results of the tests in Table 9 clearly indicate that variable *lvrp* in the long-run cointegration relation is exogenous and *lintens* is endogenous. Figure 4 shows a diagram of the long-run causal relationship between the variables under investigation.

To analyze exogeneity and endogeneity of variables with short-run Granger causality, it is necessary to estimate VECM models with adjustment mechanism whose equations are similar to equation (5), but with variable *lvrp* as the dependent variable besides *lintens*. Thus, the following models are estimated:

$$\Delta l\,\text{int}\,ens_{it} = \tilde{\mu}_{1i} + \sum_{k=1}^{p} \gamma_{11,k} \Delta l\,\text{int}\,ens_{i,t-k} + \\ + \sum_{k=1}^{q} \gamma_{12} \Delta lvrp_{i,t-k} + \phi_1 v_{i,t-1}^{ecm} + u_{1i,t}, \quad (6)$$

$$\Delta lvrp_{it} = \tilde{\mu}_{2i} + \sum_{k=1}^{q} \gamma_{21,k} \Delta lvrp_{i,t-k} + \\ + \sum_{k=1}^{p} \gamma_{22} \Delta l\,\text{int}\,ens_{i,t-k} + \phi_2 v_{i,t-1}^{ecm} + u_{2i,t}, \quad (7)$$

where $\gamma$ and $\phi$ – regression coefficients; $u$ – errors with zero mean and final variance; $v_{t-1}^{ecm}$ – long-run equilibrium correction terms.

The test results for equation (6) are shown in Table 10. The test results for equation (7) are pre-


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**Figure 5.** *Granger short-term causality diagram between the indicators under study the one-way arrows indicate a one-way relationship.*
*Source: Compiled by the authors.*

sented in Table 10. The data in the table show that in the short run, a change in rail freight intensity affects the change in workforce productivity (at 5% level of significance).

The analysis of the results of Tables 6 and 10 can be presented as a Granger short-run causality diagram between the indicators under investigation (Figure 5). The diagram shows that there is a one-way causal relationship between the variables *lvrp* and *lintens*.

## Conclusion

Thus, in line with the task at hand and according to the resulting estimates (Table 6), a 1% increase in workforce productivity in the UFD leads to a 1.781% increase in rail freight intensity in the long run. At the same time, there is a one-way causal relationship between rail freight intensity and workforce productivity in the UFD in the long run, as shown in Figure 4 (change in workforce productivity is the cause of change in rail freight intensity).

The error correction mechanism is as follows. If the workforce productivity at time *(t-1)* increases by 1% and the rail freight intensity increases by more than 1.781%, there will be a positive shock, which must be corrected for at time *t*. According to the two equations (6) – (7) of the error correction model, the variable rail freight intensity is subject to adjustment in the right direction at a rate characterized by the coefficient $\phi_1 = -0.213$ before the cointegration relation in the model $v_{t-1}^{ecm}$. The higher the value of this coefficient, the higher the speed of correction. The workforce productivity indicator does not adjust to long-run equilibrium, as the similar coefficient of the $\phi_2 = -0.002$ is statistically insignificant and negative. There is thus a one-way long-term causal relationship between these two indicators - changes in workforce productivity affect changes in rail freight intensity, but not vice versa.

In the short run, there is a one-way causality between workforce productivity and rail freight intensity (Tables 6 and 10, Figure 5), directed in the opposite direction to that in the long run (changes in rail freight intensity cause changes in workforce productivity).

Another interesting result is that the speed of adjustment to the long-term equilibrium state of freight intensity in the Ural Federal District is highest for the Tyumen region and relatively high for the YaNAO and the Chelyabinsk Region. For the KhMAO and especially for the Sverdlovsk Region, the rate of equilibrium adjustment is much lower. This result may indicate that the intensity of freight traffic in the Tyumen region, YaNAO and Chelyabinsk Region is closest to the long-term equilibrium value characteristic of the entire macroregion (UFD).

The economic sense of the obtained results in terms of their possible use for decision-making on freight traffic management, in particular by the authorities, is that it is necessary to accelerate the development of the railway transport network, which will have to absorb additional freight flows, which in the short term will lead to an increase in labour productivity (Figure 5). In turn, an increase in productivity will in the long run lead to an increase in the amount of goods shipped and the intensity of freight transport (Figure 4).

The model analyzed in this study indicates the existence of a range of effective growth rates for rail freight intensity and workforce productivity in the short and long term.

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# Socioeconomic Drivers and Risk Factors of Covid-19 Pandemic in Nigeria

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**ABSTRACT**

**Relevance.** The Covid-19 pandemic has prompted the need for a comprehensive understanding of its drivers and risk factors, particularly in the socioeconomic dimension. While previous research has primarily focused on biological vectors and mortality rates, less is known about the influence of socioeconomic factors on the spread of the virus. Understanding these factors is crucial for effective policy responses and addressing state-specific peculiarities.

**Research Objectives**. This paper aims to assess the socioeconomic drivers and risk factors of the Covid-19 pandemic in Nigeria. Specifically, it examines the impact of socioeconomic forces on infection and mortality rates. The study seeks to shed light on the role of geographic distance to epicenters, the business environment, and income inequality in shaping the spread and impact of the virus.

**Data and Methods**. The analysis employs two pooled multivariate regression models using data from 37 sub-national entities (States) in Nigeria. The first model explores the effect of socioeconomic forces on Covid-19 infection rates, while the second model examines their influence on fatality rates. The models are based on comprehensive observations and utilize state-specific data to account for variations across regions.

**Results**. We found that proximity to epicenters is associated with higher infection rates, while areas with weaker business environments and higher inequality are more vulnerable. Income inequality emerges as the sole significant driver of mortality, possibly due to limited access to testing, vaccination, and treatment centers among income-constrained populations.

**Conclusions**. The study emphasizes the importance of considering socioeconomic factors in pandemic response strategies, particularly in the context of Covid-19 in Nigeria. We reveal that geographic proximity to epicenters, business environment strength, and income inequality significantly influence infection rates. Addressing these factors, along with recognizing the impact of income inequality on mortality, can inform targeted policies and interventions for effective pandemic management. Policymakers should consider sub-national characteristics and state-specific peculiarities to tailor responses and mitigate the spread and impact of Covid-19.

**KEYWORDS**
Covid-19 Pandemic, infection, mortality, Nigeria, pooled regression, risk, socioeconomic.

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# Социально-экономические движущие силы и факторы риска пандемии Covid-19 в Нигерии

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**АННОТАЦИЯ**

**Актуальность.** Пандемия Covid-19 вызвала необходимость всестороннего понимания ее движущих сил и факторов риска, особенно в социально-экономическом измерении. Хотя предыдущие исследования в основном были сосредоточены на биологических переносчиках и уровне смертности, о влиянии социально-экономических факторов на распространение вируса известно меньше. Понимание этих факторов имеет решающее значение для эффективных политических мер и решения специфических особенностей государства.

**КЛЮЧЕВЫЕ СЛОВА**
пандемия Covid-19; инфекционное заболевание; смертность; Нигерия; сквозная регрессия; риск; социально-экономический





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**Цель исследования.** Целью данной статьи является оценка социально-экономических движущих сил и факторов риска пандемии Covid-19 в Нигерии. В частности, в нем исследуется влияние социально-экономических факторов на уровень заражения и смертности. Исследование призвано пролить свет на роль географического расстояния до эпицентров, деловой среды и неравенства доходов в формировании распространения и воздействия вируса.
**Данные и методы.** В анализе используются две модели сквозной регрессии с использованием данных из 37 субнациональных образований (штатов) в Нигерии. Первая модель исследует влияние социально-экономических факторов на уровень заражения Covid-19, а вторая модель исследует их влияние на уровень смертности. Модели основаны на комплексных наблюдениях и используют данные по конкретным штатам для учета различий между регионами.
**Результаты**. Мы обнаружили, что близость к эпицентрам связана с более высоким уровнем заражения, в то время как районы с более слабой деловой средой и более высоким уровнем неравенства более уязвимы. Неравенство доходов становится единственной значимой причиной смертности, возможно, из-за ограниченного доступа к центрам тестирования, вакцинации и лечения среди групп населения с ограниченными доходами.
**Заключение**. В исследовании подчеркивается важность учета социально-экономических факторов в стратегиях реагирования на пандемию, особенно в контексте Covid-19 в Нигерии. Мы обнаружили, что географическая близость к эпицентрам, сила деловой среды и неравенство доходов существенно влияют на уровень заражения. Устранение этих факторов, наряду с признанием влияния неравенства доходов на смертность, может стать основой для целенаправленной политики и мер по эффективному управлению пандемией. Политики должны учитывать субнациональные особенности и особенности штата, чтобы адаптировать меры реагирования и смягчить распространение и воздействие Covid-19.

**ДЛЯ ЦИТИРОВАНИЯ**
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# 尼日利亚新冠疫情的社会经济驱动因素和风险因素

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**摘要**
**现实性：由于新冠病毒**带来的危机，有必要全面了解其驱动因**素和**风险因素，特别是社会经济方面的因素。尽管之前的研究主要集中在生物媒介和死亡率上，但人们对社会经济因素对于病毒传播的影响知之甚少。了解这些因素对**制定有效的政策和解决各州的具体**问题**至关重要。**
**研究目标：本文旨在**评估尼日利亚**新冠疫情期社会**经济驱动因素和风险因素。具体而言，它探讨了社会经济因素对感染率和死亡率的影响。该研究旨在揭示距**病毒震中的地理距离、商**业环境和收入不平等**因素在影响病毒**传播和影响方面的作用。
**数据和方法：本分析使用了两个端**对端回归模型，使用的数据来自尼日利亚的37 **个次国家**实体（州）。第一个模型研究社会经济因素对**新冠感染率的影响**，**第二个模型研究社会**经济因素对死亡率的影响。这些模型以综合观测数据为基础，并使用各州的具体数据来考虑地区之间的差异。
**研究结果：我**们发现，靠近**病毒震中的地区感染率**较高，而商业环境较弱和不平等程度较高的地区则更易受损害。**收入不平等是造成死亡的唯一重要原因**，这可能是由于收入有限的人群获得检测、疫苗接种和治疗中心**的机会有限。**
**结论：**该研究强调了在**疫情**应对策略中考虑社会经济因素的重要性，特别是在尼日利亚出现**新冠病毒的背景下。我**们发现，距离**病毒震中的地理位置、商**业环境的强度和收入不平等对感染率有重大影响。解决这些因素，同时认识到收入不平等对死亡率的影响，可以为有针对性的政**策和干**预措施提供**基**础，**从而有效**应对疫情。**政策制定者**应考虑国家以下各级和各州的具体情况，以便有针对性地采取应对措施，减轻**新冠病毒的**传播和影响。

**关键词**
**冠状病毒疫情、感染、死亡、尼日利**亚、**端到端回**归、风险、**社会**经济

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## Introduction

The outbreak of the Coronavirus disease 2019 (henceforth Covid-19) pandemic, which started out as a health shock, has pushed the global economy into fragility by disrupting supply chains, imposing bottlenecks on international trade, dipping stock markets and labour market displacement. However, the effects and drivers of the pandemic would vary from one country to another as a result of the different restriction measures put in place. Variations in the level of exposure risks arise due to context-specific limitations and recommendation aimed at slowing down the transmission of COVID-19 in many countries (Billingsley et al., 2022). Behind the grim number of infections and the consequent costs to human life, governments in different countries have implemented a variety of measures to limit the spread of the virus, with such policy measures as travel restrictions, quarantines, partial and total lockdowns, school and business closure as some of the prominent examples.

Earlier empirical studies have attempted to show different socioeconomic conditions that generally explain differences in health outcomes and the spread of diseases including demographic structure, health care system, economic wellbeing, social characteristics, and natural environment, but not specifically on the Covid-19 due to the novel nature of the virus. Since the outbreak of the Covid-19 pandemic, research efforts have been focused more on the biological and epidemiological forces behind the spread and fatality of the virus but particularly less so on the socioeconomic factors linked to the pandemic. As a result, recent studies have tried to examine the socioeconomic drivers of Covid-19 at sub-national, country, and cross-country levels. The expectation is that socioeconomic factors such as geographical location and income poverty must be accounted for if policy responses are to be effective and inclusive.

In the context of Nigeria, a total of 164,719 confirmed Covid-19 infections have been documented, with some 2,062 deaths and approximately 162,657 recoveries as of April 25, 2021 (Nigeria Centre for Disease Control (NCDC) 2021). The spatial distribution of the pandemic has been uneven with some states experiencing a greater brunt in infections relative to others. For instance, Lagos, Kano and Abuja represent three states with the highest incidence of Covid-19 while Benue, Kogi and Cross rivers have the lowest incidence. This means that Covid-19 risk factors could be unequal across the country as could policy responses. Like the rest of the world, policy responses in Nigeria aimed at mitigating the spread of the pandemic have been uniform, total and decisive, including lockdown measures and travel restrictions. As a consequence, jobs and livelihoods have been lost, with many pushed to poverty and starvation as a result (Ajibo, 2020). One of the main explanations to such uniform and sub-optimal policy responses has been the lack of empirical evidence on the socioeconomic drivers and risk factors of the Covid-19 pandemic in Nigeria.

This paper is a response to the need for empirical evidence on the socioeconomic drivers and risk factors of Covid-19 pandemic Nigeria. Therefore, this paper hypothesizes that the economic costs posed by the Covid-19 pandemic could have been minimized if policy responses had been based on the underlying heterogeneity in the distribution of socioeconomic drivers and risk factors across the states in Nigeria. The methodological approach relies on state-level data on Covid-19 and other socioeconomic variables, making it possible to consider a cross-section of 37 sub-national governments in Nigeria. The paper thus explores which underlying socioeconomic conditions could be instrumental for the spread of Covid-19 in Nigeria. More specifically, given that several factors have been identified in previous empirical studies for different country contexts, this paper interrogates some of those factors to show whether they equally apply to Nigeria, or which of those are more important in the case of Nigeria. In this paper, we assess the socioeconomic drivers and risk factors of the Covid-19 pandemic in Nigeria. Specifically, it examines the impact of socioeconomic forces on infection and mortality rates.

The paper is structured as follows. Section 1 comprises the introduction and section 2 discuss the literature. Section 3 discusses stylized facts about Covid-19 pandemic in Nigeria. Section 4 describes the data and methodology, in which issues related to data and key variables are discussed. The presentation and discussion of result is provided in section 5 while section 6 concludes the paper.

## Theoretical Basis

There are vast number of studies that have attempted to show different socioeconomic conditions that generally explain differences in health outcomes and the spread of diseases including de-


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mographic structure (Ainsworth & Dayton, 2003; Gardner et al., 2020; Wallinga et al., 2006), health care system (Tanne et al., 2020; Zanakis et al., 2007), economic wellbeing (Adda, 2016; Nagano et al., 2020; Strauss et al., 1998), social characteristics (Chatters, 2010; Folland, 2008), and natural environment (Braga et al., 2002; Clay et al., 2018; Wu et al., 2020), but not specifically on Covid-19 due to the novel nature of the virus. Since the outbreak of the Covid-19 pandemic, research efforts have been focused more on the biological and epidemiological forces behind the spread and fatality of the virus but particularly less so on the socioeconomic forces linked to the pandemic. As a result, recent studies have tried to examine the socioeconomic drivers of Covid-19 both at country and sub-country levels (see (Sá, 2020; Qiu et al., 2020; Grekousis et al., 2022) and cross-country (see for example Jain & Singh, 2020; Stojkoski et al., 2020).

The Covid-19 pandemic has posed many questions for policy makers in their attempt to identify possible reasons for its rapid widespread. Considering this, certain studies on Covid-19 suggest that socioeconomic factors are positively related to the spread of the virus. In an attempt to uncover such a potential causal link, Sá (2020) estimated a simple linear regression model of infections and mortality on observable socioeconomic characteristics in England and Wales. The first estimates are based on basic demographic attributes while the second estimates consider deprivation, use of public transport and self-reported health. Results from the correlation and regression analysis show higher Covid-19 prevalence in local areas with larger households, poor self-reported health, and extensive use of public transportation. This suggests that places with large household sizes and extensive public transport commuting systems have more risk of Covid-19 infections.

In a similar study, Qiu et al. (2020) used the instrumental variable regression to examine the impact of socioeconomic factors on the transmission of Covid-19 virus based on a cross-sectional dataset covering 304 cities in China. Their results revealed that population outflows from the pandemic region have a significant impact on transmission rate with cities having more medical doctors recording lower transmission rates. They further show that cities with high GDP per capita have higher transmission rates, and that social interactions increase with increase in economic activities while cities with higher population density have lower transmission. On the environmental effect, they found transmission rate to be lower with weather conditions.

In a more extensive study, Stojkoski et al. (2020) leverage on the Bayesian model averaging (BMA) technique and a country-level data to investigate the potential impact of a diverse set of socioeconomic factors (multiple determinants - 31) in 106 countries during the first wave of contagions. The corona virus determinants Jointness space developed in the study show that the true (parsimonious) model can be explained by a few determinants, but the explanatory power of each determinant is itself a matter of country-specific fixed effects due to heterogeneity in socioeconomic characteristics across the countries. This study essentially emphasized the case for (policy implication on) preventive measures aimed at attenuating future pandemics. In support of this, Sannigrahi et al. (2020) utilised the spatial regression to examine the relation between socio-demographic factors and Covid-19 in Europe. Their results showed the role of population, poverty, and income in reducing the Covid-19 fatalities in Europe.

In terms of differences in Covid-19 incidence across the world, Jain & Singh (2020) examine the socioeconomic determinants of Covid-19 using regression analysis. They found the effect of Covid-19 to be higher in the developed countries with democracy having a positive effect on the spread and fatality of the virus. Interestingly, the availability of extensive testing facilities has been shown to be useful in containing the rates of spread and death from Covid-19. Overall, good governance plays important role in reducing the spread and fatality of Covid-19. Similarly, Koc & Sarac (2020) also examine the impact of socio-economic, demographic and health factors on Covid-19 for OECD countries (fatalities and mortalities) using a multiple linear regression. They found that higher share of health care expenditure from GDP, higher health conditions resulting from obesity and high blood glucose levels and index for government stringent measures exert great influence on Covid-19. The rate of tobacco usage has also been shown to be influential for Covid-19 fatalities across the OECD countries.

Based on different scenarios of environmental, demographic and health care factors, Perone (2021) investigated the determinants of Covid-19 fatality and mortality rate in 20 regions and 107 provinces in Italy using regression and agglomerative clustering method respectively. The estimates of the regression model revealed that overall health care efficiency,


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physician density and temperature have negative impact on the fatality rate. While aged population, car and firm density, air pollutant concentrations, relative humidity, health care saturation (critical care bed, ordinary care beds) have positive effect on fatality rate. From the clustering method analysis, it is shown that mortality rate is prevalent in the northern region as compared to less effect in the southern provinces. This supports the findings of Aron & Muellbauer (2022) that capacity constraints on hospital beds and staff determines death rate among adults. Similarly, Buja et al. (2020) investigated the demographic, socio-economic and health care determinants of Covid in Northern province of Italy using OLS regression. Their results show Covid-19 to correlate negatively with age index. This implies that the virus is more likely to affect older population. On the other hand, their result document that employment, public transport per capita, population and in-house density have positive correlation with Covid-19 fatalities. Under the health care factors, the province with large private health care facilities witnessed more fatalities.

In a more recent study, Ehlert (2021) used a multivariate spatial model to explore the relationship between socioeconomic, demographic and health care variables and Covid-19 in Germany. Their result suggests that average age, population density and the share of employment in elderly care have positive impact on Covid-19 (both cases and deaths). Physician density and proportion of school children is revealed to have a negative impact on Covid-19 during the first wave in Germany. While using quantile regression to assess the role of socio-spatial determinants of Covid-19, Sigler et al. (2021) indicates that globalisation, settlement and population exert influence on Covid-19 transmission. They also show that household size, aged population and globalisation predicts the surge in Covid-19 fatalities in countries with low cases. In countries with high cases, human development index and total population are shown to be the predicting factors of Covid-19 transmission. (Grekousis et al., 2022) examined socioeconomic and health determinants of Covid-19 mortality rate. They found that Covid-19 moratlity rate of depends on complex factors of demographic, socioeconomic and health characteristics such as income, family size, age, health insurance. In a latest study to identify the relationship between health, demographic and environmental factors with Covid-19, He et al. (2023) reveal the role of obesity and humidity as significant factors affecting Covid-19 in the Arkansas region of US.

Taking the existing literature on Covid-19, there is predominant focus given to biological and epidemiological aspects of the virus, neglecting some socioeconomic factors that contribute to its spread and mortality. While recent studies have examined the socioeconomic drivers of Covid-19 at both national and sub-national levels in various countries, there is a dearth of research specifically investigating the socioeconomic determinants of the virus in most developing economies, like Nigeria. The limited studies conducted in developing economies primarily explored general socioeconomic conditions and their impact on health outcomes, without specifically addressing Covid-19. Therefore, this study using disaggregated data aims to fill this gap by examining the specific socioeconomic determinants of Covid-19 infection and mortality rate in the Nigerian context, providing valuable insights for effective policy responses and interventions.

### *Covid-19 Pandemic in Nigeria*

In late 2019, the world experienced the outbreak of the Covid-19 virus from Wuhan district of China. The spread of the virus has led to a widespread fear among people due to the ease with which it is transmitted from human to human. The Covid-19 virus moved to other economies through human-to-human contact, with the consequent health catastrophe metamorphosing into economic and financial crises for most countries. Besides the costs to human lives, other economic costs abound. For instance, the outbreak of the virus has led to drastic disruptions in supply chains, which have continued to affect the economy through a sharp reduction in domestic production and significant decreases in export revenue.

Categorically, some states in Nigeria experienced a greater brunt of the Covid-19 risk with incidence of high cases relative to others. For instance, Lagos, Kano and Abuja are the three states with the highest incidence of Covid-19 while Benue, Kogi and Cross rivers had the lowest incidence (See Figure 1). Geographically and economically, the curious case of these extreme situations is one that might be rooted in geographical and economic polarizations. The questions skirting the mind could be on the forces that explain this observed pattern in Covid-19 spread and whether they could be linked to certain socio-economic factors. What socioeconomic factors explain the variation in Covid-19 infection and mortality rates in Nigeria?


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***Figure 1.*** *Distribution of cumulative cases*
*Source: Nigeria Centre for Disease Control (2021)*

Figure 1 paints a picture of Covid-19 infection across Nigerian states as of April 25, 2021. There are four categories of states: 1 – 100, 101 – l, 000, 1,001 – 10,000, and 10,000+. Two states with the highest number of infections are FCT Abuja and Lagos, each with more than ten thousand confirmed cases of infection. These epicentres also happen to be satellite and predominantly metropolitan. On the other extreme, Kogi state falls into the first category with number of confirmed cases not more than a hundred, representing a stark outlier despite its close proximity to FCT Abuja as one of the main epicentres. A large majority of states fall however into the third category with infections rates around 1,001 – 10,000.

In terms of effects, many businesses have had different experiences during the pandemic in accordance with the overall measures put in place by the Nigerian government. These measures resulted in limited mobility and constrained economic activities, with tourism and aviation industry as the worst hit. Such policy measures have also subjected thousands of people to hunger and starvation as most workers in Nigeria live on daily wage and therefore could not cope with the consequent wages and salary cuts from employers. It is reported that the labour market experiences large job destruction. This corroborates the ILO report of about 25 million jobs being lost as a result of this global pandemic, costing the world between $860 billion and $3.4 trillion (ILO, 2020). In response to the unprecedented vulnerabilities among the population, the government rolled out numerous social and economic measures to mitigate the impact of the pandemic. For instance, economic stimulus package was introduced to support businesses and individuals. The aim was to provide 50 percent of tax rebates to registered businesses. One of the main weaknesses of this policy is the fact that it targets formal businesses which accounts for only about 10 percent of the total workforce, despite the fact that 65 percent of Nigeria's GDP comes from the informal sector. What this implies is that majority of businesses and individuals are excluded. Another economic policy of cash transfer was introduced in April 2020 to provide support to poor and vulnerable households, in addition to other safety nets such as the CBN stimulus programme and the provision of palliatives to vulnerable households. Thus, it is pertinent to note that many of the policy responses are inconsistent with the reality, magnitude and spatial distribution of the pandemic.

## Data and Methods

The variables used in this paper draws from a set of socioeconomic indicators identified from available empirical studies on the links between Covid-19 and socioeconomic variables. The variables include urbanization, the level of economic activity, proximity, household size, income inequality, size of population, population density, poverty, deprivation, and institutions (Jain and Singh 2020; Sá 2020; Stojkoski et al. 2020). Table 1 below contains the variables used, their measurement and respective data sources.


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Table 1

**Variables and Indicators**

| Variable | Measurement | Source |
|---|---|---|
| Infection | Cumulative number of Covid-19 cases | NCDC (2021) |
| Mortality | Cumulative number of Covid-19 deaths | NCDC (2021) |
| Urbanization | Number of MSMEs | National Bureau of Statistics (2017) |
| Economic activity | Internally Generated Revenue (IGR) | National Bureau of Statistics (2019) |
| Proximity | Distance from Epicenter (km2) | distance calculator (distancefromto.net) |
| Demography | Population/density | National Population Commission (NPC) |
| Deprivation | Capability Deprivation Index (CDI) | Computed from NBS- NGHS (2016) |
| Poverty | Poverty Headcount, % of population | National Bureau of Statistics (2020) |
| Income inequality | GINI | National Bureau of Statistics (2020) |
| Healthcare | Immunization Coverage (measles) | National Bureau of Statistics (2019) |
| Resilience | Business Environment Index (BEI) | African Heritage Institution-BECANS (2017) |

*Source: The authors' compilation*

Accordingly, data on Covid-19 infection and mortality across states is sourced from the Nigeria Center for Disease Control (NCDC, 2021) while information on the number of MSMEs, IGR, poverty headcount, deprivation, income inequality, and immunization coverage are obtained from the National Bureau of Statistics at different points in time (NBS, 2016, 2017, 2019, 2020). Similarly, information on the variation in the quality of business environment (BEI) across states is obtained from the African Heritage Institution BECANS 2017 dataset. The use of pooled data in this paper is informed by the lack of time-consistent series across sub-national entities in Nigeria.

In terms of measurement and a priori expectations, we first measure urbanization by the number of MSMEs while IGR is used to capture the level of economic activity. The distribution of MSMEs and IGR across states is itself an indicator of market size, which is expected to have a positive relationship with Covid-19 incidence. Secondly, distance from epicenter is a spatial indicator of proximity, and is therefore expected to have a negative effect on the spread of Covid-19. Areas with high population size and density are expected to have higher infection and mortality rates. Similarly, deprivation, poverty and inequality tend to exacerbate the prevalence of disease, but it is not yet obvious whether they are linked to Covid-19. Lastly, immunization coverage and business environment are expected to have a negative effect on infection and mortality rates.

To guide the estimation process in this paper, we specify a pooled multivariate regression model of the functional form (see, e.g., Sá, 2020).

$$Y = f(X_1, X_2, X_3, \dots, X_n) \dots \quad (1)$$

where Y is the outcome variable and X is a vector of observable state-level characteristics. Thus in what follows, two multivariate regression models are specified in line with the socioeconomic variables identified in the previous section. These are expressed in the following equations,

$$INF_i = \beta_0 + \beta_1 SME_i + \beta_2 DFE_i + \beta_3 PPN_i + \beta_4 PPD_i + \beta_5 IGR_i + \beta_6 BEI_i + \beta_7 IMZ_i + \beta_8 IIN_i + \beta_9 POV_i + \beta_{10} DEP_i + \varepsilon_i \dots \quad (2)$$

$$MOR_i = \beta_0 + \beta_1 SME_i + \beta_2 DFE_i + \beta_3 PPN_i + \beta_4 PPD_i + \beta_5 IGR_i + \beta_6 BEI_i + \beta_7 IMZ_i + \beta_8 IIN_i + \beta_9 POV_i + \beta_{10} DEP_i + \varepsilon_i \dots \quad (3)$$

Where $INF_i$ and $MOR_i$ are the outcomes representing the cumulative rates of Covid-19 infection and mortality for ith state; $SME_i$ represent the number of small and medium scale enterprises (SMSEs) for ith state; $DFE_i$ is the physical distance from epicentre for ith state measured in kilometre square; $PPN_i$ and $PPD_i$ stand for the respective population and population density for


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state i; $IGR_i$ stands for internally generated revenue (IGR) for state i measured in NGN; $BEI_i$ is an index of business environment for ith state; $IMZ_i$ is immunization coverage; $IIN_i$, $POV_i$ and $DEP_i$ are rates of income inequality, poverty, and deprivation respectively for ith state; $\beta_0$ is the intercept and $\beta_1, \beta_2, \ldots, \beta_{10}$ capture the parameters of the explanatory variables to be estimated; the subscript i shows that the source of variation is individual entities.

Equation 2 expresses Covid-19 infection as a function of number of SMEs, distance from epicenter, population size and density, revenue, business environment, immunization coverage, inequality, poverty, and deprivation, all of which are assumed to be exogenous. In equation 3, Covid-19 mortality is expressed as a function of the same exogenous variables as in the first model. The model describes Covid-19 infection and mortality as a function of exogenous individual states characteristics. These characteristics represent the possible socioeconomic drivers and risk factors of the Covid-19 pandemic in Nigeria. The models are expected to show the direction, size and significance of each explanatory variable with respect to Covid-19 infection and mortality.

## Results and Discussion

This section describes the properties of the variables used in regression models. The statistics describe the number of cross-sectional observations, mean values, standard deviations, minimum and maximum values as shown in Table 2 below.

Table 2

**Descriptive Statistics**

| Variable | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| Covid-19 Infection | 37 | 4451.86 | 9802.32 | 5 | 58291 |
| Covid-19 Mortality | 37 | 55.7297 | 77.4143 | 2 | 439 |
| MSMEs | 37 | 1120809 | 581531 | 385489 | 3329156 |
| Distance from epicentre | 37 | 367.892 | 137.663 | 11 | 659 |
| Population | 37 | 556139 | 3823720 | 2277961 | 2.48e+07 |
| P. Density | 37 | 696.568 | 1619.43 | 56.3 | 7420.5 |
| IGR | 37 | 3.16e+10 | 6.37e+10 | 4.38e+09 | 3.82e+11 |
| Business environment index | 35 | 50.9 | 5.835641 | 34.8 | 59.4 |
| Immunization | 37 | 30.2784 | 17.07881 | 1.8 | 68.1 |
| Gini index | 36 | 28.4556 | 3.387272 | 23.49 | 40.2 |
| Poverty rate | 36 | 42.3511 | 26.08721 | 4.5 | 87.73 |
| Deprivation index | 37 | 0.481427 | 0.050644 | 0.33825 | 0.57289 |

*Source: The authors' calculation*

There are 37 observations on Covid-19 infection and mortality which means that data is available across all the sub-national governments (states) in Nigeria. The mean rate of infection is 4451.865 with a standard deviation of 9802.322. Although the mean shows the average rate of infection in Nigeria, the standard deviation indicates that there are differences in infection rates across the states within Nigeria. In the case of mortality, the average rate is quiet low compared to that of infection. This suggests that there have been high recovery rates since few infections could have resulted in mortality. The respective minimum and maximum mortality cases of 2 and 439 also point to uneven dispersion across the states. As far as the outcome variables are concerned, one implication is that policy responses need to be targeted in order to optimize the balance between the need to guarantee safety and that of protecting livelihoods.


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Table 3

**Covid-19 Infection Regression Results**

| Variable | Coefficient | Std. Error | p-value |
|---|---|---|---|
| MSMEs | -0.0050** | 0.00200 | 0.0194 |
| Distance to epicenter | -9.3409** | 4.28490 | 0.0397 |
| Population | 0.0011** | 0.00041 | 0.0122 |
| Density | 0.1195 | 0.48030 | 0.8057 |
| IGR | 0.0000*** | 0.00000 | <0.0001 |
| BEI | -247.9324** | 95.7734 | 0.0164 |
| Immunization coverage | 98.2193 | 61.0140 | 0.1211 |
| Inequality | 490.1255*** | 146.581 | 0.0028 |
| Poverty | 16.8594 | 38.6137 | 0.6665 |
| Deprivation | -22805.39 | 14569.7 | 0.1312 |
| $R^2$ | 0.9591 | | |

*Note: * indicates 10% level of significance; ** indicates 5% level of significance; *** indicates 1% level of significance*

The estimates from Table 3 above show the respective direction, magnitude and statistical significance of the coefficients in the Covid-19 infection model. The coefficients represent the drivers and risk factors of infection. The coefficient of SMSEs is -0.005, indicating not just a negative and small effect, but one that is also statistically significant with asymptotic probability value of 0.019. The coefficient of geographical distance to epicenter is -9.34 and its corresponding asymptotic probability value of approximately 0.04 suggests strong effect at the 5 percent level. This suggests that a 1 km distance away from the epicenter reduces the chances of infection by 9 persons. Population coefficient has a value of 0.001 and a probability value of 0.01, implying a very small but statistically significant effect However, the coefficient of population density is 0.11 and the corresponding probability value is approximately 0.81. The size of IGR is small as well (almost zero) but its asymptotic probability value shows high significance with less than 0.0001. The coefficient of BEI is negative, sizable (-247.93) and statistically significant with a probability value of approximately 0.02, which then means that a percentage increase in the business environment index reduces the chances of infection by approximately 248 persons. The coefficients of immunization, poverty and deprivation are 98.21, 16.86 and -22805.39 respectively while their respective probability values are 0.12, 0.66 and 0.13 are not significant enough. The coefficient of inequality is 490.13 and significant at the 1 percent level with a probability of 0.003, which then suggests that a percentage rise in Gini coefficient is associated with approximately 490 more Covid-19 cases. With respect to these results, the analysis below is based on the coefficients that have levels of significance within acceptable limits.

The results suggest, firstly, that states located geographically far away from the epicenter are less likely to have high infection rates as compared to those within proximate location. Secondly, the measure of resilience shows, as expected, that the higher the quality of business environment for any given state, the lower the infection rate. Thirdly, states with relatively higher rates of income inequality tend to have higher infection levels. This is not surprising since income distribution is directly associated with access to sanitation and healthcare facilities. All in all, the coefficients with simultaneously large and statistically significant effects on Covid-19 infection are distance to epicenter, quality of business environment, and income inequality.

The estimates presented in Table 4 above show the respective direction, magnitude and statistical significance of the coefficients in the Covid-19 mortality model as expressed in equation 3.


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Table 4

**Covid-19 Mortality Regression Results**

| Variable | Coefficient | Std. Error | p-value |
|---|---|---|---|
| MSMEs | -0.00006* | 0.00003 | 0.0581 |
| Distance to epicenter | -0.0048 | 0.06156 | 0.9392 |
| Population | 0.000015** | 0.00000 | 0.0201 |
| Density | 0.0018 | 0.00690 | 0.0732 |
| IGR | 0.0000* | 0.00000 | 0.7982 |
| BEI | -0.5279 | 1.37600 | 0.7048 |
| Immunization coverage | 0.6246 | 0.87660 | 0.4833 |
| Inequality | 3.8622* | 2.10590 | 0.0796 |
| Poverty | -0.4225 | 0.55480 | 0.4541 |
| Deprivation | -0.193.93 | 209.323 | 0.3638 |
| $R^2$ | 0.8636 | | |

*Note: * indicates 10% level of significance; ** indicates 5% level of significance; *** indicates 1% level of significance*

The coefficients represent the drivers and risk factors of infection. The value of the coefficient of MSMEs is -0.00006, which shows negative and statistically significant effect on mortality at the 10 percent level. However, the size of the impact is negligible. Distance to epicenter has a coefficient of -0.0048 with a probability value of 0.94, indicating the absence of any statistical significance. The coefficient of population size is 0.000015 (near zero) with a corresponding asymptotic probability value of 0.020 that signifies a statistical significance at the 5 percent level. The coefficient of IGR is near zero as well. These results show that IGR as proxy for urbanization has a negative, significant but small effect on Covid-19 mortality. Also as expected, distance to epicenter has a negative effect on mortality albeit the effect is very small and weak. Population size seems to have a positive and strong effect on mortality at the 5 percent level of significance, but the size of the effect is marginal. Similarly, the effect of population density is positive but small and insignificant. The IGR as an indicator of economic activity seems to have a positive, small but statistically weak effect on mortality, while locations with high poverty and deprivation are associated with low mortality rates.

While some of the coefficients in the mortality model conform to a priori expectations, they do not warrant much discussion as their effects is either small or statistically not significant. This is perhaps because of the low rate of Covid-19 mortality in Nigeria, since most infected cases have been reported to recover eventually. Thus, comparing the Covid-19 infection model against that of mortality, it is plausible to suggest that the model of Covid-19 infection does better than the model of fatality, not just on the basis of causal effects but also in terms of fit. The $R^2$ value of the infection model is 0.9591 while that of the mortality model is 0.8636. While both have a good fit, the model of infection seems to be more robust.

In summary, the results presented above suggest that infections are driven largely by spatial forces such as distance from epicenter, business environment and inequality, while the most important driver of mortality is within-state inequality. Distance from epicenter though negative as expected, is only large and significant in the case of infections (Distance could accelerate the infection but not mortality). This suggests that locations within close proximity to the epicenter are on average more vulnerable to Covid-19 spread. Also evident from the study is that states with resilient business environments are less vulnerable to Covid-19 contagion compared to those with higher fragility. Another important finding is that states with high rates of inequality will tend to have high infection and mortality rates. One implication is that Covid policy responses in Nigeria should aim at curtailing infections based on differences in geographical distance to epicenters, business environment,


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and inequality as the key drivers and risk factors of Covid-19 across the states. The caveat is that our conclusions are based on the coefficients with simultaneously large and statistically significant effects on Covid-19 infection.

## Conclusion

This paper interrogates the socioeconomic factors that drive Covid-19 pandemic in Nigeria based on state-level cross-sectional data. Using a pooled multivariate regression model of infection and mortality, the analysis narrows the spread of Covid-19 to three key drivers encapsulating the core measures of geographical proximity, resilience, and income distribution. The results point to proximity, resilience, and inequality as the most important drivers of Covid-19 in Nigeria. These have very important policy implication in terms of choosing the optimal policy response to minimize the adverse effects of the pandemic on the economy of Nigeria. The results are in line with the finding in Stojkoski et al. (2020), and that of Gupta et al. (2021) which posits that policy responses that ignore underlying vulnerabilities would only serve to exacerbate underlying inequalities.

The analysis in this paper suggests that Covid-19 infections tend to be lower the farther away from epicenters and in states with high quality business environment but could be driven up by higher income inequality. One implication is that policy responses in Nigeria should aim at curtailing infections based on state-specific differences in terms of geographical distance to the epicenter, business environment, and inequality as some of the key drivers and risk factors of Covid-19 across the states. For optimal policy responses, state-specific, as opposed to uniform measures, should be encouraged. For example, temporary lockdown policy in the epicenter and neighboring states can lessen the overall economic costs of the pandemic in Nigeria. Similarly, lockdown measures may be eased in states with high business resilience while rolling out palliatives in states with high rates of inequality can even out the adverse effects of stay-at-home measures.

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# Examining the Growth of Regional Science and Technology Clusters in the Global Economy

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**ABSTRACT**

**Relevance.** Creating policies to stimulate innovation as part of national economic development requires a more in-depth understanding of the current trends, especially the role of science and technology (S&T) clusters. In this study, we use patent and publication data to identify key S&T clusters and leading countries. The lessons learned from their experiences offer valuable guidance for other nations striving for consistent progress in research and development.

**Research objective.** The study aims to assess how well innovation processes are organized in S&T clusters; to identify the factors and drivers influencing the development of these clusters in the global economy; and to determine the competitive advantages of the top countries in terms of patent applications and publication activity.

**Data and methods.** Using the cluster approach employed in the methodology of the Global Innovation Index, we conducted a comparative analysis of the annual data and indicators published in this index related to patent and publication activity.

**Results.** Our analysis has revealed 20 key fields in S&T clusters, the leading positions being occupied by medical, digital, and computer technologies, as well as the pharmaceutical industry. In terms of patent and publication activity, the top countries in the ranking of S&T clusters are the USA, Japan, Germany, and China. Although these countries maintained their leadership in the given period (2017-2021), all of them, except for China, demonstrated a decrease in their share in the indicators under consideration.

**Conclusions.** A country is included in the ranking of the Global Innovation Index of S&T clusters when it exhibits a high quality of fundamental and applied research, as evidenced by its levels of publication and patent activity. To establish successful clusters eligible for ranking, a country should primarily formulate policies aimed at improving the quality of research and development. These policies should also facilitate growth in the key performance indicators, such as the number of patent applications and publication activity.

**KEYWORDS**

science and technology cluster, Global Innovation Index, ranking, patent, academic publication, publication activity, competitiveness

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# Анализ развития региональных научно-технических кластеров в мировой экономике

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**АННОТАЦИЯ**

**Актуальность.** Формирование политики научного и инновационного развития национальной экономики требует глубокого анализа тенденций развития данной области, значительную роль в которой играют научно-технические кластеры. Опыт стран-лидеров патентной и публикационной активности, на основе которой осуществляется выявление науч-

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но-технических кластеров, послужит примером для стран, стремящихся к достижению прогресса в данной области.
**Цель исследования.** Исследование было проведено с целью анализа эффективности организации инновационных процессов в аспекте научно-технических кластеров, выявления факторов и драйверов развития региональных научно-технических кластеров в мировой экономике, а также определения конкурентных преимуществ стран-лидеров по подаче патентных заявок и публикационной активности.
**Данные и методы.** На основе кластерного подхода, используемого в методологии Глобального инновационного индекса, в исследовании проведен сравнительный анализ ежегодно публикуемых данных и индикаторов данного индекса в области патентной и публикационной активности.
**Результаты.** Анализ развития региональных научно-технических кластеров в мировой экономике позволил выявить 20 основных научных направлений научно-технических кластеров, лидирующие позиции в которых занимают медицинские, цифровые и компьютерные технологии, а также фармацевтика. В результате анализа патентной и публикационной активности определены страны-лидеры в рейтинге научно-технических кластеров – США, Япония, Германия и Китай. Несмотря на то, что данные страны на протяжении рассматриваемого периода (2017–2021 годы) сохраняют свое лидерство, было выявлено уменьшение их доли (кроме Китая) в общей сумме анализируемых показателей.
**Выводы.** Возможность участия страны в рейтинге научно-технических кластеров Глобального инновационного индекса определяется качеством проводимых фундаментальных и прикладных исследований, о котором, в частности, свидетельствует уровень публикационной и патентной активности научного сообщества. Для вхождения в рейтинг научно-технических кластеров государству необходимо формировать такую научно-технологическую политику, которая бы способствовала как повышению качества исследований и разработок, так и росту ключевых показателей эффективности (количество патентных заявок и публикационная активность).

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# 分析世界经济中地区科技集群的发展情况

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**摘要**
**现实性：**制定国民经济科学和创新发展政策需要先对该领域的趋势进行深入分析，而科技集群在其中发挥着重要作用。在确定科技集群的基础上，领先国家在专利和出版活动方面的经验将为寻求在这一领域突破的国家树立榜样。
**研究目标：**这项研究旨在分析科技集群创新过程的组织效率，确定世界经济中区域科技集群发展的因素和驱动力，以及确定领先国家在专利申请和出版活动方面的竞争优势。
**数据与方法：**根据全球创新指数方法中使用的分组方法，本研究比较了该指数在专利和出版活动领域每年公布的数据和指标。
**研究结果：**通过对全球经济中区域科技集群发展的分析，我们确定了科技集群的20个主要科学领域，其中医疗、数字和计算机技术以及制药占据领先地位。文章根据专利和出版物的分析，确定了科技集群领先国家：美国、日本、德国和中国。尽管这些国家在本报告所述期间（2017-2021年）一直保持领先地位，但其在世界分析指标总和中所占份额（除中国外）均有所下降。
**结论：**一个国家能否参与全球创新指数的科技集群评级，取决于基础研究和应用研究的质量，特别是科学界的出版和专利活动水平。为了纳入科技集群排名，国家需要制定既有助于提高研发质量，又有助于关键绩效指标（专利申请数和出版活动数）增长的科技政策。

**关键词**
科技集群、全球创新指数、评级、专利、科学出版物、出版活动、竞争力

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## Introduction

The early 21st century saw a rapid formation of the global market space (Karanina & Karauliov, 2023), leading to heightened international competition. This competition extended to both strategic raw material markets (Kheyfets & Chernova, 2022) and markets associated with the sale of innovative products, technologies, and high-value-added services (Mirziyoyeva, 2019).

According to the Global Innovation Index (hereinafter referred to as GII), one of the aspects used to assess a country's innovation development is the consideration of science and technology (S&T) clusters. The latter are defined as geographical areas in different parts of the world with the highest number of inventors and authors of scientific publications. The emerging clusters often span multiple municipalities, federal states, and sometimes even two or more countries. The Global Innovation Index annually announces the top S&T clusters in the world (Dutta et al., 2022).

The goal of our research was to analyze the efficiency of innovations[1] from the perspective of their geographical concentration; to identify factors and drivers of the development of regional S&T clusters; and to determine the competitive advantages of the top countries in terms of patent applications and publication activity.

To achieve this goal, we studied the methodology underpinning the ranking of S&T clusters and identified the main fields of R&D of the top countries in terms of patent and publication activity in the global economy.

The results of this study can be useful for policy-making in regions actively involved in innovation. They provide insights that can inform the creation of strategies to stimulate the development of S&T clusters, making them more appealing to investors and fostering their global recognition.

## Literature review

The concept of innovation became a part of economic theory during the 1930s, largely due to the contributions of J. Schumpeter, who is credited as the pioneer of contemporary innovation theory. He was the first to consider innovation as the primary driver of economic growth and believed that production cannot exist without constant changes in technology, the exploration of new markets, and the transformation of market structures (Schumpeter, 1939; Schumpeter, 1942). Schumpeter's concepts were corroborated by D. Ricardo, who studied the impact of innovations on the economy. In the third edition of his work «On the Principles of Political Economy and Taxation,» he included a chapter titled «On Machinery,» noting that «the discovery, and useful application of machinery, always leads to the increase of the net produce of the country» (Ricardo, 1955).

Gradually, innovations became the focus of attention for an increasing number of researchers who further developed this concept or enriched it with new content. J. Allen links innovation to the introduction and mass consumption of new products, processes, or behaviors (Allen, 1966), while A. Harman views innovation in line with the ideas of J. Schumpeter and defines it as the implementation of new or significantly modernized production processes (Harman, 1971).

The development of innovation theory continues in our time. N. D. Kondratiev made a significant contribution by showing the importance of innovations and establishing the connection between long economic cycles and waves of technological inventions, as well as the duration of their practical utilization (Kondratiev 2002). Polterovich (2009) argues that innovative development should be based on robust institutions and high-quality human capital, which are necessary to ensure sustainable economic growth. Development is considered innovative when it leads to a qualitative leap in the economic structure of an entity by harnessing its innovative potential (Kochetkov & Kochetkova, 2017).

The development of innovation theory has led to the emergence of the theory of clusters. It was developed by such scholars as H. Schmitz, D. Audretsch and M. Feldman, R. Voigt, C. Tiffin, B. Preissl, and others.

Schmitz (1995) defines a cluster as the sectoral or geographical concentration of businesses. Altenburg and Meyer-Stamer (1999) define an industrial cluster as a large concentration of firms in a limited geographical area, possessing a specific specialization profile and characterized by a significant volume of inter-firm specialization and trade. These researchers list the following cluster characteristics:

- positive external impacts resulting from having a local pool of skilled workers and attraction of potential buyers;

[1] In this study, the economic efficiency of innovation and research is understood as based on minimal production costs for goods or services, maximum output/provision, and maximum profit from market operation. Economic efficiency can be viewed as a combination and outcome of the static and dynamic aspects of efficiency (Petrou 2014; see also Cabral 2000; Church & Ware 2000).


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- forward and backward linkages between firms inside the clusters;
- intensive exchange of information among companies, institutions, and individuals within the cluster, fostering a creative environment;
- joint effort aimed at creating locational advantages;
- diversified institutional infrastructure which supports the specific activities of the cluster;
- socio-cultural identity consisting of common values and the involvement of local actors in a local milieu which enhances trust (Altenburg & Meyer-Stamer, 1999).

According to Voyer (1998), who studied clusters extensively for many years as a scholar, policy developer, and promoter of the cluster approach in the private sector, the concept of industrial clustering closely resembles the concept of innovation systems because both involve opportunities and relationships. In his work, Voyer uses the term "knowledge-based industrial cluster", which he defines as regional or urban concentrations of firms including manufacturers, suppliers and service providers, in one or several industrial sectors. The operations of these firms are supported by infrastructure, which includes universities and other higher education institutions, research institutes, financial organizations, incubators, business service providers, and advanced communication/transportation systems (Voyer, 1998).

Audretsch (1995) and Feldman (1996) highlight that close relationships among member organizations are a key characteristic of a cluster. They define innovation clusters as interconnected organizations that facilitate the implementation of innovations in specific economic sectors or specialties.

Thus, an innovation cluster can be seen as a type of industrial cluster, with high-tech or knowledge-intensive companies at its core, where scientific and technological knowledge drive the development of new products and business growth.

As mentioned earlier, a distinctive feature of an innovation cluster is its geographical confinement. According to Tiffin and Bortagaray (2000), innovative clusters should be formed in science parks – administrative structures designed to promote their development, with a focus on the most technological types of production. They define an innovation cluster as an organizational structure that generates new products and enterprises through collective industrial production in a geographically limited area. This effect is achieved through a high concentration of knowledge exchange, interactive learning, and shared social values. Following Voyer, Tiffin and Bortagaray (2000) emphasize that a university, a high-tech company, or an incubator are only elements of a cluster, not the cluster itself.

Preissl (2003) considers the concept of an innovation cluster from a slightly different perspective: she considers an innovation cluster as a system of new goods and technologies existing in a specific economic sphere and at a specific time. It is evident that Preissl's concept excludes the geographical limitation of the cluster, its infrastructure elements, and the system of interaction between them. However, most researchers now consider the regional aspect of an innovation cluster as its defining characteristic, and when studying innovations, it is often the regional factor that captures the attention of scholars.

In his study, Napolskih (2019) summarized the key areas of innovation development and methods to analyze it at the regional level. He also proposed a criterion to evaluate the effectiveness of innovation development in regional innovation clusters.

In their study of regional-level innovation processes, Cherkasova and Ignatova (2020) pointed out the archaization of socio-economic relationships that happens while inefficient institutions gradually fade away and are replaced by new ones. In their study, they also address the issue of preserving social identity and maintaining the competitive advantages of the regional economy in the context of digitalization. They propose prospective solutions based on regional globalization management.

Surovitskaya et al. (2021) identify areas of growth in regional innovation ecosystems that drive the establishment of world-class scientific and educational centers. The human potential of these centers is considered an important factor of sustainable regional development. The competitiveness of scientific and educational centers hinges on the research and development (R&D) capabilities of the universities within these centers. Consequently, it is crucial to establish mechanisms that facilitate universities' active engagement in the endeavors of global research and educational centers and consortia while also maintaining and supporting these mechanisms through integrated digital technologies.

Alexeev et al. (2022) consider the implementation of closed-loop economy principles from the perspective of sustainable economic development and propose methods for identifying and creating sources of financing for S&T clusters.


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Golsalves et al. (2023) stress the need to formalize the operations of technology innovation centers in scientific, technical, and innovation institutions. They assert that such formalization is critical, benefiting both the development of these institutions and environmental conservation efforts.

The analysis of academic literature discussed above highlights the importance of the innovation factor in both national and global economic development. One of the ways to assess the economic efficiency of innovative activities is to view them through the lens of S&T clusters. This approach requires further theoretical exploration to understand the principles and mechanisms of cluster operation and the role of clusters in the innovative economy, both at the national and regional levels, a task that our research aims to address.

## Method and data

The GII methodology employs a cluster approach to identify factors influencing innovation efficiency through geographical concentration. This way we can also identify the most innovative economies globally, helping to show strengths, weaknesses, and gaps in their innovation indicators.

The geographical boundaries of innovation clusters typically do not align with geographical units for which governments or other organizations collect statistical data. S&T clusters are identified by using data from geocoded addresses of inventors listed in patent applications filed under the World Intellectual Property Organization's (WIPO) Patent Cooperation Treaty (PCT) and authors of scientific publications in the "Science and Technology" category indexed in the Web of Science database. It should be noted that publications in the social sciences and humanities were excluded from this analysis.

The names of S&T clusters in the GII are based on the names of one or several cities that form the cluster. The sizes of S&T clusters are determined using an empirical approach, which involves the following stages. First, the addresses of patent authors and scientific article authors are identified and geocoded. Then, an algorithm is applied to map the clusters based on the obtained data. Once the geocoding process is complete, the S&T clusters are identified, and detailed descriptions of the top 100 clusters are provided.

Originally, clusters were identified exclusively through patent data, which was deemed the most reliable indicator for evaluating the efficiency of inventive activities. Since 2018, the GII and S&T cluster ranking have relied on information about the authors of scientific publications from the expanded scientific citation index of Web of Science. According to GII experts, the incorporation of author details to identify S&T clusters had but a limited impact on both the results and the sizes of the clusters (Bergquist et al., 2017).

Our research on the dynamics of regional S&T clusters in the global economy is based on a comparative analysis of annually published data and indicators from the GII in the field of patent and publication activity. We intend to determine the factors affecting innovation efficiency and identify the drivers of regional S&T cluster development.

The study comprised two stages. In the first stage, the primary areas of patent performance in S&T clusters were identified for the years 2017-2020. In the second stage, the patent and publication activity of the leading S&T cluster countries was analyzed for the same period.

## Results and discussion

Our analysis of the global ranking of S&T clusters across various disciplines has revealed the specific trends in patent and publication activity of the leading countries. Additionally, it has provided insights into the most productive areas of research worldwide. We also identified the key areas of S&T clusters' patent performance in 2017-2020 as well as priority areas of their research activity (Table 1).

Table 1 illustrates that out of the top 20 areas of clusters' patent performance, the leading position in the given period is occupied by medical technologies. Other top positions are held by such fields as digital technologies, pharmaceuticals, and computer technologies.

By 2020, some of the fields had been removed from the list (these included "furniture, games," "textile and paper machinery," and "special machinery") and some had been added ("other consumer goods" and "measurements"). Patent activity significantly decreased in fields such as "transport," "organic chemistry," and "semiconductors." However, there was a significant increase in the number of S&T clusters in the "electrical machinery" and "computer technologies" sectors, while the growth in the number of clusters operating in civil engineering and biotechnologies was less pronounced. The increase in the number of S&T clusters in these fields indicates their high innovative potential and reflects the trends in the development of the real sector of the global economy.


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Table 1

**Key areas of S&T clusters' patent performance in 2017-2020**

| | Specialization of clusters | Number of clusters | |
|---|---|---|---|
| | | 2017 | 2020 |
| | **Total** | **100** | **100** |
| 1 | Medical technologies | 17 | 18 |
| 2 | Digital technologies | 16 | 15 |
| 3 | Pharmaceuticals | 15 | 15 |
| 4 | Computer technologies | 11 | 15 |
| 5 | Transport | 7 | 2 |
| 6 | Electrical machinery | 7 | 12 |
| 7 | Organic chemistry | 6 | 2 |
| 8 | Basic materials chemistry | 4 | 4 |
| 9 | Biotechnologies | 2 | 3 |
| 10 | Engines, pumps, turbines | 2 | - |
| 11 | Civil engineering | 2 | 4 |
| 12 | Optics | 2 | 2 |
| 13 | Semiconductors | 4 | 1 |
| 14 | Food chemistry | 1 | 1 |
| 15 | Mechanical parts | 1 | 1 |
| 16 | Furniture, games | 1 | - |
| 17 | Textile and paper machines | 1 | - |
| 18 | Other specialized equipment | 1 | - |
| 19 | Other consumer goods | - | 3 |
| 20 | Measurement | - | 2 |

*Sources: Compiled by the authors by using the data from the Global Innovation Index (Dutta et al. 2017, 173-176; Dutta et. al. 2020, 44-45).*

We summarized the patent applications data of S&T clusters for 2017-2021 as a percentage of the total number of patents worldwide and the number of S&T clusters. This allowed us to identify the top countries in terms of patent activity in the analyzed period (see Table 2).

As Table 2 shows, in 2017, the three global leaders in terms of patent activity were the United States (28.10%), Japan (25.01%), and China (12.15%). In 2021, these countries maintained their leadership, but compared to 2017, the indicators significantly decreased for the United States and Japan and slightly increased for China.

Overall, in the period under consideration, a significant decrease in patent activity is observed in countries such as France, Belgium, Canada, Switzerland, Australia, Israel, India, and Spain. In some countries (Belgium, Canada, India, Spain, etc.), the number of clusters remains the same, while in others, it changes, either decreasing (France, Switzerland, Israel) or increasing (Australia, the United Kingdom). It is necessary, however, to note that over the four years, in several countries the share of patent applications remained approximately the same with small fluctuations (Australia, Israel, India, etc.).

The analysis of the publication activity in the countries participating in the GII ranking shows that out of the 27 countries, the largest share of publications is attributed to the USA, followed by China, Japan, Germany, and others (Table 3).


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Table 2

**Leading countries in terms of S&T clusters' patent performance, 2017-2021**
**(1 - the share of patent applications from the global number in the current year (in %),**
**2 - the number of S&T clusters)**

| | Countries | Percentage of patent applications from the global number (1) and the number of S&T clusters (2) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2017 | | 2018 | | 2019 | | 2020 | | 2021 | |
| | | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 |
| 1 | USA | 28.10 | 31 | 16.97 | 26 | 16.98 | 26 | 16.50 | 25 | 15.67 | 24 |
| 2 | Japan | 25.01 | 8 | 15.82 | 3 | 15.64 | 3 | 16.09 | 5 | 16.05 | 5 |
| 3 | China | 12.15 | 7 | 9.14 | 16 | 10.67 | 18 | 12.36 | 17 | 14.17 | 19 |
| 4 | Germany | 9.35 | 12 | 4.30 | 8 | 7.72 | 8 | 3.98 | 8 | 3.93 | 8 |
| 5 | South Korea | 7.56 | 4 | 4.87 | 3 | 4.93 | 3 | 4.90 | 3 | 5.16 | 4 |
| 6 | France | 3.49 | 5 | 1.84 | 3 | 1.77 | 3 | 1.71 | 3 | 1.48 | 2 |
| 7 | Belgium | 1.65 | 2 | 1.07 | 2 | 1.13 | 2 | 1.09 | 2 | 1.06 | 2 |
| 8 | UK | 1.73 | 3 | 0.88 | 4 | 0.89 | 4 | 0.89 | 4 | 0.91 | 4 |
| 9 | Sweden | 1.50 | 3 | 0.92 | 3 | 0.75 | 2 | 0.91 | 3 | 0.92 | 3 |
| 10 | Canada | 1.28 | 4 | 0.78 | 4 | 0.76 | 4 | 0.74 | 4 | 0.72 | 4 |
| 11 | Switzerland | 1.43 | 3 | 0.73 | 3 | 0.70 | 3 | 0.67 | 3 | 0.46 | 2 |
| 12 | Australia | 1.00 | 3 | 0.71 | 4 | 0.71 | 4 | 0.69 | 4 | 0.67 | 4 |
| 13 | Israel | 1.24 | 2 | 0.69 | 1 | 0.70 | 1 | 0.68 | 1 | 0.66 | 1 |
| 14 | India | 0.80 | 3 | 0.52 | 3 | 0.51 | 3 | 0.50 | 3 | 0.54 | 3 |
| 15 | Netherlands | 0.59 | 2 | 0.46 | 1 | 0.45 | 1 | 0.42 | 1 | 0.40 | 1 |
| 16 | Singapore | 0.54 | 1 | 0.39 | 1 | 0.39 | 1 | 0.38 | 1 | 0.38 | 1 |
| 17 | Spain | 0.68 | 2 | 0.41 | 2 | 0.39 | 2 | 0.37 | 2 | 0.35 | 2 |
| 18 | Italy | 0.34 | 1 | 0.32 | 2 | 0.30 | 2 | 0.29 | 2 | 0.29 | 2 |
| 19 | Denmark | 0.47 | 1 | 0.28 | 1 | 0.29 | 1 | 0.28 | 1 | 0.28 | 1 |
| 20 | Finland | 0.54 | 1 | 0.31 | 1 | 0.28 | 1 | 0.27 | 1 | 0.25 | 1 |
| 21 | Russia | 0.34 | 1 | 0.23 | 1 | 0.21 | 1 | 0.20 | 1 | 0.18 | 1 |
| 22 | Taiwan | - | - | 0.19 | 2 | 0.14 | 1 | 0.26 | 1 | 0.29 | 1 |
| 23 | Turkey | - | - | 0.14 | 2 | 0.28 | 2 | 0.30 | 2 | 0.32 | 2 |
| 24 | Brazil | - | - | 0.08 | 1 | 0.08 | 1 | 0.07 | 1 | 0.07 | 1 |
| 25 | Poland | - | - | 0.04 | 1 | 0.04 | 1 | 0.04 | 1 | 0.04 | 1 |
| 26 | Iran | - | - | 0.01 | 1 | 0.01 | 1 | 0.01 | 1 | 0.02 | 1 |
| 27 | Ireland | - | - | 0.08 | 1 | 0.08 | 1 | - | - | - | - |
| 28 | Malaysia | 0.19 | 1 | - | - | - | - | - | - | - | - |

*Sources: Compiled by the author by using the data from the Global Innovation Index (Dutta et al. 2017, 173-176; Dutta et al. 2018, 203-207; Dutta et al. 2019, 68-70; Dutta et al. 2020, 44-45; Dutta et al. 2021, 30-31).*


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Table 3

**Leading countries in terms of S&T clusters' publications activity, 2018–2021 (1 - the share of publications from the global number in the current year (in %), 2 - the number of S&T clusters)**

| | Countries | Percentage (%) of publications from the global number (%) and the number of S&T clusters (2) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 2018 | | 2019 | | 2020 | | 2021 | |
| | | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 |
| 1 | USA | 13.77 | 26 | 13.31 | 26 | 13.08 | 25 | 12.55 | 24 |
| 2 | China | 9.88 | 16 | 11.34 | 18 | 12.16 | 17 | 13.76 | 19 |
| 3 | Japan | 2.93 | 3 | 2.80 | 3 | 2.77 | 4 | 2.66 | 5 |
| 4 | Germany | 2.44 | 8 | 2.41 | 8 | 2.36 | 8 | 2.32 | 8 |
| 5 | South Korea | 2.15 | 3 | 2.15 | 3 | 2.14 | 3 | 2.26 | 4 |
| 6 | UK | 2.14 | 4 | 2.16 | 4 | 2.09 | 4 | 2.04 | 4 |
| 7 | Australia | 1.84 | 4 | 1.80 | 4 | 1.79 | 4 | 1.82 | 4 |
| 8 | France | 1.54 | 3 | 1.49 | 3 | 1.41 | 3 | 1.21 | 2 |
| 9 | Canada | 1.21 | 3 | 1.51 | 4 | 1.44 | 4 | 1.41 | 4 |
| 10 | Spain | 1.14 | 2 | 1.11 | 2 | 1.08 | 2 | 1.07 | 2 |
| 11 | Italy | 0.95 | 2 | 0.90 | 2 | 0.91 | 2 | 0.89 | 2 |
| 12 | Netherlands | 0.97 | 1 | 0.94 | 1 | 0.91 | 1 | 0.88 | 1 |
| 13 | India | 0.79 | 3 | 0.79 | 3 | 0.80 | 3 | 0.82 | 3 |
| 14 | Turkey | 0.71 | 2 | 0.71 | 2 | 0.69 | 2 | 0.66 | 2 |
| 15 | Iran | 0.69 | 1 | 0.71 | 1 | 0.72 | 1 | 0.74 | 1 |
| 16 | Switzerland | 0.68 | 3 | 0.66 | 3 | 0.66 | 3 | 0.51 | 2 |
| 17 | Russia | 0.66 | 1 | 0.66 | 1 | 0.67 | 1 | 0.68 | 1 |
| 18 | Sweden | 0.63 | 3 | 0.46 | 2 | 0.61 | 2 | 0.58 | 3 |
| 19 | Singapore | 0.53 | 1 | 0.54 | 1 | 0.53 | 1 | 0.52 | 1 |
| 20 | Belgium | 0.48 | 2 | 0.54 | 2 | 0.52 | 2 | 0.51 | 2 |
| 21 | Brazil | 0.48 | 1 | 0.46 | 1 | 0.43 | 1 | 0.41 | 1 |
| 22 | Israel | 0.37 | 1 | 0.37 | 1 | 0.36 | 1 | 0.35 | 1 |
| 23 | Denmark | 0.32 | 1 | 0.32 | 1 | 0.31 | 1 | 0.3 | 1 |
| 24 | Finland | 0.21 | 1 | 0.20 | 1 | 0.20 | 1 | 0.19 | 1 |
| 25 | Poland | 0.28 | 1 | 0.28 | 1 | 0.28 | 1 | 0.28 | 1 |
| 26 | Taiwan | 0.93 | 2 | 0.61 | 1 | - | - | 0.69 | 1 |
| 27 | Ireland | 0.25 | 1 | 0.25 | 1 | - | - | - | - |

*Source: compiled by the authors by using the data from the Global Innovation Index (Dutta et al. 2018, 203–207; Dutta et al. 2019, 68–70; Dutta et al. 2020, 44–45; Dutta et al. 2021, 30–31).*

In the given period, China showed the most significant increase in the share of scientific publications compared to other countries. Therefore, it can be assumed that the increase in the number of clusters in China has had a positive impact on publication activity, although such a result is not observed in other countries. For example, the increase in the number of clusters in Japan did not


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lead to an increase in the share of publications, which may indicate insufficient activity of Japanese S&T clusters (this conclusion can be extended to other countries demonstrating the same trend). In the United States, France, Switzerland, and other countries, a decrease in the number of clusters predictably led to a decrease in researchers' publication activity.

## Conclusion

The process of identifying and ranking S&T clusters, as part of the Global Innovation Index preparation, helps us assess the efficiency of research and innovation development. Our analysis of the GII data related to the activities of the top 100 clusters worldwide from 2017 to 2021 has shown the following.

Firstly, we found that the most in-demand scientific fields are medical technologies, digital technologies, pharmaceuticals, and computer technologies. Additionally, the following areas possess high innovation potential: electric machinery, computer technologies, civil construction, and biotechnology.

Secondly, we have identified the top three countries in the ranking of S&T clusters: the United States, Japan, and China (with Germany in the fourth place). However, despite the continued leadership of these top three countries by 2021, the shares of patent applications and scientific publications for the United States and Japan decreased in the global total, while China's shares increased. As it appears, China's success may be linked to the increase in the number of S&T clusters.

The analysis of the S&T cluster ranking highlights the high competitiveness of Chinese clusters on a global scale. In 2017-2018, the number of S&T clusters in China rose sharply, more than doubling, and then continued to grow slowly thereafter (Table 2). Furthermore, it's important to note the rise in the rankings of all Chinese S&T clusters in the GII over a short period of time—both those that existed in 2017 (Nanjing, Hangzhou, Wuhan, Xi'an, Chengdu, etc.) and new ones (Qingdao and Chongqing).

The research findings on the development of regional S&T clusters in the global economy can help shape national policies for science and economy. Particularly, the ongoing science and innovation reforms in Uzbekistan require a comprehensive analysis of global scientific and economic trends and best practices. In the future, these findings will be valuable when making a decision on Uzbekistan's participation in the Science and Technology (S&T) Cluster ranking of the GII. Such research evidence can also serve as a guide in shaping the agenda for scientific and innovation development of the national economy.

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