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Миссия журнала «R-Economy» – обеспечить публикацию исследований в области региональной экономики. Мы считаем сотрудничество с экономистами из стран БРИКС нашим главным приоритетом. «R» в названии журнала ссылается на три его базовых направления – Region (региональное развитие), Regulation (сравнительное изучение региональной политики) и Reconfiguration (пространственные социально-экономические и политические преобразования).

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Evaluating the Financial Efficiency of the Healthcare System: A Three-Stage DEA Model Analysis

Relevance. Public health effectiveness is crucial for population health, especially in the face of global challenges like the COVID-19 pandemic. The study applies the Data Envelopment Analysis (DEA) model to measure the efficiency of operating costs in the health care system across various regions of Kazakhstan from 2017 to 2021. Existing methods for assessing healthcare effectiveness often overlook the system's complexity, which turns DEA into a valuable tool to identify inequalities in healthcare availability and quality.
Research objective. This study aims to employ the DEA model to measure the efficiency of operating costs in the health care system across regions of Kazakhstan in 2017–2021.
Data and methods. The DEA model was chosen for its ability to analyze the efficiency of operating costs. Data were collected from the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan.
Results. Our findings indicate the need for increased healthcare financing in specific regions, emphasizing the importance of transparent spending. The study concludes that the DEA model can regularly assess health financing, ensuring resources are directed where most needed. The novelty lies in establishing a link between financing and health outcomes.
Conclusions. The study's results and methodology can be used by public health authorities in assessing operating costs' effectiveness, allocating resources judiciously, and making informed decisions to enhance the healthcare system.

KEYWORDS
Healthcare system, efficiency analysis, regions, regional economy, Data Envelopment Analysis, Kazakhstan.

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Оценка финансовой эффективности системы здравоохранения на основе трехступенчатой модели DEA

Актуальность. Эффективность здравоохранения важна для здоровья населения. Пандемия COVID-19 подчеркнула важность готовности здравоохранения к глобальным вызовам. Правильное использование ресурсов, развитие инфраструктуры и обучение медицинского персонала для более эффективного реагирования на будущие угрозы являются актуальными задачами. Существующие методы оценки эффективности здравоохранения не всегда учитывают сложность и многообразие системы здравоохранения. Оценка эффективности здравоохранения с помощью модели Анализа Свертки Данных (DEA) позволяет выявить неравенство в доступности и качестве медицинской помощи в разных регионах Казахстана.

КЛЮЧЕВЫЕ СЛОВА
Система здравоохранения, анализ эффективности, регионы, региональная экономика, Анализ Свертки Данных (DEA), Казахстан.

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Цель исследования. Целью настоящего исследования является применение модели DEA для оценки эффективности операционных расходов системы здравоохранения в регионах Республики Казахстан в период 2017–2021 гг.
Данные и методы. В качестве метода анализа для измерения эффективности операционных затрат была выбрана модель DEA. Данные для исследования были получены из Агентства по стратегическому планированию и реформам Казахстана.
Результаты. В статье проведена оценка эффективности финансирования здравоохранения в регионах Казахстана на основе анализа различных количественных показателей. Оценка показала необходимость увеличения финансирования здравоохранения в определенных регионах страны, но с соблюдением открытости и прозрачности в расходовании средств. Результаты позволяют сделать вывод, что модель DEA может использоваться для регулярной оценки финансирования здравоохранения по регионам, более точного учета потребностей каждого региона и направления средства в регионы, где они наиболее необходимы. Также, следует подчеркнуть новизну исследования, которая заключается в выявлении связи между финансированием и индикаторами здоровья населения в области здравоохранения.
Выводы. Результаты и методика исследования могут быть использованы государственными органами управления здравоохранением для оценки эффективности операционных затрат, ресурсов и принятия более обоснованных решений в разработке политик и программ по улучшению системы здравоохранения.

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评估医疗系统的财务效率：基于 三阶段DEA模型

现实性：医疗保健效率对于人口健康非常重要。 新冠疫情凸显了医疗保健应对全球挑战的重要性。 正确利用资源、发展基础设施和培训医务人员以更好地应对未来的威胁是当务之急。现有的医疗保健效率评估方法并不总能考虑到医疗保健系统的复杂性和多样性。使用数据包络分析(DEA) 模型评估医疗保健的有效性使我们能够识别哈萨克斯坦不同地区医疗保健的可用性和质量的不平等现象。
研究目标：本研究的目的是应用 DEA 模型评估 2017-2021 年期间哈萨克斯坦共和国各地区医疗保健系统运营成本的效率。
数据与方法：选择 DEA 模型作为衡量运营成本效率的分析方法。研究数据来自哈萨克斯坦战略规划和改革署。
研究结果：本文通过对各种量化指标的分析，评估了哈萨克斯坦各地区医疗融资的有效性。评估结果表明，有必要增加国内某些地区的医疗保健资金，但必须遵守支出的公开性和透明度。结果表明，DEA模型可分地区定期评估医疗筹资情况，更准确地反映各地区的需求，将资金引导到最需要的地区。此外，还应强调本研究的新颖之处，即确定了卫生部门筹资与卫生指标之间的联系。
结论：政府卫生当局可以利用该研究的结果和方法来评估运营成本、资源的有效性，并在制定改善医疗保健系统的政策和计划时做出更明智的决策。

关键词：
医疗保健系统、效率分析、区域、区域经济、数据包络分析(DEA)、哈萨克斯坦

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Introduction

In times of crises such as the COVID-19 pandemic, the assessment of healthcare efficiency gains heightened significance. The pandemic has exposed the vulnerabilities of healthcare systems when confronted with extraordinary challenges, which brought to the fore such questions as the optimal utilization of healthcare resources, the effectiveness of medical services, and their overall impact on public health. Pecoraro et al. (2021)

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and Wynia (2020) have offered valuable insights into this critical concern.

The healthcare sector plays a crucial role in shaping the overall health of a nation as it strives for effectiveness. Progress in the healthcare system serves as an indicator of social development, reflecting successful reforms and a higher level of professionalism. At both the state and local levels, it becomes imperative to ensure consistent funding for research, innovation and adherence to professional education standards. Nevertheless, this approach comes with challenges, and the accuracy of reforms directly affects the comprehensive and precise evaluation of healthcare system efficiency.

Since gaining independence in 1991, Kazakhstan's healthcare system has undergone significant transformations, driven by proactive governmental reforms to enhance access, quality, and affordability of healthcare for its citizens[1]. Post-independence, Kazakhstan's healthcare system witnessed decentralization measures, maintaining a balance between regional autonomy and central government control (Amagoh, 2021). The Ministry of Health shapes national health policies, while regional health departments manage healthcare services within their respective areas. These regional entities oversee state-owned hospitals and polyclinics, whereas national clinics and research centers are under the supervision of the Ministry of Health (Health Systems in Action: Kazakhstan, 2022).

In this research the lowest inefficiency score is observed in 2017. The Healthcare Minister of Kazakhstan associated the ineffectiveness of the healthcare system with corrupt practices, highlighting that in 2017, the healthcare sector ranked among the top five most corrupt sectors within the country's economy[2]. Widespread corruption can potentially influence the well-being of societies. Nations characterized by elevated corruption levels allocate a smaller proportion of their gross domestic product towards healthcare expenditures was proved by Glynn (2022). Moreover, President Kassym-Jomart Tokayev stated that special focus ought to be given to combatting corruption in customs, construction, education, and healthcare. The relevant government ministries are tasked with creating a comprehensive strategy for systematically eliminating corruption in these domains[3]. Therefore, the Ministry of Healthcare of the Republic of Kazakhstan together with the Anti-Corruption Agency has developed a roadmap to prevent corruption risks in the healthcare sector[4].

To enhance the efficiency of the national healthcare system, substantial efforts were made in legislation in 2018, aligning with the "Densaulyk 2016–2019" national healthcare advancement initiative. This resulted in a notable improvement in the healthcare system, as reported by the official information source of the Prime Minister of the Republic of Kazakhstan in 2019[5]. Meanwhile, a significant improvement is already demonstrated in Figure 1. The State Program for the Development of Healthcare of the Republic of Kazakhstan, "Densaulyk," for 2020–2025 was established with the objective of ensuring quality and affordable healthcare. Despite the anticipation of significant improvements in the healthcare system, the advent of COVID-19 in Kazakhstan in March 2020 disrupted these expectations, leading to adverse repercussions[6]. The COVID-19 crisis exposed the vulnerability of emerging economies, which were less able to withstand the economic shock than developed countries (Voskanyan, 2020).

Kazakhstan employs a mixed healthcare model, blending public and private elements. The government primarily provides healthcare through

[1] OECD Reviews of Health Systems: Kazakhstan (2018). Retrieved from: https://www.oecd-ilibrary.org/social-issues-migration-health/oecd-reviews-of-health-systems-kazakhstan-2018_9789264289062-en (Accessed: 31.06.2023).

[2] Minister: corruption in Kazakhstan's health care system is flourishing (2017). Retrieved from: https://ru.sputnik.kz/20170407/ministr-korrupciya-v-sisteme-zdravoohraneniya-kazahstana-procvetaet-1954450.html (Accessed: 10.07.2023).

[3] The head of state held a meeting on combating corruption (2022). Retrieved from: Official website of the President of the Republic of Kazakhstan. Retrieved from: https://www.akorda.kz/ru/glava-gosudarstva-provel-soveshchanie-po-voprosam-protivodeystviya-korrupcii-1128 (Accessed: 10.07.2023).

[4] The Ministry of Health of the RK jointly with the Anti-Corruption Agency Discussed The Issues of Minimizing Corruption Risks (2023). Retrieved from: Ministry of Health of the Republic of Kazakhstan. Retrieved from: https://www.gov.kz/memleket/entities/dsm/press/news/details/505996?lang=ru (Accessed: 11.07.2023).

[5] Densaulyk State Health Development Program: key indicators for 2018 (2018). Retrieved from: Official information resource Prime Minister of the Republic of Kazakhstan. Retrieved from: https://primeminister.kz/ru/news/zdravoohranenie/gosprogramma-razvitiya-zdravoohraneniya-densaulik-kluchevie-pokazateli-za-2018-god-17654 (Accessed: 11.07.2023).

[6] Covid-19 in Kazakhstan: the scope of the problem, assessment of services, health and social protection (2021). Retrieved from: 21_05_COVID_2_.indd (soros.kz) (Accessed: 12.07.2023).

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state-owned facilities like hospitals, clinics, and polyclinics. The establishment of the Social Health Insurance Fund in 2016 aimed to become the main buyer of publicly funded healthcare services. The fund collects insurance premiums from employees and employers and began reimbursing services in 2020[7] (Hejduková & Kureková, 2016).

This study aims to assess the effectiveness of healthcare financing across the regions of Kazakhstan from 2017 to 2021. Using a non-parametric technique, we intend to assess changes in the efficiency of healthcare financing in Kazakhstan's regions from 2017 to 2021 through Data Envelopment Analysis (DEA). DEA is selected for its suitability in measuring productive efficiency, considering the distinctive management characteristics of medical establishments and financing expenditures in the regions of Kazakhstan. We are going to identify the level of efficiency by using various indicators, such as operating costs, the number of medical facilities, beds, and other health metrics.

The above-described purpose of the study has determined the following goals:

– identify indicators for the DEA model and analyze financial data in the healthcare system of the Republic of Kazakhstan using the DEA method;

– examine changes in healthcare financing efficiency in different periods, encompassing periods before and after the COVID-19 pandemic;

– devise recommendations for enhancing the healthcare financing system in Kazakhstan, propose healthcare and financing solutions, and outline avenues for further research in this domain.

Theoretical novelty in this study lies in the first-time application of the DEA method to study the healthcare sector of the country. With multiple inputs and outputs, this application contributes fresh insights by showcasing the method's adaptability to a new context.

The non-parametric DEA method, in comparison to existing approaches, effectively gauged performance levels. The authors enhanced and adjusted the methodology by expanding input and output indicators to evaluate the financial efficiency of the healthcare system at the regional level.

Furthermore, the practical significance of the research extends to potential use by government healthcare agencies for assessing the system's effectiveness, informing sector development, and shaping policies. However, a limitation of the study is the absence of detailed official data on healthcare fund allocation, hindering an in-depth regional analysis for the case of Kazakhstan.

This article will begin by presenting an overview of the methodology, followed by the selection of relevant indicators that will be applied to the study of various regions of Kazakhstan. Subsequently, we will assess the efficiency of healthcare financing across the regions and discuss the resulting efficiency scores, ultimately determining the levels of efficiency.

Finally, it is worth noting that there is a lack of studies evaluating healthcare financing systems at the regional level. The evaluation is necessary, however, since it enhances data comparability across diverse regions, enabling researchers to identify the most successful financing and management practices. Therefore, our aim is to bridge this gap and provide a more nuanced consideration of specific regional characteristics, facilitating the adaptation of financing strategies to meet local needs. Our findings can be of interest to local authorities and healthcare organizations, seeking to make well-informed decisions regarding the financing and management of their regional healthcare systems.

Literature Review

The effectiveness of healthcare financing was evaluated in many countries. For instance, Ivankova et al. (2020) assess the effectiveness of health care financing in OECD countries by applying regression analysis with the use of indicator limits. Their methodology, however, was unable to provide a complete picture of the efficiency of health care financing: the relationship between the indicators was investigated, but the efficiency of financing itself was not identified.

Onwujekwe (2019) assesses the effectiveness of health financing in Nigeria using in-depth interview where inefficiency in health financing was identified. But the methodology failed to fully uncover and determine the extent of inefficiency.

It should be noted that we have found very few works devoted to analyzing the financial efficiency of the health care system and the methodologies used in the works could not reveal the level of efficiency.

[7] World Health Organization annual report 2019 (2019). Retrieved from: https://apps.who.int/iris/handle/10665/333249 (Accessed: 13.07.2023).

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Nevertheless, there are several works employing Data Envelopment Analysis (DEA) to identify the effectiveness of certain financial and medical resources. However, the application of DEA in healthcare cost-benefit analysis is still relatively limited.

Liu et al. (2021) conducted the analysis of health system cost-benefit and provided several key insights. They showed that the provision of pediatric services in China exhibits significant geographical heterogeneity, evident resource redundancy, and a limited role for financial capital. To enhance the efficiency of public pediatric services, they suggested that improvements in economic, technological, and professional environments, coupled with investments in urbanization, education, and an increase in the birth rate, can contribute positively.

Furthermore, Gong & Kang (2023) employed the DEA model and Difference-in-Differences (DID) analysis to optimize the allocation of medical and healthcare financial resources. Their objective was to enhance employee health within the corporate sector.

Additionally, Wu (2023) emphasized the importance of reducing medical costs to enhance financial efficiency in hospitals. This research, however, focused exclusively on the level of individual hospitals.

Measuring a country's development often revolves around the status of its health systems, which serve as crucial indicators (Alexander, 2003). A shared priority for nations is ensuring citizens' access to sufficient medical prevention, protection, and care. The World Health Organization (WHO) underscores the significance of a well-functioning health system that provides quality services promptly and appropriately to all individuals.

Key constituents of public healthcare systems encompass funding, resources, effective leadership, and governance[8]. Resources include medical personnel, healthcare facilities, equipment, and medications (Jovanovic, 2013). Human resources stand as the linchpin of any health system, requiring ongoing development (Kuhlmann et al., 2018). The availability and equitable distribution of resources are essential prerequisites for an efficient healthcare system, necessitating efficient funding mechanisms.

Healthcare policies are tailored to a country's economic capacities, resulting in distinct health systems with varied funding models (Greer et al., 2017b).

Generally, health systems can be categorized into four models (Wallace, 2013):

1) The Beveridge model relies on taxation for financing, providing universal healthcare through state-owned institutions (Hejduková & Kureková, 2016);

2) The Bismarck model relies on mandatory health insurance contributions, covering the entire population with a non-profit orientation (Wranik, 2011);

3) The National Health Insurance (NHI) model combines elements of the Bismarck and Beveridge models, with predominantly private institutions and state-paid services[9];

4) The out-of-pocket model is prevalent in underdeveloped countries, where individuals bear full healthcare costs, often limiting access to the wealthier population.

Funding models shape healthcare access and affordability, and different models may coexist within countries. For example, the United States has elements from all four models, often classified as having an out-of-pocket model due to high per capita health insurance expenditure (Squires, D. & Anderson, C., 2015).

Efficiency is a goal for healthcare systems, aiming for resource optimization and adequate services (Cylus & Pearson, 2016). Thus, assessing healthcare system efficiency is vital, enabling accurate resource allocation and identifying improvement areas (Varabyova & Müller, 2016).

Efficiency assessment in healthcare remains a topic of interest. Radojicic et al. (2019) used Data Envelopment Analysis to assess healthcare efficiency in 22 countries. Most literature focuses on hospital efficiency, with limited studies evaluating national health system efficiency (Hollingsworth, 2008). Interest grew after the World Health Organization's 2000 report evaluated health system effectiveness across 191 countries (Evans et al., 2001).

As for Kazakhstan, there are very few works analyzing the financial efficiency of the health-

[8] World health statistics (2010). Retrieved from: https://www.who.int/publications/i/item/9789241563987 (Accessed: 15.07.2023).

[9] World Health Organization annual report 2019 (2019). Retrieved from: https://www.modernacupuncture.com/docs/2019-WHO-Report.pdf (Accessed: 16.07.2023).

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care system, but in the article "SWOT Analysis and Expert Assessment of the Effectiveness of the Introduction of Healthcare Information Systems in Polyclinics in Aktobe, Kazakhstan", the authors noted the inefficient use of financial resources in one of the regions of the Republic of Kazakhstan (Yermukhanova et al., 2022).

Furthermore, Doskeyeva et al. (2018) examined the outcomes of healthcare financing system reforms and identified persistent challenges. Notably, the management and organization of financial resources emerged as a prominent issue.

However, there have been no studies regarding Efficiency assessment in healthcare in the regions of the Republic of Kazakhstan using Data Envelopment Analysis.

Methods and Data

The evaluation of healthcare financing efficiency in Kazakhstan relies on Data Envelopment Analysis (DEA), a method commonly employed for assessing socioeconomic trends (Cooper et al., 2011). The DEA methodology enables us to compare the efficiency level to an 'ideal' state, representing the most optimal development level of the analyzed sphere for a specific year. This approach allows us to assess how the efficiency of the healthcare sector changes over the years under consideration.

DEA analysis proves suitable for researching healthcare efficiency, facilitating the establishment of input and output parameters to assess the healthcare sector's condition and efficiency over the specified period (Stefko et al., 2018). For our study, we chose a calendar year to dynamically evaluate the efficiency of Kazakhstan's healthcare system. The annual efficiency index serves as an abstract analogy to the primary economic indicators found in the statistical reports of the country's socio-economic development. However, the distinction lies only in the quantitative evaluation, as the annual efficiency index is calculated using a comparative model with absolute efficiency.

The DEA approach encompasses two fundamental models: CCR (Charnes, Cooper, Rhodes) and BCC (Banker, Charnes, Cooper). Both can be applied in input-oriented, output-oriented, and non-oriented models. In this research, an input-oriented model based on the variable returns to scale (VRS model) was employed. The VRS model is more relevant for the healthcare system in the regions of Kazakhstan due to its complexity with numerous inputs and outputs, likely exhibiting some degree of increasing or decreasing returns to scale. Additionally, it is more flexible than the CRS model and widely used in evaluating the efficiency of hospitals, health systems, and government agencies. This model was chosen for its practical relevance in assessing technical efficiency (Jia and Yuan, 2017).

The computation relies on mathematical programming to achieve the best possible outcome. In this context, each individual year is treated as a Decision-Making Unit (DMU). The mathematical model used to assess the healthcare system's efficiency is expressed as an equation:

$$E_{\max} = \frac{k_1 y_1 + k_2 y_2 + \ldots + k_y y_{y0}}{n_1 x_1 + n_2 x_2 + \ldots + n_m x_{m0}} = \frac{\sum_{r=1}^{s} k_y y_{y0}}{\sum_{i=1}^{m} n_i x_{i0}} \quad (1)$$

where E — efficiency evaluation, determined using DEA; j — the number of years considered for analysis; y_{rj} — the volume of indicator r, adopted in a specific year j; x_{ij} — the volume of result i, adopted in a specific year j; i — the number of indicators used in the country's healthcare sector; r — the number of resulting indicators of the country's healthcare sector; k_r — resource weight coefficient r assigned by DEA; n_r — weighting coefficient of result i assigned by DEA.

The data required for DEA estimation are the outputs y_{rj} and inputs x_{ij} over a finite period in a given year in a definite set of indicators. Thus, x_{ij} shows the volume of input parameter i that applies year j, and y_{rj} is the volume of parameter r at the output for year j.

If the calculated efficiency (E) for a specific year is below one, it signifies inefficiency for that period. The prioritized goals interpret the entirety of the computed results, providing insights into the implications of different efficiency levels.

In the model, constraints are applied to coefficients k and n to ensure that the calculated efficiency does not exceed 100%:

$$j = \frac{k_1 y_{1j} + k_2 y_{2j} + \ldots + k_y y_{rj}}{n_1 x_{1j} + n_2 x_{2j} + \ldots + n_m x_{mj}} = \frac{\sum_{r=1}^{s} k_y y_{rj}}{\sum_{i=1}^{m} n_i x_{ij}} \leq 1 \quad (2)$$

where $k_1, \ldots, k_n > 0$ and $n_1, \ldots, n_m \geq 0$.

To apply DEA in a standard linear programming package, the objective function should be transformed as follows:

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$$\text{Max}E = k_1 y_1 + k_2 y_2 + \ldots + k_r y_{r0} = \left(\sum_{r=1}^{s} k_r y_{r0} \right) \quad (3)$$

According to the constraints:

$$n_1 x_{10} + n_2 x_{20} + \ldots + n_m x_{m0} = \sum_{i=0}^{m} n_i x_{io} = 0 \quad (4)$$

$$k_1 x_{1j} + k_2 y_{2j} + \ldots + k_r y_{rj} \leq$$
$$\leq n_1 x_{1j} + n_2 x_{2j} + \ldots + n_m x_{mj} \quad (5)$$

We will transform the above expression into a standard mathematical form:

$$\sum_{r=1}^{s} k_r y_{rj} \leq \sum_{i=1}^{m} n_i x_{ij} \quad (6)$$

Weighting coefficients are determined using a "coverage model". The dual linear programming model will be used at $E \rightarrow$ min under the following prerequisites:

$$\sum_{j=1}^{s} \lambda_j x_{ij} \leq E x_{i0} \quad i = 1, 2, \ldots, m \quad (6.1)$$

$$\sum_{j=1}^{s} \lambda_j y_{ij} \leq y_{r0} \quad r = 1, 2, \ldots, s \quad (6.2)$$

$$\lambda_j \geq 0 \quad q = 1, 2, \ldots, z \quad (6.3)$$

The mathematical calculation reduces the equations to linear through the slack variable. The binary efficiency model minimizes the value of E, subject to the constraints (6.1) that the sum of weighted inputs by year is less than or equal to the input of the year for which the estimate is made, (6.2) the weighted sum of outputs by year is grander than or equal to the output of the year being evaluated. λ is the value of the weighting coefficient. All years with a non-zero value of λ indicator are effective.

Years for which the E efficiency indicator equals one represent the efficiency limit, while years with an E efficiency indicator less than one indicate inefficiency. The assessment of the healthcare system efficiency in Kazakhstan is conducted using the Python (pyDea) software platform

This approach in calculation allows us to determine the efficiency of the healthcare sector in regions of Kazakhstan by year in the given period (2017–2021). This time interval was chosen because the last study on the healthcare financing system in Kazakhstan was conducted in 2016 (Ahmed et al, 2019). However, the methodology for assessing the efficiency of this system at the regional level in the country has not been applied and used.

In this research, we analyze Kazakhstan's healthcare financing system. We have developed Decision Making Units (DMU) at the regional level, consisting of 17 regions in 2021 and 16 regions in 2017. In the first step, DEA window analysis is performed with 6 inputs and 4 outputs (Table 1). DEA window analysis calculates healthcare

Table 1

DEA model variables

Ind.	Variable	Definition
Input variables		
X1	Operating Expenses	Total number of operating costs for maintaining the health care system, producing products and providing services
X2	Number of medical facilities	Total number of medical facilities in the country
X3	Number of beds	Total number of beds in the medical facility
X4	Number of beds for sick children	Total number of beds for children in a medical facility
X5	Number of doctors	The total number of doctors of the medical facility
X6	Number of secondary medical staff	Total number of secondary medical staff
Output variables		
Y1	Child mortality rate	Children under the age of 5 per 1 thousand births are considered
Y2	Maternal mortality rate	Number of women's deaths during childbirth per 100,000 live births is considered
Y3	Mortality rate of the population from infectious and parasitic diseases	Mortality rate from infectious and parasitic diseases per 100,000 population is considered
Y4	Life expectancy	Average number of years that a person could expect to live

Source: compiled by the authors

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facilities and operating expenses, which are significant financial statements. The selection of inputs and outputs in the DEA method is informed by a literature review, as illustrated and determined by Worthington (2004)

As the DEA model is established based on the ratio of input and output parameters, we identify the key determining parameters for the medical field. The specifications and general characteristics of these parameters are outlined in Table 1.

Results and Discussion

Healthcare expenditure worldwide experienced significant growth in the last twenty years, increasing by over twofold in real terms. In 2019, the total expenditure amounted to US$ 8.5 trillion, equivalent to 9.8 % of the global GDP. However, the distribution of these funds was highly unequal, with approximately 80% attributed to high-income countries.[10] The distribution of global health expenditure across income groups reveals significant disparities. High-income countries allocate a substantial portion, ranging from 17% to 37 % (with the USA spending 42 %), while upper-middle income countries spend between 2.8 % and 16 % (Kazakhstan spending 3,79 %) (Global Health Expenditure Database). In contrast, low-income countries allocated a mere 0.24 % of their GDP towards healthcare in 2019. This stark contrast underscores the substantial inequality in the allocation of global health spending across different income groups.[11]

The report produced by the European Observatory on Health Systems and Policies "Health Systems in Action Insight (2022)" highlighted Kazakhstan's economic prosperity. The report also noted that healthcare expenditure is relatively modest and comparatively low considering the country's national wealth. In 2019, individual health spending in Kazakhstan reached US$ 765 when adjusted for purchasing power. Although surpassing the Central Asian average of US$ 552, it fell short of the averages for upper-middle-income nations within the WHO European Region (US$ 1,338) and the region as a whole (US$ 3,226).[12]

This research aims to assess the financial efficiency of expenses in the regions of Kazakhstan, thus the DEA approach was applied to the regions of Kazakhstan in the period of 2017–2021 using data that were gathered from the Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan.

Efficient regions are those with DEA efficiency scores equal to 1, operating at the efficiency frontier. They fully utilize inputs to produce outputs and perform optimally given the considered inputs and outputs. Close-to-efficient regions have scores very close to 1, indicating high efficiency with minor areas for improvement. Inefficient regions, with scores significantly less than 1, suggest suboptimal use of inputs for outputs. Identifying inefficient regions is crucial because it signals areas that can be improved to enhance overall performance and efficiency.

The results that were calculated by applying DEA methodology are shown in Table 2.

The regions of Atyrau, West Kazakhstan, North Kazakhstan, and Mangistau displayed notably high efficiency scores. In contrast, Akmola, Aktobe, Almaty, Kostanay, Kyzylorda, Pavlodar, Turkestan, Nur-Sultan city, and Shymkent city showcased scores that were closely aligned with those of the efficient regions. Zhambyl and Almaty city delivered performances that fell within the average range, while Karaganda and East Kazakhstan demonstrated significantly lower levels of efficiency.

This disparity in resource use and operational expenditures across different regions in Kazakhstan highlights variations in efficiency regarding resource allocation and financial management. These differences underscore the need for tailored evaluations and governance strategies in healthcare and other public sector domains. The insights gained from these findings provide a valuable foundation for future investigations and the development of strategies to improve performance in regions with lower efficiency levels.

[10] Report of the Health Systems Governance and Financing UHL. Global expenditure on health: Public spending on the rise? (2021). Retrieved from: https://www.who.int/publications/i/item/9789240041219 (Accessed: 20.07.2023).

[11] Official site of the World health organization. Global Health Expenditure Database (2022). Retrieved from: https://apps.who.int/nha/database/PHC_Country_profile/Index/en (Accessed: 20.07.2023).

[12] European Observatory on Health Systems and Policies, WHO Europe. Health systems in action: Kazakhstan (2022). ISBN: 978 92 890 5914 5. Retrieved from: https://eurohealthobservatory.who.int/publications/i/health-systems-in-action-kazakhstan-2022(Accessed: 22.07.2023).

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Table 2

Results of the DEA (input orientation, VRS) analysis

Regions/DMUs	2017	2018	2019	2020	2021	growth rate to the basic year, %	Average efficient score
Akmola	0,80	1,00	1,00	1,00	1,00	25	0,96
Aktobe	0,77	0,86	0,84	1,00	1,00	29	0,89
Almaty	0,43	1,00	0,77	1,00	0,79	83	0,80
Atyrau	1,00	1,00	1,00	1,00	1,00	0	1,00
West Kazakhstan	1,00	1,00	1,00	1,00	0,99	–1	1,00
Zhambyl	0,61	0,71	0,67	0,70	0,72	18	0,68
Karaganda	0,42	0,46	0,46	0,47	0,43	9,53	0,45
Kostanay	0,75	0,79	0,83	1,00	0,85	5,43	0,85
Kyzylorda	0,73	0,75	0,75	1,00	1,00	3,80	0,85
Mangistau	1,00	1,00	1,00	1,00	1,00	0,00	1,00
Pavlodar	0,78	1,00	1,00	1,00	0,90	15,4	0,94
North Kazakhstan	1,00	1,00	1,00	1,00	1,00	0	1,00
Turkestan	0,89	0,69	0,69	1,00	1,00	12	0,86
East Kazakhstan	0,42	0,48	0,46	1,00	0,48	14,28	0,57
Nur-Sultan city	1,00	1,00	1,00	1,00	1,00	0	1,00
Almaty city	0,89	0,79	0,61	1,00	0,57	0,64	0,77
Shymkent city	-	1,00	0,87	1,00	1,00	0	0,97

Source: Calculated by the authors based on the Bureau of National Statistics Agency for Strategic Planning and Reforms of the Republic of Kazakhstan (2023). Retrieved from: https://stat.gov.kz/ru/industries/social-statistics/stat-medicine/ (Accessed: 20.06.2023)

The wide gap in economic development between different regions of Kazakhstan is a major obstacle to national development (Kireyeva et al., 2022).

According to the results of the DEA analysis and its average score for 2017–2021, it is possible to divide the regions into the following groups:

1. Efficient regions (efficiency score equals 1.0): Atyrau, West Kazakhstan, North Kazakhstan, and Mangistau;

2. Highly efficient regions (from 0.8 to 1.0): Akmola, Aktobe Almaty, Kostanay, Kyzylorda, Pavlodar, Turkestan, Nur-Sultan city, Shymkent city;

3. Medium efficiency (from 0.6 to 0.8): Karaganda, Almaty city.

4. Inefficient regions (under 0.6): Karaganda, East Kazakhstan

The period from 2017 to 2021 saw varying growth rates among several regions. The region of Almaty led with the highest growth rate of 83%, while Aktobe, Akmola, Zhambyl, Pavlodar, East Kazakhstan, and Turkestan demonstrated moderate growth rates of 29%, 25%, 18%, 15.4%, 14.28%, and 12%, respectively.

Conversely, some regions experienced slower growth, such as Karaganda with a rate of 9.53%, Kostanay at 5.43%, and Kyzylorda at 3.80%. Notably, the growth rate in Almaty was only 0.64%. Additionally, West Kazakhstan showed a negative growth rate of –1%. Figure 1 shows the regions that lie on the efficiency frontier.

Every year the amount of money allocated to health care increases, for example, local budget expenditures on healthcare in Kazakhstan almost doubled from 2018 to 2022, reaching 0.3 billion tenge. Shymkent saw the most significant growth, with expenditures increasing from 0.1 billion tenge to 9.9 billion tenge over the same period. Almaty city had the largest share of local budget expenditures on healthcare, at an average of 14.0 % for 2018–2022. Turkestan region came in second, with an average of 9.9 %, followed by Almaty region (9.0 %), East Kazakhstan region (8.8%), and Astana city (7.2 %). The lowest share of local budget expenditures on healthcare was recorded in Mangistau region (2.3 %), West-Kazakhstan region (2.6 %), North-Kazakhstan region (3.2 %), Akmola region (3.3 %), Atyrau region (3.6 %), and Shymkent city (3.7 %).[13]

[13] How much money from the RK state budget is spent on healthcare (2023). Retrieved from: https://spik.kz/skolko-deneg-iz-gosbyudzheta-rk-tratitsya-na-zdravookhranenie?ysclid=lm9c85w3x8976138483 (Accessed: 27.07.2023).

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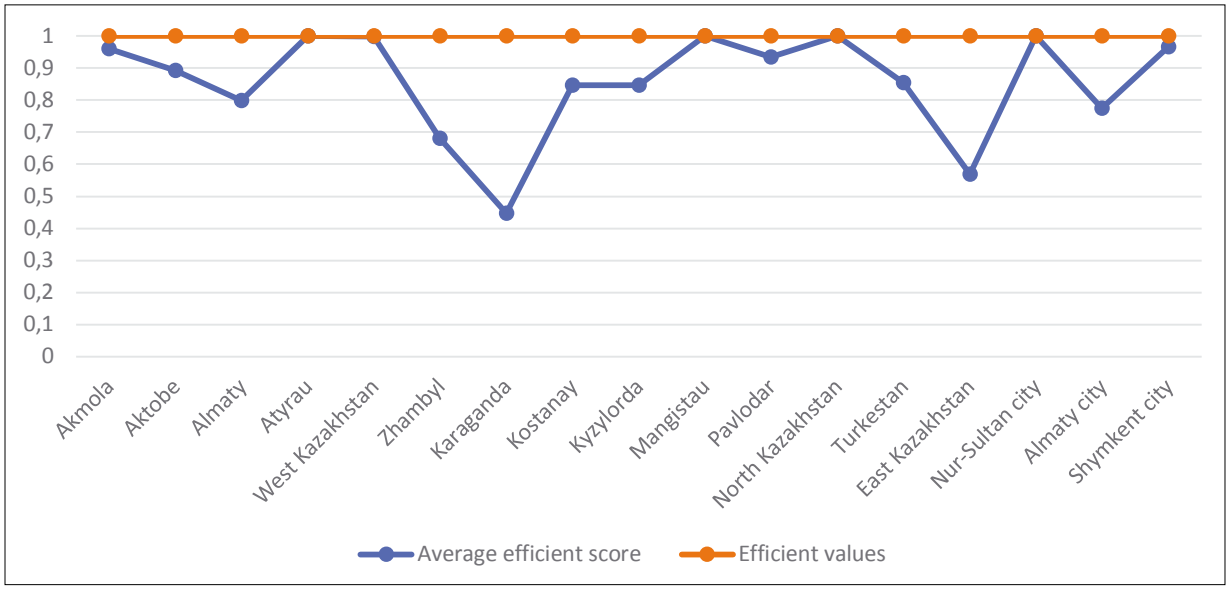

Figure 1. *Efficiency target points*

Source: Calculated by the authors based on the Bureau of National Statistics Agency for Strategic Planning and Reforms of the Republic of Kazakhstan (2023). Retrieved from URL: https://stat.gov.kz/ru/industries/social-statistics/stat-medicine/ (Accessed: 25.06.2023).

Since 2018, East Kazakhstan has had the highest level of expenditures on healthcare relative to income, with an average excess of 0.7 %. In 2019, the excess was 1.1 %. The largest excess of expenditure over income occurred in 2020, when there was a global crisis and high incidence of disease, at 4.3 %. In 2021, revenues lagged expenditures by 0.2%. In summary, local budget expenditures on healthcare in Kazakhstan have increased significantly in recent years. Shymkent has seen the most growth, while East Kazakhstan has had the highest level of expenditures relative to income. The global crisis and high incidence of disease in 2020 led to a significant increase in expenditures in all regions.

In addition to current revenues and expenditures, healthcare in East Kazakhstan receives transfers for capital expenditures, which account for 27.2 % of the republican level. According to Figure 5, the main source of transfers for healthcare in Kazakhstan is the Social Health Insurance Fund (52.39 %). The second largest source is the republican budget (37.53 %). In Kazakhstan, 13 % of transfers for healthcare are spent on capital repairs, and 17.5 % are spent on the acquisition of fixed assets.

Atyrau, Mangistau, and North Kazakhstan exhibit efficient scores for several reasons. These regions have experienced substantial investments in healthcare, including the construction of new hospitals and clinics, the purchase of modern medical equipment, and the training of healthcare professionals. In 2021 alone, notable investments included $1 billion from the Kazakh government for a new cancer center in Atyrau, $500 million for the acquisition of medical equipment in Mangistau, and the training of 1,000 new doctors and nurses in North Kazakhstan.

Despite increased funding, regional disparities in healthcare performance remain a challenge. Transparency issues hinder effective financing and contribute to corruption. A roadmap to prevent corruption risks in healthcare has been developed. Legislative efforts and the “Densaulyk 2016-2019” initiative improved the healthcare system, but COVID-19 disrupted these gains[14].

Conclusion

This paper investigates the use of Data Envelopment Analysis (DEA) to assess the operational efficiency of healthcare financing in Kazakhstan. Our findings confirm the hypotheses and show the significance of efficient health financing for enhancing healthcare quality and population

[14] Healthcare in Kazakhstan: problems and solutions (2020). Retrieved from: https://borgenproject.org/healthcare-in-kazakhstan/ (Accessed: 28.07.2023).

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health. Additionally, the study highlights DEA's unique applicability in analyzing healthcare funding across Asian nations with similar traditions and a tendency for paternalistic management across diverse sectors.

Our analysis relied on publicly accessible statistical data, focusing on quantitative indicators like operational expenditures (the main financial marker), medical facility counts, beds, pediatric beds, medical personnel, child mortality rate, maternal mortality rate, general population mortality rate, and life expectancy. The primary focus of this efficiency analysis is the reduction of both mortality and morbidity. In order to enhance the management of healthcare financing in Kazakhstan, increased attention and improvements are necessary.

The lowest healthcare efficiency in Kazakhstan was recorded in 2017 and the peak efficiency in 2020, which was largely attributed to increased funding during the COVID-19 crisis.

During the COVID-19 pandemic, the operational framework of healthcare financing in Kazakhstan demonstrated noteworthy efficiency in the sector, aligning closely with the conceptual "ideal" model. However, while life expectancy increased, certain health indicators remained problematic. The government is dedicated to improving the health and overall welfare of the population through comprehensive national initiatives, including expanding primary healthcare services, enhancing care quality, and increasing healthcare funding.

The study recommends to increase the financing of the healthcare system, particularly focusing on salaries and the procurement of medical equipment. Emphasizing transparency in healthcare spending is crucial to prevent unreliable practices and corruption. The application of the DEA model enables regular assessments of healthcare financing results by region, considering service quality, accessibility, and population health indicators more accurately. This approach implies that funds should be directed to regions where they are most needed.

For further in-depth analysis it is planned to apply the methodology to assess the efficiency of financing in the context of private and public hospitals and compare the results.

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Conceptual Approach to Managing the Development of Creative Industries in Second-Tier Industrial Cities

Relevance. In contemporary urban development, knowledge and creativity play pivotal roles in transforming cities into instruments for increased attractiveness, economic growth, and citizen well-being. Despite this recognition, second-tier cities face challenges due to the lack of a comprehensive concept for managing creative industries. The creative economy, proven effective in various countries, holds potential solutions to address accumulated issues.
Research objective. This study aims to conceptualize the management of the creative sector in second-tier industrial cities, fostering their revitalization and transformation into growth zones.
Data and methods. The empirical focus includes 14 creative clusters in old industrial second-tier cities of the Urals and Siberia in Russia. The study constructs a typology delineating five types of creative cluster formation, based on public-private sector interaction. Content analysis examines research literature and is complemented by a systematic approach.
Results. The article systematizes the most pivotal problems in the management of creative industries' development and shows the importance of addressing institutional and coordination issues. Types of creative cluster formation are identified based on the degree of interaction between the public and private sectors in the development of creative industries. Two key types of creative cluster formation—initiative-based and dependent—are identified through case studies. The study formulates a conceptual approach to managing creative industries in second-tier industrial cities.
Conclusions. The management of creative industries in second-tier cities deserves to be acknowledged as a distinct area of management. Development of creative industries requires a systematic state support system and a well-defined strategy. Local authorities play a crucial role in this process, acting as focal points for cooperative efforts through regulatory innovations in urban creative industries. Key instruments for effective policy implementation include the transformation of urban spaces, establishment of creative clusters, provision of grants to support small businesses, and stimulation of export activities.

KEYWORDS
creative industry, creative cluster, state support, state policy, creative city, second-tier cities, city management

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Концептуальный подход к управлению развитием креативных индустрий в промышленных городах второго эшелона

Актуальность. В условиях цифровой трансформации знания и креативность признаны основными факторами, определяющими развитие креативных кластеров в городах. Вместе с тем отсутствует цельная концепция управления креативными индустриями на уровне городов второго эшелона, в которых накопилось множество проблем, и для которых инструментом их решения может стать креативная экономика, успевшая доказать свою эффективность в ряде стран.

КЛЮЧЕВЫЕ СЛОВА
креативная индустрия, креативный кластер, государственная поддержка, государственная политика, креативный город, города второго эшелона, управление городами

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Целью данного исследования является концептуализация управления развитием креативного сектора в промышленных городах второго эшелона для их возрождения и превращения в зоны роста.
Данные и методы. Эмпирическую базу исследования составляют 14 креативных кластеров старопромышленных городов второго эшелона Урала и Сибири. Основным методом исследования является метод типологизации, на основе которого выделено 5 типов формирования креативных кластеров по степени взаимодействия государственного и частного сектора. Также в ходе исследования были использованы метод контент-анализа существующей научной литературы и метод систематизации.
Результаты. В статье систематизированы существующие проблемы в управлении развитием креативных индустрий, акцентирована важность решения институциональной и координационной проблем. Выделены типы формирования креативных кластеров по степени взаимодействия государственного и частного секторов в развитии креативных отраслей. На основе анализа кейсов промышленных городов второго эшелона выявлены два ключевых типа формирования креативных кластеров: инициативный и зависимый. В результате исследования сформирован концептуальный подход к управлению развитием креативных индустрий в промышленных городах второго эшелона.
Выводы. Управление процессами развития креативных индустрий в городах второго эшелона следует рассматривать как самостоятельный объект. Развитие в них креативных индустрий невозможно без системы государственной поддержки с выверенной стратегией. Местные органы власти должны стать центром притяжения всех заинтересованных в сотрудничестве лиц за счет разработки регулятивных инноваций в городских креативных индустриях. Основными инструментами реализации такой политики могут быть: преобразование городских пространств, создание на местах промышленных объектов креативных кластеров, поддержка малого и среднего бизнеса грантами, стимулирование экспорта креативных товаров и услуг.

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管理二线工业城市创意产业发展的概念方法

现实性：在数字化转型的条件下，知识和创造力被认为是决定城市创意集群发展的主要因素。与此同时，二线城市缺乏统一的创意产业管理理念。这些城市积累了许多问题，创意经济已在许多国家证明了其有效性，也许可以成为解决这些问题的工具。
研究目标：本研究的目的是对二线工业城市的创意产业发展进行概念化管理，以促进其振兴并使该区域实现经济增长。
数据与方法：研究的实证基础是乌拉尔和西伯利亚第二梯队老工业城市的 14 个创意集群。研究的主要方法是类型学方法，在此基础上，作者根据公共部门和私营部门之间的互动程度确定了 5 种创意集群类型。研究还对现有科学文献进行了内容和系统化分析。
研究结果： 文章系统阐述了创意产业发展管理中存在的问题，强调了解决制度和协调问题的重要性。文章根据公共部门和私营部门在创意产业发展中的互动程度，确定了创意产业集群的形成类型。根据对二线工业城市案例的分析，作者确定了创意产业集群形成的两种主要类型：主动型和依附型。通过研究，文章形成了二线工业城市创意产业发展的概念方法。
结论：二线城市创意产业发展过程的管理应被视为一个独立的对象。如果没有经过验证的国家战略支持，二线城市的创意产业发展是不可能的。地方当局应通过发展城市创意产业的监管创新，成为所有有兴趣合作的利益相关者的吸引力中心。实施此类政策的主要方法可以是：改造城市空间、在工业设施所在地建立创意集群、以补助金支持中小型企业、刺激创意产品和服务的出口等。

关键词
创意产业、创意集群、国家支持、国家政策、创意城市、二线城市、城市管理

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Introduction

Creativity, commonly understood as a unique ability to generate new ideas, is a key factor in the economic growth of both national economies and individual cities. The global experience in the development of creative industries accumulated for more than two decades compellingly demonstrates that they can act as drivers of economic development worldwide, significantly outpacing the growth dynamics of traditional sectors.[1]

The concepts of creativity and creative economy are gaining increasing recognition in our time, as more countries are advancing policies centered around creative industries. These industries, leveraging «soft power,» have the capacity to transform traditional sectors, foster economic growth, and enhance the competitiveness of national economies (Liu & Chiu, 2017). A surge of interest in the creative economy can be explained by governments' attempts to find new engines of growth and job creation in response to economic crises, declines in production, and changes in economic structures (Domenech et al., 2021). Political measures in the field of the creative economy aim to enhance the quality of education, support startups and small to medium-sized businesses, strengthen the innovative potential of territories, explore new markets, and foster the development of creative clusters (Kim et al., 2013). In a broad sense, countries seek to enhance international competitiveness by promoting their comparative advantages rooted in creativity.

Research from the last two decades compellingly illustrates the fact that creative industries are becoming the main driver for sustainable urban development and inclusive growth. Cities, with their well-established infrastructure and supportive institutional environment, serve as hubs for commercial, intellectual, and creative activities. The increasing influx of people into cities brings forth a collective contribution of talent, knowledge, and capital to these urban centers.

The United States and China are the world leaders in terms of gross value added in the segment of creative industries. Out of the 200 cities in the Global Cities Innovation Index, which covers 200 agglomerations out of 2,769 in 135 countries, 66 % belong to the top 10 countries: 40 to the United States, 22 to continental China, and 16 to the United Kingdom. 29 out of 53 countries have only one innovation hub[2][3]. Thus, some cities ascend to the summit of the innovation economy, while others establish themselves on the creative or technological pedestal, and still others find their own path in specific niches.

During the formation stage, the concentration of creative industries takes place in large cities that already serve as centers of financial capital, investments, and power, or have significant historical heritage (Boccella & Salerno, 2016). As urban development advances, there is a growing need to closely examine the creative processes in small and medium-sized cities. These cities possess a wealth of industrial heritage that has been underexplored and merits careful investigation. The development of creative industries in old industrial cities brings a number of distinct advantages, shaped by the challenges these territories encounter:

– Industrial inventions and innovations are stimulated through the synergistic interaction between creative industries and manufacturing sectors; industrial production becomes more diversified (Starkova, 2022; Tsygankova, 2022);

– Creative industries have a positive impact on employment levels. Since creative industries have a relatively higher youth employment rate compared to other economic sectors, they help retain young populations in depressed areas with high migration outflows (Khryseva, 2022 (a); Visizivi, 2019);

– Revitalization of depressed urban areas enhances the quality of life in cities, improves the environmental situation, and overall contributes to urban development (Khryseva, 2022b);

– Industrial development sites are transformed into a comfortable urban environment (Amosova, 2019);

[1] UNESCO (2022). Re-shaping policies for creativity: Addressing culture as a global public good. Retrieved from: https://unesdoc.unesco.org/ark:/48223/pf0000380474 (accessed date: 15.11.2023г.)

[2] V. O. Boos, L. M. Gokhberg, E. A. Ivanova et al. (2023). HSE Global Cities Innovation Index — 2023. National Research University 'Higher School of Economics'. Moscow: Higher School of Economics. Retrieved from: https://gcii.hse.ru/?ysclid=lpxhde1ypq27705106 (accessed date: 15.11.2023г.)

[3] The ranking was developed by the team of the Russian Cluster Observatory of the Institute for Statistical Studies and Economics of Knowledge, Higher School of Economics (HSE), as a tool for assessing the competitive advantages of cities in terms of their attractiveness to technological and creative leaders.

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– Creative industries are more resilient to crises, global downturns, and pandemics. During the COVID-19 pandemic, creative services proved to be more resilient than other services. In 2020, the export of creative services decreased by only 1.8%, while the fall in the export of all services was 20%.[4]

Cities become fertile ground for the expansion of creative industries as long as they offer abundant opportunities to commercialize new ideas and products. However, the process of generating, promoting, and commercializing creative ideas requires significant financial resources, which most small cities lack (Bernovich, 2022). Therefore, as global experience shows, the state support system is pivotal to the formation of creative industries, and policies in this area tend to have a distinct regional focus.[5] The main instruments for implementing such a policy include transforming urban spaces, establishing creative clusters on the sites of industrial facilities, providing grants to support small and medium-sized businesses, and promoting the export of creative goods and services.

In Russia, what comes to the fore is the need for an effective management system for the creative sector, especially considering that 85% of all cities are small or medium-sized. The majority of these cities have been grappling with serious challenges since the 1990s, many of which have taken on an existential nature. The unanswered questions in understanding the development of creative industries in cities encourage scholars and experts to engage in continuous academic discussion.

This research aims is to conceptualize how to manage the development of the creative sector in second-tier industrial cities, promoting their revitalization and transformation into growth zones.

To achieve this purpose, the following tasks were set:

1. Analyze the current problems in managing the development of creative industries and the problems inherent in the system of their support in Russia;

2. Identify the types of creative cluster formation in second-tier cities depending on the degree of the interaction between the public and private sectors;

3. Establish a conceptual approach to the management of second-tier cities in the context of creative development.

Theoretical framework

The creative economy has every reason to be considered an independent object of management since it is characterized by a system of partnership relationships forming a supply chain and attracting a specific type of creative participants (Abuzyarova, 2023). In this economic system, the state's function is to organize creative industries by establishing the legal framework for their operation, developing national and regional infrastructure, and offering financial and methodological support to creative businesses.

Creative industries are the direct outcome of government liberalization reforms in trade and privatization in the 1980s and 90s. These reforms aimed to liberate culture from state subsidies and stimulate the post-industrial economy as creativity was recognized as a source of innovation, entrepreneurship, and knowledge capitalization (Wyatt & Trevena, 2020). However, in the realm of policy, creative industries represent a radical departure from traditional justifications of state cultural policy as this concept introduces alternative motives for «cultural self-expression and potentially new goals of cultural policy: profit and economic growth» (Svensson et al., 2017). The implementation of programs and other initiatives aimed at the development and support of creative industries has led to a significant change in approaches to public administration. The adoption of a policy in the sphere of creative industries meant a rethinking of culture, which has always financially depended on government subsidies, towards culture as an industry focused on creative entrepreneurship.

Research on creativity was initially concentrated mainly in capitals and large metropolises; only relatively recently has there been a surge of academic and professional interest in the unique assets and economy of small provincial towns (Montalto et al., 2019). Numerous cases have formed a solid belief that small cities with an appealing historical and architectural heritage can possess significant advantages over larger ones

[4] Report of National Institute of Urban Affairs. Championing 'Local' Identity. 2022. Available at: https://niua.in/U20/sites/default/files/Championing_Local_Identity.pdf (accessed date: 15.11.2023r.)

[5] V. V. Vlasova, M. A. Gershman, L. M. Gokhberg et al. (2021). Moscow's creative economy in figures. National Research University 'Higher School of Economics'. Moscow: Higher School of Economics, 108 p.

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(Serafinelli & Tabellini, 2017). Most of these cities have a low-intensity creative economy with a single well-developed area, making them more in need of comprehensive methodological and administrative support, as well as state measures to expand their creative offerings (Meijers & Burger, 2017).

Research literature provides examples of cities where government policies create favorable conditions for transforming them into new economic centers beyond the capitals (Meijers & Burger, 2017). Some studies focus on the mechanisms underlying the placement of creative industries' locations in these small cities, assessing them primarily in terms of their impact and significance for attracting and retaining visitors (Wijngaarden et al., 2019; Gong & Hassink R.,2017).

One of the key directions in local management policy is the development and support of creative clusters, enabling the urban economy to generate new jobs, stimulate innovation, and create spaces for communication and collaboration for creative individuals (Petrenko et al., 2020). Special importance is given to the «cluster's reputation» when creative entrepreneurs choose a location capable of «retaining creative workers» in second and third-tier cities (Montanari, 2018). There is sufficient evidence that small provincial towns, like larger cities, can attract visitor flows, but to achieve this, the local urban image is crucial because creative workers often choose locations depending on their expectations regarding the location's image. The place can be used for producing creative products but it also can become a product itself by promoting its value and developing place branding (Sujjakulvanich et al., 2021).

F. R. Wulandari et al. (2021) focus on the processes and mechanisms of management in the development of creative industries. The authors emphasize that modern, vigorously developing urban areas require a dynamic management system to adapt to their constantly changing surrounding environment. Government decision-making in public administration should be based on interaction based on formal and informal agreements between the government, public, and private sectors.

Sujjakulvanich et al. (2021) emphasize the need for policy management to consider the unique nature of the creative economy, where «skills, knowledge, and creativity are transmitted through local and national connections.» It is focused on the social cohesion and sustainability of local communities rather than enormous financial gains. In this context, key factors in the creative economy are institutions, knowledge, and innovative ideas within spatial boundaries and beyond them. The city serves as a platform for the exchange of values, a space for dialogue and interaction between consumers, consumer communities, and firms (Aritenang, 2020). Furthermore, research has shown that resource constraints, influenced by industrial and geographical contexts, can be compensated by social relationships and local identity, in whose creation or reinterpretation local authorities can play a significant role (Stam & van de Ven, 2019).

Another crucial element in the successful development of creativity in cities is effective policy-making aimed at fostering 21st-century digital skills for creative industries (Laar, 2022; Laksitoa & Ratmonoa, 2021). Lee's (2020) research investigates the impact of digital technologies on reshaping business models in the creative industries. The state and private sector's roles in these processes are examined by Unceta et al. (2021). Andrianova (2022) analyzes the positive experience of implementing digital transformation and developing creative industries policy in the Republic of Korea.

Recent studies have shown promise in using a «systemic and dynamic approach» to explore the growth of cultural and creative industries in urban settings. In this approach, these industries are seen as vital components of the institutional environment where entrepreneurship emerges and evolves (Loots et al., 2021). In other words, we are dealing here with an ecosystemic approach, suggesting that successful entrepreneurship emerges as a result of interaction between entrepreneurs and the surrounding environment, encompassing dynamic local social, institutional, and cultural processes, as well as actors, that encourage and enhance the formation and growth of new firms (Malecki, 2018; Stam & Ven, 2019). Managing the development of business ecosystems becomes an integral aspect of overall administration. Abuzyarova (2023) explores how the state acts establishes national and regional infrastructure and thus acts as a facilitator of creative ecosystems. The paper also delves into additional measures that support the formation of these ecosystems, focusing on the development and transformation of domestic creative clusters.

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Research on the management policy of the creative sector in cities has intensified after the COVID-19 pandemic. A large body of research has explored issues related to supporting small and medium-sized enterprises in the creative sector, particularly those affected by lockdowns. Additionally, attention has been given to workers in the informal sector, seen as the driving force behind the creative economy (Zhang et al., 2020). Snowball and Hadisi (2020) demonstrated that a prevalent issue encountered by workers in informal culture is the absence of social security and satisfactory working conditions. On the other hand, the pandemic has significantly accelerated the development of a new consumer segment – prosumers, who actively participate in creating the goods and services they need by devising new technical solutions, engaging in digital design, remote learning technologies, etc.[6]

In research on management processes, the main focus remains on timeless questions, for example, how policies promoting creative industries in urban environments will transform urban spaces (Kuziner & Petrunina, 2022; Starikova et al., 2018) and how creative industries can contribute to the revitalization of cities (Huazhong & Silva, 2018; Joffe et al., 2022). However, due to constantly evolving external factors, there are still many unexplored aspects related to the development and management of creative industries, especially in cities with specific characteristics, such as old industrial second-tier cities.

Methodology

Conceptually, the study relies on the works of Russian and international scholars addressing issues of management and development in creative industries. The empirical focus of the study encompasses 14 creative clusters situated in old industrial second-tier cities of the Urals and Siberia.

The main research method involves the use of typology, through which 5 types of creative cluster formation are identified based on the degree of interaction between the public and private sectors. In this study, we also applied content analysis methods to examine the research literature on the topic and systematization methods to consolidate insights into management practices in the realm of creative industries.

In the first stage, we formulated the key problems of managing the development of creative industries in Russia. We also analyzed the key regulatory documents to identify the issues that are not covered by current legislation and require further clarification. In the second stage, we analyzed cases of creative clusters in old industrial cities of the Urals and Siberia. We aim to describe a distinct category of creative clusters – 'initiative-based' – which reflects the developmental mechanisms of creative clusters in Russian cities. Finally, we consolidated the existing knowledge in the realm of creative industries and formulated the fundamental principles for managing the development of creative industries in second-tier cities.

The study draws from Russian and international academic publications, regulatory legal acts in the field of creative industries, official websites of development institutions in the creative economy, and information gathered from the websites of creative clusters.

Results and Discussion

Challenges in managing the development of creative industries

Management of creative industries addresses primarily the priority tasks of the territory, which may vary depending on its specific characteristics. It should be noted, however, that in what concerns the emerging creative sector in the Russian economy, there are management issues that are common to all types of territories. Both academic studies and legislative frameworks explore several critical aspects, including the formation of human capital in the creative economy (Bezuglaya, 2021); the establishment of necessary infrastructure for a creative environment (Efimova, 2023); securing financing; and other problematic areas (Koroleva, 2022).

The primary strategic document outlining the directions for the development of creative industries in Russia is the Concept for the Development of Creative Industries and Mechanisms for their State Support in Large and Major Urban Agglomerations until 2030 (hereinafter referred to as the Concept)[7]. This document comprehensive-

[6] Development of the creative economy. News website of the Higher School of Economics. Retrieved from: https://unescofutures.hse.ru/news/824123788.html?ysclid=lpwfwglzpx944182319 (accessed date: 10.10.2023г.)

[7] Concept for the Development of Creative Industries and Mechanisms for their State Support in Large and Major Urban Agglomerations until 2030. №2613-r of 20 September 2021.

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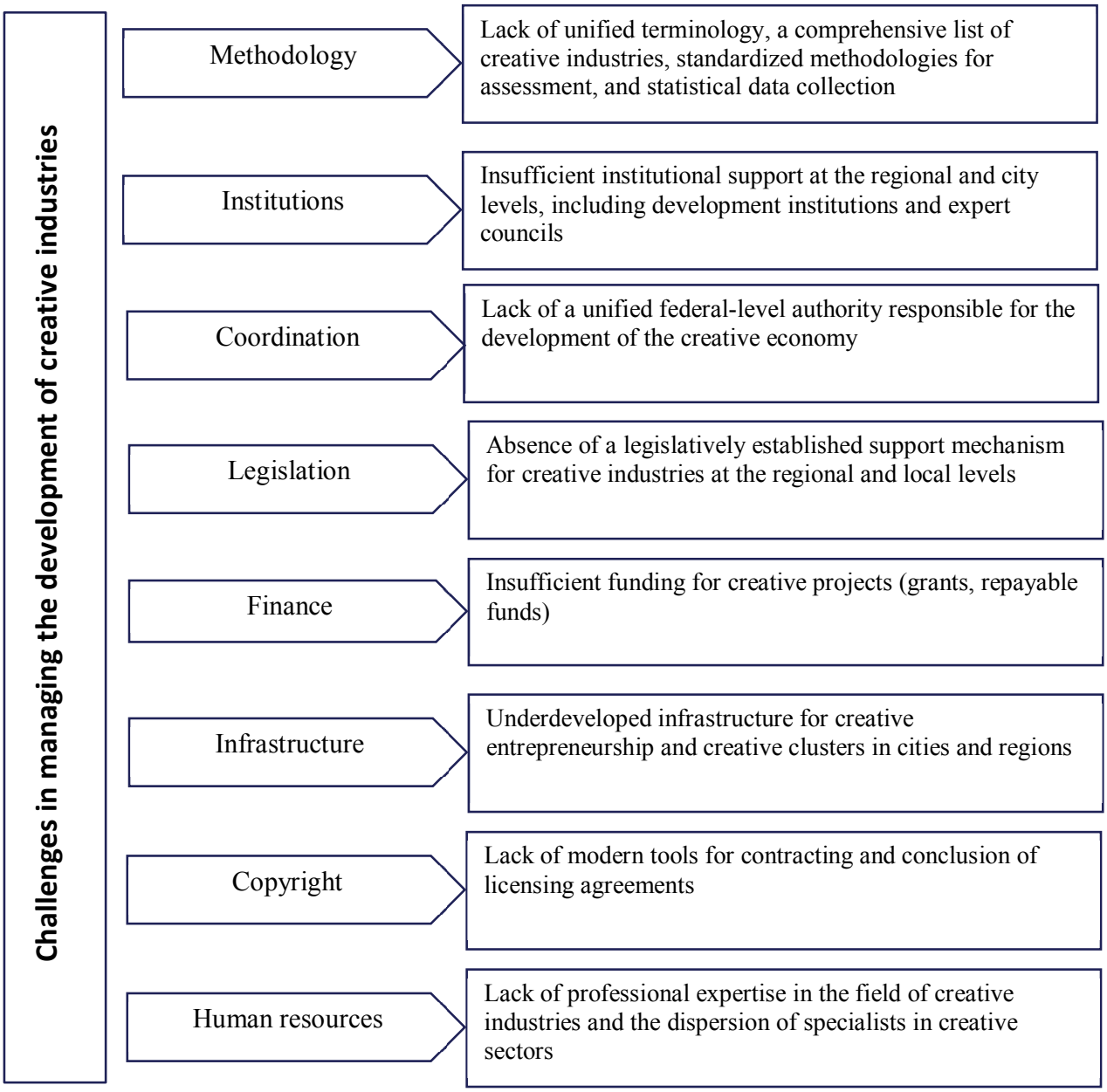

Figure 1. *Challenges in managing the development of creative industries*

Source: compiled by the authors based on the Concept for the Development of Creative Industries and Mechanisms for their State Support in Large and Major Urban Agglomerations until 2030.

ly addresses all the challenges and issues of management in the Russian creative sector. This document is supplemented with the Action Plan for 2022–2024, which specifies which executive authorities are responsible for each stage.[8] Analysis of these documents highlighted various management challenges in the creative economy (see Figure 1).

Partially methodological, legislative, and institutional issues can be addressed with the enactment of the Federal Law 'On the Development of Creative Industries in the Russian Federation.'[9]

[8] Action Plan for the Implementation of the Concept for the Development of Creative Industries and Mechanisms for their State Support in Large and Major Urban Agglomerations until 2030, approved by the decree of the Government of the Russian Federation of August 17, 2022, No. 2290-r.

[9] Draft Law No. 474016-8 «On the Development of Creative Industries in the Russian Federation». Official website of the State Duma of the Russian Federation. Available at: https://sozd.duma.gov.ru/bill/474016-8?ysclid=lpku05tagv437704478 (accessed date: 10.10.2023r.)

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This law provides definitions for creative industries and creative clusters; identifies types of creative industries; and places a special emphasis on measures for state support to the creative sector. It should be noted that the powers of government authorities are distributed between the federal and regional levels. Therefore, the urban policy for the development of creative industries is planned to be realized in accordance with the region's key strategic directions, that is, top-down. Additionally, this draft law does not specify the main coordinating authority responsible for implementing state policy in the field of creative industries. The Action Plan allocates responsibilities among over 10 executive authorities (Table 1). We also found that across all implementation directions of the Concept, the Ministry of Culture is listed as the responsible executor. Active participation of the Ministry of Industry and Trade and the Ministry of Digital Development, Communications, and Mass Media is also implied, while other structures participate selectively, in accordance with the assigned functions.

Additionally, the current legislation fails to set a system of interactions between institutions of development as well as to define their functions or outline possibilities for their coordination and exchange of expertise. Institutions of development refer to specialized structures created by the state and aimed primarily at the implementation and collaborative work with private businesses to finance projects that are priorities for the economy and society (Farkhutdinova, 2020). Institutions of development are considered the most effective tools for achieving economic growth in regions (Stepanov, 2021). Therefore, in the field of the creative economy, these institutions are specialized state organizations at the federal, regional, and local levels, whose activities are aimed at stimulating the development of creative industries.

Table 1

Executors of activities for the implementation of the Strategy in 2022–2024 Concepts for the development of creative industries

		Ministry of Culture	Ministry of Industry and Trade	Ministry of Economic Development	Ministry of Digital Development	Ministry of Education and Science	Federal Agency for Youth Affairs	Russian Center for Intellectual Property Rights Circulation	Higher School of Economics	Agency for Strategic Initiatives (ASI)	Russian Presidential Academy of National Economy and Public Administration (RANEPA)	Executive bodies of regional governments	Russian Union of Industrialists and Entrepreneurs	Federal Service for State Statistics (Rosstat)	Foundation 'Roscongress', Federal Agency for Tourism (Rostourism), Innosocium Foundation, Ministry of Labour, Ministry of Education	Federal Customs Service of Russia (FTS), Federal Technical Regulation and Metrology Agency (Rosstandart)
1	Regulatory legal support	+	+	+				+	+		+	+		+		
2	Education, human capital development	+	+	+		+	+		+	+	+	+			+	
3	Infrastructure development	+	+		+		+					+				
4	Financial support, economic incentives and investments	+	+	+	+			+					+			
5	Protection and management of intellectual property	+	+		+			+								
6	Sustainable development of individual industries	+	+		+			+								+
7	Development of digital services	+			+	+		+	+	+						
	Total	7	6	3	5	2	2	5	3	2	2	3	1	1	1	1

Source: compiled by the authors based on the Action Plan for the Implementation of the Concept for the Development of Creative Industries and Mechanisms for Their State Support in Large and Major Urban Agglomerations until 2030, approved by the decree of the Government of the Russian Federation of August 17, 2022, No. 2290-r.

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Table 2

Organizations (institutions) affecting the development of creative industries

Type of organization	Functions	Examples of organizations
Institutions of development in the sphere of creative economy	financing, information support, consulting, education, expertise, lobbying, networking, infrastructure	Agency for Strategic Initiatives (ASI), Fund of Creative Technologies (Ulyanovsk), Center for Creative Industries of Novosibirsk Region, Krespectiva (Kaliningrad), and others.
Federal structures	financing, information support, consulting, education, expertise, lobbying, networking, infrastructure	Ministry of Culture, Russian Youth Agency, Russian Cultural Center, Ministry of Economic Development, Russian Foundation for the Development of Information Technologies, etc
Industry-specific and cross-industry organizations	financing, information support, consulting, education, expertise, lobbying, networking, infrastructure	Autonomous Nonprofit Organization «Creative Economy,» Creative Practices Support Fund, Autonomous Nonprofit Organization «Film Production Development Center» (Perm), Ideas for Museums (St. Petersburg), etc.
Educational organizations	Education, networking, information support, expertise	Higher School of Economics, Kazan Innovative University, School of Creative Industries Vladivostok)

Source: compiled by the authors based on Creative Russia Map, produced by the Autonomous Non-Profit Organization «Creative Industries Federation» and the Autonomous Non-Profit Organization «Creative Practices.» Available at: https://map.creative-russia.ru/?ysclid=lpjkva7tf2823193537 (accessed date: 12.10.2023r.)

To boost the development of the creative sector, we need to tackle institutional challenges[10]; in Russia this could be done by following successful models found in European countries with thriving creative industries.

The Autonomous Nonprofit Organization 'Federation of Creative Industries' conducts extensive analysis in this field. Its primary goal is to unite and collaborate with leading professional organizations, creative unions, and companies – it identifies leaders in creative industries, conducts educational activities, and engages with the community on various levels. As a result, a catalog of 783 infrastructure organizations has been compiled under the Creative Russia Map project[11]. This catalog encompasses development institutions and educational institutions in the field of the creative economy, federal structures, industry-specific and cross-industry organizations (a total of 783 organizations) (Table 2)

We analyzed the functions of all groups of organizations and found that various institutions duplicate the same functions in supporting the economic processes of creative economy development. Moreover, there is no unified regulatory body ensuring coordination among these organizations. This conclusion agrees with that of Izdiev (2021), who showed that there are currently no clear boundaries between the work of federal institutions and regional development institutions. In the future, federal institutions should be made responsible for large projects of interregional and national significance. Their participation in co-financing projects in regions can vary or be differentiated based on factors such as industry and territorial characteristics. Federal institutions should also provide information and analytical support for the work of regional development institutions.

The Agency for Strategic Initiatives (ASI) is at the core of the development of the creative industry, and, according to the President's directives, it will soon take on a key role in normative activities in the field of creative industries[12]. Additionally, in 2023, the Center for the Development of the Creative Economy was established under the ASI, which will help regions devise strategies in this

[10] Creative industries. Development practices of foreign countries. Support measures in the Russian Federation for the period of sanctions. Trends in the development of creative industries in the regions of Russia 2019-2021.Available at: https://assets.kept.ru/upload/pdf/2022/11/ru-creative-industries-kept-survey.pdf (accessed date: 11/28/2023)

[11] Official website of Creative Russia Map. Available at: https://map.creative-russia.ru/?ysclid=lpjkva7tf2823193537 (accessed date: 20.11.2023)

[12] List of assignments from the President of the Russian Federation following his visit to the exhibition «Development of the Creative Economy in Russia» on August 15, 2023. Available at: http://www.kremlin.ru/acts/assignments/orders/72053

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sphere[13]. Among other things, the Center will assist in building ecosystems for the creative economy, organize educational events, establish a unified digital knowledge base in this field, and so on.

While institutional foundation for creative industries is actively forming, this process is hampered by the lack of organizational subordination and clear functions, which affects the interaction among institutions. In our view, the priority should be given to the coordination issue: it is necessary to specify the government agency that would be responsible for the development of the creative sector of the economy and the key development institute, while providing legislative delineation of their areas of responsibility. To make coordination more efficient, we recommend legally designating the Ministry of Culture as the primary coordinating government body. Simultaneously, the ASI should be put in charge of fostering development in the creative industries. This approach means that a structured hierarchy among cross-sectoral institutions should be established, particularly in terms of data collection and coordination.

[13] O. Yaroslavtseva. Russia will establish a center for the development of the creative economy. 02.06.2023 Official website of the Agency for Strategic Initiatives. Retrieved from: https://asi.ru/news/194156/?ysclid=lpca3wx0o6651296471

Types of management of creative industry development in industrial second-tier cities

Creative clusters span various sectors of the creative economy and are the key to the development of this sector (Gutierrez-Posada et al., 2022). Despite the undeniable importance of legislative and institutional development, which is determined at both the federal and regional levels in Russia, i. e., «top-down,» the process of creative cluster formation starts in cities and thus can be described as «bottom-up.» In this regard, the strategy for managing the creative sector should take into account the bidirectional nature of its development. A similar idea was described by Evans (2009) in his work 'From Cultural Quarters to Creative Clusters: Creative Spaces in the New City Economy', where he identifies 4 stages in the evolution of creative clusters according to their maturity levels: dependent, aspirational, emergent, and mature. These stages illustrate the role of the public sector, the nature of markets, and the size of the firm as key distinguishing factors. Such differentiation reflects the extent of collaboration and the depth of the relationship between the public and private sectors in the management strategies of creative industries.

We adjusted this approach to the development of creative clusters in second-tier industrial cities by taking into account their specific characteristics (see Table 3). First of all, creative clusters

Table 3

Types of creative cluster formation in second-tier cities according to the degree of public and private sector interactions

Type of cluster formation	Level of government intervention	Characteristics of organizations in creative industries
Type 1: Dependent	Creative clusters appeared as a result of the government's efforts (infrastructure development, state subsidies).	Underdeveloped creative industries, lack of bottom-up initiative
Type 2: Emergent	High level of state institutional and advertising support	Initiative on the part of independent creative organizations and/or former cultural enterprises of the public sector; a small number of initiators and their scale
Type 3: Developing	Infrastructure investments from the public sector	Active growth in the number and scale of the creative sector at the levels of cities and regions; high cultural consumption; the creative sector's entry into international markets
Type 4: Initiative-based	Financial and administrative support from the state in response to requests from stakeholders in the creative sector	The formation and growth of creative clusters results from a bidirectional initiative
Type 5: Mature	Indirect state intervention	Initiators are large creative enterprises, diversified by industries; highly developed national and international markets; business consumption of a creative product

Source: compiled by the authors

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in old industrial cities often appear on the sites of former industrial territories. The high capital costs make renovation projects unprofitable, requiring extensive government support (Rumyantseva, 2023), which involves financing, assistance in real estate matters, and the establishment of development institutions to mediate between authorities and creators (O'Connor & Gu, 2010). The widespread use of financial tools, especially grant aid, introduces a new approach to forming creative clusters driven by initiatives within the creative sector. This model introduces a fresh paradigm of interaction between the government and creative businesses, with a focus on the «bottom-up» initiative.

The typology of creative cluster formation has identified «initiative-based» (7 clusters) and «dependent» (5 clusters) types as the types prevalent in second-tier old industrial cities (Table 4). In this case, the initiative of stakeholders in the creative sector is supported by regional and federal authorities in accordance with the priority areas reflected in regional strategies. Undoubtedly, the classification of a creative cluster into one or another type of formation may be somewhat arbitrary since it may not take into account the indirect influence of governmental structures on the cluster's development.

Each type of cluster formation necessitates a unique management strategy. This strategy should facilitate goal setting and the selection of methods to involve stakeholders in management, taking into account the specific characteristics of the location where this process will be implemented. To this end, it is necessary to devise a conceptual approach to the management of cities interested in developing their creative sectors.

Table 4

Creative clusters of second-tier cities in Sverdlovsk, Chelyabinsk, Kemerovo and Altai regions

City size	City	Object	Cluster site	Cluster type
Sverdlovsk region				
settlement	Chernoistochinsk (3.5)	Creative cluster in Chernoistochinsk	Demidov ironworks (not operational)	4
small – 10–50	Sysert (20)	Creative cluster *Leto na zavode*	Turchaninov-Solomirsky Ironworks	4
	Aramil (14)	Creative cluster *Razvitie fabriki idej ili pro tekstil v Aramile*	Aramil cloth factory (not operational)	4
medium-sized – 50–100	Polevskoy (54)	Museum Complex *Severskaya Domna*	Seversky Pipe Plant (operational)	5
large – 100–250	Pervouralsk (113)	Innovation Culture Centre	Starotrubny factory (not operational)	1
large – 250–500	Nizhny Tagil (334)	Creative cluster *Samorodok*	College of Applied Disciplines (not operational)	2
		Association of museums and heritage sites *Gornozavodskoy Ural*	Building of the former City Council	1
Chelyabinsk region				
small – 10–50	Satka (43)	Creative cluster *Art-Satka*	Building of the Branch of the South Ural State University	4
large – 250–500	Magnitogorsk (418)	Multifunctional park *Prityazhenie*	Park (free territory)	4
Kemerovo region				
medium-sized – 50–100	Mezhdurechensk (95.4)	Eco-resort *Mezhdurechensk. Gorod taigi*	Mountain Yugus, Mountain Cherny Salan, and Podnebesnye Zubia	4
large – 250–500	Novokuznetsk (544)	Creative cluster *KMK Hotel* (ecosystem)	KMK Hotel (not operational)	2

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Table 4

City size	City	Object	Cluster site	Cluster type
Altai region				
small – 10–50	Zarinsky district of Altai region (13.7)	Sports and Tourism Cluster *Tyagun*	on the territory of Tyagunsky Selsoviet, Zarinsky District, Altai Region	1
	Belokurikha (14.7)	Tourist and Recreational Cluster *Belokurikha*	Belokurikha	1
medium-sized – 50–100	Novoaltaysk (73)	Creative space *Vmeste*	–	2
large – 100–250	Biysk (184)	Creative space *Kalendar*	based on the Youth Center for Civic Initiatives *Vector*	4
		Comprehensive tourist route *Small Golden Ring of Altai*	Chuysky Trakt: Biysk, Belokurikha, Biysky, Krasnogorsky, Altaisky, and Smolensky districts	1

Source: compiled by the authors based on the data from the official websites of the creative clusters of the Urals and Siberia

Conceptual approach to the management of second-tier cities in the context of creative development

City management is a complex process aimed at the efficient use of resources, creation of urban infrastructure, and development of a comfortable and safe environment. The systemic approach to city management is reflected in the *concept of governance*, which underpins it and encompasses a set of principles, methods, and tools necessary to achieve goals. *The systemic concept*, in turn, views the city as a complex system that must constantly adapt to changes in both internal and external factors, with the choice of management methods depending on circumstances. To implement the concept, local authorities should establish a *city development strategy* aligned with fundamental management principles and setting priorities and regulations in all areas of urban life. In this context, the strategy represents a vision of the city's future, which should be «jointly developed and recognized by the people», reflecting the values of the local community, the goals and objectives of its development, and the ways to achieve them (Zhiharevich, 2016). Strategic planning not only shapes the vision of the city's future through input from the urban community but also sets a direction to turn urban space into an appealing hub for investment and living.

Over the last 30 years, the paradigm of Russia's territorial development has been shaped by the predominantly adverse social and economic factors, including the economic-geographical position and historical development of the economy. Old industrial cities have faced serious challenges due to structural constraints, such as outdated and non-competitive industrial base, low-quality infrastructure, population reduction, and aging, along with an uncomfortable living environment.[14] To address these questions, it is necessary to create innovative models of urban development, which implies stimulating creative growth and implementing strategies for improving the quality of life in cities (Kar et al., 2019; Popov & Semyachkov, 2020).

Leveraging creativity as a development tool for second-tier cities presents a significant challenge. Nevertheless, adverse factors can be «purposefully altered and, consequently, are manageable» (Pavlysh, 2018). We need a focused government policy that creates and enhances conditions to boost cities' competitiveness. Among other things, it is necessary to address the factors that impede the development of efficient urbanization forms and improvement of the overall quality of life in cities (Semyachkov, 2021). It should be noted that an important condition for the success of investments in urban infrastructure development, human capital growth, and innovations is that these management decisions should be grounded in solid evidence.

[14] New geography of regional development. Assessment of the economic potential of Russian regions and possibilities of its effective use. Report. International Bank for Reconstruction an Development/The World Bank. 92 p. Available at: https://ac.gov.ru/archive/files/content/16352/geografiya-rosta-pdf.pdf?ysclid=lpz4whh8gc149417833 (date of access 10.15.2023)

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The primary objective of the *concept for managing creativity development* in second-tier cities is to formulate a strategy that, in the short term, would enable the city to retain its population, generate new employment opportunities, enhance attractiveness, and, in the long term, establish innovative potential and identify avenues for its realization. The main principles of management can be summarized in the following three provisions.

First, there is no one-size-fits-all policy for different cities, which means that mindless copying should be avoided at all costs (Imperiale et al., 2021). The development of urban creative economy relies on the context-dependent understanding of the urbanization process and should involve institutional collaboration to determine the «social-spatial coevolution» between the diverse dynamics of creative clusters and the urban form (Cheng-Yi Lin, 2017).

Secondly, a truly effective policy for the development of urban creative industries should combine industrial, cultural policies, and urban planning. The initiative in this matter should belong to local authorities, who, in collaboration with regions, need to develop a set of measures for institutional, advisory, and other types of support, tailored to local conditions to the maximum extent. In essence, the goal is to establish a «functional model» that encourages a reassessment of culture, urban planning, marketing, and, most importantly, management in small and medium-sized cities. This transformation aims to position the creative factor as the primary driver of innovation in these urban areas.

Moreover, aside from external funding like crowdfunding and fundraising, the urban creative industry needs financial infrastructure and government support due to its unique characteristics. Unlike other economic sectors, the results of creative activities are akin to public goods, making it financially challenging to provide them on a non-profit basis. This is also explained by the fact that in certain segments, the creation of creative goods is associated with high risk (Kostko, 2021).

To effectively manage urban development, analysis of the city's creative potential and challenges should be taken as the point of departure. The results of this analysis will further guide the implementation of measures outlined in the strategic development plan. The strategic management model for creating a creative sector or cluster should follow such principles as a systemic approach, integrity, emergence, hierarchy, and self-organization (Merkulov & Shemyakina, 2018). Local authorities should prioritize transparency, encourage public discussion on city issues, and ensure accessible public services.

The municipality's task is to concentrate its efforts on developing a long-term strategy for the city, defining goals and resources, and coordinating the efforts of government officials, businesses, and the community, which involves implementing the «communicative planning» principle based on shared participation (Zhikharevich, 2016).

The experience of small European towns offers the following set of approaches to developing a city strategy, which may be relevant to second-tier Russian cities, providing a suitable *framework for a management concept*:

1) an objective assessment of the city's resources (e.g. natural conditions suitable for recreation and tourism, interesting locations in the city center, historical and natural landmarks), assets and advantages;

2) engagement of all stakeholders in the development of the strategy, ensuring that they have a sense of involvement and responsibility for its realization;

3) external financial support as a proof that the strategy was chosen correctly;

4) incentives to attract investments to the city;

5) collaboration within the region;

6) creating and maintaining a favorable environment (Johnson et al., 2015).

A sound municipal strategy should be ambitious, focused on implementing «flagship priority projects,» equipped with an elaborate mechanism of implementation and monitoring (Zhiharevich, 2016).

Practice shows that the most viable *strategies* for second-tier cities are as follows: investing in historical and architectural heritage; creating central locations for small businesses; and renovating the historical city center. It is important to attract small businesses, which are the dominant source of jobs in the creative sector and contribute to the diversification of the city's economy.

By enhancing the quality of city management and urban planning, second-tier cities can create more favorable conditions for an inclusive «personalized economy»–an economy tailored to the creative characteristics of each worker (Mamedov, 2017). Unlocking the potential of urban creativity involves attracting diverse resources to enhance and develop people's quality of life (Yarime, 2017).

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The transition to a new model of urban development is reinforced by the possibilities created by digital technologies. Their role lies primarily in building the city's ecosystem (Ramenskaya, 2020) and conditions for the sustainable development of the urban environment (Popov & Semyachkov, 2020). Digital technologies significantly enhance the ability of local authorities to forecast and manage urban processes (Khelladi et al., 2020).

Conclusion

Attracting investments and people to small and medium-sized provincial cities is the main «leitmotif of territorial development today» (Stalmakova, 2019). Cities located in old industrial areas face an acute shortage of new forms and directions of entrepreneurial activity, innovative technological and managerial solutions, etc. Like their counterparts, these cities aim to attract investments and tourist flows. They strive to develop infrastructure, draw in human capital, and stimulate entrepreneurial activity. However, unlike large metropolises that have a more favorable environment to attract creative individuals, second-tier cities with partially destroyed architecture, a lack of job opportunities, and industrial enterprises that have ceased operations are not synergy hubs for R&D and research commercialization (Zhiharevich, 2016).

Cities can achieve improved living conditions, business opportunities, and tourism conditions by leveraging their unique advantages. However, the realization of these goals requires comprehensive institutional and financial support from all levels of government. An important role belongs to the municipality, whose task is to develop a special approach to managing creative industry projects, applying new technologies, and involving all stakeholders in this process. City strategy building should be a collaborative process involving government, businesses, and local communities, with municipalities taking the lead.

The overall concept of urban development should be collaboratively designed and implemented with the participation of local authorities, the academic community, entrepreneurs, and public organizations (Bokolo, 2021). In order to create a new direction for the economy and a new image for the city, it is essential to turn the city's problems and shortcomings into strengths. This approach helps ensure «greater stability and predictability» in urban development and minimize the consequences of various crises at the local level. The city's ability to thrive, attract investments, and secure vital human resources–critical for its competitive edge–depends on how well the creative decisions are put into action.

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Development Trends and Dynamics of Industrial Specialization in Russian Regions

Relevance. The study of the industrial structure of regional economies has gained relevance amid shifting geopolitics and unprecedented sanctions, prompting the need for economic restructuring, product/sector substitution, and the exploration of new growth opportunities at national and regional levels.
Research objective. This study evaluates the dynamics of industrial specializations in Russian regions and their role in ensuring stable regional economic development. The hypothesis is that there is a direct link between the resilience of the regional economic system and its industrial specializations. Here, resilience refers to the territory's ability to minimize the negative impacts of external shocks and threats and restore its economic level during a specified adaptation period.
Data and method. The focus of this study is industrially developed regions whose economies rely predominantly on manufacturing. The study uses Rosstat data on shipped goods, performed works, and services from 2019 to 2022. Data cleansing involves removing the inflationary component using producer price indices. The Herfindahl-Hirschman Index is used for the sectors in the «C. Manufacturing» category of OKVED2 (All-Russian Classifier of Economic Activities).
Results. The study identifies regional variations in industrial specialization levels and progression, categorizing regions into diversified and specialized. We found the transformation of the economic structure in the majority of the examined regions and identified the «new» and «departed» sectors of industrial specialization. Resilience to crises is analyzed, revealing three groups of regions based on their resilience levels. Key industries driving regional development are also identified.
Conclusions. Analysis of industrially developed regions uncovers unique structural transformations, offering valuable insights for regional policymakers. Future research avenues may involve refining socio-economic profiles based on industrial specialization and formulating government measures to support industrial development.

KEYWORDS
industrially developed regions; industrial specialization; external constraints; drivers of development; structural change; economic transformation; adaptive capacity; sanctions

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Тенденции развития и динамика промышленной специализации в регионах России

Актуальность. Исследования отраслевой структуры экономики регионов актуализированы новыми геополитическими вызовами и беспрецедентным санкционным давлением, обуславливающим необходимость структурной перестройки экономики, импортозамещения ряда продуктов и отраслей, поиска принципиально новых точек роста экономики России и ее отдельных регионов.

КЛЮЧЕВЫЕ СЛОВА
индустриально развитые регионы; промышленная специализация; внешние ограничения; драйверы развития; структурные

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Цель исследования. Статья посвящена оценке динамики отраслей специализации индустриально развитых регионов и их роли в обеспечении устойчивого развития региональной экономики. Авторами ставится гипотеза о том, что устойчивое состояние экономической системы непосредственным образом связано с отраслями специализации. При этом под устойчивым состоянием понимается состояние, которое позволяет территории за определенный период адаптации минимизировать негативные воздействия внешних шоков и угроз и восстановить уровень экономики.
Данные и методы. Объектом исследования являются индустриально развиты регионы, основу экономики которых составляет обрабатывающая промышленность. Исследование базируется на использовании данных Росстата об объеме отгрузки товаров собственного производства, выполненных работ и услуг собственными силами, в период с 2019 по 2022 гг. по разделам «Промышленное производство» по ОКВЭД2 до второго знака для четырнадцати индустриально развитых регионов РФ. Произведена очистка данных от инфляционной составляющей за счет их корректировки в соответствии с индексами цен производителей из официальной статистики. Это позволило определить фактическую производственную динамику в региональных экономиках. Проведен анализ отраслевой специализации регионов на основании расчета индекса Херфиндаля-Хиршмана для отраслей, входящих в раздел «С. Обрабатывающие производства».
Результаты. Выявлены региональные различия в уровне и динамике развития промышленной специализации, выделены два типа регионов: диверсифицированные и специализированные. Доказано, что трансформация структуры экономики происходит в большинстве рассматриваемых регионах, определены «новые» и «ушедшие» отрасли промышленной специализации. Устойчивость регионов к кризисам рассмотрена авторами с точки зрения адаптации их экономики к новым условиям и восстановления положительной динамики региональных показателей объемов производства обрабатывающей промышленности, являющейся специализирующей для рассматриваемых регионов. Выделены три группы регионов по уровню их устойчивости. Для каждого региона определены отрасли-драйверы регионального развития.
Выводы. Проведенный анализ динамики отраслей специализации индустриально развитых регионов показал, что трансформация структуры экономики происходит в большинстве рассматриваемых регионах, но при этом отличаются определенной спецификой. Полученные результаты могут использоваться для обоснования приоритетов регионального развития, актуализации региональной и промышленной политики регионов РФ. Развитием исследования может быть дальнейшее уточнение социально-экономических профилей регионов с учетом их промышленной специализации и выработке государственных мер поддержки промышленности.

изменения; трансформация экономики; адаптационные возможности; санкции

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工业化地区产业专业化发展趋势及动态

现实性：区域经济部门结构的研究成为趋势，这是因为新的地缘政治挑战和前所未有的制裁压力的影响。经济结构亟待重组，一些产品和行业需要进口替代，俄罗斯经济及其各个地区的新增长点也应从根本上进行寻找。
研究目**标：**文章专门评估了工业发达地区专业化产业的动态，及其对地区经济可持续发展的作用。作者假设经济体系的稳定状态与专业化产业直接相关。在这种情况下，稳定状态为地区在一定适应期内将外部冲击和威胁的负面影响降至最低并恢复经济水平的状态。
数据与方法：研究对象是以制造业为经济基础的工业发达地区。研究基

关键词
工业化地区、产业专业化、 外部限制、 发展驱动力、结构变化、经济转型、 适应能力、制裁

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于俄罗斯国家统计局提供的数据，这些数据涉及 2019 年至 2022 年期间俄罗斯联邦 14 个工业化地区“工业生产”分部的货物运输量、完成量和服务量，并按照 OKVED2 的数据精确至小数点后二位。文章根据官方统计的生产者价格指数对数据进行了调整，剔除了通货膨胀因素，从而能够确定地区经济的实际生产动态。 另外，文章根据对“C. 制造业”行业的赫芬达尔-赫希曼指数计算，对各地区的工业专业化情况进行了分析。
研究**结果**：文章揭示了工业专业化发展水平的地区差异，确定了两类地区：多样化和专业化。事实证明，大部分地区的经济结构都发生了转变，“新的”和“已消失的”工业专业化分支已被确定。作者分析了各地区经济适应新条件和恢复制造业生产量的动态和指标，并考虑了这些地区抵御危机的能力。根据各地区的稳定程度，文章确定了三组地区。每个地区都确定了地区发展的驱动产业。
结论：对工业发达地区专业化分支动态的分析表明，经济结构的转型在大部分地区都在进行，但它们又有一定的特殊性。研究结果可用于确定地区发展的重点，有助于俄罗斯各地区和产业政策的更新。这项研究还可以进一步明确各地区的社会经济概况，同时有助于其产业专业化以及政府支持产业的措施制定。

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Introduction

Analysis of the regional economy's industrial structure is a key research stage, which contributes to productive state regulation, particularly in its territorial aspect. Effective development of the national economy can be ensured through the establishment of a spatial-industrial structure based on highly competitive industrial complexes located in regions with access to specific resources.

In the case of Russia, the «Strategy for Spatial Development of the Russian Federation for the Period until 2025,» adopted in 2019, outlines the principle of strategic consistency for regional policy[1]. Among other things, this strategy specifies that, to reduce interregional disparities, it is essential to identify prospective centers of economic growth and the economic specializations of regions within the main areas of the country's spatial development. According to the Strategy, the «promising economic specialization of a subject of the Russian Federation is a combination of aggregated types of economic activities (industries), determined by a favorable combination of competitive advantages (spatial factors for locating types of economic activities)[2]. The introduction of the terms «promising» and «non-promising» industries into the framework of regional strategic management — referring to sectors that are potentially supported or unsupported by mechanisms of state policies for regional development in specific territories — has raised a discussion among Russian economists (Bukhvald & Kolchugina, 2019; Lexin, 2019; Minakir, 2019). Blanutz (2020) argues that the disparities among Russian regions are so significant that the goal stated in the Strategy to mitigate interregional differences and shape a new structure of spatial-industrial placement by 2025 is unattainable. Ivanov & Bukhvald (2019) provide a detailed critique of the concept of «promising» industrial specialization introduced in the Strategy. The authors point out that Russian regions differ significantly regarding their economic specialization: some regions have a well-established specialization, while others lack any specialization. Therefore, the strategic aim of introducing this kind of specialization may not consistently contribute to stable regional development. Even though it might be effective to formulate a list of «promising specializations» and thus align sectoral and spatial development tasks in the Russian economy, the current toolkit hinders its efficient implementation in state governance. Additional research is needed to identify the established specializations of Russian regions, analyze their dynamics, and explore potential structural shifts.

The need for further research on the industrial structure of the regional economy arises from emerging geopolitical challenges and unprecedented sanctions. These challenges also underscore the requirement for restructuring of the economy, import substitution across various

[1] Decree of the Government of the Russian Federation of 13.02.2019 No. 207-r (in the version dated 23.03.2021) «On Approval of the Spatial Development Strategy of the Russian Federation for the Period until 2025».

[2] Decree of the Government of the Russian Federation of 13.02.2019 No. 207-r (in the version dated 23.03.2021) «On Approval of the Spatial Development Strategy of the Russian Federation for the Period until 2025».

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products and sectors, and the exploration of fundamentally new growth opportunities. Regional policy should be aligned with the overall trends of the national socio-economic development (Regional Development Trends..., 2023). The USA and Western countries have imposed a wide range of trade and economic sanctions against Russia after the start of the special operation in Ukraine. These restrictive measures affected Russia's exports and imports as well as its monetary and financial system, impacting virtually all sectors of the economy. The effects of these measures were intensified by sanctions affecting logistics, resulting in difficulties with cargo delivery, extended timelines, and increased transportation costs (Lenchuk, 2023).

External sanctions, of different types and varying intensities, impact the performance of regions, particularly those whose primary specializations are associated with manufacturing. Structural changes in the economy are fundamental to stable economic development (Hidalgo & Hausmann, 2011; Boschma, 2017).

President Vladimir Putin emphasized the «need to create conditions for restructuring of the economy, including the implementation of large-scale technological projects, stimulating economic activity, and developing infrastructure in Russian regions.»[3] The need to restructure the Russian economy has been also repeatedly highlighted by the Head of Russia's Central Bank Elvira Nabiullina[4], the Minister of Finance Anton Siluanov[5], and Prime Minister Mikhail Mishustin[6]. In the medium and long term, it is impossible to maintain the previous configuration of the structure of the Russian economy and its individual regions. Therefore, it is necessary to identify the prospects for structural shifts and explore the possible drivers for future regional development.

For steady regional industrial growth and balanced national development, it is essential that the stages of specialization formation effectively tackle current challenges. Contemporary challenges involve diverse processes such as technological and structural changes in the global production and consumption of specific commodities, the disruption of value chains and the formation of new ones, trade protectionism, and various restrictions, including sanctions.

In this study, we hypothesize that the resilience of the economic system is directly linked to its industrial specializations. It should be noted that in this context, «resilience» refers to a condition where a region can, over a defined period of adaptation, minimize the adverse effects of external shocks and threats, ultimately restoring its economic levels. Over the period from 2019 to 2023, the Russian economy experienced two significant external economic shocks: in 2020, it was the COVID-19 restrictions, and since 2022, it has been under sanctions pressure. We intend to verify our hypothesis by examining how well the regional economy copes with external shocks. The research focuses on industrially developed regions whose economies are primarily based on manufacturing (Akberdina, 2020).

There are different approaches to identifying the territories that can be described as industrially developed Russian regions and their number may range from two to three dozen. For instance, the above-mentioned study by V. V. Akberdina identifies 20 such regions. We have selected 14 territories by applying the following principle: these are the regions whose share of industrial production constitutes a significant proportion of the total volume of shipments of local products, completed works, and services, and whose share of manufacturing industries (section 'C' according to OKVED2 (All-Russian Classifier of Economic Activities)) exceeds 60% of the volume of industrial production shipments.

The study aims to analyze the dynamics of industrial specialization and structural changes in the economy of industrially developed regions in the context of today's external constraints. To

[3] V. V. Putin. President of Russia. Source: http://www.kremlin.ru/events/president/transcripts/deliberations/69336 (accessed date: 15.07.23)

[4] «The economy can temporarily exist by relying on the currently available reserves, but once they are depleted, structural transformation and the search for new business models will commence.» Source: RBC. https://www.rbc.ru/economics/18/04/2022/625d1abd9a7947966eb090a3?ysclid=lmu827klnz329385686 (accessed date: 15.08.23)

[5] «In response to new challenges, Russia is embarking on a long-term restructuring of the economy.» Source: Business Online Business Electronic Newspaper https://m.business-gazeta.ru/news/550951?ysclid=lopfye398n594757491 (accessed date: 16.08.23)

[6] «We will continue the adaptation and restructuring of the Russian economy, supporting the reorientation of exports and expanding our ties with friendly countries and states. We are building production chains in the country and striving to increase the level of our technological and economic sovereignty.» Source: https://regnum.ru/news/3696399 ?ysclid=lmu89yo5ls17069893 (accessed date: 16.08.23)

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achieve this goal, we have set the following tasks: propose a methodological approach to assessing the dynamics of industrial specialization; analyze the dynamics of industrial specialization and structural changes in the economy of Russian regions under the influence of external shocks; assess the resilience of their economies to external shocks; and identify the key drivers of industrial development in these regions.

Theoretical framework

The challenge of sustaining economic growth amidst systemic transformations and changes in foreign economic relations has long been a subject of interest for researchers, in Russia and other countries. Various shocks – geopolitical, economic, pandemic-related, financial, and currency-related — have significantly impacted the development of national economies. This has led to a surge in studies examining the ways socio-economic systems adapt to such challenges.

Nikolaev & Makhotaeva (2021) studied the resilience of regional economies to shocks, focusing on manufacturing industries. They found that the majority of regions with higher growth rates in manufacturing in the post-crisis period exhibited an increase in innovation activity.

N. N. Mikheeva (2021) addresses issues of regional resilience to crisis shocks and methods for their assessment, showing that the resilience of regions does not depend on the nature of the crisis or the size of the region, what is more important is the presence of large agglomerations.

A recent area of study in research on the adaptive aspects of regional socio-economic systems is focused on regional resilience. This field examines the dynamic capabilities of socio-economic systems to withstand diverse external challenges and adapt to new conditions and circumstances (Chernova, 2023).

When we talk about resilient regional development, what we mean is the region's ability to withstand external shocks (resistance) as well as the capacity to restore equilibrium (recovery). One of the founders of this approach, K. Foster (2007), interpreted resilience as the region's ability to anticipate shocks, be ready for them, respond, and recover after disturbances. R. Martin (2012) proposed to connect the concept of «resilience» with the concept of hysteresis in the economy (the transition of the economy from one stable equilibrium to another) and defined resilience as the ability of the economy to adapt its structure (on the level of firms, industries, technologies and institutions) to a new development pattern.

For quite a long period, both Russian and international scholars have explored the connection between regional resilient development and industrial structure, examining how the degree of economic specialization/diversification influences the region's resilience. However, the outcomes of such research are often ambiguous, which can be explained by significant differences in the economic structures of various countries and the connections between them. Dissart (2003) argues that regional economic diversification itself is not a guarantee of resilience; rather it is the interconnections between industries that play a crucial role. Mai et al. (2019), based on Chinese economic data, demonstrated that the industrial sector plays a stabilizing role in regional development, while rapidly growing sectors such as the financial sector, construction, and real estate operations have the most destabilizing influence. In a study based on American data, Min J. et al. (2020) explore how the structure of regional economies in the United States influences the volatility of their economic growth, identifying only four sectors: federal government, construction, manufacturing, and tourism. As a result, they was found that the specialization of different sectors has varying effects on sustainable development: the federal government and industry have a positive impact on resilience, whereas construction, conversely, has a negative influence. Additionally, the conclusion is drawn that the development of innovative technologies in tourism provides an opportunity for the rapid advancement of innovation in the region overall and in the digital economy in particular. Rocchetta & Mina (2019) argue that regions with technologically coordinated, rather than simply diversified, industries are better prepared for unforeseen economic crises and demonstrate adaptive resilience. Moreover, regional economies are generally more resilient when innovations occur in sectors with the highest growth potential.

Malkina (2020) examines the correlation between the resilience of regional economy and the degree of its industrial diversification. Despite the author's conclusion about a correlation between regional economic resilience and diversification rather than specialization, the factual material presented in the article shows the existence of a certain number of resilient regions with

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a low-diversified economic structure. This once again emphasizes the need to assess the dynamics of industrial specializations and the role these industries play in ensuring the resilient development of the regional economy.

O. A. Romanova discusses development opportunities for regional industrial complexes in the face of the new reality. Her research not only demonstrates that it is possible to maintain the stability of regional economies but also shows their capacity for adaptive recovery and economic growth under new conditions (Romanova, 2022).

The study by V. V. Akberdina is worthy of special attention: she identifies factors that contribute to the development of adaptive capabilities in socio-economic systems in the face of emerging challenges (Akberdina, 2022). There are studies investigating the resilience of single-industry regions (Ionova, 2022; Danilova & Pravdina, 2022) and Arctic settlements (Filimonova, 2021; Nikulkina, 2021).

The main distinction between economic resilience and economic stability lies in the fact that resilience has a dynamic nature and corresponds to the ability to return to the original or a similar state after being disrupted by some external influence (Baskakova & Slukina, 2021). Dynamic development is sustained by the existence of a certain stability zone, and factors such as industry affiliation, scale, and production structure, along with social and psychological processes, determine the system's degree of stability as leaving this zone renders the system unstable.

Economic recovery forecasts are mainly associated with the activation of economic growth drivers after a period of adaptation to external constraints. These drivers are supposed to ensure the required economic dynamics (Nikolaev, 2023). In the academic literature, there are numerous viewpoints regarding what can serve as a driver of economic growth: lending for small and medium businesses (Orlovsky, 2016); competition[7]; public-private partnerships (Bozharenko, 2012); low-carbon development (Lugovoy et al., 2015); specific industries, resources[8], institutions, infrastructure, megaprojects, innovations, etc.

In our study, we will focus on the dynamics of industrial specialization and structural changes in the economy of industrially developed regions under the influence of emerging external constraints. The analysis of fundamental aspects of industrial specialization is essential for identifying the drivers of regional development.

Method and data

One of the key factors determining the development of regions is their industrial specialization. In modern conditions, the specialization of industrial-territorial complexes is influenced by various multidirectional factors (resource depletion, emergence of new technologies and products, changes in the current production chains and creation of new ones, changing external constraints, etc.).

The transformations of the sectoral structure of regional economies are of great interest to researchers. Much attention is given to the specifics of regional economies and their specializations as a key aspect of economic development (Lexin & Shvetsov, 2012; Lyubimov et al., 2017). By identifying regional specialization and competitive advantages, we can gain a better understanding of the nature of structural changes and formulate a more effective regional policy (Kutsenko & Eferin, 2019). The industrial structure reflects the level of specialization of a region in specific sectors at both national and local levels (Melkov, 2022). Analysis of structural shifts helps us assess the mobility of the economic structure and draw conclusions about the changes in the role and position of individual industries in the region's economy or of the region in the overall national economy.

In the last five years, structural transformations in regional economies in Russia have been influenced by two successive external shocks: the pandemic and sanctions. Under the influence of these shocks, several industries, which previously constituted regional specializations, couldn't withstand the external pressure, resulting in a decrease in their share in the regional economic structure. In contrast, other industries, adapting to the new

[7] Shcherbinina, M. Yu., Stefanova, N. A. (2016). Competition as a driver of economic growth. Modern research and innovation, 6. [Electronic resource]. Access mode: https://web.snauka.ru/issues/2016/06/69360 (accessed date: 03.05.2023).

[8] Kalmykov, N. N., Katsaurova, S. Yu. Drivers and barriers to the growth of the Russian economy: a sociological analysis of the opinions of the expert community [Electronic resource]. Access mode: https://www.ranepa.ru/images/News/2017-07/13-07-2017-ekonomika-issl.pdf (accessed date: 29.05.2023)

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economic conditions, occupied the vacated niches and increased their share in the structure. In a single region, it is possible to witness both the concurrent growth in production volumes for certain industries, including the emergence of new sectors, and a decline in production for other industries. This can ultimately result in some industries' complete loss of their special status in a region.

The logical scheme of the proposed approach to assessing the dynamics of industrial specialization and structural changes of industrially developed regions is presented in Figure 1.

Our analysis relies on the following statistical data: the volume of shipments of the region's own produced goods, performed works, and services, during the period from 2017 to 2022 (according to OKVED2). We intentionally use only this indicator as it correlates with GDP, thus enabling us to compare sectoral changes with the dynamics of the region's economic growth. The methodology does not analyze statistical indicators related to the distribution of investments in fixed capital, the number of employees, and wage levels in the industrial structure. This omission is intentional to avoid potential distortions in our conclusions about the region's production structure, given the variations in labor productivity and capital intensity across different sectors.

Stages	Calculated indices	Regional profile
1. Determining the degree of diversification of the regional economy as of the base period in 2019.	1.1. Herfindahl-Hirschman Index for manufacturing industries	Diversified/Specialized
	1.2. Coefficient of specialization for manufacturing industries	Number and list of industrial specializations
2. Analysis of the dynamics of industrial specialization and structural changes in the period of external shocks (2020–2022).	2.1. Dynamics of the Herfindahl-Hirschman Index	Change in the region's type based on its level of specialization (when such a change is detected)
	2.2. Dynamics of the coefficient of specialization for industries	Identification of 'new' specializations
		Identification of 'departed' specializations
3. Studying the resilience of the regional economy to external shocks	3.1. Growth rate of the shipment of own goods for each industrial specialization in the region, adjusted for inflation, year on year	Result of the economy's adaptation to external shocks: 1) decline; 2) return to the previous level; 3) growth
	3.2. Growth rate of the shipment of own goods for each industrial specialization in the region, adjusted for inflation, from the 1st half of 2023 to the 1st half of 2022	Identification of drivers for the development of regional economies

Figure 1. *Methodology for assessing the dynamics of industrial specialization and structural changes in regions*

Source: compiled by the authors

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We agree with other researchers that incorporating cost indicators in the analysis creates challenges due to the volatility of data stemming from the inflationary component. To minimize the impact of this factor on the results, we propose adjusting the assessment of the growth dynamics of shipment volumes for each of the analyzed sectors by the level of the producer price index for that sector in the specified region over the given period (year to the previous year). This way we can assess the actual change in shipment volumes, describe the dynamics of sectoral development, and compare regional specializations at the interregional level. The source of data on producer price indices at the industrial and regional levels is the EMISS database (Unified Interdepartmental Statistical Information System).

Since in 2017–2023 the Russian economy experienced two external shocks, the pandemic and sanctions, we have identified the pre-shock baseline level of the regional economic system as that of the year 2019. The dynamic indicators for 2019–2020 characterize the response of regional production systems to the impact of the pandemic restrictions. The indicators for 2020–2021 characterize the economic recovery in the period when these restrictions were lifted. The indicators for 2021–2022 characterize the impact of sanctions on the regional economy. Additionally, we assess the level of adaptation of the regional economy to the impact of sanctions by looking at operational data from territorial statistical services. This assessment involves examining the dynamics of sectoral production indicators by comparing data from the first half of 2023 with data of the first half of 2022.

The analysis of dynamic changes is conducted not across the entire spectrum of industries but only for industries constituting regions' specializations. The choice of this approach is determined by our hypothesis that there is a connection between regional economic growth and the growth of specialized industries. We identified regional specializations by calculating the Herfindahl-Hirschman Index (HHI, ranging from 0 to 1) for industries listed in the «C. Manufacturing Industries» section (OKVED2), up to the second digit. For a more in-depth analysis and detailed examination of the ongoing changes in the region, we recommend considering a broader list of industries, up to the fourth digit. The approach itself will not change since the databases for the indicators of finished product shipments and the producer price index used in this methodology are compiled by statistical authorities to the necessary level of detail. Such deep detailing, however, fell beyond the scope of this article, so the validation of this methodology was carried out by using the data with the depth of two OKVED digits.

An industry is considered to be the region's industrial specialization if it meets the following criteria:

$$C_y = \frac{Y_o}{Y_p} > 1, \quad (1)$$

where Y_o is the region's share in the country for the given specialization; Y_p is the region's share in the country for the whole industry;

$$Y_o = \frac{V_C^i}{V_{RU}^i}, \quad (2)$$

where V_C^i is the volume of shipments of own goods for industry i in region y; V_{RU}^i is the volume of shipments of own goods for industry i for the whole country;

$$Y_p = \frac{V_C^{IND}}{V_{RU}^{IND}}, \quad (3)$$

where V_C^{IND} is the volume of shipments of own goods across all industries in region y; V_{RU}^{IND} is the volume of shipments of own goods across all industries for the whole country.

If we examine coefficients C_y for individual industries within the region's industrial production structure and notice that the coefficient that previously exceeded 1 falls below 1 at a certain point, we can conclude that the respective industry can no longer be considered that region's specialization. Conversely, if in the base year 2019, an industry was not characterized by coefficient $C_y => 1$, and in a later period, this coefficient for the industry exceeded 1, it means that this industry has become a new specialization for this region.

This study aims to identify industries that drive regional development and are characterized by high adaptability to modern economic conditions. Thus, the most significant outcome will be the identification of these «new» industries constituting regional specialization.

Averina & Nikulina (2021) explain the importance of developing new industrial specializations and highlight the need to address the transformation of regional specializations. They argue

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that achieving higher levels and superior quality of economic growth partly depends on fostering the growth of emerging and rapidly advancing sectors in the economy.

The conclusion on regional economic structural transformation is drawn from analyzing the dynamics of the Herfindahl-Hirschman Index in manufacturing. Grebenkin (2019) proposed a classification of regions into three groups based on their industrial specialization stability: those with a trend towards de-specialization; those increasing specialization; and those with no evident change.

Following this classification, we also consider three groups of regions:

– regions with a tendency towards industrial de-specialization;

– regions with a tendency to increase industrial specialization;

– and regions whose industrial specialization remains unchanged.

Furthermore, when we consider the transition to the next stage, which involves studying the resilience of the regional economy to the impact of external shocks, regions are grouped based on the trajectory of post-crisis development. Depending on the dynamics of regions' industrial specialization, any industry can be aligned with four development scenarios: «emergence,» «growth,» «decline,» and «disappearance» (Kutsenko & Yeferyin, 2019). Taking into account the number of specializations and the degree of their development, we can distinguish four types of regions: «agglomeration,» «diversification,» «specialization,» and «differentiation» (Ibid). Therefore, the following groups of regions are distinguished based on the type of resilience:

– regions that have returned to the previous (pre-crisis) level of development;

– regions transitioning to a growth trajectory;

– regions transitioning to a declining trajectory.

This approach is based on determining the system's ability to return to its initial state after an exogenous shock — a concept frequently employed in research on the economic resilience of territories[9]. In other words, the faster the economy returns to its previous state, the more resilient it is (Mikheeva, 2021). It should be noted that there is another approach that considers resilience as the system's ability to change in response to a shock (Pendall et al., 2010). While the latter approach provides an understanding of the system's long-term resilience, the former approach is employed to assess short-term development prospects. Since in this study we operate with a relatively short time series of data, our primary focus is on assessing the speed of economic recovery to the previous level and the deviation of the current state from the pre-crisis level. Furthermore, with a more extended time series of observations in the future, it will be possible to expand the methodological framework.

Since we hypothesize that the stability of the regional economic system and its adaptive capabilities are directly linked to industrial specialization, we intend to focus on the dynamic changes in the volume growth indices of shipped products in both «new» specialization sectors and those that have increased their share in the regional economic structure.

Our analysis covers four periods: 1) 2020 - the shock from restrictions related to the coronavirus pandemic; 2) 2021 — the period of recovery from the pandemic shock; 3) 2022 — the shock from restrictions associated with sanctions from Western countries; 4) the first half of 2023 — the period of adaptation to the new economic conditions. For each region, we identify industries showing an increase in production volumes in 2022 compared to the baseline of 2019 and maintaining a growth trend in the first half of 2023. In this process, an assessment is made of the factor impact of these industries on the overall economic recovery of the region after the influence of external shocks and constraints. When this correlation is identified, these industries are defined as drivers of regional development.

Results

Since the focus of this study is on industrial regions of Russia, while testing this methodology, we intentionally narrowed down the number of analyzed regions. We applied the following criteria for selecting regions for our list: 1) the share

[9] Hill E., Clair T. St., Wial H., Wolman H., Atkins P., Blumenthal P., Ficenec S., Friedhoff A. Economic Shocks and Regional Economic Resilience. Building resilient regions. Institute of Governmental studies. University of California. Working Paper 2011-03. Available at: https://www.researchgate.net/publication/285940047_Economic_shocks_and_regional_economic_resilience (accessed 20.08.2023).

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of industrial production constitutes a significant portion of the total volume of shipments of the region's own products, performed works, and services; 2) the share of manufacturing industry (section «C» in OKVED2) constitutes more than 60 % of the volume of industrial production shipments. As a result, 14 regions were included in this list (see Table 1 below).

Taking into account the number of industrial specializations and the degree of their development, two types of industrially developed regions have been identified: diversified (D) and specialized (S). Industrially developed regions with the highest number of industrial specializations (diversified type) include Moscow (20 industries), Vladimir (14), Leningrad (13), Yaroslavl (12), Nizhny Novgorod (12), Novgorod (11), Rostov (11), Kaluga (10), and Omsk (8) regions. The smallest number of industrial specializations (specialized type) is characteristic of Vologda (5), Chelyabinsk (5), Lipetsk (6), Sverdlovsk (7) regions, and the Republic of Bashkortostan (6).

Table 1

Characteristics of industrially developed regions, 2019

Regions	Indicators of industrial development		HHI	Number of specializations	Type of specialization	Industrial specializations ***
	Industry share *	Section C share***				
Moscow	57.13	84.36	0.089	20	D	10, 11, 13, 14, 15, 16, 17, 18, 20, 21, 22, 23, 25, 26, 27, 28, 30, 31, 32, 33
Chelyabinsk	85.80	91.14	0.400	5	S	15, 23, 24, 25, 28
Sverdlovsk	74.58	87.21	0.416	7	S	16, 22, 23, 24, 28, 30, 33
Omsk	66.62	84.90	0.134	8	D	10, 11, 19, 20, 22, 26, 30, 33
Yaroslavl	75.81	83.38	0.103	12	D	13, 15, 17, 18, 20, 22, 27, 28, 29, 30, 31, 32
Rostov	73.37	81.58	0.093	11	D	10, 13, 14, 15, 19, 22, 23, 25, 28, 30, 31
Lipetsk	82.57	97.24	0.494	6	S	10, 17, 22, 24, 27, 28
Vladimir	88.55	94.03	0.164	14	D	10, 13, 14, 15, 16, 21, 22, 23, 25, 26, 27, 28, 31, 32
Leningrad	75.26	94.86	0.054	13	D	10, 12, 13, 14, 16, 17, 18, 20, 22, 23, 27, 30, 31
Vologda	86.30	96.67	0.370	5	S	16, 20, 23, 24, 25
Nizhny Novgorod	71.62	89.19	0.151	12	D	11, 13, 14, 15, 17, 19, 20, 22, 24, 25, 26, 29
Novgorod	81.36	93.59	0.229	11	D	10, 16, 17, 18, 20, 23, 26, 27, 28, 31, 33
Kaluga	88.17	97.91	0.255	10	D	10, 17, 21, 22, 23, 25, 26, 27, 29, 32
Republic of Bashkortostan	79.46	81.82	0.422	6	S	14, 19, 20, 28, 30, 32

Source: Compiled by the authors based on Rosstat data

*Share of industry (Sections B, C, D, and E) in the total volume of own shipped goods, performed works, and services across all types of economic activities, %.

**Share of Section C (Manufacturing Industry) in the total volume of industrial goods and services (sum of Sections B, C, D, and E), %.

***The category of MANUFACTURING INDUSTRIES (Section C) encompasses the following: 10. Food product manufacturing; 11. Beverage manufacturing; 12. Tobacco product manufacturing; 13. Textile product manufacturing; 14. Clothing manufacturing; 15. Leather and leather product manufacturing; 16. Wood processing and production of wood and cork products, excluding furniture, production of straw and plaiting materials; 17. Paper and paper product manufacturing; 18. Printing and reproduction of recorded media; 19. Coke and petroleum product manufacturing; 20. Chemical manufacturing; 21. Manufacturing of pharmaceutical and medical products used in medicine and veterinary medicine; 22. Rubber and plastic product manufacturing; 23. Manufacturing of other non-metallic mineral products; 24. Metallurgical manufacturing; 25. Manufacturing of fabricated metal products, except machinery and equipment; 26. Computer, electronic, and optical product manufacturing; 27. Electrical equipment manufacturing; 28. Manufacturing of machinery and equipment not included in other groups; 29. Manufacturing of motor vehicles, trailers, and semi-trailers; 30. Manufacturing of other transport equipment and machinery; 31. Furniture manufacturing; 32. Manufacturing of other finished products; 33. Repair and installation of machinery and equipment.

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The most common industrial specializations found in Russian regions include the following: 10. Food product manufacturing; 17. Paper and paper product manufacturing; 20. Chemical manufacturing; 22. Rubber and plastic product manufacturing; 23. Manufacturing of other non-metallic mineral products; 25. Manufacturing of fabricated metal products, except machinery and equipment; 27. Electrical equipment manufacturing; 28. Manufacturing of machinery and equipment, not included in other groups; 30. Manufacturing of other transport equipment and machinery.

The least common industries include: 12. Tobacco product manufacturing; 11. Beverage manufacturing; 21. Manufacturing of pharmaceutical and medical products used in medicine and veterinary medicine (see Table 1).

For the period from 2019 to 2022, we have analyzed the dynamics of industrial specializations in Russian regions and identified «new» specializations that emerged and «departed» sectors that can no longer be considered specialization sectors for each analyzed region. In the given period, in 14 regions there appeared 15 new sectors and 15 sectors ceased to be specialization sectors (Table 2).

13 out of 14 regions experienced structural economic transformations in 2020–2022. Within a single region, we could observe new specializations emerging alongside the loss of others. However, despite the emergence of new specializations or the loss of market share and the shift away from previous specializations, in twelve out of fourteen regions, the level of specialization calculated through the Herfindahl-Hirschman Index has not undergone significant changes. The regions that previously had a diversified or specialized structure have largely retained this characteristic.

Meanwhile, two regions experienced more significant changes during this period. In the case of Novgorod region, there was a decrease in the degree of economic diversification. As of 2019, the region had a sufficiently diversified structure in manufacturing, but by 2021–2022, it had lost three of its industrial specializations («manufacturing of computers, electronic and optical products»; «manufacturing of machinery and equipment not included in other groups»; «repair and installation of machinery and equipment»). The current conditions are conducive to the development of the region's mono-specialization: the share of the sector «manufacturing of chemicals and chemical products» increased from 40 % in 2019 to 59.4 % in 2022. Due to the transformations in recent years, this region can currently be described as a region with a specialized economic structure rather than a diversified one.

On the contrary, the economic structure of Kaluga region has become more diversified. Due to the crisis and the vacant niche left by motor vehicle production amid the sanctions, the region has acquired new specializations – «clothing manufacturing», «wood processing and production of wood and cork products», and «manufacturing of other transport equipment and machinery». This shift contributed to an increased level of industrial diversification in the region. However, when the crisis is overcome and the automotive industry has recovered its production volumes, this process could be mitigated.

We also examined the economic resilience of industrially developed regions to the impact of crises. To assess the impact of external shocks on the dynamics of shipments in the manufacturing industry, the following periods were analyzed: 2020–2019, 2021–2020, 2022–2021, and the first half of 2023 (Figure 2). The figure also includes a curve illustrating the changes in production from 2019 to 2022, indicating whether the economic system has managed to restore its level of development before the impact of external shocks or not. It should be noted that these indices are adjusted for the inflationary component, indicating the net increase or decrease in industrial production.

The year 2020 was characterized by the impact of the coronavirus pandemic (COVID-19), as a result of which the economy experienced an unprecedented crisis. This crisis led to the decline in manufacturing indices in all 14 analyzed regions, although the extent of the decrease in industrial production volumes varied among them. The most significant decline was recorded in Vologda region (the index to 2019 was 56.8 %), where industries such as the production of chemicals and chemical products, as well as metallurgy, were most affected, showing a decline of more than 50 %. In Bashkortostan, printing and related activities experienced a loss of more than 50 % (48.7 %), and the production of coke and petroleum products fell by 45.9 %; in Chelyabinsk region, the printing and related activities sector showed a decline of 34.8 %. A slight decrease in production indices in the manufacturing industry (4.6 %) is observed in Moscow region.

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Table 2

Dynamics of industrial specializations of Russian regions in 2019–2022

Regions	HHI (scaled from 0 to 1)				Type of specialization	Tendencies in industrial specialization	«New» sectors	«Departed» sectors
	2019	2020	2021	2022				
Moscow	0.090	0.097	0.088	0.090	D	No change	no	33 Repair and installation of machinery and equipment
Chelyabinsk	0.400	0.374	0.497	0.421	S	No change	29 Manufacturing of motor vehicles, trailers and semi-trailers; 33 Repair and installation of machinery and equipment	15 Manufacturing of leather and leather products
Sverdlovsk	0.416	0.374	0.458	0.420	S	No change	27 Manufacturing of electrical equipment 32 Manufacturing of other finished products	22 Manufacturing of rubber and plastic products
Omsk	0.134	0.054	0.118	0.104	D	No change	25 Manufacturing of finished metal products, except for machinery and equipment	no
Yaroslavl	0.103	0.112	0.102	0.096	D	No change	no	no
Rostov	0.117	0.104	0.118	0.093	D	No change	24 Metallurgical production; 27 Manufacturing of electrical equipment	no
Lipetsk	0.494	0.495	0.571	0.484	S	No change	no	22 Manufacturing of rubber and plastic products
Vladimir	0.164	0.177	0.159	0.187	D	No change	no	14 Clothing manufacturing; 15 Manufacturing of leather and leather products
Leningrad	0.054	0.063	0.054	0.137	D	No change	33 Repair and installation of machinery and equipment	27 Manufacturing of electrical equipment
Vologda	0.370	0.370	0.420	0.363	S	No change	no	23 Production of other non-metallic mineral products 25 Manufacturing of finished metal products, except for machinery and equipment
Nizhny Novgorod	0.151	0.113	0.106	0.110	D	No change	10 Food production; 16 Wood processing and manufacture of wood products;	11 Beverage production; 19 Production of coke and petroleum products
Novgorod	0.229	0.230	0.327	0.403	D	Tendency towards greater specialization	no	26 Manufacturing of computers, electronic and optical products; 28 Manufacturing of machinery and equipment not included in other groups; 33 Repair and installation of machinery and equipment
Kaluga	0.255	0.229	0.204	0.092	D	Tendency towards greater diversification	14 Clothing manufacturing; 16 Wood processing and manufacture of wood products; 28 Production of machinery and equipment not included in other groups; 30 Manufacture of other vehicles and equipment	no
Republic of Bashkortostan	0.422	0.304	0.341	0.348	S	No change	16 Wood processing and manufacture of wood products;	32 Manufacturing of other finished products

Source: developed by the authors using the data retrieved from EMISS (https://fedstat.ru/indicator/57722)

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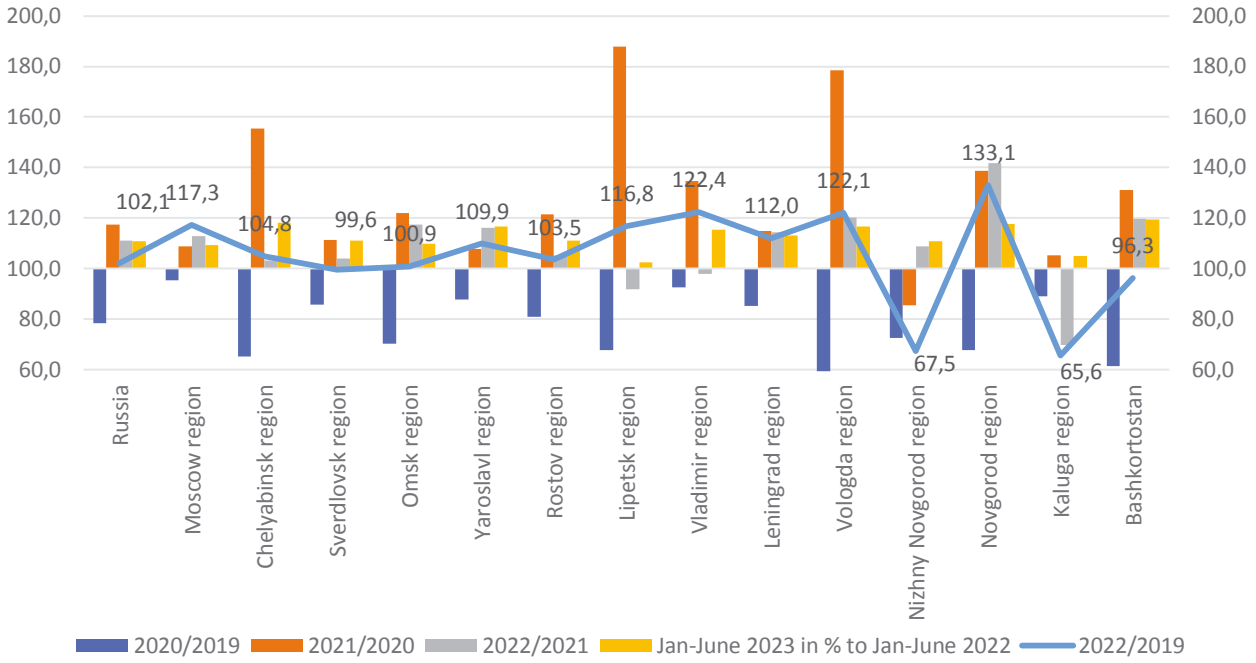

***Figure 2**. Indices of the manufacturing industry in Russian regions*
Source: Compiled by the authors based on Rosstat data

The post-pandemic year of 2021 saw recovery processes in Russian regions. Industrial production rebounded to the 2020 level in all the regions under consideration. The positive dynamics of industrial production reflected the low base effect of 2020, especially in the regions with the greatest decline.

When the geopolitical situation aggravated and sanctions against Russia were imposed, the economic recovery in 2021 was disrupted. However, despite the negative impact of sanctions and the exodus of some international companies from the Russian market, in 2022, there was an increase in production volumes in manufacturing in 11 out of the 14 examined regions. Three regions — Lipetsk, Vladimir, and Kaluga regions — showed a decline in industrial production volumes in 2022. In Lipetsk region, the most significant decline compared to 2021 was observed in the production of electrical equipment (49.6 %) and rubber and plastic products (74.2%) in 2022. Vladimir region experienced a notable decline in the production of pharmaceuticals and medical materials (18.8 %) and metallurgical production (59.4 %). In Kaluga region, the most significant decline is observed in the production of motor vehicles, trailers, and semi-trailers (28.7 %), the repair and installation of machinery and equipment (54.3 %), and the production of rubber and plastic products (59 %).

We assess the resilience of regions to crises by examining how well their economies adapt to new conditions and restore positive dynamics in regional indicators. The rates of recovery may not necessarily reach the levels observed in the pre-crisis period. In Table 3, regions are grouped by the type of resilience based on the trajectory of post-crisis development.

The first group of regions that have returned to their pre-crisis development levels (with an index of 95–105 % in 2022 compared to 2019) includes five regions.

In Sverdlovsk region, three specializations have strengthened their positions: «repair and installation of machinery and equipment» showed a significant growth (the production volume increased by 326.6 % from 2019 to 2022), and there was also growth in «wood processing and production of wood and cork products» and «manufacturing of machinery and equipment not included in other groups.» The region also acquired two new specializations, including «manufacturing of electrical equipment», which is identified as a development driver (growth of 138.8 %). The declining industries — those that have not reached the 2019 level — are the production of other transport equipment, other non-metallic products, and metallurgical production. «Manufacturing of rubber and plastic products» has

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Table 3

Groups of regions by resilience type and industrial specialization, 2019–2023

Groups of regions by resilience type	Regions	Industrial production index		Industry (OKVED index)*	Industrial production index	
		2022 to 2019, %	first half of 2023 to first half of 2022, %		2022 to 2019, %	first half of 2023 to first half of 2022, %
Regions returning to the pre-crisis level	Sverdlovsk	99.6	111.2	16	124.5	132.5
				27	138.8	111.0
				28	144.6	132.4
				33	326.6	200.6
	Chelyabinsk	105.3	118.3	24	101.1	119.6
				29	100.7	107.7
	Rostov	103.5	111.0	10	195.6	113.7
				13	126.2	118.9
				22	125.9	109.2
				25	122.8	139.1
				27	314.5	107.7
				28	122.7	122.9
	Omsk	100.9	109.8	10	131.0	105.4
				20	117.7	124.8
				26	168.5	131.5
	Republic of Bashkortostan	96.3	119.4	16	158.6	131.9
				30	117.8	102.7
Regions transitioning to a growth trajectory	Moscow	135.0	109.2	10	112.1	102.9
				13	137.4	125.7
				14	174.8	116.8
				15	140.8	127.7
				16	164.5	131.2
				17	167.3	113.0
				18	167.1	101.8
				20	129.3	121.1
				22	148.9	131.5
				23	112.4	114.9
				25	150.8	108.6
				26	208.4	150.5
				31	144.1	130.3
	Yaroslavl	109.9	116.8	17	182.9	134.5
				22	125.0	217.4
				27	116.8	123.0
				29	104.4	118.2
				31	118.9	108.5
	Lipetsk	116.8	102.6	10	134.0	103.3
				24	102.0	100.2
	Vladimir	122.4	115.5	10	152.8	102.4
				13	128.7	100.9
				16	208.6	118.7
				22	106.5	123.2
				27	156.7	149.6

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Table 3

Groups of regions by resilience type	Regions	Industrial production index		Industry (OKVED index)*	Industrial production index	
		2022 to 2019, %	first half of 2023 to first half of 2022, %		2022 to 2019, %	first half of 2023 to first half of 2022, %
Regions transitioning to a growth trajectory	Vladimir	122.4	115.5	28	212.3	101.7
				31	197.3	111.8
				32	120.5	103.2
	Leningrad	112.0	113.1	10	118.2	101.2
				14	168.1	197.2
				18	103.6	113.3
				20	197.3	155.7
	Vologda	122.1	116.8	16	130.2	118.6
				20	109.2	128.8
				24	102.3	110.9
	Novgorod	133.1	117.7	10	115.4	109.2
				20	135.6	135.1
				27	164.7	106.2
Regions transitioning to a declining trajectory	Nizhny Novgorod	67.5	110.8	10	140.3	114.3
				14	101.6	111.8
				16	199.0	104.1
				17	153.6	101.9
				22	124.0	113.2
				26	119.4	110.6
	Kaluga	65.6	105.0	16	206.8	110.9
				17	161.8	116.1
				23	126.8	105.8
				25	134.1	117.2
				27	110.5	127.0

Source: developed by the authors using the data retrieved from EMISS (https://fedstat.ru/indicator/57609?id=57609)

*See the note in Table 1 specifying these industries.

been removed from the list of the region's specializations.

In Chelyabinsk region, its main industry - metallurgy — has returned to the levels of 2019. Two new specializations have emerged, one of which is the production of motor vehicles, which has become a major driver of regional development. Industries with negative dynamics in the given period comprise the production of finished metal products, other non-metallic mineral products, as well as machinery and equipment not included in other groups. Manufacturing of leather and leather goods has ceased to be the region's specialization, primarily due to this industry's dependence on imported raw materials.

In Rostov region, five key industries demonstrated growth: «food production» (2022 production volume increased by 195.6 % compared to 2019), «textile production» (growth of 126.2 %), «production of rubber and plastic products» (growth of 125.9 %), «production of finished metal products, except for machinery and equipment» (growth of 122.8 %), and «production of machinery and equipment not included in other groups» (growth of 122.7 %). The region also acquired a new specialization — «manufacturing of electrical equipment» (threefold growth compared to the 2019 baseline). At the same time, four sectors show negative dynamics, with the greatest decline in the production volumes of the sectors «other non-metallic mineral products» (33.1 %) and «other transport equipment and machinery» (58.7 %). However, despite the significant decline in production volumes, these sectors did not lose their special status.

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In Omsk region, there is a growth in production volumes in three key industries: «food production» (2022 production volume increased by 131.0 % compared to 2019), «production of chemical substances» (growth of 117.7 %), and «manufacturing of computers, electronic and optical products» (growth — 168.5 %). The latter industry is crucial to regional development, as its production is significantly linked to import substitution processes. Declining industries include the following: coke and petroleum production; rubber and plastic product manufacturing; other transport equipment and machinery; repair and installation of machinery and equipment.

In Bashkortostan, two industries can be identified as drivers of development: the long-established industry «manufacture of other transport equipment and machinery» (production volume growth from 2019 to 2022 amounted to 117.8 %) and the new specialization «wood processing and production of wood and cork products» (158.6 %). The following industries did not reach the level of 2019: production of coke and petroleum products, chemicals and products, machinery and equipment not included in other groups. There was one departed specialization — «manufacturing of other finished products».

In the second group there are seven regions that have returned to their pre-crisis levels and demonstrate an upward trend (the 2022 index relative to 2019 is over 105 %).

Moscow region, with the highest number of industrial specializations (20), demonstrates robust growth in thirteen of them. The production growth rates in these sectors in 2022–2019 ranged from 112.1 % to 208.4 %. The most significant decline was observed in the following sectors: «electrical equipment manufacturing» (51.1 %), «manufacturing of other vehicles and equipment» (51.3 %), and «manufacturing of other finished products» (61.4 %). The sector «repair and installation of machinery and equipment» saw a threefold reduction in production volumes, and as a result this industry lost its special place in the region's economy.

In Yaroslavl region, five industries have been identified as drivers of regional development, and the production of paper and paper products had the most significant growth, showing a 1.8 times increase. Nine industries, while retaining their special status, did not reach the level of 2019. Additionally, one industry — the production of computers, electronic and optical products — significantly reduced its production volumes and ceased to be the region's specialization.

A major driver for the development of Lipetsk region, featuring six key industries, is the primary sector of metallurgy. Another significant driver is the food production sector, which saw a 134 % increase in production volumes from 2019 to 2022. Manufacturing of rubber and plastic products ceased to be a specialized industry due to the significant reduction in its production volumes.

In Vladimir region, over half of its key industries are showing positive dynamics. A two-fold increase in production volumes is observed in the following sectors: «wood processing», «machinery and equipment manufacturing (not included in other groups) «, and «furniture manufacturing». There is, however, a substantial decline in the production of pharmaceuticals (55.3 %). The production of clothing nearly halved during the period under consideration and ceased to be the region's key specialization. Another «departed» sector is the production of leather and leather goods.

In Leningrad region, four industries — food production, clothing, printing, and the production of chemicals — have become drivers of development. Additionally, a new specialization has emerged: the repair and installation of machinery and equipment. Six industries show a negative trend, and the region has lost one specialization — the production of electrical equipment.

In Vologda region, such industries as production of chemicals and products, metallurgy, and wood processing are growing steadily. At the same time, the region has lost two of its industrial specializations — «manufacturing of other non-metallic mineral products» and «manufacturing of finished metal products and repairs».

Despite the highest growth rate in production volumes, Novgorod region shows negative dynamics in three industries. The most significant decline is observed in the production of beverages (14.8 %) and wood processing (58.5 %). The region has lost three of its specializations: the production of computers, electronic and optical products; the production of machinery and equipment not included in other groups; and the repair and installation of machinery and equipment. The drivers of regional development, where production growth offset negative effects, were food production (growth of 115.4 %), the production of chemical substances (135.6 %), and manufacturing of rubber and plastic products (164.7 %).

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Two regions, Kaluga and Nizhny Novgorod, belong to the third group of regions transitioning to a declining trajectory. In both regions, the production of motor vehicles significantly decreased. In Nizhny Novgorod region, the 2022 production volume made up 36.3 % of the 2019 level, and in Kaluga region, this figure was 35.3 %. Nizhny Novgorod region lost such specializations as the production of beverages, whose production volume was only at 8 % of the 2019 level, and the production of coke and petroleum products (at 8.5 %). Given this negative trend, the key drivers for the development of Kaluga region are the production of paper and paper products (1.6 times growth); production of other non-metallic mineral products (126.8 % growth); production of finished metal products, except for machinery and equipment (134.1 %); and production of electrical equipment (110.5 %). In Kaluga region, despite a significant decrease in the share of the leading industry — the automotive industry, several industries have become new specialized sectors: wood processing, clothing manufacturing, production of machinery and equipment not included in other groups, and production of other vehicles and equipment. In Nizhny Novgorod region, the main growth drivers were five industries: wood processing (growth of 199.0 %), production of paper and paper products (153.6 %), production of rubber and plastic products (124 %), clothing manufacturing (101.6 %), and production of computers, electronic, and optical products (119.4 %). In addition, the region gained a new industrial specialization - food production (140.3 %). Overall, in these two regions, there was a search for new industries into which resources from the main industry could be redirected during the crisis.

Summarizing the above data on the dynamics of industrial specialization in 2019–2023, the following conclusions can be drawn:

1. The drivers of economic recovery were the industries of domestic consumer demand: food production, textile and clothing manufacturing, furniture production, as well as wood processing and the production of wood, paper, and pulp products.

2. Against the backdrop of import substitution, the key industries driving economic recovery are the production of chemicals and chemical products, as well as the manufacturing of machinery and equipment (except for motor vehicles).

3. The reason why these industries have become drivers of economic development and contributed to the economy's adaptive recovery in the face of external constraints is their technological and organizational readiness to increase production. When major competitors exited the market in the process of import substitution, domestic producers managed to occupy vacated niches left by Western companies. At the same time, the sale of finished products is associated with meeting domestic demand.

4. These industries are set for further growth through expanding domestic markets. Additionally, changes in external policy restrictions could open up opportunities for international exports.

5. Different regions show varying trends in the production volumes of a particular industry. In some, there is significant growth leading to the appearance of a new specialization, while in others, there is a notable decline, causing a departure from specialized sectors. This applies to the following industries: the production of electrical equipment and computers, the production of finished metal products (except for machinery and equipment), and the repair and installation of machinery and equipment. To investigate the reasons behind these trends, a more detailed analysis of the sector up to the fourth digit of OKVED code is required. In general, we can conclude that these industries involve manufacturing of specific types of products that can act as drivers of development. However, the industry's dependence on resource imports imposes limitations on its development.

6. Two industries that are crucial for Russia's economy and act as key industrial specializations in various regions were severely impacted by external restrictions: manufacturing of coke and petroleum products, and motor vehicle production. Trade restrictions have resulted in a decline in their production volumes. In the petrochemical industry, this decline is attributed to a sharp reduction in sales in the Western market for finished Russian goods. Meanwhile, in the automotive manufacturing sector, the decrease is linked to restrictions on the supply of imported components and machine parts. Both of these industries cannot be considered as anti-crisis growth drivers. On the contrary, they require close attention from the government in order to devise and implement temporary support mechanisms. This will help maintain employment levels and, consequently, address potential issues related to layoffs and income loss for a significant portion of workers.

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Conclusion

Our analysis has revealed disparities in the level and dynamics of development of Russian regions' industrial specializations. Since we take as a point of departure the understanding that the resilience of the regional economic system is closely tied to industrial specialization, we categorized regions into two types: those with a diversified structure and those with more distinct industrial specializations.

Analysis of the dynamics of industrial specialization levels revealed notable variations in the speed and extent of changes across different regions. In one region, new specializations may emerge alongside the loss of special status by certain industries. In the given period, 14 regions acquired 15 new specializations while 15 sectors ceased to be specialization sectors (Table 2). However, despite the emergence of new specializations or the departure of existing ones, in twelve out of fourteen regions, the level of specialization in the regional economy has not undergone any significant changes. The regions that previously had a diversified or specialized structure have remained as such. In two regions significant transformations were detected. In Novgorod region the level of economic diversification decreased, which means that the current conditions are conducive to the development of the region's mono-specialization: the share of the sector «manufacture of chemicals and chemical products» increased from 40% in 2019 to 59.4% in 2022. On the contrary, the economic structure of Kaluga Region has become more diversified. Due to the crisis and the vacant niche left by motor vehicle production amid the sanctions, the region has acquired new specializations such as clothing manufacturing, wood processing and production of wood and cork products, and manufacture of other transport equipment and machinery. This shift contributed to an increased level of industrial diversification in the region. However, when the crisis is overcome and the automotive industry has recovered its production volumes, this process could be mitigated.

We assessed Russian regions' resilience to crises by analyzing how their economies adapted to new conditions and restored positive dynamics, focusing specifically on the production volumes of the manufacturing industry, identified as a key specialization for the regions in question. We divided the regions into three groups: 1) those that restored their pre-crisis level of development (Sverdlovsk, Chelyabinsk, Rostov and Omsk regions, the Republic of Bashkortostan); 2) those that transitioned to a growth trajectory (Moscow, Yaroslavl, Lipetsk, Vladimir, Leningrad, Vologda, and Novgorod regions); and 3) those that transitioned to a declining trajectory (Nizhny Novgorod and Kaluga regions). For each region in each of the above-mentioned groups we identified the sectors that showed growth in production volumes and maintained their upward trends in the first six months of 2023. Therefore, these sectors can be deemed drivers for the regions' economic development.

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Assessment of the level and structure of stress in tax revenues of the federal and regional budgets

Relevance. In recent years, the Russian economy has faced the global challenges posed by the COVID-19 pandemic and unprecedented sanctions. Understanding how the tax systems of Russian regions respond to these external shocks is crucial for identifying critical stress sources affecting budgets at various levels.
Research objective. This study aims to assess and compare tax revenue stress across the federal districts of the Russian Federation, considering different levels of the budget system, and to identify the underlying sources of this stress.
Data and methods. The study relies on official data from the Federal Tax Service of the Russian Federation on tax revenues to federal and regional budgets in the federal districts. The analysis covers monthly data from January 2013 to December 2022. The stress index was calculated by measuring the difference between the moving standard deviation and the mean of the annual tax revenue growth rate, with a lag of 1 month. The methodology for decomposing the sources of tax revenue stress was also tested.
Results. Over-time assessments of stress indices for tax revenues to federal and regional budgets were obtained for the Russian Federation and its federal districts. The varying levels, dynamics, and budgetary distribution of tax revenue stress across federal districts are explained by differences in the structure, growth rates, and volatility of various taxes, as well as their correlations in these districts. Decomposition of federal and regional tax stress showed the unique role of mineral extraction tax and profit tax as stress amplifiers during crises, while in stable periods, they contribute significantly to stress reduction. The study also establishes the distinct roles of federal districts in intensifying or alleviating overall tax revenue stress during pandemic and sanctions shocks, as well as periods of relative stability.
Conclusions. This research demonstrates the importance of assessing and identifying sources of tax revenue stress in regions. Such insights help identify vulnerabilities and reserves for enhancing the resilience of regional and federal budgets through the diversification of regional economic systems and adjustments to tax system rules in response to changing external conditions.

KEYWORDS
Stress index, tax revenues, tax system, federal budget, regional budgets, decomposition, economic crisis, pandemic, sanctions, federal districts

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Оценка уровня и структуры стресса налоговых поступлений федерального и региональных бюджетов

Актуальность. Российская экономика за последние несколько лет пережила кризис пандемии COVID-19, беспрецедентные санкции. Исследование реакции налоговых систем российских регионов на внешние шоки позволяет отследить наиболее важные источники стресса бюджетов разных уровней.
Цель. Оценка и сравнение стресса налоговых поступлений в федераль-

КЛЮЧЕВЫЕ СЛОВА
индекс стресса, налоговые поступления, налоговая система, федеральный бюджет,

ных округах РФ для разных уровней бюджетной системы и выявление его источников.
Данные и методы. Использовались официальные данные ФНС РФ о поступлениях по разным налогам в федеральный и региональные бюджеты в федеральных округах России в помесячном выражении с января 2013 года по декабрь 2022 года. Индекс стресса определялся как разница скользящего стандартного отклонения и среднего значения темпа прироста годовых налоговых поступлений с лагом в 1 месяц. Апробирована методика декомпозиции индекса стресса налоговых поступлений по источникам.
Результаты. Получены динамические оценки индексов стресса налоговых поступлений в федеральный и региональный бюджеты для РФ и ее федеральных округов. Разные уровень, динамика и бюджетное распределение стресса налоговых поступлений в федеральных округах объяснены разной структурой налоговых поступлений, темпами роста, волатильностью и корреляцией разных налогов в этих округах. Выявлена особая роль НДПИ и налога на прибыль как усилителей стресса для ряда федеральных округов в периоды кризисов, в то время как в стабильные периоды они значительно способствуют его снижению. Также установлена разная роль федеральных округов в усилении и снижении общего стресса налоговых поступлений в бюджеты разных уровней в периоды воздействия пандемического и санкционного шока и периоды относительной стабильности.
Выводы. Адекватная оценка и идентификация источников стресса налоговых поступлений в регионах позволяет находить уязвимые точки и резервы роста устойчивости регионального и федерального бюджета путем диверсификации региональных экономических систем и адаптации правил налоговой системы к меняющимся условиям внешней среды.

региональные бюджеты, декомпозиция, экономический кризис, пандемия, санкции, федеральные округа

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联邦和地区预算税收压力水平和结构估算

现实性：俄罗斯经济在过去几年中经历了 COVID-19 和前所未有的制裁。通过研究俄罗斯各地区税收制度对外部冲击的反应，我们可以追踪各级预算压力的最重要来源。
研究目标：评估和比较俄罗斯联邦各联邦区各级预算系统的税收压力并确定其来源。
数据与方法：文章使用的是俄罗斯联邦税务局 2013 年 1 月至 2022 年 12 月俄罗斯各联邦和地区预算系统中各种税收收入的官方数据。压力指数被定义为滞后 1 个月的年税收收入增长率的移动标准偏差与平均值之差。另外，按来源分解税收压力指数的方法已经通过测试。
研究结果：文章对俄罗斯联邦及其联邦区的联邦和地区预算中的税收压力指数进行了动态估算。各联邦区税收压力的不同水平、动态和预算分布可以用这些地区不同税收的结构、增长率、波动性和相关性来解释。在危机时期，矿产开采税和利润税对一些联邦区的压力增大起着特殊作用，而在稳定时期，它们则对减轻压力做出了重大贡献。此外，文章还确定了新冠疫情和制裁冲击时期以及相对稳定时期，以及各联邦区在增加和减少各级预算的总体税收压力时的不同作用。
结论：文章充分评估和确定了各地区税收压力的来源。研究建议，可以通过地区经济体系的多样化和税收制度的调整来适应外部环境条件的变化，并为地区和联邦预算的可持续性增长找到薄弱点和增长点。

关键词
压力指数、税收收入、税收制度、联邦预算、地区预算、分解、经济危机、疫情、制裁、联邦地区

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Introduction

In the era of global economic uncertainty and interconnected markets, evaluating the system's stress resistance and its ability to withstand shocks is paramount. Above all, it is important to develop effective methodologies to measure stress levels and comprehend the contributing factors. Analysis of stress dynamics at the regional economic level provides valuable insights into variations in resistance, adaptive capacity, and their underlying sources.

External shocks have varying impacts on different parameters of regional economies, and one

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such parameter is tax revenues, which closely align with GDP. Monthly tax statistics provide a timely basis for operational analysis. Moreover, tax revenues play a substantial role in shaping both regional and national budgetary systems, influencing their capacity to deliver public goods, finance investment projects, and determine the potential for subsequent regional economic development.

This study focuses on tax revenues in Russian federal districts (macro-regions) and the entire country. More specifically, it examines the stress levels of tax revenues in these federal districts and their distribution between different levels of the budget system (federal and regional budgets).

This study aims to evaluate and compare the stress levels of tax revenues across federal districts for both federal and regional budgets over different periods: pre-pandemic, pandemic, recovery, and new sanctions. The objectives include the following: developing approaches for assessing and decomposing the stress of tax revenues in regions; evaluating the stress of tax revenues from federal districts to both the federal and regional budgets, and identifying their sources; decomposing the stress of tax revenues to different levels of budgets by taxes in various periods, and by federal districts in different periods; and, finally, identifying factors contributing to the sustainable development and risks of tax revenues in federal districts, along with providing general recommendations to enhance the resilience of regional tax systems to new shocks.

The study's hypothesis is that the stress experienced by regions in their tax revenues, across different budget levels, is contingent on factors such as structural composition, growth rates, volatility of revenues from diverse taxes, and interconnectedness. The effective management of stress involves optimizing the diversification of tax portfolios in regions.

The subsequent article is structured as follows. The "Theoretical Framework" section provides an overview of relevant literature, covering topics such as stress measurement in the economy, the resilience of regional economies to new shocks, and the operation of regional tax systems in Russia and globally amid global turbulence. The section "Data and Methods" describes the databases employed and elucidates our methodology for calculating the tax revenue stress index, including its decomposition by sources. The "Results" section deals with the dynamic estimates of tax revenue stress in federal districts, spanning various budget levels, and conducts an in-depth analysis of the sources of tax revenue stress over time. Finally, the "Conclusions" section presents the study's findings, offering both theoretical and practical recommendations. Additionally, it describes the study's limitations and proposes avenues for future research.

Theoretical framework

Assessment of economic systems' exposure to stress and their responses to this gained prominence in the banking sector, notably in a study by the European Central Bank (Hollo et al., 2012). This study constructed an overall stress index using portfolio theory, aggregating five market sub-indices based on 15 individual financial stress indicators while considering time-varying cross-correlations between these sub-indices.

Continuing this line of research, Kremer (2016) compared approaches to measuring financial stress. Another notable work by specialists from the International Monetary Fund (Balakrishnan et al., 2009) proposed an overall stress index based on four market price indicators and a stock market pressure index. Each component was pre-normalized using the equivalent variance method, providing the advantage of insulating significant fluctuations in one component from affecting the overall index. The additive function facilitated the decomposition of contributions into sub-indices.

In the Russian context, Stolbov (2019), Fedorova (2015), and Ekimova (2017) systematically addressed approaches to measuring stress experienced by economic systems and attempted to construct indices using Russian economic data. An interesting contribution comes from Smirnov & Smirnov (2022), who developed a methodology for the daily Index of Economic Stress, incorporating indicators from financial, commodity, real, banking, and consumer sectors. This Economic Stress Index demonstrated the ability to generate "alarm signals" during recessions in 1998, 2008–2009, 2015–2016, and the 2020 coronacrisis.

Additionally, Malkina & Balakin (2023) provided analysis of theoretical and methodological concepts and proposed novel approaches to assess industrial and financial stress in the Russian economy.

Stress indices primarily aim to forecast and identify economic crises, impacting various in-

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dicators, including taxes. The sensitivity of taxes to different crises is an important area of study for economists globally, with notable research by Gnangnon (2022) confirming the influence of tax revenue instability on GDP in both developed and developing countries based on an analysis of 146 countries from 1981–2016.

Interest in this research has surged since the 2020 pandemic. For instance, an OECD survey explores the impact of tax and fiscal policies on pandemic mitigation and economic recovery, outlining key policy reforms necessary for restoring public finances.

An earlier study by the International Monetary Fund (Brondolo, 2009) underscores the crucial role of expanding taxpayer assistance, focusing policies on emerging risks, introducing legislative reforms for tax administration, and enhancing communication programs to boost tax collection during crises.

Russian researchers also contribute to understanding the impact of different crises on tax revenues. Gurvich & Suslina (2015) highlight the sensitivity of individual tax collection to macroeconomic shocks and tax policy decisions. This sensitivity poses an additional risk to the budget system's revenues, and a decline in tax collection during a crisis can exacerbate the negative effects of reduced tax bases and structural shifts. Pogorletskiy & Pokrovskaia (2021), drawing on the consequences of the COVID-19 pandemic and crisis recovery experience, advocate for the core principles of modern fiscal policy, emphasizing a clear social orientation, government withdrawal of excess revenues during the pandemic, and alignment with the recovery strategies of other countries in the post-crisis period.

In many studies, the exploration of tax revenue sensitivity during different crises often revolves around forecasting (e.g., Kostina & Mashentseva, 2019). Some works specifically examine the tax response to pandemics. For instance, Kakaulina (2021) forecasts a decline in personal income tax revenues in the consolidated budgets of Russian regions from 2020-2023 due to the COVID-19 pandemic. The author identifies three factors contributing to the decrease: the overall economic impact of the pandemic, the revenue base's crisis sensitivity, and the regional tax revenues' sensitivity to changes in the revenue base. Lykova (2020) observes a rise in excise tax revenues in Russia during the pandemic and associated economic crisis, attributed to rate hikes on certain excisable goods and an increase in their budgetary contributions.

In the context of our study, works exploring the resilience of regional systems and its determining factors are particularly intriguing. Various approaches exist for assessing the resilience of regional tax systems. For example, Nerudova et al. (2019) employ a multidimensional approach to socio-economic sustainability, encompassing the needs of society in the sustainable development of the economy, society, environment, and institutions.

Several authors emphasize the significance of the tax system and fiscal policy in shaping a stable economic system (e.g., Mutascu et al., 2011). Goswami et al. (2021) examine the impact of the COVID-19 pandemic on regional macroeconomic performance in Indian states. Their analysis reveals that states with high COVID-19 prevalence, unfavorable initial economic conditions, and a higher proportion of employment in the secondary and tertiary sectors suffered more significant economic losses. In contrast, states with effective containment strategies, better healthcare capacity, and a higher proportion of primary sector employment experienced smaller economic losses.

Russian researchers, including Troyanskaya & Vylkova (2019), concentrate on fiscal sustainability indicators to evaluate municipalities' capacity to secure stable development of a region through consistent tax and fee revenues. Tsepelev & Kakaulina (2014) argue that unpredictable, sharp fluctuations in the tax burden can destabilize the economy and impede economic growth.

Mikheeva (2021) points out the regional component as a significant factor determining resilience. Klimanov & Kazakova (2021) note the challenges in Russia's transition to sustainable development due to high interregional differentiation and limitations in regional strategic planning. Meanwhile, Zhikharevich et al. (2021) identify a paradox in Russia, where subsidization and a backward economic structure are factors that increase resilience.

Several studies examine the resilience of specific macro-regions (federal districts of the Russian Federation) to external shocks. For instance, Mitrofanova et al. (2021) analyze industrial regions in southern Russia, demonstrating that the development prospects of the regional industri-

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al complex depend on the balance between state regulation and market self-regulation, and are influenced by the accumulated potential of the regional industry and available adaptive capabilities. Their subsequent study (Mitrofanova et al., 2022) supports the idea that advanced development is characteristic of regions with a high level of socio-economic potential and a diversified economy.

Minakir & Naiden (2021) attribute failures in stabilizing demographic potential and developing the social system of the Far Eastern regions of Russia to the misalignment of state policy, indicating the incapacity of the institutional paradigm to achieve the set goals. Kolomak (2020) explains significant differences in the response of Russian regional economies to the pandemic by factors such as the speed of the virus's spread, implemented restrictive measures, and regional development peculiarities before the crisis.

Kuznetsova (2021) identifies factors contributing to regional resilience during the pandemic, including the degree of diversification of regional economies, their innovation potential, and economic specialization. Turgel et al. (2021) highlight the greater vulnerability of regions with a high urban population and developed small and medium-sized businesses in the acute phase of the pandemic. Regional responses to the crisis depend on the severity of measures restricting business and social activities, as well as the extent of regional differentiation in economic support measures. Additionally, the introduction of digital technologies, new delivery methods, and orientation toward new market segments prove crucial in stabilizing aggregate supply and demand.

Malkina (2022) provides evidence that the share of employees in the public sector positively impacts the resilience of regional economies during the pandemic, while the degree of openness and the scale of the economy, along with the share of the extractive industry, have a negative impact.

While the response of Russian regions to the COVID-19 pandemic has been extensively studied, there has been limited research on their resilience to the recent sanctions. For instance, Stepanov et al. (2022) analyze Sverdlovsk region, with a high concentration of mining and manufacturing enterprises, revealing the complex impact of international economic sanctions on the trajectory and dynamics of the Russian industrial sector. Akberdina (2022) explores the Greater Urals, encompassing industrial, resource, resource-industrial, and agrarian-industrial regions, demonstrating that resilience factors effective in the first wave of sanctions (2014-2015) proved insufficient to overcome the crisis caused by the sanctions in 2022.

Building on these works and expanding our earlier research (Malkina & Balakin, 2022), this study introduces new approaches to investigating the tax system's resilience, focusing on tax revenue. We analyze the dynamics and structure of the tax system stress index in the Russian Federation in the pre-pandemic, pandemic, and recovery periods. The study extends the tax stress analysis to macro-regions (federal districts), explores the distribution of tax revenue stress across budget system levels, and covers a more relevant period, reflecting the impact of the new sanctions on Russian regions.

Data and methods

The study relies on the official data from the country's Federal Tax Service, covering tax revenues on a monthly basis from January 2013 to December 2022[1].

The data encompassed a range of tax types and fees administered by the Federal Tax Service, including profit tax, personal income tax, value-added tax, excise taxes, state duty, natural taxes (such as the mineral extraction tax and royalties), property taxes (including personal and corporate property taxes, transport tax, tax on gambling business, and land tax), and special tax regimes (unified agricultural tax, unified tax on imputed income, and the simplified taxation system, among others).

The methodology for calculating and decomposing the tax system stress index, proposed in our previous article (Malkina & Balakin, 2022), was adapted for assessing the stress of tax revenues in the federal districts of Russia. This adaptation includes the distribution of stress between federal and regional budgets, as well as a decomposition of stress by taxes and federal districts in this study.

[1] Report on accrual and receipt of taxes, fees, insurance contributions and other mandatory payments to the budget system of the Russian Federation // URL: https://www.nalog.gov.ru/rn77/related_activities/statistics_and_analytics/forms/ (date of access 17.07.2022)

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The methodology includes the following steps:

1. Calculation of moving growth rates of annual tax revenues from *k*-tax (or from all taxes) in the *i*-district (country) in the *j*-month with a step of 1 month which allows to cope with the problems of seasonality and different frequency of tax revenues:

$$t_{kij} = \frac{T_{kiJ}}{T_{kiJ-12}} - 1, \quad (1)$$

where $T_{kiJ} = \sum_{j=j-11}^{j} T_{kij}$ is the volume of revenues from the *k*-tax in the *i*-district for 12 consecutive months ending with the *j*-month; $T_{kiJ-12} = \sum_{j=j-23}^{j-12} T_{kij}$ is the volume of revenues from the *k*-th tax in the *i*-th district for 12 consecutive months ending in month *j*-12;

2. Calculation of the moving average growth rate of *k*-tax revenues in *i*-district for 12 consecutive months, ending with the *j*-month:

$$\tau_{kij} = \frac{\sum_{j=j-11}^{j} t_{kij}}{12}. \quad (2)$$

3. Determination of the moving standard deviation of the growth rate for 12 consecutive months ending at *j*-month:

$$\sigma_{kij} = \sqrt{\frac{\sum_{j=j-11}^{j} (t_{kij} - \tau_{kij})^2}{12}}. \quad (3)$$

4. Calculation of stress index of revenues from *k*-tax in *i*-district:

$$SI_{kij} = \sigma_{kij} - \tau_{kij}. \quad (4)$$

In this approach, the stress of tax revenues increases with lower growth rates and higher volatility. The suggested stress index serves as an alternative to the coefficient of variation, which is unsuitable for assessing the variation in growth rates of indicators. Furthermore, the stress index resembles the simplest anti-utility function, akin to the Arrow-Pratt function.

5. Decomposition of the tax revenue stress index in *i*-district (country) by sources (taxes and tax groups).

5.1. Decomposition of the growth rate of tax revenues by *K* taxes:

$$t_{ij} = \sum_{k=1}^{K} t_{kij} \cdot \alpha_{kiJ-12}, \quad (5)$$

where $\alpha_{kiJ-12} = \frac{T_{kiJ-12}}{Ti_{J-12}}$ is a share of *k*-tax (tax group) in total tax revenues a year ago, and $\sum_{k=1}^{K} \alpha_{kiJ-12} = 1$.

Contribution of *k*-tax to the growth rate of total tax revenues:

$$t_{ij}(k) = t_{kij} \cdot \alpha_{kiJ-12}. \quad (6)$$

Similarly, the contribution of *k*-tax to the average growth rate of tax revenues:

$$\tau_{ij}(k) = \tau_{kij} \cdot \alpha_{kiJ-12}. \quad (7)$$

5.2. Decomposition of the standard deviation of the growth rate of tax revenues by *K* taxes:

$$\sigma_{ij} = \frac{\sum_{k=1}^{K} CoVar\left(t_{ij}; t_{kij} \cdot \alpha_{kiJ-12}\right)}{\sigma_{ij}}, \quad (8)$$

where $\sum_{k=1}^{K} CoVar\left(t_{ij}; t_{kij} \cdot \alpha_{kiJ-12}\right) = CoVar\left(t_{ij}; t_{ij}\right) = Var\left(t_{ij}\right)$ is decomposed variance of the growth rate of tax revenues.

The contribution of each tax to the standard deviation of the growth rate of tax revenues:

$$\sigma_{ij}(k) = \frac{CoVar\left(t_{ij}; t_{kij} \cdot \alpha_{kiJ-12}\right)}{\sigma_{ij}}. \quad (9)$$

5.3. General decomposition of the tax revenue stress index by sources:

$$SI_{ij} = \sigma_{ij} - \tau_{ij} = \sum_{k=1}^{K} \left(\sigma_{ij}(k) - \tau_{ij}(k)\right). \quad (10)$$

Similarly, the decomposition of the country's tax revenue stress index by federal districts follows a comparable approach.

The devised methodology facilitates the identification of each tax and district's contribution to the overall stress of tax revenues for both federal and regional budgets in various periods. Its implementation enables us to discern the impact of specific taxes and federal districts on the increase or decrease of tax revenue stress in budgets of different levels during turbulent and relatively calm periods. Furthermore, it allows for the identification of unique sources and mitigating factors influencing tax revenue stress in each of the 8 federal districts of the Russian Federation.

Results

The dynamic values of the stress of the country's total tax revenues to the federal and regional

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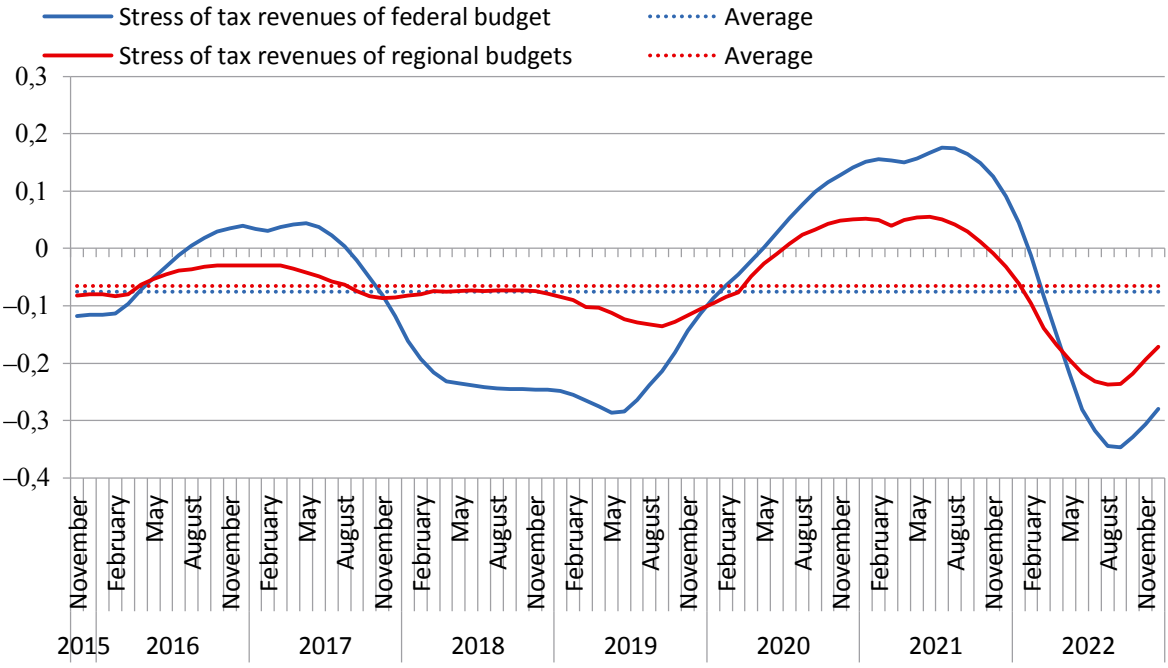

Figure 1: *Stress of tax revenues of federal and regional budgets in the Russian Federation*

Source: the authors' calculations are based on statistical data of the Federal Tax Service. Retrieved from: https://www.nalog.gov.ru/rn77/related_activities/statistics_and_analytics/forms/ (date of access: 17.07.2023)

budgets, calculated based on formulas (1–4), are depicted in Figure 1, while those for federal districts are illustrated in Figure 2. In all figures, the solid blue curve represents the stress of the federal budget, the blue dotted line denotes the average stress of revenues to the federal budget throughout the observed period, the solid red curve indicates the stress of regional budgets, and the red dotted line signifies the average stress for regional budgets.

Our analysis has shown that the average stress level for revenues allocated to regional budgets is consistently higher throughout the entire period compared to revenues to the federal budget. This pattern holds true for both the country as a whole and the majority of federal districts. The Southern Federal District stands out with the highest excess of regional stress over federal stress (4.42 percentage points), followed by the Volga Federal District (3.16 points). The Central Federal District and the Far Eastern Federal District exhibit lower stress levels for tax revenues to regional budgets than for the federal budget. The Central Federal District has a notable difference of 1.26 points.

The Far Eastern Federal District stands out for having the maximum average stress level for tax revenues in both the federal and regional budgets among all districts. The excess stress over the average Russian level is significant, amounting to 7.89 points for the federal budget and 6.63 points for regional budgets. The Urals Federal District rates second in terms of stress levels for tax revenues to the federal and regional budgets, with an excess over the average Russian level of 2.77 points for the federal budget and 3.23 points for regional budgets.

The Southern Federal District exhibits the lowest average stress level for tax revenues to the federal budget, with 4.07 points below the national average. Additionally, the stress for revenues to the federal budget is notably lower than the national average in the Volga Federal District (–0.77 points). The Central Federal District has the lowest level of stress for regional budgets, standing –1.3 points compared to the value for the whole country. It is also below the national average in the North-Western Federal District and Southern Federal District.

Examining the variability of stress values over time adds an interesting dimension. As per the standard deviation, the stress of tax revenues to the federal budget is most volatile in the Far Eastern Federal District (s = 0.347), closely followed by the Urals Federal District (s = 0.258). The Cen-

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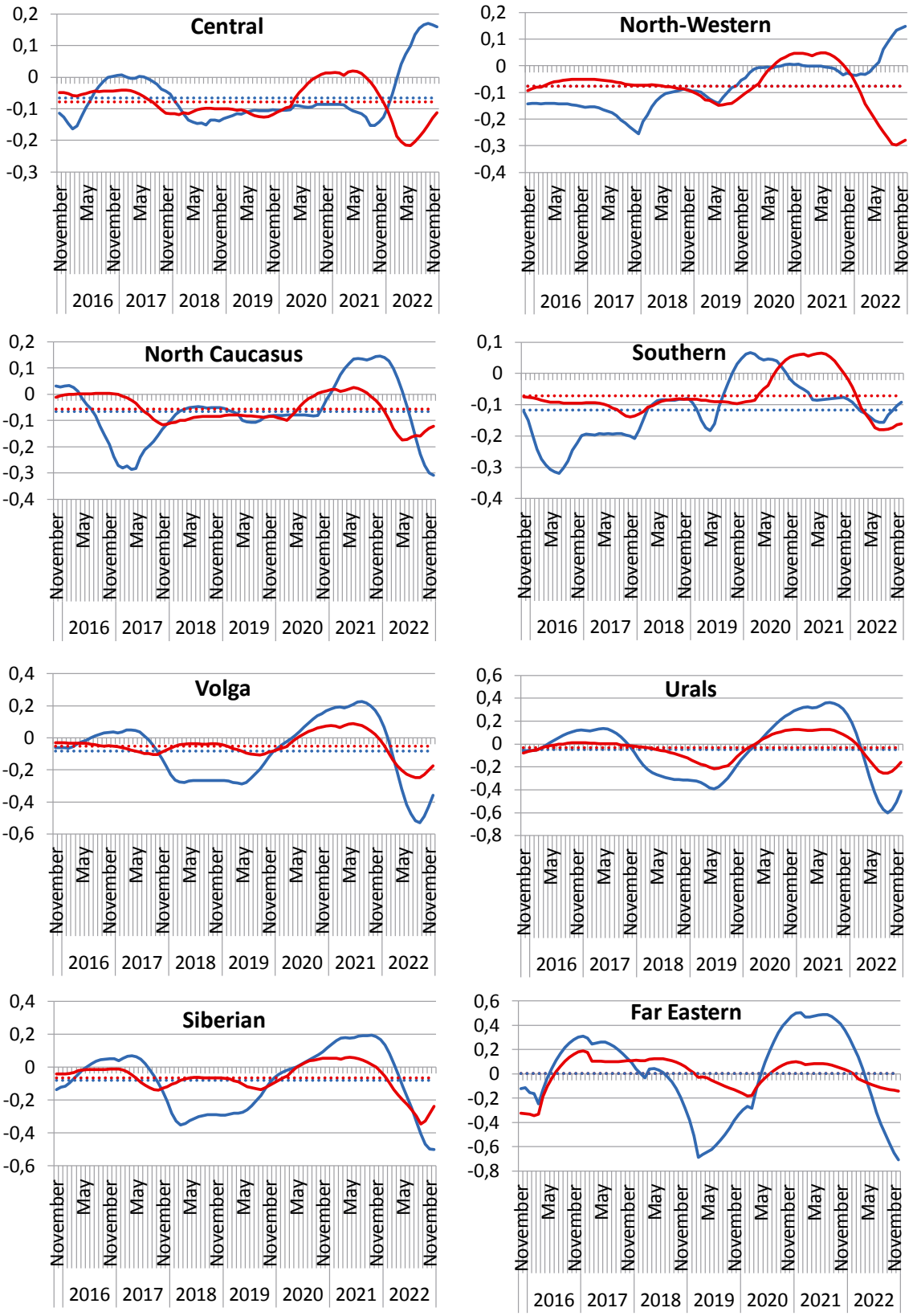

Figure 2. *Stress of tax revenues of federal and regional budgets in the federal districts of the Russian Federation*

Source: the authors' calculations are based on statistical data of the Federal Tax Service. Retrieved from: https://www.nalog.gov.ru/rn77/related_activities/statistics_and_analytics/forms/ (date of access: 17.07.2023)

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tral Federal District (s = 0.082) and the Northwestern Federal District (s = 0.088) exhibit the most stable tax revenues.

A slightly different scenario unfolds for regional budget revenues. The instability of the stress level varies from s = 0.055 in the North Caucasus Federal District and = 0.057 in the Central Federal District to s = 0.106 in the Urals Federal District and s = 0.128 in the Far Eastern Federal District. At the national level, the variation of stress is higher at the federal level (s = 0.155) compared to the regional level (s = 0.071), aligning with our earlier conclusion regarding a higher tax revenue risk at the federal level (Malkina & Balakin, 2016).

Furthermore, there is a similar dynamics of stress in tax revenues for federal and regional budgets. The linear correlation of stress between federal and regional levels over time is 0.87, suggesting the influence of similar macroeconomic factors. However, examining federal districts reveals a close relationship between federal and regional stress levels only in the Urals Federal District (time correlation coefficient of 0.96), the Volga Federal District (0.81), and the Siberian Federal District (0.72). The Far Eastern District exhibits a correlation at 0.59, the Southern District at 0.40, and the North Caucasus District at 0.28. The Central and Northwestern Federal Districts, on the other hand, show negative correlation coefficients of federal and regional stress levels (–0.42 and –0.21, respectively).

The disparities in the level and dynamics of tax revenue stress across federal districts and budget levels stem from various factors, including the structure of tax revenues, dynamics (growth rates and volatility) of different taxes, and the correlation of revenues. Lower stress in tax revenues is associated with a tax portfolio consisting of steadily growing taxes and optimal diversification, where revenue growth rates are least correlated. Tables 1 and 2 outline these four factors of tax revenue stress for federal and regional budgets, with cells highlighting the most significant factors in each federal district shaded in gray.

The primary stress factors affecting revenues to the federal budget of the Russian Federation vary across federal districts (see Table 1). In the Central Federal District, the increased share and relatively

Table 1

Stress factors of tax revenues from federal districts to the federal budget of the Russian Federation

RF and Federal Districts	Profit tax	VAT	Excise taxes	Natural taxes	State duty	Special regimes
			α_{ki} (%)			
Russian Federation	8.8	35.6	3.0	51.8	0.2	0.5
Central	24.9	75.3	–6.8	6.2	0.3	0.0
North-Western	10.4	36.6	29.7	22.8	0.2	0.3
North Caucasus	5.4	66.3	8.0	19.7	0.5	0.0
Southern	9.6	36.7	29.0	24.4	0.3	0.0
Volga	3.4	34.2	0.8	61.4	0.1	0.0
Urals	1.9	19.2	–0.5	79.4	0.0	0.0
Siberian	5.3	34.0	3.3	57.3	0.1	0.0
Far Eastern	31.8	–6.8	2.8	54.2	0.3	17.7
			τ_{kij} (%)			
Russian Federation	22.0	14.1	–16.6	22.2	0.5	25.6
Central	21.0	14.1	–244.8	831.2	1.7	1084.5
North-Western	26.2	8.0	10.5	29.3	–0.2	9.9
North Caucasus	28.8	21.4	–10.1	14.3	4.0	–
Southern	36.4	23.0	11.3	27.4	1.8	–
Volga	20.7	17.4	27.1	26.9	–0.7	–
Urals	22.6	17.0	49.3	18.7	–0.8	–
Siberian	30.3	15.4	22.5	22.7	–1.0	–
Far Eastern	33.4	142.5	19.1	30.2	–0.3	27.0

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Table 1

RF and Federal Districts	Profit tax	VAT	Excise taxes	Natural taxes	State duty	Special regimes
			σ_{ki} (%)			
Russian Federation	10.7	3.5	58.5	15.6	2.5	34.0
Central	11.2	4.8	677.5	644.4	3.1	2929.3
North-Western	12.3	8.6	13.4	21.0	2.9	17.8
North Caucasus	15.3	12.3	29.9	17.6	5.8	–
Southern	17.8	11.7	14.9	11.5	3.5	–
Volga	14.2	5.1	170.8	18.6	2.5	–
Urals	18.3	10.0	1585.3	14.4	2.7	–
Siberian	15.7	6.7	36.2	16.7	2.2	–
Far Eastern	33.0	671.1	25.7	16.2	2.1	35.4
			r_{ki}			
Russian Federation	0.932	0.833	–0.603	0.954	0.165	0.769
Central	0.000	0.339	–0.189	–0.600	0.077	–0.666
North-Western	–0.276	0.700	0.644	–0.274	0.500	–0.112
North Caucasus	–0.160	0.776	0.746	0.246	0.534	–
Southern	0.073	0.550	0.424	0.623	0.827	–
Volga	0.917	0.908	–0.445	0.977	–0.005	–
Urals	0.697	0.979	0.478	0.999	0.017	–
Siberian	0.915	0.585	0.212	0.951	0.067	–
Far Eastern	0.721	0.452	–0.117	0.889	0.391	0.884

Note. Calculated on the basis of data for the whole period under consideration: from January 2013 to December 2022. Denotations: α_{ki} is average share of k-tax in total tax revenues in the federal budget in the i-district in the period under consideration; τ_{kij} is average growth rate of k-tax in the i-district; σ_{ki} is average standard deviation of the growth rate of k-tax in the i-district; r_{ki} is correlation of the growth rate of k-tax with the growth rate of total tax revenues in the i-district.

Source: the authors' calculations are based on statistical data of the Federal Tax Service. Retrieved from: https://www.nalog.gov.ru/rn77/related_activities/statistics_and_analytics/forms/ (date of access: 17.07.2023)

higher volatility of profit tax and VAT are significant stress contributors, although the lack of correlation between the growth rates of the profit tax and other taxes helps alleviate this stress. In the North-Western Federal District, VAT emerges as the main stress factor due to its substantial share in revenues, lower-than-average rates, positive correlation with the growth rates of other taxes, and increased volatility. Excise tax revenues, however, mitigate the overall stress of tax revenues from the North-Western Federal District to the federal budget.

In the North Caucasus Federal District, VAT remains a primary source of stress, but its revenues grow at a higher rate than the national average, thus dampening the overall stress of tax revenues. Similarly, in the Southern Federal District, the situation mirrors that of the North Caucasus Federal District. However, in addition to VAT, excise duties also play a damping role, similar to the North-Western Federal District.

In the Volga, Urals, Siberian, and Far Eastern Federal Districts, the stress on tax revenues to the federal budget is primarily driven by natural taxes, specifically the Mineral Extraction Tax (MET). Additionally, in all four districts, the MET rates exhibit significant correlation with the growth rates of other taxes. Given that the growth rates of the MET show a positive relationship with their standard deviation, it further amplifies the stress on tax revenues. The Far Eastern Federal District shows the most favorable correlation between MET growth rates and their volatility, while the Urals Federal District demonstrates the least favorable correlation. In the Far Eastern Federal District, profit tax also contributes significantly to the stress on tax revenues to the federal budget. As the second most important tax in this district's revenue structure, it exhibits increased growth rates, heightened volatility, and a substantial relationship with other taxes.

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Table 2

Stress factors of tax revenues to territorial budgets of federal districts

RF and Federal Districts	Profit tax	Personal imcome tax	Excise taxes	Property tax	Natural tax	State duty	Special regimes
			α_{ki} (%)				
Russian Federation	31.8	39.7	7.6	13.6	0.8	0.2	6.2
Central	32.6	44.6	5.1	11.9	0.1	0.2	5.6
North-Western	33.3	41.9	4.2	13.6	0.6	0.2	6.2
North Caucasus	18.9	50.2	5.0	17.5	0.1	0.5	7.8
Southern	24.7	39.7	8.6	17.2	0.2	0.4	9.3
Volga	28.1	34.0	18.6	13.2	0.2	0.3	5.5
Urals	38.8	34.6	2.2	19.9	0.5	0.2	3.8
Siberian	32.5	34.6	12.8	11.7	2.5	0.3	5.5
Far Eastern	30.8	36.2	3.8	12.3	5.4	0.2	11.4
			τ_{ki} (%)				
Russian Federation	13.7	8.9	10.5	6.4	12.6	6.4	12.2
Central	13.4	10.5	10.3	6.7	13.0	6.1	17.2
North-Western	16.5	9.6	7.3	6.7	14.2	7.6	14.7
North Caucasus	15.5	7.4	5.5	8.8	6.8	8.1	13.2
Southern	12.8	8.8	11.0	7.3	15.7	9.1	15.8
Volga	13.4	6.8	13.2	4.7	9.4	5.6	12.8
Urals	14.9	7.1	3.5	6.7	16.2	7.4	11.2
Siberian	21.3	7.4	9.0	4.2	15.7	5.4	13.2
Far Eastern	9.0	7.8	12.9	9.6	12.1	4.6	3.4
			σ_{ki} (%)				
Russian Federation	8.5	1.4	5.3	4.0	6.2	3.3	7.8
Central	7.6	1.6	5.4	4.4	9.7	3.0	4.7
North-Western	9.6	1.5	5.4	4.5	7.7	3.2	4.9
North Caucasus	13.5	2.7	20.2	4.2	7.8	4.9	4.8
Southern	8.2	2.9	5.5	4.4	9.1	3.3	4.8
Volga	10.1	1.5	7.3	4.0	3.7	3.6	4.1
Urals	15.3	1.5	10.6	5.6	17.4	3.3	4.2
Siberian	12.5	1.9	5.8	4.6	4.4	4.5	4.2
Far Eastern	12.3	1.4	8.1	4.8	10.0	4.7	22.7
			r_{ki} (%)				
Russian Federation	0.995	0.871	0.162	0.510	0.351	–0.073	0.835
Central	0.979	0.880	0.102	0.498	0.649	–0.350	0.969
North-Western	0.986	0.815	0.795	0.477	0.487	0.036	0.912
North Caucasus	0.929	0.495	–0.274	0.361	0.147	–0.373	0.762
Southern	0.928	0.669	–0.027	0.587	0.905	0.027	0.774
Volga	0.981	0.830	0.461	0.539	0.548	–0.320	0.840
Urals	0.989	0.809	–0.221	0.406	–0.607	–0.194	0.808
Siberian	0.985	0.689	0.351	0.637	0.526	–0.189	0.831
Far Eastern	0.971	0.059	–0.100	0.207	0.712	0.804	0.958

Source: the authors' calculations are based on statistical data of the Federal Tax Service. Retrieved from: https://www.nalog.gov.ru/rn77/related_activities/statistics_and_analytics/forms/ (date of access 17.07.2023)

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Concerning revenues in the federal districts to regional budgets, their stress predominantly depends on two taxes – the personal income tax (PIT) and profit tax. In most districts, they are closely correlated with other taxes. The profit tax exhibits a higher growth rate than the PIT, with the PIT displaying a more stable growth rate. The most favorable situation for the profit tax (in terms of the ratio of tax growth rates and their volatility) is observed in the Central Federal District, while the least favorable is in the Far Eastern Federal District. The PIT plays a significant role in mitigating stress across all regions, and its impact is particularly noticeable in the Central and North-Western Federal Districts.

Excises are the third most important source of tax revenues in the Volga and Siberian Federal Districts. In the Siberian Federal District, their rates are weakly negatively correlated with the growth rates of other taxes, reducing overall stress. In the Volga Federal District, excise taxes grow at a rate higher than the national average, and their correlation with volatility is noteworthy. Property taxes contribute significantly to regional budget revenues in the North Caucasus, Southern, and Urals Federal Districts. The North Caucasus Federal District exhibits the greatest contribution to reducing the stress of the tax system based on a combination of characteristics. Finally, tax revenues under special regimes (apparently, in terms of production sharing agreements) are a significant stress factor in the Far Eastern Federal District.

The structure of tax revenue stress in federal districts can vary significantly over time. Based on the turning points in the dynamics of overall stress (Fig. 1), we have identified four sub-periods in the study period (11.2015–12.2022): 1) pre-pandemic (11.2015–03.2020); 2) pandemic (04.2020–03.2021); 3) post-pandemic (04.2021–03.2022); and 4) new sanctions (03.2022–12.2022). Figures 3 and 4 present the results of decomposition (using formulas 5–10) of the stress of tax revenues to budgets of different levels by sources — taxes.

First of all, it is striking that those taxes, which are the main stress dampers in relatively stable periods, become the main stress amplifiers in crisis periods. This applies to natural taxes

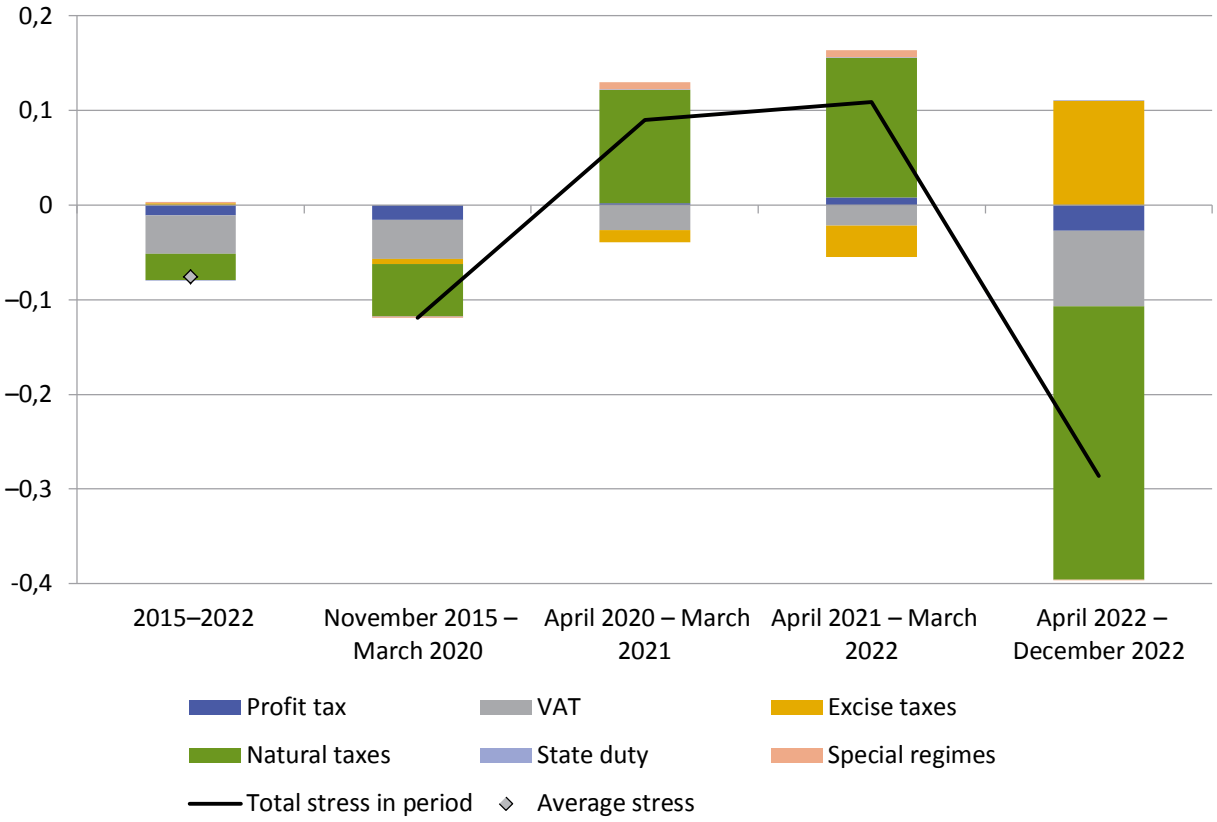

Figure 3. *Decomposition of stress of tax revenues to the federal budget by taxes*

Source: the authors' calculations are on statistical data of the Federal Tax Service. Retrieved from: https://www.nalog.gov.ru/rn77/related_activities/statistics_and_analytics/forms/ (date of reference 17.07.2023)

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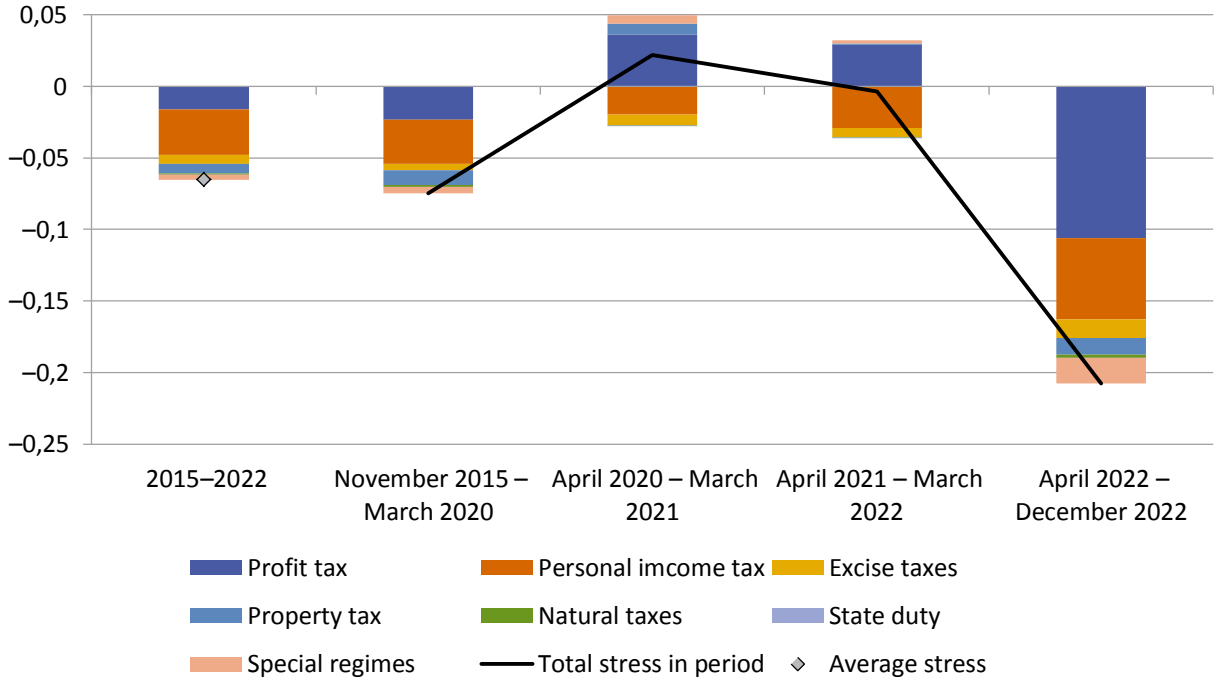

Figure 4. *Decomposition of stress of tax revenues to regional budgets by taxes*

Source: the authors' calculation based on Federal Tax Service statistical data. Retrieved from: https://www.nalog.gov.ru/rn77/related_activities/statistics_and_analytics/forms/ (date of access 17.07.2023)

for the federal budget and profit tax for regional budgets. For the federal budget, the stress of tax revenues in different periods is reduced due to the stable dynamics of VAT, while at the level of regional budgets the main stress damper is the PIT. In crisis periods, the stress of both levels slightly increases due to the instability of revenues from tax special regimes, where an important role is played by revenues from small and medium-sized businesses. Stress from property taxes received by regional budgets increased under the pandemic conditions, which is mainly due to the introduction of a number of property tax exemptions for enterprises of industries recognized as the most affected by the pandemic. Excises alleviate the overall stress on regional budgets; however, during the new sanctions period, they substantially contributed to the increase in stress on the federal budget. This is linked to the transfer of a portion of excise tax revenues to the regional level, along with an increase in tax rates. This impact not only affected the growth rate of excises but also their volatility. Finally, it should be noted that the new sanctions have not yet fully affected tax revenues, and the tax system is still undergoing changes.

Figures 5 and 6 show the decomposition of stress of tax revenues to budgets of different levels by federal districts.

The data analysis shows that during crisis periods, extractive districts, primarily the Urals Federal District and, to a lesser extent, the Volga, Far Eastern, and Siberian Federal Districts, significantly contribute to the stress on federal budget revenues. However, in more stable periods characterized by the recovery of production volumes and increased export resource prices, these same districts play a contrasting role as key stress reducers. In contrast, the Central Federal District consistently contributes to alleviating overall stress on federal budget revenues, with lesser contributions from the North-Western and Southern Federal Districts. The North Caucasus Federal District's minimal share in tax revenues (e.g., 0.49 % in 2022) renders it insignificant in the context of overall stress reduction.

Regarding stress on regional budget revenues, the Central Federal District is the primary contributor to its reduction across all periods. During the crisis period, the contribution of all districts to stress reduction decreased significantly, while the Urals, Volga, and Far Eastern Federal Districts saw

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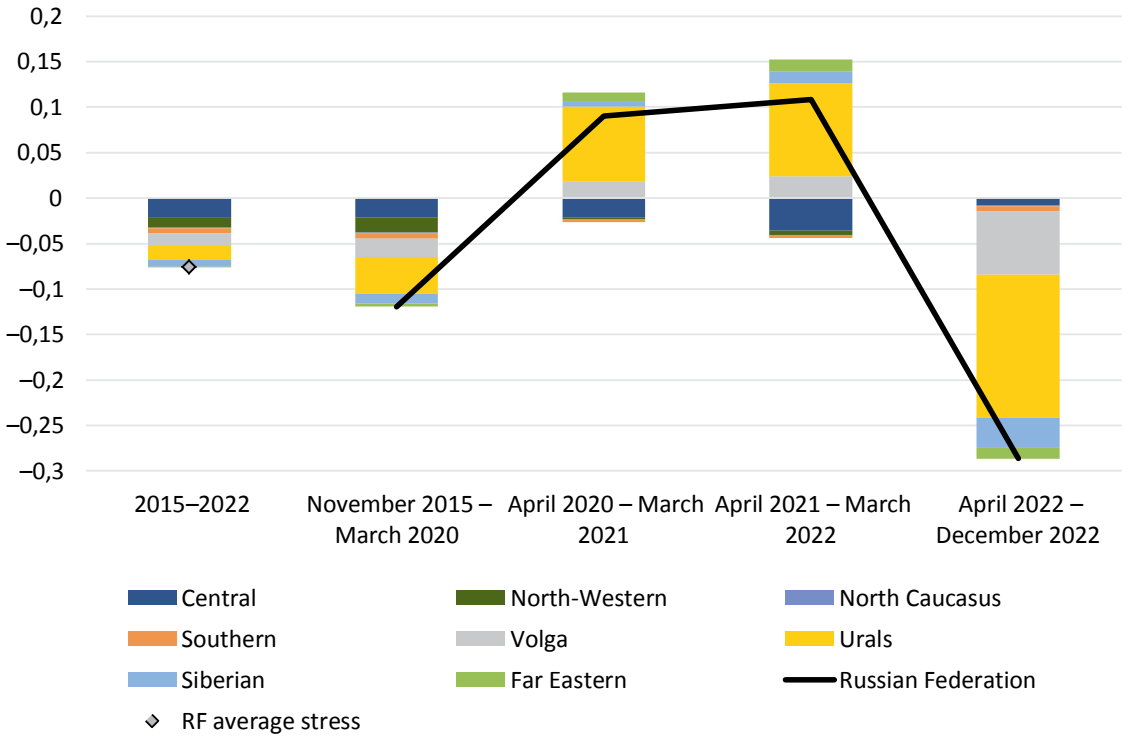

Figure 5. *Decomposition of stress of tax revenues to the federal budget by federal districts*

Source: the authors' calculations are based on statistical data of the Federal Tax Service. Retrieved from: https://www.nalog.gov.ru/rn77/related_activities/statistics_and_analytics/forms/ (date of access 17.07.2022)

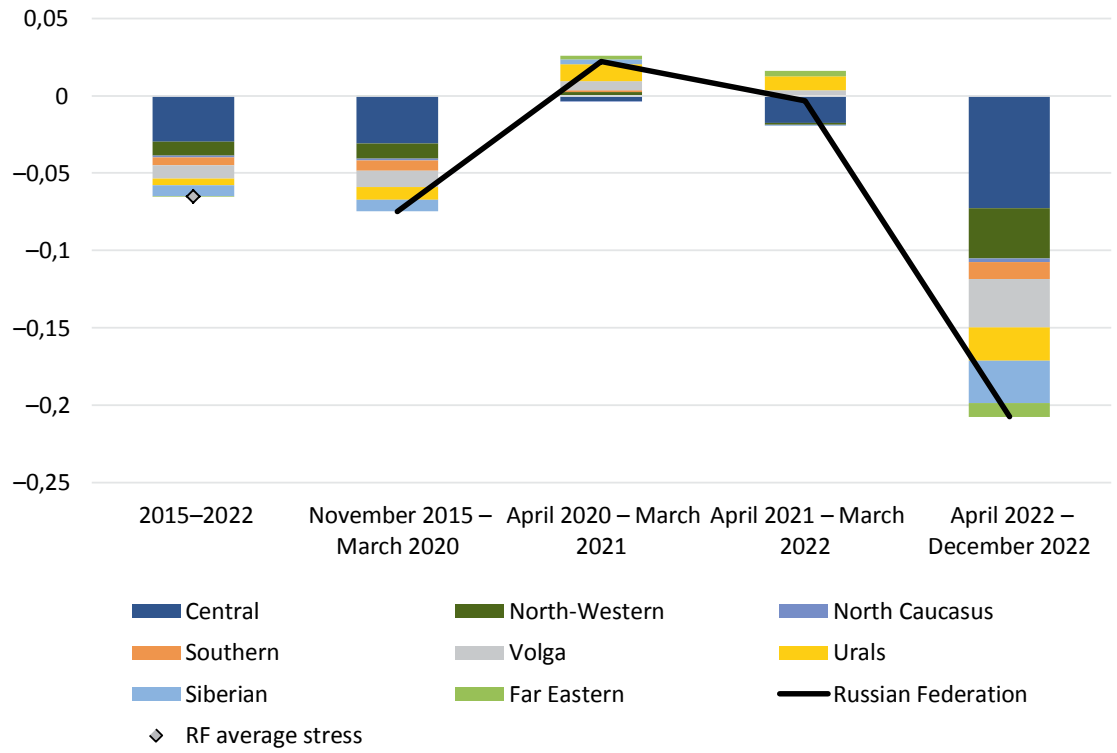

Figure 6. *Decomposition of stress of tax revenues to regional budgets by federal districts*

Source: the authors' calculations are based on statistical data of the Federal Tax Service. Retrieved from: https://www.nalog.gov.ru/rn77/related_activities/statistics_and_analytics/forms/ (date of access: 17.07.2022)

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their contributions turn positive. Notably, in the post-sanctions period of 2022, most regions exhibited stable growth in tax revenues to regional budgets. However, in the final three months of 2022, there was a notable decrease in growth rates and increased volatility of tax revenues, showing a mild impact on overall stress (as illustrated by Figures 1 and 2).

Conclusions

Applying the proposed methodology, we calculated the dynamic estimates of tax revenue stress for both federal and regional budgets in Russia's federal districts from 2013 to 2022, along with providing a detailed breakdown by sources.

The analysis reveals that, on average, stress in tax revenues to regional budgets surpasses that of tax revenues to the federal budget, with significant variations among districts. The Far Eastern and Urals Federal Districts exhibit the highest stress levels and variability, while the Southern Federal District experiences the least stress in federal budget revenues (though its contribution is small), and the Central Federal District has the lowest stress in regional budget revenues. There is a notable positive correlation between stress values for the federal and regional budgets in Russia and some federal districts, except for weakly negative correlations in the Central and North-Western Federal Districts.

It is demonstrated that the difference in the level and dynamics of tax revenue stress in federal districts both among themselves and for different levels of the budget system is explained by a number of factors: the structure of tax revenues, dynamics (growth rates and volatility) of different taxes and correlation of revenues in them. Proper diversification of the tax portfolio contributes to the reduction of the overall level of stress and decreases the reaction of tax revenues of the regions to external shocks.

The decomposition of tax revenues by sources showed that some highly productive taxes (natural taxes and profit tax), which are the main sources of stress for federal and regional budgets in periods of crises, become its main dampers in periods of recovery growth. A similar situation is observed in the districts (to a greater extent it concerns the Urals Federal District). At the same time, the Central Federal District remains the main stress dampener of revenues to the budgets of both levels in all periods.

These findings offer valuable insights for advancing theoretical and methodological approaches to stress measurement in tax systems. Moreover, they provide practical guidance for regional and federal authorities in managing tax revenue risks at different budget levels, identifying vulnerabilities, and proposing strategies for overall sustainability through risk distribution and enhanced tax portfolio diversification.

The study's limitation lies in its focus on internal sources of stress, without considering external factors. Future research should address this limitation by incorporating external factors into the stress assessment model for regional tax systems.

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The effect of COVID-19 restrictions (lockdown) on GDP growth in CIS countries

Relevance. Global economy has suffered significant economic consequences as a result of the COVID-19. The impact of the pandemic crisis had generally been felt around the world. However, developing economies, with their many institutional constraints, have been much more affected by the crisis. This prompted governments to devise stringent policies to limit its destructiveness, with the goal of saving the populace while minimizing economic damage.
Research objective. We investigate the effect of government's stringent policies on economic growth and the influence of stringent policies and inflation on economic growth in CIS's countries.
Data and methods. Our analysis is conducted using quantile regression, which is an extension of the Johnson-Neumann interval OLS, and a simple slope analysis for the period from 1 March 2020 to 17 September 2021.
Results. Our findings show that the government's stringent policies have a negative effect on economy, reducing GDP growth by 4.9% in the mean model. Excessively stringent policies have a negative impact on the economy and the consequent decline in living conditions.
Conclusions. The findings of this study reveal that policymakers should take a targeted approach to COVID policies, considering the varying effects of stringency across different levels of economic growth and taking into account the potential interaction with inflation rates. By implementing policies that balance the need for public health and economic growth, policymakers can mitigate the negative impacts of COVID restrictions on the economy and minimize the risk of stagnation traps.

KEYWORDS
GDP growth, COVID-19, stringency index, inflation rate, CIS country, quantile regression.

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Воздействие ограничительных мер в условиях COVID-19 на рост ВВП в странах СНГ

Актуальность. Мировая экономика понесла значительные потери в результате COVID-19. Воздействие пандемического кризиса в целом ощущалось во всем мире. Однако развивающиеся экономики с их многочисленными институциональными ограничениями пострадали от кризиса в большей степени. В связи с этим правительствам пришлось разрабатывать жесткую политику, направленную на ограничение разрушительных последствий пандемии с целью спасения населения и минимизации экономического ущерба.
Цель исследования. Мы исследуем влияние жесткой политики правительства на экономический рост, а также влияние жесткой политики и инфляции на экономический рост в странах СНГ.
Данные и методы. Анализ проводится с использованием квантильной регрессии, которая является расширением интервального метода наи-

КЛЮЧЕВЫЕ СЛОВА
Рост ВВП, COVID-19, индекс правительственных ограничений, уровень инфляции, страны СНГ, квантильная регрессия

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меньших квадратов Джонсона-Неймана и простого наклонного анализа для периода с 1 марта 2020 года по 17 сентября 2021 года.
Результаты. Результаты исследования показывают, что правительственные ограничения оказывают негативное влияние на экономику, снижая рост ВВП на 4,9% в средней модели. Проведение излишне жесткой политики оказывает негативное влияние на состояние экономики и, как следствие, снижает уровень жизни.
Выводы. Результаты данного исследования показывают, что политикам следует применять целенаправленный подход к разработке политики противодействия COVID, с учетом различного воздействия ограничительных мер в зависимости от уровня экономического роста страны и с учетом потенциального взаимодействия с инфляционным показателем. Проводя политику, обеспечивающую баланс между потребностями здоровья населения и экономическим ростом, государственные органы могут смягчить негативное влияние ограничений COVID на экономику и минимизировать риск возникновения ловушек стагнации.

ДЛЯ ЦИТИРОВАНИЯ
Джураева, З., Окрах, Д. и Назири, Г. Н. (2023). Воздействие ограничительных мер в условиях COVID-19 на рост ВВП в странах СНГ. *R-Economy*, 9(4), 422–436. doi: 10.15826/recon.2023.9.4.026

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期间的限制性措施对独联体国家国内生产总值增长的影响

现实性：COVID-19 给世界经济造成了重大损失。全世界普遍感受到了这一疫情危机的影响。然而，一些发展中经济体由于存在许多体制限制，受危机的影响更为严重。因此，各国政府必须制定严格的政策来限制疫情的破坏性影响，以拯救民众和最大限度地减少经济损失。
研究目标：我们研究了政府紧缩政策对经济增长的影响，以及紧缩政策和通货膨胀对独联体国家经济增长的影响。
数据与方法：分析采用了分位数回归，该方法的基础是Johnson-Neyman（JN）的最小二乘法；以及简单斜率分析法，分析期为 2020 年 3 月 1 日至 2021 年 9 月 17 日。
研究结果：研究结果表明，政府的限制措施对经济产生了负面影响，在平均模式下，国内生产总值的增长率降低了 4.9%。实施过于严格的政策会对经济状况产生负面影响，从而降低生活水平。
结论：本研究结果表明，政策制定者在制定应对 COVID 的政策时应采取有针对性的方法，考虑到限制性措施因国家经济增长水平不同而产生的不同影响，并考虑到通货膨胀率的潜在作用。通过实施兼顾公共卫生需求与经济增长的政策，政府当局可以减轻 COVID 限制措施对经济的负面影响，最大限度地降低陷入停滞陷阱的风险。

关键字
GDP 增长、COVID-19、政府限制指数、通货膨胀率、独联体国家、分位数回归

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Introduction

The COVID-19 pandemic has become one of the world's greatest challenges since World War II, with its economic impact far more widespread and severe than most previous crises, this recent disease outbreaks has caused far greater economic damage than any other crisis known till today. Moreover, COVID-19 has caused significant disruption to global value chains, now accounting for more than two-thirds of global trade (Lucas, 2020). To prevent the spread of the virus, governments have implemented lockdowns and restricted the movement of people (Kumar et al., 2021).

The implementation of COVID-19 pandemic movement restrictions as part of countries' control measures has implications for food security, as movement restrictions coincided with planting periods for most staple crops (Ayanlade, Radeny, 2020). The lockdowns triggered by the outbreak have significantly impeded economic activity and thus the income cycle (Henry, 2021). Furthermore, declining economic activity and the perception of income cycles pose challenges to economic growth in most countries (Inegbedion, 2021; Smianov et al. 2020; Ashraf& Goodell, 2022).

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According to the Organization for Economic Cooperation and Development[1] the containment measures put in place to prevent the spread of the COVID-19 pandemic have resulted in many businesses being temporarily closed, chaos spread in financial markets, and the erosion of confidence, increased trade uncertainty, and travel and movement restrictions. The main consequences were output falls by 20–25 % in many economies, with consumer spending possibly falling by a third. This has affected GDP growth in most countries, especially in the services and retail sectors, construction works and non-essential manufacturing, the latter being the least affected as most manufacturing firms are less labor intensive.

König and Winkler (2021) found that the impact of mandatory social distancing imposed by lockdown policies and voluntary social distancing triggered by COVID-19 fatality rates on GDP growth in the first three quarters of 2020 was the most severe. They found that more restrictive measures resulted in lower GDP growth. Fezzi and Fanghella (2020) discovered that Italy's GDP declined by 30% over a 3-week period due to the severe lockdown policies. Jena et al. (2021) found that in the April-June of 2020 GDP figures for eight countries, namely the United States, Mexico, Germany, Italy, Spain, France, India, and Japan, experienced sharp declines.

To investigate the impact of the government's rigorous policies on economic growth, as well as the interplay between stringent policies and inflation on economic growth, we conducted an empirical study across CIS countries. The countries included in the study are Armenia, Belarus, Kazakhstan, Kyrgyzstan, Russia, Tajikistan, and Uzbekistan. The study spans the period from March 1, 2020, to September 17, 2021. We employed a quantile regression model, which is an extension of the ordinary least squares (OLS) method, to examine the linkage between economic growth, stringency index, and inflation rate. We found that government policies that are more stringent have a significantly negative effect on economic growth, regardless of the level of growth. The results showed that GDP growth would decrease by 4.9 % in the mean model due to these stringent policies, leading to what Fornaro and Wolf (2020) referred to as stagnation traps. This happens because businesses are hesitant to invest in uncertain situations, leading to weak economic growth.

The study also examined the interaction between the stringency index and inflation rate using the Johnson-Neymar interval. The results indicated that if restrictions are overextended, their impact becomes extremely harmful to the economy. On the other hand, the interaction effect between stringency and the inflation rate has a positive effect on the economy, provided that the measures are not too extreme and are not continuous. This study contributes to the existing literature on the impact of government policies on economic growth and inflation in CIS countries. It highlights the importance of finding the right balance between stringent policies and economic growth, particularly in times of uncertainty. The findings could be useful for policymakers in developing countries who are grappling with the economic fallout from the COVID-19 pandemic and other crises.

The rest of the paper follows this structure: Section 2 outlines the theoretical framework; Section 3 presents the research hypothesis; Section 4 introduces the methodology and data set; Section 5 contains the results and discussion; and the final section offers some concluding considerations.

Theoretical framework

Effect of COVID-19 on the economy

The effect of COVID-19 on the global economy has been profound and far-reaching, creating an intricate web of challenges that have reverberated across industries and nations. As the pandemic swiftly spread, it triggered an unprecedented series of events, leading to a cascade of economic disruptions.

The economies of many countries have been severely impacted by the pandemic (Akbulaev et al. 2020). In fact, the global recession caused by COVID-19 is the worst since World War II. According to the April 2021 IMF World Economic Outlook report, the global economy in 2020 will contract by 3.5 %, down 7% from its October 2019 growth forecast of 3.4 %. At the global level, fiscal support reached nearly $16 trillion in 2020 (Yeyati & Filippini, 2010). The Chinese economy is also losing its position as the world's leading exporter. Although transport, tourism, trade, health, and

[1] Organisation of Economic Cooperation and Development. Report 2020. Retrieved from https://www.Organisation-of-Economic-Cooperation-and-Development.org/coronavirus/policy-responses/evaluating-the-initial-impact-of-COVID-19-containment-measures-on-economic-activity-b1f6b68b

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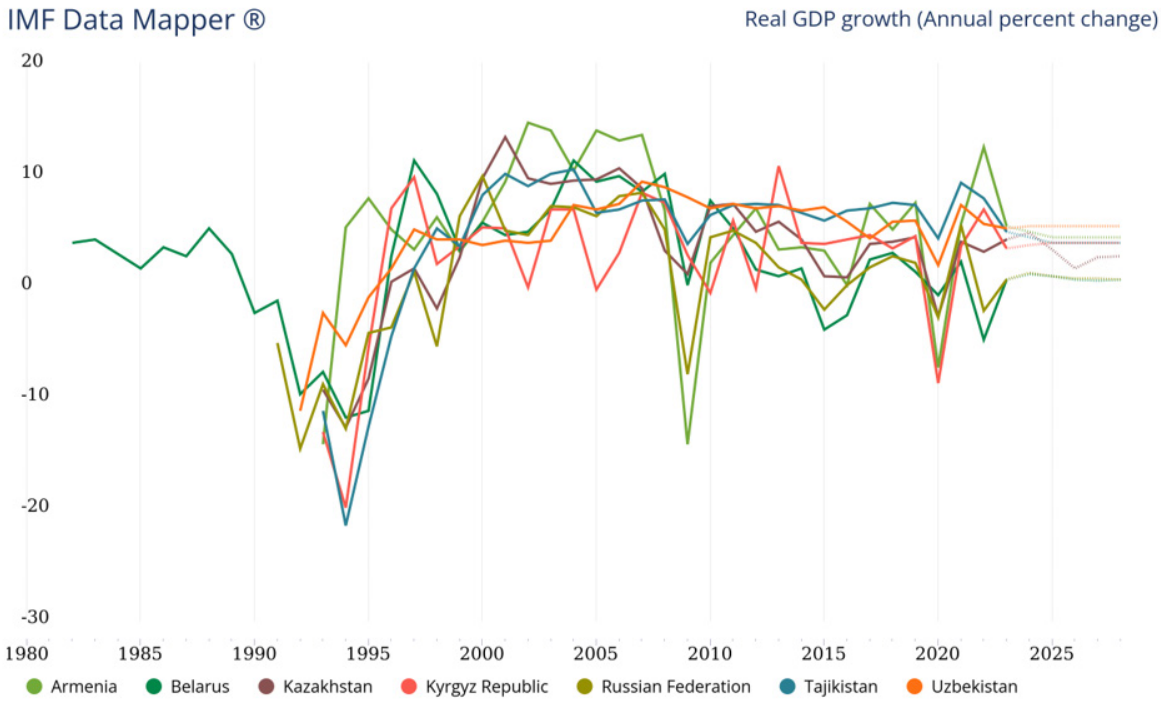

Figure 1. *GDP growth of CIS countries during COVID-19 pandemic*
Source: International Monetary Fund. Retrieved from: https://www.imf.org/external/datamapper/index.php

other sectors have been affected by the pandemic, the economic sector most affected by COVID-19 is the household sector (Susilawati et al., 2020). According to the World Bank's report[2], trade in goods declined sharply, contributing to the economic decline of producing countries, but reflecting a displacement of demand for goods from contact-intensive services (hindered by COVID-related restrictions and recovered rapidly) and the significant resilience of global value chains to the temporary disruptions in the first half of this year. Beckman and Countryman (2021) analyze the agricultural sector and conclude that the effects of COVID-19-induced changes will have a more significant influence on the overall US economy compared to the initial contribution of agriculture to the economy during the onset of the pandemic. However, non-agricultural shocks surpass agricultural impacts by a factor of three, according to their findings.

According to Dhar (2020), due to the COVID-19 outbreak, imports to China fell by 4 % year-on-year to $299.54 billion, while exports from China dropped to $292.45 billion in January-February 2020. It decreased by 17.2 % from the previous year (Dhar, 2020). Using radiofrequency indicators, Chen et al. (2020) examined the economic impact of his COVID-19 in Europe and the United States during the early stages of the pandemic. They found that countries in Europe and the United States that experienced large outbreaks suffered greater economic losses. European energy consumption witnessed a significant reduction, ranging from 20–29 % in the median weekly production of countries in mid-April. The most affected nations, such as Italy and Spain, experienced nearly double the decrease. Similarly, U.S. electricity usage saw a substantial decline, with average daily usage in early April dropping by 5 % compared to the same period in 2019. Moreover, the first six weeks of the pandemic saw a surge in new unemployment claims, reaching 30 million, leading to a decline in employment and labor force participation (Bick & Blandin, 2021).

The economic repercussions of COVID-19 in these countries include escalating healthcare expenses, market failures within multidimensional healthcare systems, heightened domestic spending, an upsurge in the burden of non-communicable diseases, and a decrease in GDP (Figure 1).

[2] The World Bank. (2021). Global Economic Prospects, January 2021: Subdued Global Economic Recovery. January. Washington, DC.

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Additionally, there are socioeconomic implications, including increased unemployment and poverty stemming from missed economic opportunities.

During the pandemic, remittances from migrant workers abroad are a major component of GDP affected by the COVID-19 crisis. According to Ibbotson (2020) at the start of the crisis, as many as 4.2 million Central Asians were working in Russia alone, and many others in Europe, Turkey, Middle East and China. Further, it is also mentioned that remittances contribute between 30 and 50 percent of GDP in Kyrgyzstan and Tajikistan in a typical year. This figure is lower in percentage terms in Kazakhstan and Uzbekistan, but it is still a significant amount (Ibbotson, 2020). Economic activity in Russia decreased by almost 25% (Kolomak, 2020), while in Belarus, external economic transactions with the rest of the world resulted in a current account deficit of $0.2 billion, equivalent to 0.4% of GDP (Bandarenka, 2022). The Uzbek economy weakened in part due to lower prices and supplies of natural gas to Russia and China, as well as lower remittances from migrant workers in Russia (about $1.3 billion) (Kurpayanidi & Abdullaev, 2021). According to Shimizutani and Yamada (2021), the COVID-19 pandemic has had a negative impact on the economy of Tajikistan by reducing migration and remittances. The authors examined the impact of COVID-19 on various welfare outcomes of households in Tajikistan, where remittances have recently exceeded a quarter of annual GDP, using a dataset about households. Monthly single family covers the pre- and post-pandemic period. They found that the negative impacts of the pandemic on the health of households were substantial after April 2020 and were particularly pronounced in the second quarter of 2020. Employment and household incomes fell, food insecurity immediately worsened with the first confirmed cases of COVID-19, and it continued to worsen six months after the start of the pandemic in Tajikistan (Murakami, 2022).

Stringency and economic growth

In the initial phases of the pandemic, most countries prioritized measures such as social distancing and testing for individuals infected with COVID-19 to curb the spread of the novel coronavirus. Furthermore, many nations implemented travel restrictions as a means to manage infections resulting from the new coronavirus (Kumar et al., 2021).

In March 2020, when the pandemic struck Central Asia, the region found itself unprepared and responded in varied ways. During the period from March to May, Kazakhstan, Kyrgyzstan, and Uzbekistan promptly acknowledged the pandemic and implemented diverse measures. These measures ranged from declaring a state of emergency to imposing quarantine measures and enforcing strict lockdowns, including significant restrictions or closures of borders and countries. In July, Kazakhstan and Uzbekistan re-imposed restrictive measures, and Tajikistan announced its first COVID-19 cases in May (Balakrishnan, 2020). Russia implemented restrictive measures on March 30, 2020 (Osadchuk et al., 2020). In March 2020, Belarus imposed relatively mild restrictions on travellers arriving in the country in self-isolation (Charemza et al., 2022). Lockdowns have adverse effects on society, the economy, and education, as highlighted by Kumar et al. (2021). Consequently, the economies of these countries experience negative consequences, as illustrated in Figure 2.

The increase in the number of cases and deaths caused by the coronavirus has also forced governments of the world's major economies to take stringent restrictive measures.

To curb the spread of the disease, the Chinese government had to close down major manufacturing hubs. This disruption in China, being a significant manufacturing center, has had a ripple effect on global supply chains, impacting various sectors, ranging from pharmaceuticals to automotive. Many countries, witnessing primary infections in endemic areas, responded by suspending flights and closing borders, leading to a significant reduction in travel, numerous flight cancellations, and substantial losses for airlines (Gupta et al., 2020).

König and Winkler (2021), utilizing evidence of GDP growth in 42 countries during the first, second, and third quarters of 2020, identified changes in lockdown severity as the most crucial factor influencing GDP development. The inclusion of a lag variable enables the distinction between two effects: a negative impact where more restrictive measures result in lower GDP growth in the same quarter, and a positive catch-up effect associated with austerity occurring one quarter later. Cross et al. (2020) examined the stringen-

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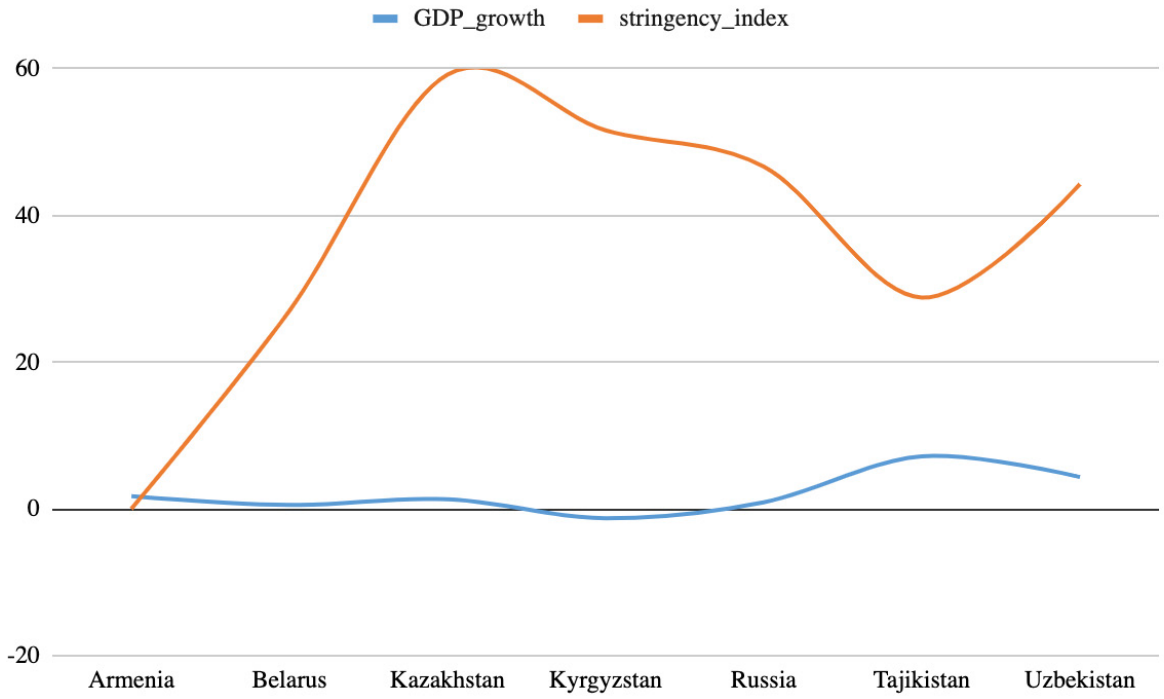

Figure 2. *Government response from COVID-19 and its effect on GDP growth of CIS countries.*

Note: Stringency index — Oxford Coronavirus Government Response Tracker (OxCGRT). The policy stringency index ranged within the score from 0 to 100. The higher is the score, the higher is the level of policy response.

Source: calculated by the authors based on World Population Review, Retrieved from: https://worldpopulationreview.com/country-rankings/gdp-growth-by-country (data of access: 15.10.2022); Tradingeconomics.com,retrieved from: https://tradingeconomics.com/country-list/gdp-annual-growth-rate?continent=world (data of access: 15.10.2022); Our World in Data, retrieved from: https://ourworldindata.org (data of access: 17.10.2022).

cy of the response, quantified by the stringency index, and examined how restrictive interventions affected infection rates and gross domestic product in China and her OECD countries. They found that China imposed the most stringent restrictions and Sweden and Japan the least stringent, given the response timeframe. The projected GDP decline ranges from -8% (Japan) to –15.4% (UK). Tighter restrictions generally slowed virus transmission but did not reach statistical significance and decreased GDP ($p = 0.006$).

Timing played a crucial role: Governments that swiftly responded to the pandemic witnessed a notable reduction in virus infections ($p = 0.013$) but also experienced a significant decrease in GDP ($p = 0.044$). As a result, the authors argue that the timing of COVID-19 intervention has a more substantial impact on GDP than on infection rates. To support sectors of the economy, governments have expanded measures to support the economy. The U.S. government introduced more than 50 economic assistance programs, including moratoriums on small business debt service costs, fines, taxes, penalties, utility bills, and insurance premiums[3].

During the global pandemic, governments worldwide implemented measures to mitigate its economic impact and offered financial support to their citizens. They formulated economic recovery strategies, including injecting funds into the economy through stimulus packages, to alleviate the hardships faced by the people. Specifically, the Spanish government implemented income and liquidity support measures, which were expected to reach 3.7% of GDP in discretionary measures and around 15.6% of GDP in off-budget measures (Aspachs et al., 2021). The UK government also announced additional support for businesses in retail, hospitality, and leisure following the Prime Minister's declaration of a third lockdown,

[3] Viney, B., Bowles, J., Dvorkin, E., & Gallagher, L. (2020). Supporting small business through coronavirus: Ideas from experts and leaders across NYC. The Center for an Urban Future. Retrieved from https://nycfuture.org/research/supporting-small-business-through-coronavirus.

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with a package totaling £4.6 billion[4]. 44 of WTO members announced urgent stimulus and backstop measures for businesses by April 2020. These measures primarily include government loans and loan guarantees, moratoriums on interest and principal on unpaid loans, tax and rent exemptions, and relaxation of financial regulations (release of deposits or restricted cash). Furthermore, France announced the subsequent payment of unguaranteed direct taxes and loans without any actual guarantees for the assets of the company or its management. Declared a two-month delay in filing annual tax returns. In March 2020, the United Arab Emirates announced extension of filing tax returns, six-month arrears on rent, relaxation of installment payments, refund of deposits and security deposits, end of fines. Qatar also announced on March 15 a six-month grace period for installment payments on unpaid loans and interest payments for a temporary waiver of water and electricity bills (Assefa, 2021). The top ten countries with the highest percentage of GDP allocated to stimulus packages, in comparison to the rest of the world, were Bahrain, Malta, Austria, Luxembourg, France, Oman, Belgium, Sweden, Germany, and Malaysia, with percentages of 31.30, 25.61, 25.11, 22.91, 22.59, 22.59, 19.61, 18.65, 17.29, and 16.42 %, respectively (Vitenu-Sackey, Barfi, 2021).

Adapting strategies from other nations, the governments of CIS countries have customized them to suit their specific economic and social circumstances. For instance, at the beginning of 2020, the Armenian government devised anti-crisis measures, encompassing several essential activities aimed at bolstering the socio-economic situation within the country. The amount of government support was about 150 billion Armenian dram or about 2.3 % of national GDP (Voskanyan, 2022). In Belarus, the government limited itself to economic stimulus measures, which included a revision of the refinancing rate of the National Bank of the country to 7.75 percentage points, which consequently made loans cheaper for households and businesses. In Kazakhstan, 5.9 trillion tenge ($13.98 billion or 9.0 % of GDP) was allocated. Beneficiaries were earmarked to improve access to health care, to provide payments to those who had lost their jobs, and to support businesses (Sabyr, Әbilqayır, 2021). Similarly, in Russia a total of 2.9 trillion roubles ($39.77 billion, equivalent to 2.7 % of GDP) was allocated to the response to the pandemic. These subsidies included subsidies of various forms, mostly for households, about 0.8 % of GDP, tax deferrals and exemptions of 0.3% of GDP, and loans and state guarantees of 1.4 % of GDP (Klepach, 2020).

In July 2020, Tajikistan increased state budget expenditure on medicine by 90 %, rising from USD 178.5 million to USD 334 million. The State Sanitary and Epidemiological Surveillance Service was reinstated in May 2020, leading to a tight schedule for the country's hospitals and polyclinics, along with the organization of training and retraining courses for medical personnel. By July 2020, the number of laboratories capable of conducting relevant tests had increased from two to ten, with the daily number of coronavirus tests reaching 1,500–2,000. Since autumn 2020, the government has provided material assistance to the most vulnerable groups of citizens. The Antimonopoly Service of Tajikistan intensified control over prices for essential consumer goods and medicines. Tariffs for electricity, communications, and utilities were temporarily frozen, and tax holidays were granted to the affected sectors of the economy (Popov, 2021).

Uzbekistan also developed a programme to support the economy and reduce the negative effects of the coronavirus pandemic. On 19 March 2020, President Shavkat Mirziyav signed a decree designed to mitigate the impact of the coronavirus epidemic on the economy, focusing on four points: containing the spread of the coronavirus, supporting businesses, expanding social protection measures, and ensuring the continued functioning of the financial sector. The decree allocated 10 trillion UZS (about US $1.05 billion) to the Anti-Crisis Fund. The fund was used to help affected entrepreneurs and government companies, as well as to provide social assistance to the population (Teshaboeva, 2020).

While the restrictive measures adopted by national governments have curtailed the spread of the virus, these policies have dampened the pace of economic growth.

Hypotheses

The impact of COVID-19 on the global economy has been unprecedented. In response, governments worldwide implemented stringent policies to mitigate its destructive effects, aiming to protect the population while minimizing economic

[4] Lea, R. (2021). Another lockdown and more Government support. Arbuthnot Banking Group, 11.

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damage. The stringency index reflects the degree of strictness in government-imposed restrictions on businesses, hindering the free flow of goods, services, and funds within and between economies (Hale et al., 2020; König, Winkler, 2020).

"We know how to revive the economy; what we don't know is how to bring people back to life," remarked the President of Ghana[5]. This quote holds particular relevance in the context of this paper, which focuses on CIS countries. It encapsulates the profound dilemma faced by governments globally, including those in the CIS region, in responding to the dual challenges of the COVID-19 pandemic. This statement underscores the intrinsic tension between safeguarding public health and minimizing economic damage, a delicate balance that is central to your examination of the impacts and policy responses within the CIS countries in the wake of the COVID-19 crisis.

Lockdowns limit labor supply and improve health prospects at the expense of economic production and consumption. Health conditions are not fixed but undergo changes in line with the SIRD model. The trade-offs encountered by governments are dynamic rather than static, and the issue of time discrepancies transforms over time (Ferguson et al., 2020).

Extant research has shown that stringent policies by the government had a negative effect on the economy. According to Coibion et al. (2021), higher uncertainty leads to lower spending by households on nondurable goods and services. Trade and transportation disruptions resulted in a significant drop in remittances and government revenues, resulting in urgent balance of payments and fiscal financing requirements. Most developing countries depend on remittances from families abroad, which is especially true for the countries under study. Businesses are the fuel that powers the economy and if this power is no more the economy comes to a standstill. According to Kolomak (2020), economic activity in Russia decreased by nearly 25% as a result of the lockdown measures, with some regions experiencing a more than twofold decrease in production output. The COVID-19 shock was amplified by the plunge in oil prices and the accompanying volatility in financial markets. This sent shockwaves to the surrounding CIS countries like Armenia, Uzbekistan, Tajikistan. According to a McKinsey & Company report[6], "lockdowns also cause uncertainty to remain high", and "this uncertainty is paralyzing". The uncertainty that came along with the lockdown caused the collapse of a lot of SMEs. With the above stated points in mind, we are going to put forward the following hypotheses.

H1: The CIS governments' stringent policies had a severe negative effect on economic growth.

As the pandemic unfolded, global inflation initially showed signs of moderation, continuing a downward trajectory during the initial months of the crisis. However, from late 2020 onward, escalating prices steadily propelled inflation to higher levels. In the 18 months following the onset of 2021, the average global cost of living surged at a pace surpassing the cumulative increase of the preceding five years. This inflationary surge can be attributed to a decline in aggregate supply, a phenomenon driving the nominal rate upwards within the conventional RANK model.

The fundamental reason behind this inflationary trend lies in the disproportionate contraction of aggregate demand relative to aggregate supply, exacerbated by stringent government policies. These measures, including widespread lockdowns and business closures, severely disrupted global supply chains, resulting in substantial losses for both national and international enterprises. In an effort to counteract the financial repercussions on individuals and small businesses, governments simultaneously implemented policies such as issuing stimulus checks and augmenting unemployment benefits.

Auray and Eyquem (2020) highlight the significant impact of lockdowns on employment, emphasizing that if the number of employed workers is adversely affected, the ensuing negative effects become markedly pronounced, inducing deflationary pressures. In response to the economic downturn, governments injected substantial amounts of money into the system through expansive stimulus packages. While averting a prolonged and deep recession, the unprecedented size of these global

[5] Ghanaweb. (2022). Retrieved from https://mobile.ghanaweb.com/GhanaHomePage/NewsArchive/Things-are-getting-better-and-will-get-better-Akufo-Addo-assures-Ghanaians-1794203

[6] Smit, Sven, Martin Hirt, Penny Dash, Audrey Lucas, Tom Latkovic, Matt Wilson, Ezra Greenberg, Kevin Buehler & Klemens Hjartar. (2020). Crushing Coronavirus Uncertainty: The Big 'Unlock' for our Economies, Report, McKinsey & Company

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stimulus packages, as documented by Elgin et al. (2020), resulted in an excess of money circulating in the economy, leading to demand-pull inflation. This brings us to our second hypothesis:

H2: The interplay of stringent government policies and inflation had a positive impact on economic growth in CIS countries.

In essence, the intricate dynamics of government measures, economic shocks, and unprecedented stimulus efforts converged to reshape global economic conditions during the pandemic, creating an environment where inflation became both a consequence of disrupted supply chains and a tool for stimulating economic recovery, particularly in the context of the Commonwealth of Independent States (CIS).

Data and Methods

The main purpose of this study is to show the impact of restriction measures on economic growth in the CIS. To achieve our goal, we use a quantile regression model, an extension of OLS. Quantile regression estimation is more resilient to outliers. To examine interaction effects, we use Johnson-Neimann intervals and simple slope analysis. The Johnson-Neyman interval provides two moderator values at which the slope of the predictor goes from insignificant to significant. The form of the investigated OLS regression is the following:

$$GDP\_growth_{it} = \beta_0 + \\ + \beta_1 stri\_index_{it} + \beta_2 infl\_rate_{it} + \\ + \beta_3 unemp\_rate_{it} + \beta_4 hd\_index_{it} + \epsilon_{it}, \quad (1)$$

where GDP_growth_{it} is the dependent variable and $stri\_index_{it}$ is the research variable, i is the country, t is time and ϵ is the error term. The data are further elaborated below.

We use weekly panel data from March 1, 2020, till September 17, 2021.We chose the following CIS countries for our research: Armenia, Belarus, Kazakhstan, Kyrgyzstan, Russia, Tajikistan, and Uzbekistan. As a dependent variable we use GDP growth rate (GDP_growth_{it}) from World Population Review and tradingeconomics.com[7,8].

To determine the impact of government measures to contain the outbreak and their impact on economic growth, we examined indicators from the Oxford Coronavirus Government Response Tracker — stringency index ($stri\_index_{it}$). This is a basic index calculated using data from the 9 main components: school closures, workplace closures, cancellation of public events, restrictions on public gatherings, closure of public transport, house arrest, restrictions on internal freedom of movement, restrictions on international travel, public relations campaigns.

$stri\_index_{it}$, ranged between 0 and 100. The higher is the score, the higher is the level of policy response (Charemza et al. 2022). We have collected data from Our World in Data (https://ourworldindata.org). Nominal GDP is often adjusted for inflation to reflect real GDP (Sarel, 1996). Based on this, we used the inflation rate ($infl\_rate_{it}$) from the Eurasian Commission and tradingeconomics.com. Unemployment is a major cause of widespread poverty and income inequality. Therefore, understanding the relationship between unemployment rate and economic growth during the covid-19 pandemic is extremely important. We add unemployment rate ($unemp\_rate_{it}$) and get data from the World Bank, National Bank of Tajikistan and tradingeconomics.com and human development index (hd_index_{it}). The hd_index_{it} is a measure that summarizes key aspects of human development: a long and healthy life, a good education and a good standard of living. We have collected data from Our World in Data (https://ourworldindata.org). Tables 1 and 2 provide descriptive statistics and correlations of the variables.

Results and Discussion

The magnitude and intensity of the coefficients on our predictors change across the quantiles, as shown in Table 3. Government stringent policies have a negative effect on GDP growth, which will decrease GDP growth by 4.9% in the mean model. The results of the quantile regression suggest that the effect of stringency on the dependent variable varies across different quantiles of the distribution. Specifically, the 40th percentile shows the highest effect of stringency, followed by the 80th percentile, while the lowest effect is indicated in the 20th percentile, which is also negatively insignificant. The 60th percentile indicates the weakest level of significance. These

[7] World Population Review. Available at: https://worldpopulationreview.com/country-rankings/gdp-growth-by-country (data of access: 15.10.2022).

[8] Tradingeconomics.com. Available at: https://tradingeconomics.com/country-list/gdp-annual-growth-rate?continent=world (data of access: 15.10.2022).

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Table 1

Descriptive Statistics

	n	mean	sd	Skew	kurtosis	se	min	max
GDP_growth_{it}	931	2.10	5.36	–0.50	0.15	0.18	–13.50	13.30
$unemp\_rate_{it}$	931	10.09	3.42	0.46	–0.21	0.11	3.70	17.90
$infl\_rate_{it}$	931	7.66	4.46	1.51	1.81	0.15	2.90	21.20
$stri\_index_{it}$	931	36.80	25.23	0.11	–0.82	0.83	0.00	92.73
hd_index_{it}	931	0.76	0.06	-0.27	–1.58	0.00	0.67	0.83

Source: calculated by the authors

Table 2

Pearson Correlation

Index value	GDP_growth_{it}	$stri\_index_{it}$	$infl\_rate_{it}$	$unemp\_rate_{it}$	hd_index_{it}
GDP_growth_{it}	1.00				
$stri\_index_{it}$	0.18	1.00			
$infl\_rate_{it}$	–0.03	–0.42	1.00		
$unemp\_rate_{it}$	–0.17	0.01	–0.47	1.00	
hd_index_{it}	–0.25	–0.08	–0.21	0.04	1.00

Source: calculated by the authors

Table 3

Empirical results of the quantile regression of the variables

	OLS	20th	40th	60th	80th
Intercept	21.274*** (2.582)	21.116* (9.172)	26.808*** (2.776)	26.541*** (5.374)	20.451*** (1.450)
$stri\_index_{it}$	–0.049*** (0.007)	–0.015 (0.031)	–0.056*** (0.009)	–0.027* (0.012)	–0.040*** (0.003)
$infl\_rate_{it}$	0.153** (0.056)	0.194 (0.137)	0.069 (0.039)	0.171 (0.097)	–0.067 (0.040)
$unemp\_rate_{it}$	–0.179*** (0.049)	–0.461** (0.168)	–0.058 (0.129)	0.082 (0.093)	0.189*** (0.031)
hd_index_{it}	–23.016*** (2.803)	–26.738** (8.674)	–30.566*** (2.790)	–31.851*** (5.915)	–17.580*** (1.787)
Adjusted R-squared	0.122				
Country FE	Yes	Yes	Yes	Yes	Yes

Source: calculated by the authors

Note: Coefficients and the standard errors in parenthesis. Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1.

findings suggest that the impact of stringency on the dependent variable is not uniform across the entire distribution, and there are significant variations in the effects at different quantiles. This implies that the effect of stringency on the dependent variable is not linear and may depend on the specific threshold or cutoff point of the dependent variable. Generally, the results of government stringent policies have a significantly negative effect on economic growth irrespective of the level of growth of the country. This confirms our first hypothesis (H1). The restrictive measures reduced the GDP of some CIS countries because most migrants lost their jobs or were unable to go to work in Russia due to government restrictions, closed borders, and flight cancellations. In Russia, oil production was reduced, and the price collapsed; production chains were also suspended, resulting in an economic downturn. Our results confirm the findings of Kok (2020) who investigated the short-term trade-off between the stringency of NPIs and economic growth. Alfaro et al. (2020) also indicate why there are variations in the effect of government stringentness on economic growth from different levels.

Inflation rate is only statistically significant for the mean model. The 20th, 40th, 60th and the 80th quantiles are not statistically significant.

Balancing rescue efforts with economic activity posed a significant challenge, which not all CIS countries were able to meet. This is partly due to certain governments heavily relying on foreign exchange flows, such as money repatriated from migrant workers, and facing budget deficits, making external borrowing more complicated.

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Under such circumstances, some countries have requested financial support and credit from international financial institutions such as the World Bank, IMF, AfDB and EBRD[9]. As a result, governments could manage inflation rates during lockdowns and predict their impact on economic growth.

The impact of the unemployment rate on GDP growth diminishes as GDP growth transitions from the 20th percentile to the 80th percentile. The 80th percentile exhibits the strongest positive significance, while the 20th percentile is negative with a less robust significance level. The relatively low effect of unemployment is attributed to the government's decision to retain jobs during the period of restrictive measures until the decline in the spread of the coronavirus. Additionally, in some of the countries under consideration, the duration of restrictive measures was relatively short.

Interesting findings emerge when examining the impact of the Human Development Index (HDI), revealing a consistently negative significance across all quantiles. Well-being, a constituent of HDI, has been previously explored in the literature, illustrating the effects of COVID-19 on overall well-being (Ranasingheet al., 2020; Rooney, & McNicholas, 2020; Maugeri, & Musumeci, 2021). This makes the results not surprising as the COVID-19 had a devastating effect on the physical, mental and psychological wellbeing of people which automatically translates into its effect on economic growth.

Coefficient Plots

The graph below depicts the difference in coefficients across quantiles using bootstrapped confidence intervals. It also includes the OLS estimates and their confidence intervals, which are constant across all quantiles.

Figure 3 shows that the majority of the OLS coefficients are within the confidence intervals of the quantile regression coefficients. This means that the quantile regression results are not statistically significantly different from the OLS results, except for the $unemp\_rate_{it}$ and hd_index_{it}.

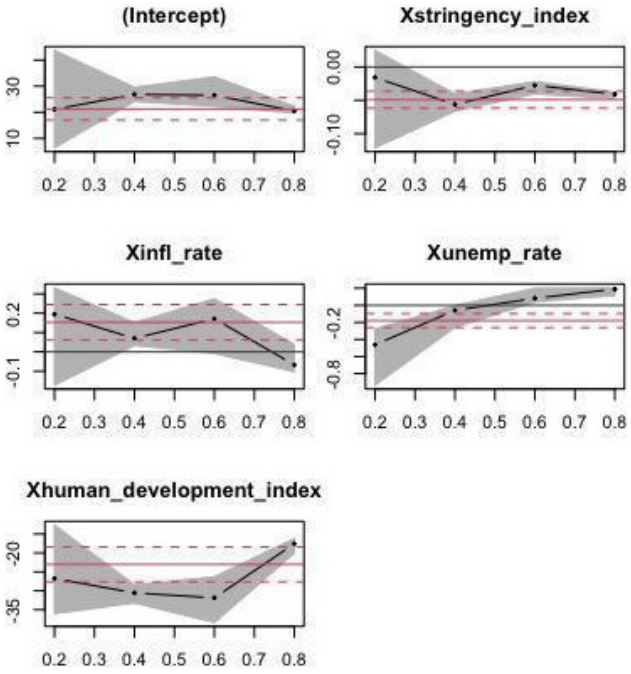

Figure 3. *Confidence intervals of coefficients*

Source: calculated by the authors

To identify the interaction of $stri\_index_{it}$ and $infl\_rate_{it}$. We use the Johnson-Neyman interval and simple slope analysis. The results are indicated in figure 4 and table 4. It is identified that when the $stri\_index_{it}$ is within the interval [–34.22, 93.51], the slope of $infl\_rate_{it}$ is $p < .05$. This indicates at all levels of government stringent policies, inflation rate positively moderated its effect on economic growth. When stringency equals 62. The interactive effect increases economic growth by 29 %.

This confirms our second hypothesis (H2). Stringent policies exceeding a certain threshold tend to exert a negative influence on the economy, as evidenced by the draconian measures implemented by the Chinese government. However, when such policies are not prolonged and are viewed as short-term measures, they can have a positive impact on the economy. Extended restrictions may diminish trust in the government, particularly within the business community, which bears the brunt of COVID-19 restrictions. Coccia (2021) found that prolonged lockdowns have a negative impact on GDP growth. Countries with longer lockups (i.e. ~2 months) from Q2 2019 to Q2 2020 experienced an average decline in GDP of around 21%, but had shorter lockups of around 15 days.

[9] Radjabov, B. (2020). Post-COVID-19: Challenges and Opportuntiies for Central Asia. Retrieved from Central Asia-Caucasus Institute: https://www. cacianalyst. org/publications/analytical-articles/item/13622-post-covid-19-challenges-and-opportunities-for-central-asia. html

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Table 4

Johnson-Neyman interval and simple slopes analysis for the interaction of inflation and stringency

Parameters	est	s.e	z.val	P
Slope of $infl\_rate_{it}$ when $stri\_index_{it}$ = 11.56610 (–1 SD):	0.28	0.06	4.60	0.00
Slope of $infl\_rate_{it}$ when $stri\_index_{it}$ = 36.79575 (Mean):	0.28	0.05	5.33	0.00
Slope of $infl\_rate_{it}$ when $stri\_index_{it}$ = 62.02540 (+ 1 SD):	0.29	0.09	3.27	0.00
When $stri\_index_{it}$ is INSIDE the interval [–34.22, 93.51], the slope of $infl\_rate_{it}$ is $p < .05$. The range of observed values of $stri\_index_{it}$ is [0.00, 92.73]				

Source: calculated by the authors

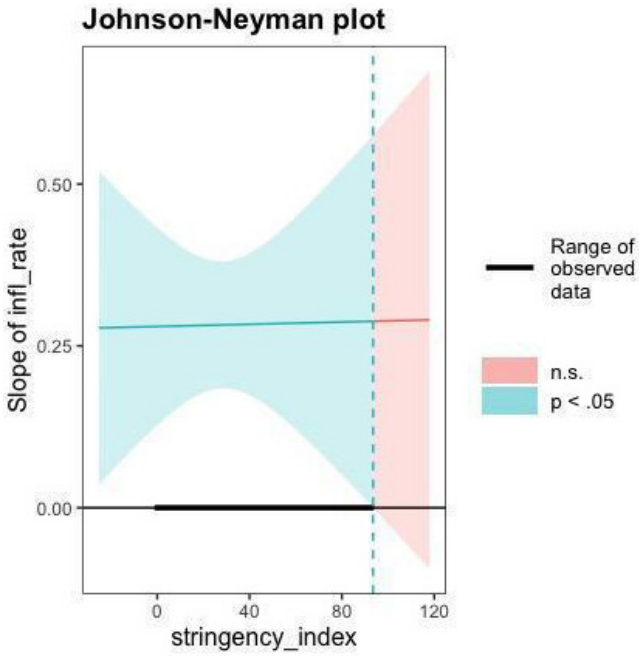

Figure 4. *Johnson-Neyman plot of the Interaction $stri\_index_{it}$ x $infl\_rate_{it}$ on economic growth. In the x label, $stri\_index_{it}$ standard deviations (SD). The y- plan slope of $infl\_rate_{it}$. Green areas represent significant ($p < 0.05$) slopes, and orange areas represent non-significant slopes. The tick line represents the range of observed data*

Source: calculated by the authors

Conclusion

This study examines the impact of stringent COVID policies implemented by various CIS governments on economic growth. Various governments imposed restrictions to slow the spread of the COVID pandemic at the expense of economic development. Using weekly panel data from March 1, 2020 till September 17, 2021 and quantile regression method, we discovered that stringent policies have a significantly negative effect on economic growth irrespective of the level of growth of the country. These stringent policies create what Fornaro and Wolf (2020) term as stagnation traps, leading to weak growth due to businesses' reluctance to invest in situations of uncertainty.

According to the most recent McKinsey Global Survey on Economic Conditions, inflation is the most frequently mentioned threat to economies[10]. We tested the interaction between stringency and inflation rate using the Johnson-Neymar interval. The findings suggest that when restrictions are excessively prolonged, their impact becomes highly detrimental to the economy.

The interaction effect has a positive impact on the economy when the measures are moderate and not continuous.

Based on the findings of this study, policymakers should aim for a balanced approach that addresses both public health and economic growth needs. While stringent policies may be necessary to curb the virus's spread, they should be implemented cautiously to minimize adverse economic effects. Targeted measures focusing on vulnerable populations, like the elderly and those with pre-existing conditions, can be considered, while ensuring minimal impact on other economic sectors.

Policymakers must also recognize the varied effects of stringency across different economic growth levels. The study indicates that stringent policies negatively impact economic growth regardless of a country's growth level. Therefore, policies should be customized to each country's unique economic circumstances and growth potential.

Additionally, policymakers should factor in the interaction between stringency and inflation rate when crafting COVID policies. The study

[10] McKinsey Global Survey. (2022). The coronavirus effect on global economic sentiment. Retrieved from https://www.mckinsey.com/capabilities/strategy-and-corporate-finance/our-insights/the-coronavirus-effect-on-global-economic-sentiment

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highlights that overly restrictive measures can harm the economy significantly. Hence, a balanced approach that considers both public health and economic growth, while addressing potential inflationary impacts, is recommended. Such a strategy can help mitigate the adverse effects of COVID restrictions on the economy and reduce the risk of stagnation traps.

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Challenges and potential of monotowns: a systematic literature review

Relevance. Monotowns, or single-industry settlements, are pivotal in the economic and social landscapes of former Soviet countries. This systematic literature review explores monotowns, examining their evolution, challenges and implications of these unique urban formations from the 18th century to the present day. The study's relevance lies in its comprehensive analysis of these towns, which have been significant yet underexplored in academic discourse.
Research objective. The objective of this review is to critically examine the multifaceted nature of monotowns, focusing on their socio-economic dynamics, challenges, and potential transformation. The review aims to elucidate the complex interplay of economic, social, and political factors that shape these towns and to identify unexplored areas in this field of study.
Data and Methods. To achieve these objectives, the study employs a systematic review protocol comprising four phases: search query, document type, publication stage, and language. This approach involves analyzing a wide range of sources from international and regional databases, ensuring a holistic view of monotowns that captures both historical and contemporary perspectives.
Results. Monotowns exhibit considerable resilience amidst economic fluctuations and confront distinct socio-economic challenges, including issues specific to mining monotowns and issues related to public health. The findings underscore the importance of adaptive strategies, corporate social responsibility, and proactive government intervention in addressing these challenges.
Conclusion. This review provides a comprehensive exploration of monotowns, contributing valuable insights for future research, particularly in understanding their socio-economic dynamics and the challenges they face. The study is significant for scholars in economic development of the territories and business studies, offering a foundation for further exploration of these unique urban formations.

KEYWORDS
Monotowns, single-industry towns, company towns, single industry, systematic literature review, bibliometric analysis

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Вызовы и перспективы моногородов: систематический обзор литературы

Актуальность. Моногорода, или монопрофильные населенные пункты, занимают центральное место в экономическом и социальном ландшафте бывших советских стран. В этом систематическом обзоре литературы исследуются моногорода, рассматривается их эволюция, проблемы и последствия создания этих уникальных городских образований, начиная с 18 века до наших дней. Актуальность исследования заключается в его всестороннем анализе этих городов, которые имеют большое значение, но недостаточно изучены в академическом дискурсе.

КЛЮЧЕВЫЕ СЛОВА
моногорода, моноотраслевые города, промышленный город, моноотраслевая экономика, систематический обзор литературы, библиометрический анализ

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Цель исследования. Целью данного обзора является критический анализ многогранной природы моногородов с акцентом на их социально-экономическую динамику, проблемы и потенциальную трансформацию. Анализ направлен на изучение сложного взаимодействия экономических, социальных и политических факторов, формирующих эти города, и выявление неизведанных областей в рамках этой тематики.
Данные и методы. Для достижения этих целей в исследовании используется протокол систематического обзора, состоящий из четырех этапов: поисковый запрос, тип документа, этап публикации и язык. Этот подход предполагает анализ широкого спектра источников из международных и региональных баз данных, обеспечивая целостное представление о моногородах, отражающее как историческую, так и современную перспективу.
Результаты. Моногорода демонстрируют значительную устойчивость к экономическим колебаниям и сталкиваются с различными социально-экономическими проблемами, включая проблемы, характерные для горнодобывающих моногородов, и проблемы, связанные со здравоохранением. Результаты подчеркивают важность адаптивных стратегий, корпоративной социальной ответственности и активного вмешательства правительства в решение этих проблем.
Заключение. В этом обзоре представлено всестороннее исследование моногородов, что дает ценную информацию для будущих исследований, особенно для понимания их социально-экономической динамики и проблем, с которыми они сталкиваются. Исследование имеет большое значение для ученых в области экономического развития территорий и бизнеса, поскольку дает основу для дальнейшего изучения этих уникальных городских образований.

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单一产业城市的挑战与前景：文献系统回顾

现实性：单一城市或单一定居点在前苏联国家的经济和社会景观中占据着中心位置。这篇系统的文献综述探讨了单一城市的独特形态，研究了它们从 18 世纪初至今的演变、挑战和更广泛的影响。这项研究的意义在于作者对这些城市的全面分析，这些城市虽然很重要，但在学术讨论中尚未得到充分研究。
研究目标：本综述旨在批判性地分析单一产业城镇的多面性，重点关注其社会经济动态、挑战和潜在转型。分析旨在探讨影响这些城市的经济、社会和政治因素的相互作用，并确定这一主题的未知领域。
数据与方法：为了实现这些目标，本研究采用了一种系统性审查方案，包括四个阶段：搜索查询、文件类型、出版阶段和语言。这个方案包括分析国际和地区数据库中的各种资料来源，提供反映历史和当代视角下的单一产业城市。
研究结果：单一产业城市表现出对经济波动的显着适应能力。它面临着各种社会经济挑战，包括采矿产业城市特有的挑战和健康问题。研究结果强调了适应性战略、企业社会责任和政府积极干预在应对这些挑战方面的重要性。
结论：本综述对单一产业城市进行了全面研究，为今后的研究提供了有价值的信息，特别是有助于了解这些城市的社会经济动态及其面临的挑战。本文章为进一步研究这些独特的城市形态提供了基础，对经济地理学者和商业学者具有重要意义。

关键词
单一城市、单一产业城市、单一工业经济、系统文献综述、文献计量分析

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Introduction

Monotowns, found in countries like Russia and Kazakhstan, are characterized not only by their demographic features but, more importantly, by their exclusive economic focus. Typically centered around a specific industry, these towns' economic and social prosperity depends on the success of that particular sector (Nurzhan, 2015). In Kazakhstan, towns with a population cap of up to 200,000 often exemplify the 'monotown' phenomenon, where the local economy is significantly influenced or dominated by a single industry. This demographic threshold underscores the tendency for smaller towns to evolve into monotowns, where the economic and social fabric is tightly interwoven with the fortunes of that predominant sector. The concept of monotowns is crucial not only for a better understanding of regional economic structures but also for analyzing broader socio-economic impacts and developmental strategies.

The conceptual inception of monotowns extends far beyond the Stalinist era. Although there's a prevalent narrative that links the prominence of monotowns primarily to the Stalinist period (Josephson, 2014; Venovcevs, 2021), it is essential to acknowledge the broader historical and global context of these urban formations. Monotowns have been a crucial element in shaping economic and social landscapes, especially in terms of industrial organization, since the early 18th century in Russia.

Analysis of these specialized settlements provides valuable insights when considering agglomeration, localized economies, and functional classification. This perspective reveals the complex interplay of their association with specific functional classes, influencing socio-economic trajectories and potentially leading to particular developmental patterns or lock-ins (Maksimova, 2015). The study of monotowns, therefore, offers significant value to both academic research and practical applications in regional development and urban planning.

This paper aims to bridge a knowledge gap by offering a comprehensive understanding of monotowns, a topic that has often been overlooked in systematic reviews. The study's objective is to present a nuanced examination of monotowns, exploring their characteristics, impacts, and evolution within different socio-economic frameworks.

To address this goal, we formulated the following research questions:

RQ1: What are the characteristics, advantages, and disadvantages of monotowns as discussed in the existing literature?

RQ2: What patterns can be observed in the publications discussing monotowns?

RQ3: What prospective avenues and focal points can be identified for future research on monotowns?

In dealing with these research questions, we adopted a dual methodological approach: firstly, through a systematic literature review (SLR) that canvassed international databases, and secondly, by delving deeper into non-indexed and regional studies via an extra literature review. This combined methodology not only enriches our understanding of the subject matter but also ensures a comprehensive analysis of both global and local perspectives.

In summary, this paper contributes to the existing literature by providing a detailed examination of monotowns, their role in socio-economic development, and their implications for future urban and industrial planning. The findings and discussions presented herein are intended to inform both academic discourse and practical decision-making in related fields.

Theoretical framework

Even though they are not explicitly called so, monotowns or monotown-like cities exist in countries other than Russia and Kazakhstan, such as Slovakia and Poland. These cities display similar characteristics and challenges that can be observed in a global context.

In Slovakia, the term "monofunctional city" is used to describe monotowns, which emerged due to the country's previous industrial orientation. After the Velvet Revolution in 1989, only a handful of cities with significant dominant companies successfully adjusted to the new socio-economic organization of the state. Monotowns like Podbrezová, Partizánske, and Svit exemplify this, being primarily characterized by steel and footwear industries. Nonetheless, these cities have diversified their economies in recent years by incorporating new industries and services (Blam et al., 2016).

While the term "monotown" is not explicitly used in Poland, the country has several "monofunctional cities" or small towns dominated by

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a single enterprise or economic function. Typically small or medium-sized, these cities fall into three categories. Although certain cities faced challenges after the economic transformation, those within urban agglomerations have successfully developed new economic functions. Furthermore, some agricultural centers and specialized towns with exogenous economic functions have displayed signs of recovery (Blam et al., 2016).

The academic literature thoroughly explores the primary challenges encountered by monotowns, including environmental, economic, and social aspects, which we will consider in more detail.

Environmental challenges

Historically, Russian monotowns have served as symbols of economic progress both in their respective regions and across the nation. However, these single-industry towns, predominantly established during the Soviet era around mining enterprises, have experienced significant environmental challenges over time (Pyzheva, 2020). Prominent challenges include mercury contamination causing the pollution of the Nura River in Temirtau, inadequate solid waste disposal facilities in Zyrianovsk, and occurrences of underground water flooding the town after mine inundations (Nurzhan, 2015). Consequently, these environmental issues have become urgent concerns for both residents and policymakers striving to tackle the complex problems encountered by monotowns.

Economic challenges

Economic challenges in monotowns have become a significant problem, primarily arising from limited diversification, constrained prospects for further development of sustaining enterprises, and the local workforce and town budget's high dependence on these enterprises' performance (Nurzhan, 2015).

Economic factors, such as the type of industry, its level of development, the overall condition of the market, the level of competition, the profitability of the enterprise, and the state of its capital, contribute to the complex nature of unemployment. Demographic factors, including manpower strength, sex and age distribution, and workforce aging, also play a significant role in influencing employment outcomes. Furthermore, geographic factors like distance from major markets and urban centers can impact job availability and economic stability. It is also important to consider external factors, such as the global resource market, which can further exacerbate unemployment rates in monotowns (Nurzhan, 2015). Consequently, understanding and addressing these intertwined factors is crucial for tackling the economic challenges faced by monotowns.

Monotowns face various social challenges, often stemming from the limited opportunities for diversification and growth beyond their dependence on dominant enterprises (Beleva et al., 2021). One such challenge is the recruitment, training, and retention of personnel in these towns. In monotowns employers face challenges in hiring skilled workers, providing specialized job training, and ensuring comfortable living conditions to attract and retain staff (Nikiforova et al., 2018).

For monotowns to achieve long-term sustainable development, there must be a balance of interests between the city, private capital, and the state. Among other things, it means that businesses need to be stimulated to be more socially responsible, local government and urban identity should be improved, while local communities should be more actively involved in municipal activities (Musina & Neucheva, 2018).

Social challenges faced by monotowns

The economic challenges faced by monotowns often give rise to various social issues, such as high unemployment levels, low average incomes and living standards, population outflows, and an increased risk of social unrest (Nurzhan, 2015). Outbound mobility is common in these towns, as people believe that bigger cities offer more opportunities. In response, local authorities, main businesses and educational institutions are collaborating to promote education as an attraction and as a way to support progress (Veselkova et al., 2021).

Education plays a vital role in creating symbolic capital and enhancing the prestige of a locality. Cooperation between businesses, education, and municipal authorities should be an integral part of the town development strategy. Exploring new ways for businesses and education to interact, such as providing access to technical university degrees and trade schools in monotowns, has the potential to retain young people and generate the essential social and symbolic capital for development (Veselkova et al., 2021).

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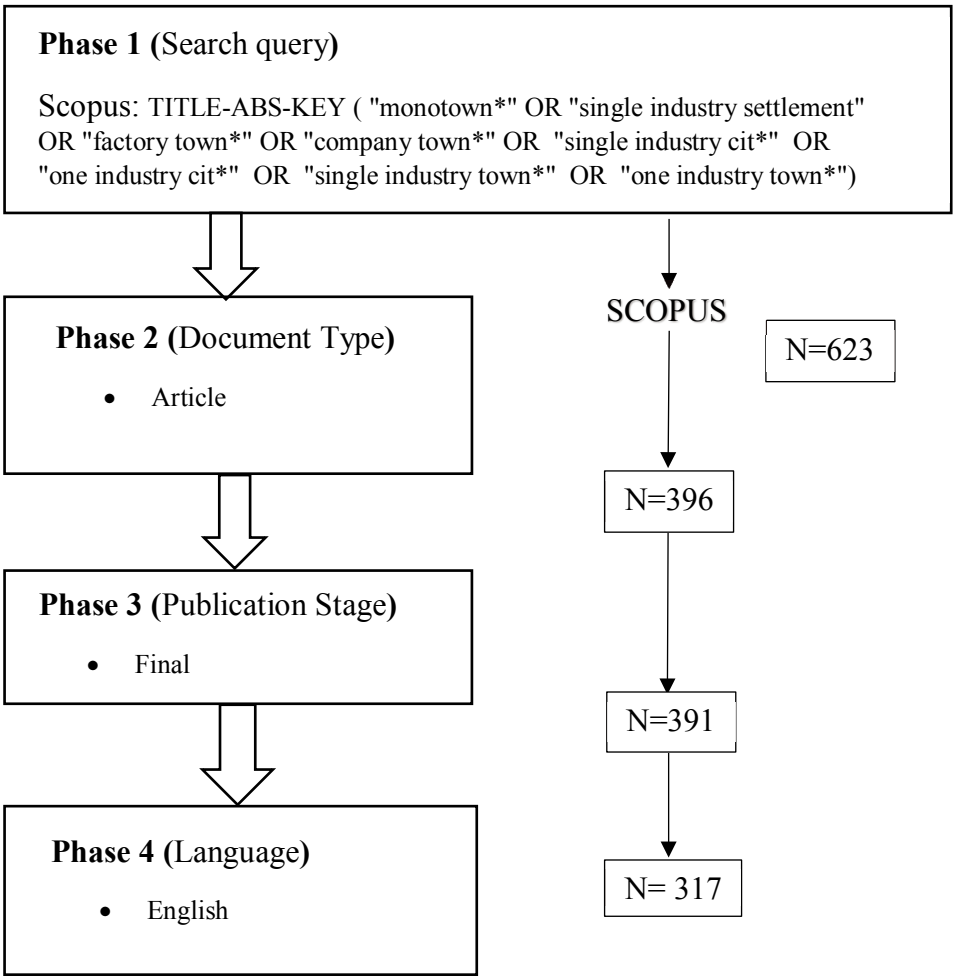

Figure 1. *Review Protocol for the Data Collection Phase of the Systematic Literature Review*

Ivanova (2021) points out the differences among single-industry towns based on factors like socio-economic development, population size, industry specialization, administrative status, and territorial distribution. Despite a decline in population in many of these towns, the current support programs lack customization. The population decrease is often linked to working-age people leaving due to environmental issues, inadequate healthcare, high unemployment, and low wages. The current diversification strategies haven't had a significant impact on labor market indicators, emphasizing the need for personalized measures tailored to the specific characteristics of each single-industry town when creating effective support programs.

Methodology

Consistent with the purpose of our study, we conducted a systematic literature review (SLR). An SLR is a structured, transparent, comprehensive, and replicable approach characterized by a pre-defined protocol. This method enables the identification and synthesis of all relevant published studies via a rigorous scientific methodology (Fink, 2019; Littell et al., 2008). To conduct SLR, a systematic reviewing protocol is needed to overcome bias (van Oorschot et al., 2018). Our review protocol starts with describing the rationale for the review and proposing the research questions. In line with the approach suggested by Crossan and Apaydin (2010), our study comprises the following stages: (1) data collection, (2) data analysis, and (3) synthesis. Additionally, we used the checklist described by Moher et al. (2015), recommending items to include in a systematic review.

Our systematic literature review began with a search query using the Web of Science (WoS) and Scopus bibliographic databases, recognized for their comprehensiveness (Pranckutė, 2021) and widespread use in literature reviews (Martín-Martín et al., 2018). In the literature,

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terms like "monotown," "single-industry settlement," "factory town," and "company town" are often used interchangeably (Shastitko & Fatikhova, 2015). To align with the search capabilities of our chosen databases, we crafted a search query using these keywords along with 'single industry cities.' The search was limited to these terms appearing in the "title," "abstract," and "keywords" sections of research articles, and we focused on articles written in English. The steps and the number of articles at each stage in the data collection phase are detailed in the review protocol shown in Figure 1.

In the second stage of our SLR, the articles retrieved from the Scopus and WoS databases were meticulously read and examined by the authors. This rigorous review was undertaken to ensure that all results aligned with our research criteria. Following this comprehensive evaluation, all 317 articles initially obtained in the first stage were deemed suitable and, consequently, were selected to proceed to the next step of our systematic review.

In the third stage of our systematic review, we employed the bibliometric analysis technique known as bibliographic coupling to uncover thematic similarities between studies. This method, particularly useful for new publications, emerging fields, and less developed sub-fields (Zupic & Čater, 2015), measures the similarities between two papers by examining their shared references, with the premise that papers with more common references are strongly interconnected (Suchek et al., 2021). The bibliographic coupling analysis was performed using VOSviewer software, version 1.6.19. This approach facilitated the identification of clusters representing more recent research themes, revealing interconnected themes and patterns in the selected studies.

Results

Descriptive analysis

The data collection protocol yielded a total of 317 articles pertaining to monotowns, single industry settlements, factory towns, company towns, single industry cities, one industry cities, single industry towns, and one industry towns, as depicted in Figure 1. The trends and fluctuations in the number of these articles published annually are illustrated in Figure 2. The oldest article identified in our data collection dates to 1907, even predating the establishment of the Soviet Union, which is notably associated with the concept of monotowns. This research, titled "The Social Work of a Church in a Factory Town" by Evans (1907), underscores the longstanding schol-

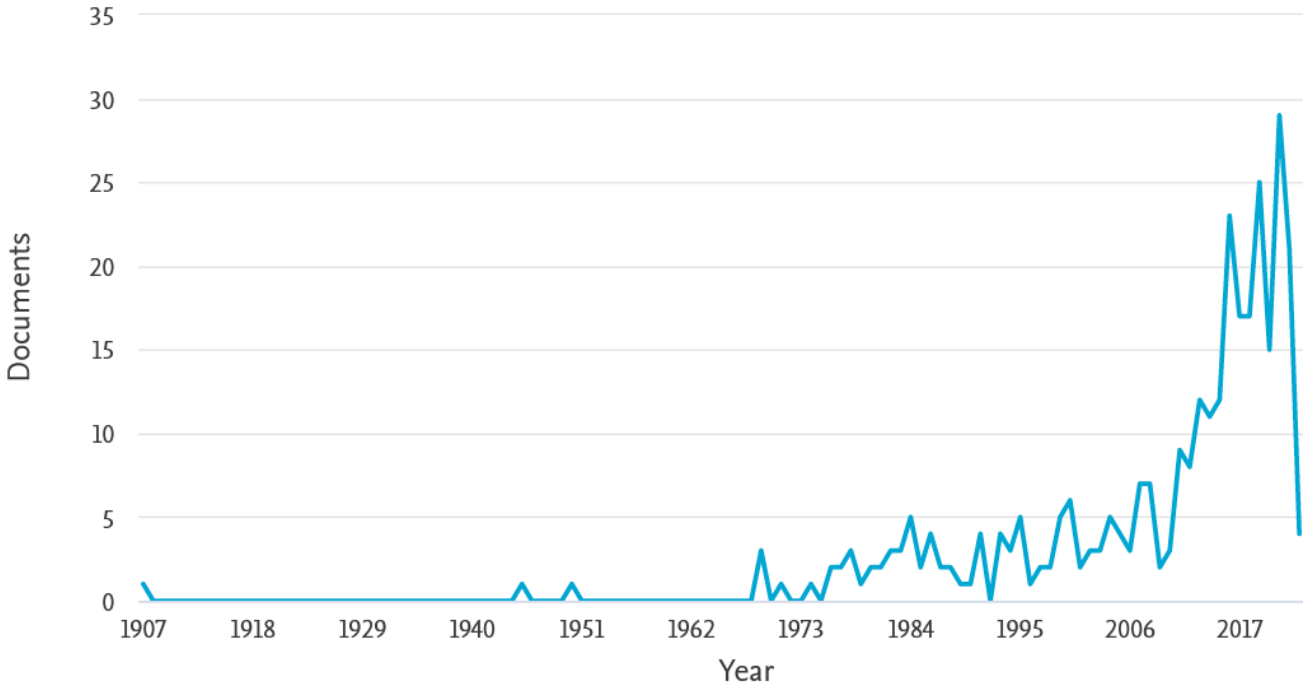

Figure 2. *The Cluster of Annual Output in Publications*

Source: Based on the authors' analysis of publications in the Scopus database.

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arly interest in such single-industry communities. The scholarly interest and research output on monotowns have notably increased, particularly from the 1980s onwards, culminating in a peak of 29 articles published in 2021 alone. This trend underlines the growing relevance and importance of studying monotowns in contemporary academic discourse.

The initial wave of articles from the 1970s to 1980s concentrated on the rise and growth of monotowns, exploring the topic mainly from an economic viewpoint. (Alanen, 1977; von Rabenau, 1976). From the 1980s to the 1990s, the analysis of monotowns extended to incorporate social (Krahn & Gartrell, 1983) and governmental perspectives (Krahn & Gartrell, 1983). The period between 1990 and 2000 was a time of significant transition for monotowns, with a series of important research contributions shedding light on the intricate interplay between dominant industries and the socio-economic fabrics of these single-industry towns. The era was marked by pivotal changes in global and local economies, including the closure or downsizing of major industries, which necessitated a shift toward economic diversification, as seen in the case of Kamaishi (Wiltshire, 1991). The research during this period began to investigate deeper into the labor dynamics in monotowns, exploring how dominant companies' efforts to stabilize their workforces could reinforce non-capitalist social structures, as exemplified by the Pilgrim's Rest study (Bonner & Shapiro, 1993). Additionally, researchers started to probe into the social dimension of monotowns, tying income, education, home ownership, and health status to neighborhood cohesion, as observed in the Elliot Lake research (Robinson & Wilkinson, 1995). The Kazakhstani research painted a vivid picture of the welfare impacts of company downsizing in these monotowns (Rama & Scott, 1999). Overall, the period of 1990-2000 marked a significant expansion and deepening of academia's understanding of the socio-economic realities of monotowns and the challenges they face.

Studies published between 2000 and 2010 show a shift in focus from the effects of industry downsizing or closure on one-company towns, which dominated the 1990s, to exploring the resilience, adaptability, and transformation of such towns in response to broader socioeconomic changes. This period saw an increased interest in how these towns diversified their economies, capitalized on human capital, and reimagined their identities. The early 21st century was characterized by rapid globalization, technological innovation, and the growing influence of the knowledge economy, and these developments are reflected in the studies. The examination of Silicon Valley as a modern, high-tech variant of the company town illustrates this shift in focus (English-Lueck, 2000). Furthermore, there was an increasing emphasis on understanding the social and cultural dynamics of one-company towns, including the changing relationships between corporations and their communities (Phillimore & Bell, 2005), the impact of work on community life (English-Lueck, 2000), and the historical and colonial influences on urban planning in company towns (Rego & Meneguetti, 2008). This decade's research therefore presents a more nuanced and multifaceted understanding of one-company towns, acknowledging their potential for transformation and reinvention in the face of industrial and economic changes.

The post-2010 period marked a significant shift in the study of company towns, characterized by a deeper investigation into their socio-economic intricacies. Researchers turned their focus to understanding how broader global phenomena such as neoliberal policies, globalization, and changing labor practices affected these towns. Scholars also started to pay more attention to the historical context, the urban planning process, and the socio-cultural dynamics within these towns. Comparisons across cultures and continents became more common, with studies investigating parallels and differences between company towns in countries such as India (Sanchez, 2012), Iran (Jafari, 2013), Kuwait (Alissa, 2013), Russia (Satybaldina, 2013), and the United States (Satybaldina, 2015). The research also focused on the consequences of dependence on a single industry, including the resultant social risks and challenges in innovation and adaptability. There was an increase in studies dealing with specific cases, such as the collapse of unions due to political affiliations or the effectiveness of policy programs aimed at fostering growth (Cooley, 2014). This period represented a more critical and comprehensive approach to the analysis of company towns, showcasing the diverse and interconnected factors that influence their development and survival.

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Analysis of bibliographic coupling

We used the VOSViewer 1.6.19 program to perform bibliographic classifications of the documents, aiming to identify the main themes in research on monotowns. Out of the 317 articles, the program associated 150. Following this, we needed to establish two key parameters. The first parameter was the clustering resolution ratio, determining the level of detail in the clustering process. The second parameter was the minimum cluster size, setting a threshold for the smallest number of studies within a single cluster (Van Eck & Waltman, 2018). To ensure a comprehensive and meaningful analysis of the collected data, we established specific parameters after rigorous testing of several alternatives. Finally, we chose a clustering resolution ratio of 0.25 and a minimum cluster size of 3. Applying these parameters led to the formation of five distinct clusters (refer to Figure 3), showing an uneven distribution of studies. The majority of the articles were found in the first two clusters, while the remaining three clusters contained fewer articles.

We manually executed cluster labeling by reviewing the full texts of studies within each respective cluster to discern common themes. Subsequently, we processed the abstracts and keyword sections of these studies using text cloud applications. Thus, we determined the most frequently used words based on their frequency distribution, guiding the naming of the clusters.

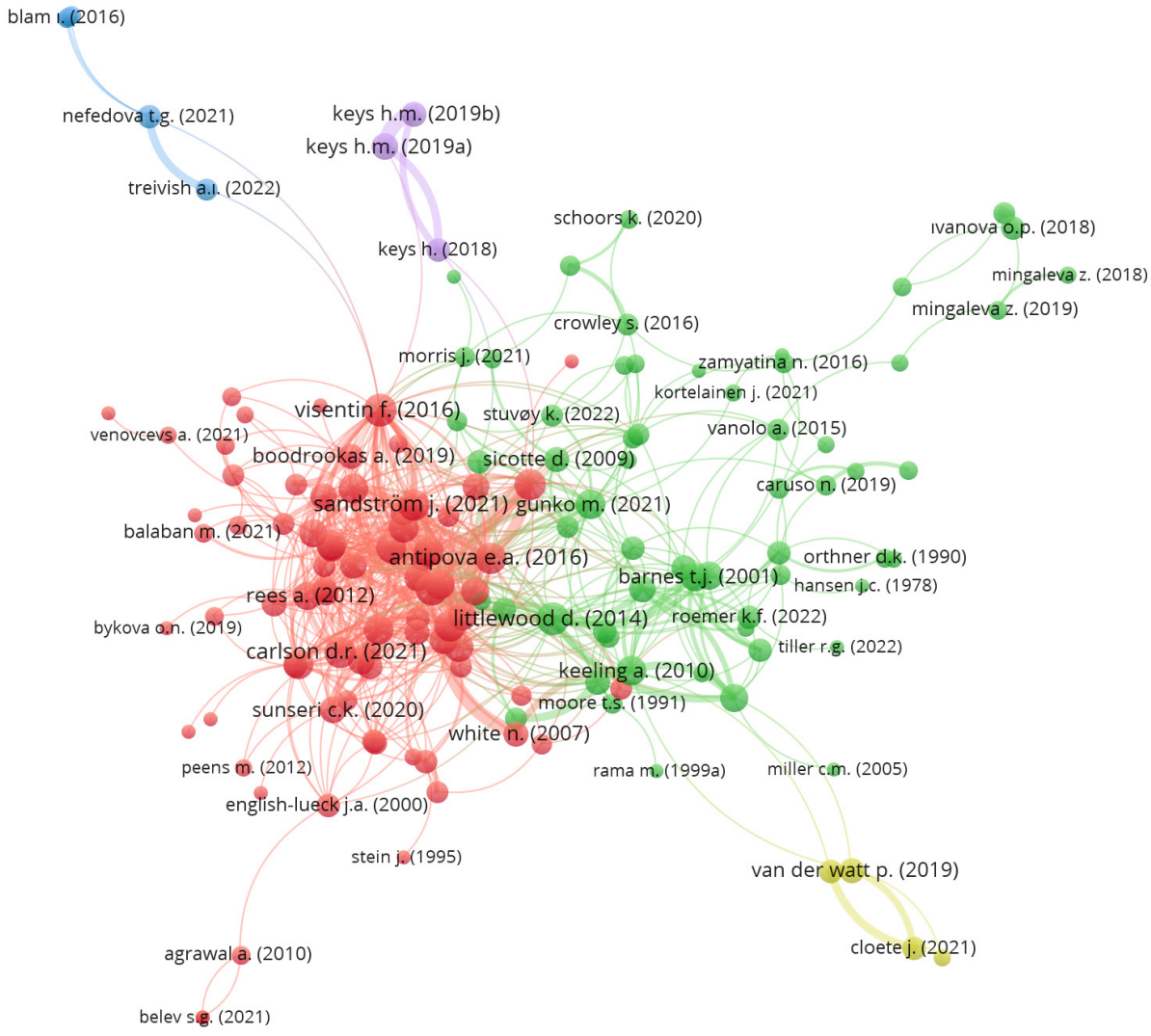

Figure 3. *Cluster Network of Research Trends in Monotowns*

Source: Based on bibliographic output from VOSviewer 1.6.19

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Company towns and their impact on urbanism and society (n = 78)

The articles in the first cluster collectively explore various aspects of company towns and their impact on society, economy, and culture. Some articles analyze the emergence and development of company towns, focusing on their role in providing social services and infrastructure for workers (Varini, 2016; White, 2004, 2007). Visentin (2016) looks at the ideological underpinnings of company towns, emphasizing utopianism, paternalism, and the myth of progress, and examines how these concepts manifested in towns like Piazzola sul Brenta in Italy and Borgonyà in Spain, considering cultural and geographical influences on their development.

Agrawal et al. (2010) investigate the concentration of inventive activity in North American "company towns," noting that large firms in these areas heavily rely on their own prior inventions, resulting in a narrower geographic scope of impact and less diverse innovation compared to more varied locations. Beleva et al. (2021) assess the effectiveness of the Priority Development Areas program in Russian monotowns, finding that while firms gain resident status based on prior success, this status does not significantly influence revenue growth, indicating limitations in the program's effectiveness in supporting business growth in these settings.

English-Lueck (2000) provides a contemporary perspective by examining Silicon Valley as a modern company town, illustrating how its high-technology environment and global talent pool have created a community where work is the dominant social order, constituting a twenty-first-century reworking of the company town concept. Antipova and Titov (2016) offer an economic geographical analysis of single-industry towns in Belarus, shedding light on their role in the settlement system, functional typologies, and the development challenges they face amidst center-periphery polarization.

Others explore the impact of company towns on workers' lives, including the manipulation of physical space to promote community surveillance and decrease interaction with neighbors (Westmont, 2022). Rees (2012) examines the distinct shift in spatial practices in the 1880s, where aesthetic applications of Beaux Arts and Arts and Crafts in communities like Pullman, Illinois, and Port Sunlight near Liverpool were used as visual ideologies for social control and brand identity, underscoring an important shift in spatial practices and the influence of these aesthetics on later City Beautiful and Garden City movements.

Sunseri (2020) investigates the historical emergence of an American working class, stressing the importance of shared material culture and the role of class consciousness as evidenced by labor organizing in company towns like Mono Mills, California. Furthermore, Carlson (2023) examines racialization processes in these towns, exposing how labor hierarchies and spatial segregation in Pacific Northwestern sawmill towns entrenched perceptions of Nikkei immigrants as "foreign," impacting their social integration.

Several articles highlight the challenges arising when the needs of the local community conflict with the needs of the company, underscoring the importance of corporate social responsibility in maintaining a positive relationship with the community (Sundström & Hyder, 2008; Taizhanov et al., 2016). Moreover, the articles also discuss the relationship between company towns and broader economic and political structures, including the emergence of working-class consciousness (Sunseri, 2020), the impact of the Soviet legacy on resource extraction industries (Venovcevs, 2021), and the influence of political and economic processes on the design of New Urban developments (Veninga, 2004).

Finally, the studies in this cluster deal with the cultural significance of company towns, including the role of material culture in negotiating identity and status (Westmont, 2020), as well as the emergence of unique social networks based on mutual obligation and responsibility (Varini, 2016), and the materialized community responses to racial discrimination as evidenced in towns like Barneston, Washington (Carlson, 2023). In summary, these diverse studies collectively illuminate the complex interplay between company towns and various social dimensions, underscoring their significant role in shaping both local and broader socio-economic landscapes.

Evolving dynamics and community resilience in single-industry towns (n = 60)

The articles in this cluster critically examine the evolving dynamics in single-industry towns and their effects on community resilience. Central to the discussion is Littlewood (2014)'s study on corporate social responsibility (CSR) in min-

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ing communities in Namibia, offering a critical perspective on the sustainability and viability of towns post-industry. Roemer and Haggerty (2022) analyze the fiscal impacts of deindustrialization in fossil-fuel-dependent communities, focusing on Colstrip, Montana, as they navigate the U.S. energy system's decarbonization. Sicotte (2009)'s exploration of environmental injustice in Hayden, Arizona, reveals the complex relationship between economic decline, health issues, and power imbalances in resource-dependent towns.

Barnes et al. (2001) apply Harold Innis's economic theories to single-industry towns, using Port Alberni, British Columbia, as a case study to illustrate the "cyclonic" nature of resource-based economies. Keeling (2010) delves into the environmental and social impacts in Uranium City, further illustrating the consequences of cyclical developments. Gunko et al. (2021) emphasize the role of local agency in Russian monotowns (*monogoroda)*, demonstrating how internal resources and leadership can drive positive change.

In addition, Tiller et al. (2022) contribute to this body of work by examining the role of community resilience in single-industry towns, particularly focusing on how these communities respond to and manage economic and environmental shifts. Rollwagen (2007), Ryser et al. (2020), and Schoors and Weill (2020) offer insights into labor force mobilization and community adaptation strategies, while Storey and Hall (2018) explore the implications of these dynamics for local economies. Ivanova et al. (2018) further enriches this discourse by focusing on the socio-economic development challenges in Russian single-industry towns, particularly examining factors affecting sustainable development and the potential for intraregional industrial clusters in areas like Yurga, Kemerovo region, to support growth and attract investment.

Cases from diverse geographical locations, including Canada, Russia, the United States, and Italy, provide a global perspective on single-industry towns. Key themes emerge, such as the importance of understanding historical traditions (Solecki, 1996), the dynamics surrounding mobile workforces (Ryser et al., 2020), the impact of branding strategies on company and community identities (Scott & Bennett, 2015), and the potential consequences for urban inequality and insecurity (Stuvøy & Shirobokova, 2022). This cluster, through its varied perspectives, underscores the necessity for adaptability and resilience in single-industry towns facing economic, social, and environmental changes.

Socioeconomic dynamics and challenges in monofunctional towns (n = 5)

The five articles in this cluster examined the socioeconomic dynamics, challenges, and corporate social responsibility practices in monofunctional towns, predominantly in Russia, with some comparisons to Poland and Slovakia. The studies focus on agglomerative relations (Averkieva et al., 2015), population dynamics (Zemlyanskii, 2011), and production and nonproduction relations (Averkieva et al., 2015) in these towns. A common theme across the articles is the crucial role of dominant local employers, often large companies, in shaping local and regional development through their direct influence on social policy (Blam et al., 2016; Nefedova & Treivish, 2021). The survival and development of these towns are closely linked to the success of these companies and their relationships with local governments and communities (Blam et al., 2016; Nefedova & Treivish, 2021). These single-industry towns face challenges such as population decline, economic dependence on key industries, and environmental polarization. Factors such as a successful "owner," state interest, and personal initiatives contribute to their development and resilience.

Transformation and challenges in mining company towns (n = 4)

The fourth cluster of research papers focuses on the transformation of mining company towns, particularly in South Africa, Mexico, Australia, and Canada. These towns, historically managed by mining companies, provided not only work and housing but also various services and facilities for the workers. The process of "normalisation" has led to the towns being freed from company control, with a shift towards local government management (Cloete & Marais, 2021; Marais et al., 2018; van der Watt & Marais, 2019). The papers discuss various challenges faced by these towns, such as the path dependency of the migrant labor system (Cloete & Marais, 2021), goal dependency of government policy (Cloete & Marais, 2021), preservation problems of historical sites (Collazo, 2020), and the impact of globalization, corporate decision-making, political ideology, and government policies (Marais et al., 2018).

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The studies in this cluster indicate that the process of normalisation, which involves the transition of mining company towns from company control to local government management, creates challenges for local governments. These challenges include the struggle to provide basic services like housing, utilities, and infrastructure for the communities in these towns. Additionally, the normalisation process does not effectively deal with the long-term risks that arise when mines decline or close, such as unemployment, economic downturn, and potential community displacement. The research emphasizes the need for a more in-depth and comprehensive understanding of the changes taking place in mining towns, as well as the difficulties faced by local communities during this transformation. This understanding is crucial for developing effective policies and strategies that address the challenges arising from normalisation and ensure the long-term sustainability and well-being of these communities.

Health programs and social inclusion in monotowns of Hispaniola (n = 3)

The three papers forming this cluster have a focus on the health programs aimed at eliminating lymphatic filariasis (LF) and malaria in the monotowns (agricultural company towns) of Hispaniola, an island shared by Haiti and the Dominican Republic (DR) (Keys et al., 2018; Keys, Noland, De Rochars, Blount, et al., 2019; Keys, Noland, De Rochars, Taylor, et al., 2019). These monotowns, known as *bateyes*, predominantly house marginalized Haitian migrants and their descendants, who often face social exclusion, discrimination, and barriers to healthcare access. The studies highlight how the LF elimination program (PELF) has helped improve the health of this population while generating trust in government health activities and counteracting some effects of social exclusion. Despite low transmission rates of malaria and LF in the monotowns, there are identified gaps in intervention coverage, malaria knowledge, treatment-seeking behavior, and service delivery. If these gaps are addressed, particularly in what concerns marginalized populations, this will help improve the quality of surveillance for these diseases and promote island-wide elimination. The studies also emphasize the importance of public health community engagement strategies in avoiding stigma, fostering active participation, and working towards community ownership of disease control and elimination goals in monotowns.

Further insights into monotowns: Urban development and governance in post-Soviet countries

This section summarizes themes and findings from additional literature (including the papers that were not included in the SLR), offering an overview of diverse issues explored in academic research on monotowns.

– *Urbanization and sustainability*. Post-Soviet urbanization presents challenges and opportunities, particularly in sustainable urban development and governance. The rapid growth of megacities like Almaty and Astana in Kazakhstan emphasizes the importance of sustainable urban planning and resource management, considering factors such as energy consumption, resource utilization, and waste production (Turgel et al., 2016; Turgel & Zinovyeva, 2017).

– *Gender and urbanization*. The impacts of urbanization are not gender-neutral. Research reveals variations in gender interactions, stereotypes, and employment patterns in urban settings, particularly in monotowns (Khvan & Bulkina, 2018). Understanding these dynamics is crucial for promoting gender equality and inclusive urban development (Uzakova et al., 2022).

– *Regional economic development*. Monotowns, reliant on single industries, present challenges for regional economic development (Voronina et al., 2021). Research in Kazakhstan shows their role in economic growth and diversification but also issues of uneven development and industry dependence (Rastvortseva & Manaeva, 2016).

– *Regulatory impact assessment*. Regulatory impact assessment (RIA) plays a critical role in state economic regulation across post-Soviet countries (Voronina et al., 2021). The effectiveness of RIA is scrutinized, with emphasis on the need for improved methodological support, evaluation of its impact, and integration into national economic growth strategies (Fomin et al., 2020). Issues related to formalization risks and alternative solutions require attention in RIA implementation (Prishchepa, 2019).

– *Government initiatives and policies*. Government support and policies are central to urban development. The study on monotowns in the Republic of Kazakhstan emphasizes the significance

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of administrative and economic methods in their regulation (Pyatsheva, 2019). Advocacy for integrating RIA into national strategies is proposed to stimulate business and economic growth (Malyy, 2020).

– *Global-local interconnections*. Urban development in post-Soviet countries is intricately influenced by global-local interconnections. Responding to global economic crises, federal policies have redefined monotowns as spaces for development. This resurgence of town-forming enterprises as urban governing bodies carries implications for urban inequality and insecurity, as highlighted by Asanova and Nurseitova (2022).

– *Mortality and indigenous populations*. The health of Arctic indigenous populations in monotowns is examined, with data on mortality rates presenting challenges that necessitate structured statistical diagnostic studies.

In summary, post-Soviet urban development and governance involve complexities such as urbanization challenges, regional economic disparities, regulatory impact assessment, government initiatives, gender dynamics, global-local interconnections, and health disparities among indigenous populations. Addressing these issues is crucial for achieving sustainable, equitable, and inclusive urban development in the region.

Conclusion

The systematic literature review, organized into five clusters, provides a nuanced understanding of the impacts, changes, and challenges associated with monotowns.

The first cluster explores how company towns extensively influence society, economy, and culture, covering aspects of surveillance, social responsibility, economic structures, and cultural identities.

The second cluster emphasizes the resilience required by single-industry towns amid changing economic and social dynamics. Insights from global cases discuss historical traditions, labor mobilization, branding, and potential inequality.

The third, despite its small size, sheds light on the socioeconomic dynamics and challenges faced by monofunctional towns. Survival is linked to dominant local companies, with challenges including population decline, economic dependence, and environmental issues.

Cluster four focuses on mining company towns, revealing challenges associated with the transition from company to local government control, including struggles in providing basic services, economic downturn risks, and community displacement.

Lastly, the fifth cluster emphasizes the pivotal role of health programs in Hispaniola's monotowns, addressing social exclusion and healthcare access barriers.

In conclusion, the current research foregrounds the complex interplay of economic, social, and political factors influencing the evolution, resilience, and challenges of monotowns. Adaptive strategies, social responsibility, government intervention, and inclusive policies are essential for their sustainability and community well-being.

The identified clusters suggest potential avenues for further research. Clusters three and four indicate a need for more extensive research into socioeconomic dynamics, challenges, and corporate social responsibility practices in monofunctional towns, with potential exploration in various countries beyond Russia such as Poland and Slovakia. Cities dominated by a single industry might exist in various countries, even if they are not explicitly labeled as monotowns. Thus, additional countries might also be considered as potential subjects for research in this area. For instance, Turkey has several cities where certain industries are predominant. These include Zonguldak for coal mining, Isparta for rose cultivation, Adana for cotton production, Bursa for automotive, Antalya for tourism, and Aydın for fig production. The fourth cluster, focusing on the transformation of mining company towns, presents opportunities for more in-depth investigation.

While our systematic literature review (SLR) on monotowns was comprehensive, it became apparent that a significant body of knowledge existed outside of widely recognized international databases such as Scopus and WoS. Given the deep regional significance of monotowns, especially in Russia and Kazakhstan, an exploration beyond these databases was essential for a more holistic understanding. This led us to a more focused review of Russian journals, revealing nuanced insights.

Despite its significant contributions, this study is not without limitations. Based on their references, only 150 of the 317 articles were associated by the software used in this research. It could mean that the field is highly diverse, with

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researchers drawing on a wide variety of different sources and theoretical frameworks. This might suggest that there isn't yet an established set of key references or seminal works that are commonly cited across the field.

In addition, the first two clusters encompass the majority of the articles, which suggests that these clusters might correspond to well-established and extensively studied areas within the monotowns research field. These could be domains that have traditionally drawn significant scholarly interest or are perceived as fundamental to the discipline. The third and fourth clusters, with fewer articles, may represent areas with potential research gaps warranting further exploration. Despite their smaller sizes, these clusters offer pivotal insights and enhance the diversity and depth of the research field. The fifth cluster, containing only three articles by a singular author, could be a result of numerous shared references originating from the same project.

Another potential limitation of this study may stem from the data collection procedure, which is restricted to articles written only in English. Given the prevalence of monotowns in predominantly ex-Soviet countries, the exclusion of Russian-language sources could be considered a notable limitation of this study.

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