Creative reindustrialization: Data base as a digital footprint for second-tier cities of the Urals and Siberia

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Abstract. The modern stage of development of research in the field of regional economics involves the application of a wide coverage of regional economic systems data. Their overall totals form a digital trace of the development of the territory. A scientific digital footprint of the key factors and patterns of creative industries in the second-tier cities of Siberia and the Urals, reflected in the web application, allows imagining, comparing and comprehending the current state and perspectives of creative industries in second-tier cities. In this article, considering the demography dynamics and diversification of creative business activity as well as data on created enterprises, the author highlights the cities that are interested in creative reindustrialization the most – oil and gas specialize cities of Khanty-Mansiysk autonomous okrug – Megion, Nefteyugansk, Nizhnevartovsk, Nyagan, and Uray. Second-tier cities that display a relatively higher level of economic activity diversification encompass Novokuznetsk, Biysk, Nyagan, Prokopyevsk, Rubtsovsk, Sysert, and Uray. At the same time large industrial centers in regions provide more favorable conditions for the development of creative enterprises. Whereas in the regional context, the Tomsk region and Altai Krai lag behind other regions in absolute terms. Thus, the first obvious strategical step in municipal development through creative reindustrialization is using the essential opportunities highlighted by demography conditions, mainly in oil and gas towns. Whereas large industrial centers in regions could use more favorable conditions for the development of creative enterprises for its further development.

Key words: Second-tier city; Creative reindustrialization; Scientific digital footprint; Diversity and concentration; Creative business activity.

1 Introduction

The current state of research in the field of regional economics involves the utilization of extensive regional economic systems data, producing a digital representation of the development of the given territory. In accordance with foreign research experience, the trend

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leans towards the use of open data, which ensures comparability and fosters discussion among scholars, enhancing the quality of final conclusions [1]. In Russia, there is an Open Data portal, as well as government statistics EMISS and municipal statistics data from the Federal State Statistics Service available for urban research. Commercial options also exist for enterprises to accumulate financial reporting data, such as SPARK and FIRA information and analytical systems.

When comparing the collected data at the regional and municipal levels, the data at the municipal level is found to be lacking. Specifically, the statistics data at the municipal level is characterized by discontinuity, incompleteness, and inconsistency amongst groups of similar parameters. Furthermore, the data accumulated from financial statements of enterprises require additional processing and comparison with the available municipal statistics. As a result, the current stage of the development of the analysis and evaluation system for the digital footprint of Russian cities is still in its early stages.

The objective of the present investigation is to produce a scientifically-grounded digital footprint, which will be manifest through an online application, delineating the fundamental drivers and tendencies observable within the creative industries situated in Siberia and the Urals second-tired cities.

2 Creative reindustrialization

Reindustrialization is becoming an actual trend of socio-economic and spatial development of regions and cities, replacing the processes of deindustrialization in Europe, the USA and other countries [2-3]. Capello and Ceriosa define it as «reinforcement of the pre-existing specialized industrial structure through an upgrading strategy, when firms adjust to the new conditions based on their established practices». However, in the context of creative industries, the concept of reindustrialization, especially for second-tier cities in the region, acquires a new sound.

The creative economy is one of the fastest growing sectors of the global economy, providing income growth, new jobs and export earnings, offering production diversification for certain regions, and can strengthen competitiveness. It has been suggested that higher levels of creative activities in a region are associated with greater economic resilience, exemplified by the ability to curb job loss [4]. Creative economy has become an important tool for urban revitalization, contributes to the revision of the model of urban structure and helps in the reconstruction of old neighbourhoods [5]. In our view, the process of urban economic revitalization at the expense of the creative cluster reflects the term «creative reindustrialization», by which it is proposed to understand a new form of transformation of the industrial city economy through the development of creative activities, which leads to the recovery and transition to sustainable development of such city economy [6]. The key factors in the development of creative industries are the high level of urbanization and diversity both within the creative industries and the types of economic activities of the city [7]. Major cities (administrative centres of regions) that naturally concentrate the main share of creative industries [8], are widely elaborated, while the development opportunities of the second-tiered cities are relatively less explored. Second-tier cities in these research identified as contenders for leadership in the creative industries sector behind the administrative centres of the regions of Urals and Siberia, which possess undeniable dominance in the advancement of the aforementioned industries. We focus on the very cities of Sverdlovsk, Chelyabinsk, Kemerovo and Tomsk region, as well as Altay Kray and Khanty-Mansiysk autonomous okrug.

3 Database

According to the analysis, the municipal databases can currently be classified into several groups of informational and analytical tools. These include open data from federal statistics, cartographic materials and other Russian and Foreign Databases.

Federal statistics open data are gathered and disseminated by the Federal State Statistics Service. These data pertain to social, economic, and demographic factors concerning various cities and regions of Russia. Population, employment, wages, education, health care, and other factors are examples of such data. Other examples of open data tools include the «Open Data» portal and the state statistics database known as EMISS.

Cartographic materials are introduced by different scientific groups. The «Map of Clusters in Russia» project, developed by the Russian Cluster Observatory at the Institute for Statistical Studies and Economics of Knowledge at the National Research University Higher School of Economics (HSE), provides information on clusters, their specialization, and the products (services) they produce, as well as the priorities for the region's development. It also includes information on partners, management bodies, and projects. The map allows for analysis and real-time tracking of relevant practices in the field of cluster development. Another example of creating cartographic databases in a regional context is the "Interregional Clusters" project (ruclusters.ru), created by specialists from the Perm Polytechnic University [10]. The developed web application allows for identifying interregional clusters, conducting smart benchmarking, and evaluating spatial development of regions based on data from 2019. The digital footprint is represented in the "Virtual Population of Russia" project (http://webcensus.ru/).

Other databases of the creative industries can be analyzed in addition to the atlas prepared by the Agency for Strategic Initiatives (ASI), which primarily focuses on large and major cities in the country [11]. This gap can be filled by the atlas prepared by experts from the Higher School of Economics, which provides a snapshot of data on creative industries for a single year [12]. A point of interest pertains to the creative potential index devised by «Trust Technologies» at the behest of VEB RF, in addition to the «Political Space of Industrial Cities of the Urals» database [13], containing geographical, socio-economic, political, socio-cultural, and other attributes of industrial cities, affording opportunities for numerical inquiry.

The analysis of international experience in building databases and creating a digital footprint reveals several notable projects, including on-broadway.com, atlas.cid.harvard.edu, and the eye@RIS service. The on-broadway.com project collects visual context of Manhattan in New York City using social networks to reflect the digital spatial footprint of the area. The atlas.cid.harvard.edu project reveals the concept of complexity as a system of interconnected industries that ultimately form a country's profile. The combination of geographic, dynamic, network tools, and country profile snapshots allows for international comparisons and comparisons based on current data. Additionally, the 3T index proposed by Florida [7], which combines talent, technology, and tolerance, is of interest in the research into creative reindustrialization. The eye@RIS service is one of the largest databases in the fields of economics and science, collecting, analyzing, and providing information on public and private research programs, funding, patents, and much more.

The shortcomings of the existing systems include inability to generate interactive graphics for selected cities, city information being scattered across multiple resources making data collection, consolidation and analysis more complex, as well as a lack of detailed information on cities in most resources, which mainly contain information on regions as a whole. To study the patterns of creative reindustrialization in second-tier cities, a web application (https://cities-analysis-site.web.app) is proposed based on processed and calculated economic indicators for cities, using open data. This application can be used for processing and visualizing economic and creative industry data for cities in the Sverdlovsk,

Chelyabinsk, Kemerovo, and Tomsk region, Altai Krai, and the Khanty-Mansi autonomous okrug.

4 Research methodology

4.1 The scope of second-tier cities

The present study suggests categorizing a group of cities as second-tier cities, selected based on their growth potential and development of a specific parameter in comparison to others, with an aim to secure a leading position within a given territory or region. Through clustering on the results obtained by applying the method of data envelopment analysis (DEA) [9] were able to identify the following list of cities that fall within the category of second-tier cities by creative industry effectiveness: Verhnaya Pyshma, Kamensk-Uralsky, Nizhny Tagil, Pervouralsk, and Sysert in the Sverdlovsk region; Zlatoust, Kopeysk, Magnitogorsk, Miass, and Ozersk in the Chelyabinsk region; Belovo, Novokuznetsk, and Prokopyevsk in the Kemerovo region; Biysk and Rubtsovsk in the Altai region; Seversk in the Tomsk region; and Kogalym, Megion, Nefteyugansk, Nizhnevartovsk, Nyagan, Sourgout, and Uray in the Khanty-Mansi autonomous okrug are a selection of cities suggested for this study (Fig. 1).

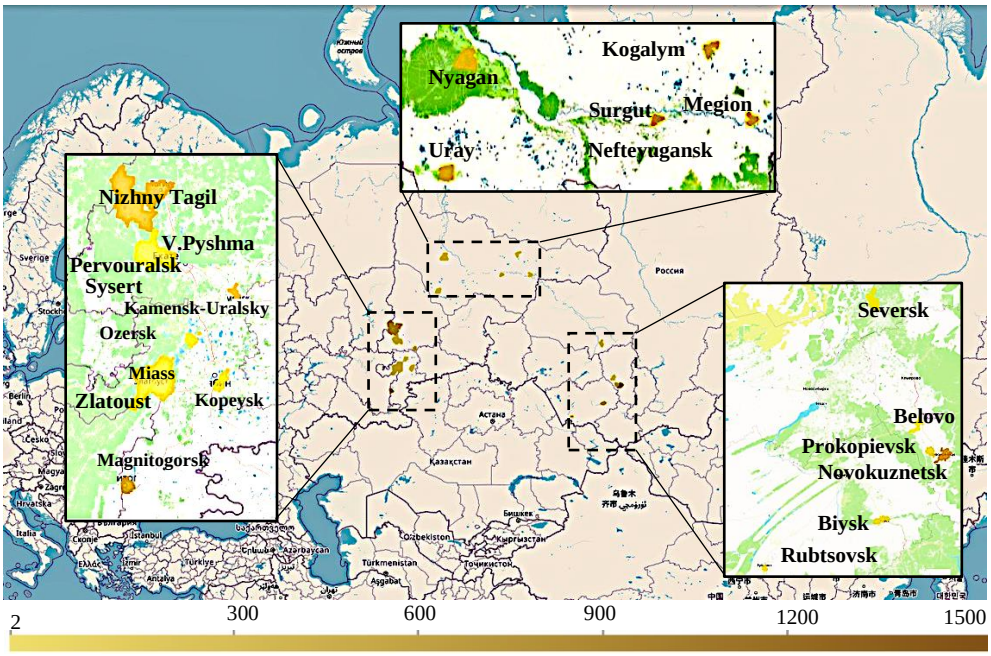

Fig. 1. Geography of the second-tier cities by population, thousand people.

We combine all cities by geographical location in the following way: 1) Sverdlovsk and Chelyabinsk region (left frame); Khanty-Mansi autonomous okrug (upper frame); Kemerovo and Tomsk region plus Altay Kray (right frame). All data are depicted in detail in epy web-app given previously, where gathered these and other data on considered cities. One can also find the other cities and its data in the elaborated web-app. More information concerning regions are presented in references [14].

4.2 Data and methods

The analysis of existing methods for identifying creative industries, developed by HSE and ASI, indicates that while ASI proposes a broader range of General Russian Classifier of Economic Activities (OKVED) codes for identifying creative industries, HSE's methodologies allow for a greater assessment of cities and consider data on the number of individual enterprises. Based on the theory of fuzzy sets concerning population centers and their boundaries, as well as types of activity in relatively small cities, it is suggested to use the maximum range of OKVED codes that identify creative industries proposed by ASI and to classify the OKVED codes by types of creative industries according to the methodology of the HSE, with the goal of facilitating comparisons of results obtained for different cities.

The database includes both aggregate and special indicators, including:

1) Aggregated indicators for cities and creative industries: revenue, fixed assets, wages, number of registered, operating, and dissolved enterprises; number of registered, operating, and dissolved individual enterprises.

2) Special indicators for cities: concentration indices for revenue, fixed assets, and wages of city enterprises (*HHI*); concentration of creative industry organizations by revenue, fixed assets, and wages (HHI_{ci}).

$$HHI = \sum_{i=1}^{n} \partial_i^2 \quad (1)$$

HHI is concentration of indicators of the financial condition of enterprises in the city; ∂ is the share of financial condition in the aggregated value; HHI_{CI} is determined by this formula only for a limited number of enterprises classified as creative industries according to OKVED.

3) indicators by types of creative industries in accordance with the HSE methodology (art industry; performing arts; music; film and animation; photography; publishing; broadcasting; IT and video games; advertising; architecture; design; fashion; jewelry; museums, libraries, archives; cultural heritage; education);

4) indicators of municipal statistics: population, goods shipped, investment and migration.

A web-based application has been created by the project team, including the author of this article, that presents the growth indicators of urban centers and their respective creative industries via a mapping system, in addition to a database of relevant data, dynamic graphs depicting underlying trends, and an interactive dashboard specific to the creative sectors.

4.3 Assumptions and constrains

This particular research helps to identify why some second-tier cities are interested in the creative reindustrialization more than others. We offer the specific decision-making support tool (web-app) to these reasons. Moreover, we consider these web-app as the specific digital footprint represented the economic space of the second-tier cities in Siberia and the Urals. Nevertheless, in context of this particular research we found no reason to present in detail the specific data on land use zones or a short notation of the roles of technological advancements, environmental concerns, central-local governmental policies and regulations that can be the subject of the further research.

5 Results

In the period from 1999 to 2021, the analysis of the dynamics of collected indicators allows us to identify the following patterns of development of the selected list of second-tier cities. The data of statistical socio-economic indicators allow the following conclusions.

Heterogeneous dynamics of population growth is revealed in second-tier cities. Over the period from 1999 to 2021, there is an increase in the population of the cities of Kopeysk (twice), Surgut (43%), Verkhnaya Pyshma (30%), Nefteyugansk (27%), Megion (25%), Nizhnevartovsk (20%), Kogalym (15%), Uray (10%), Nyagan (8%). Nevertheless, a positive growth in migration balance is observed only in Surgut (3.7 thousand people) and Verkhnaya Pyshma (1.7 thousand people). In the rest of the cities (14 out of 23) taken into consideration, a decline in the population is observed. Among the cities with positive population growth special attention should be paid to those that have a negative (or mostly negative) migration balance. These include Megion, Nefteyugansk, Nizhnevartovsk, Nyagan, and Uray (Fig. 2).

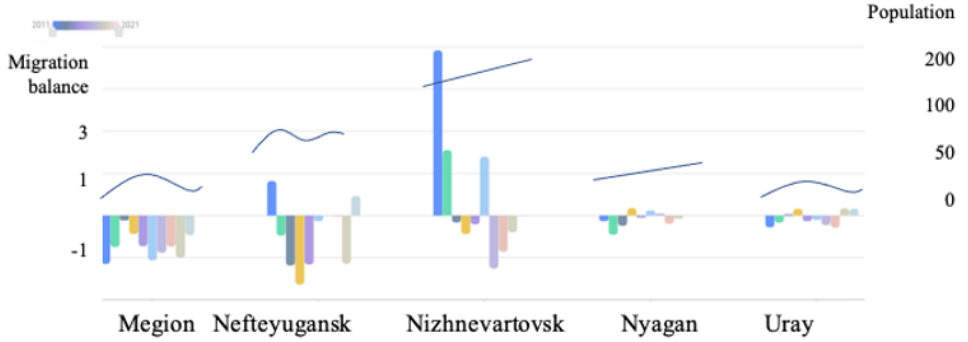

Fig. 2. Migration balance and population in dynamics for 2011-2021, thousand people.

Creative industries in these cities can be the most effective means of locally consolidating young people in cities that prioritize their development, resulting in an improved environment for future generations. Such cities experience a positive natural increase of the youth population in spite of negative migration balances, creating a favorable trend for their future. Consequently, creative industries can achieve maximum impact in these cities. A focus on creative industries will also support the development of small and medium-sized businesses that are experiencing a significant decline in activity [14].

Capital investments exhibits a higher trend in the cities of Khanty-Mansiysk autonomous okrug (Surgut, Nyagan, Nefteyugansk, and Nizhnevartovsk). Among these, Nyagan stands out as the leader in attracting investments per capita with 411 thousand rubles, followed by Megion with 336.6 thousand rubles. The volume of investment is expectedly higher in major industrial centers of the regions such as Novokuznetsk, Magnitogorsk, and Nizhny Tagil. However, when considering investments per capita, some adjustments are necessary. Concentration, urbanization, and returns to scale could be influential factors for the development of creative industries in these cities. Moreover, the financing potential of creative industries also plays a decisive role in promoting their growth.

According to economic data, the foremost industrial hubs in their respective regions continued to dominate the 2020 shipment rankings. Surgut, having shipped products worth 2.2 trillion rubles, topped the chart followed by Magnitogorsk with 2 trillion rubles, Novokuznetsk with 1.7 trillion rubles, and Nizhny Tagil with 1.3 trillion rubles. In terms of per capita statistics, Verkhnyaya Pyshma led the way with 15.8 million rubles per capita, followed by Surgut, Magnitogorsk, and Sysert at 6 million rubles per capita and 5 million rubles per capita, respectively. These figures exclude the impact of size on these rankings.

The analysis of financial statements of enterprises included in the database (https://cities-analysis-site.web.app) yields the following findings: Kogalym, Megion and Nefteyugansk exhibit a high level of entrepreneurial activity with revenues ranging from 75-250 million rubles per operating enterprise in 2020. In terms of fixed assets per enterprise, Kogalym, Yugorsk, Megion, Nyagan and Seversk demonstrate a robust financial profile of 14-240

million rubles per enterprise. Furthermore, for labour compensation per enterprise, Yugorsk, Kogalym, Megion, and Nefteyugansk exhibit a relatively high value of 7-38 million rubles per enterprise. Consequently, the cities with a strong concentration of oil and gas industries are deemed to possess a key industrial and financial potential.

The cities of Novokuznetsk, Biysk, Nyagan, Prokopyevsk, Rubtsovsk, Sysert, Uray, and Seversk (with slightly lower diversification) exhibit higher levels of diversity in terms of enterprise revenues, as indicated by the HHI metric. Similarly, Kopeisk, Nefteyugansk, Rubtsovsk, Nyagan, Uray, Novokuznetsk, Biysk, and Sysert demonstrate the greatest diversification in terms of enterprises' fixed assets, with HHI not exceeding 0.1, a trend that is consistent with the concentration of revenues. Diversification of wages, as indicated by HHI not exceeding 0.04, is observed in Kogalym, Rubtsovsk, Megion, Nyagan, Urai, and Seversk.

If we consider the indicators of operating and registered enterprises in the creative industries as a whole, they reflect an expected pattern of spatial distribution with the largest numbers being present in the major industrial centers of the regions, namely Novokuznetsk, Magnitogorsk, Nizhny Tagil and Surgut. However, it is important to note that the monetary indicators of revenues, fixed assets and wages in the creative industries exhibit a peak pattern. More specifically, Verkhnyaya Pyshma experienced a peak in fixed assets in 2021, Magnitogorsk in 2006, Nizhnevartovsk in 1999, and Uray in 2009 and 2010. Novokuznetsk witnessed a peak in revenue in 2017, while Nizhny Tagil observed this trend during the years 2018-2020. It must be emphasized that the peak-like nature of these dynamics, featuring a one-time 20-fold increase from the previous period, suggests the presence of a "movement" of assets. Such movement is often associated with the employment of grey schemes for the "withdrawal" of capital from the business.

Based on the absolute indicators of revenues, fixed assets, and labour remuneration, the concentration indicators of revenues, labour remuneration, and fixed assets within the creative industries of Nizhnevartovsk, Novokuznetsk, and Belovo exhibit significant fluctuations. Generally, a greater diversity in entrepreneurial activities within the creative industries can be observed in the oil and gas cities of the Khanty-Mansi autonomous okrug, as well as in the Altai Krai, specifically in Nefteyugansk, Nyagan, and Rubtsovsk (HHI of creative industries by revenue not exceeding 0.06). In addition, Kogalym, Kopeysk, and Seversk also display relatively diversified activities.

One of the most valuable indicators collected in the database and characterizing the entrepreneurial activity of the creative industries in the cities under consideration is the number of enterprises created annually. Figures 3-7 present data on the number of established enterprises in the studied cities, identifying that in the regional context, the Tomsk region and Altai Krai fall behind other regions in absolute terms.

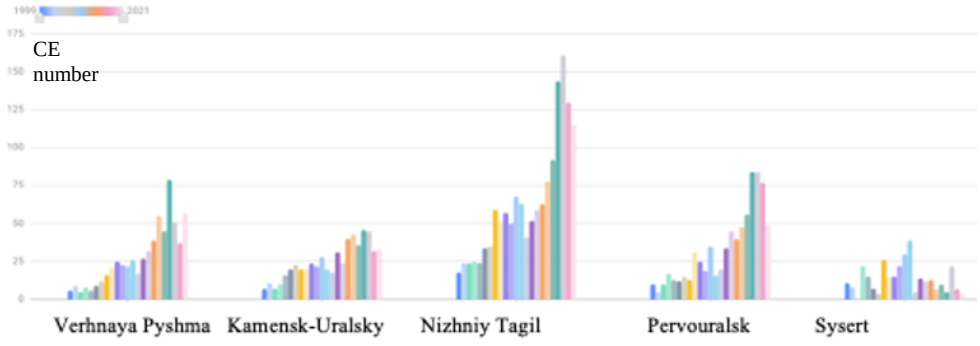

Fig. 3. The dynamics of the number of created enterprises (CE) of the creative industries in the second-tired cities of the Sverdlovsk region, 1999-2021.

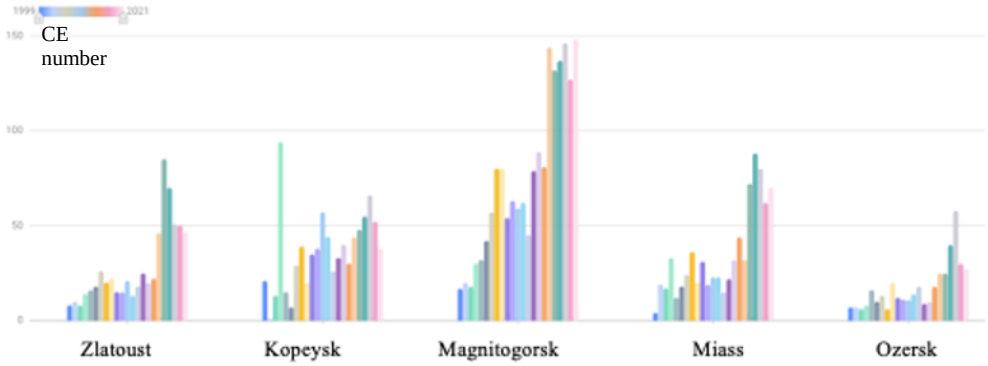

Fig. 4. The dynamics of the number of created enterprises (CE) of the creative industries in the second-tiered cities of the Chelyabinsk region, 1999-2021.

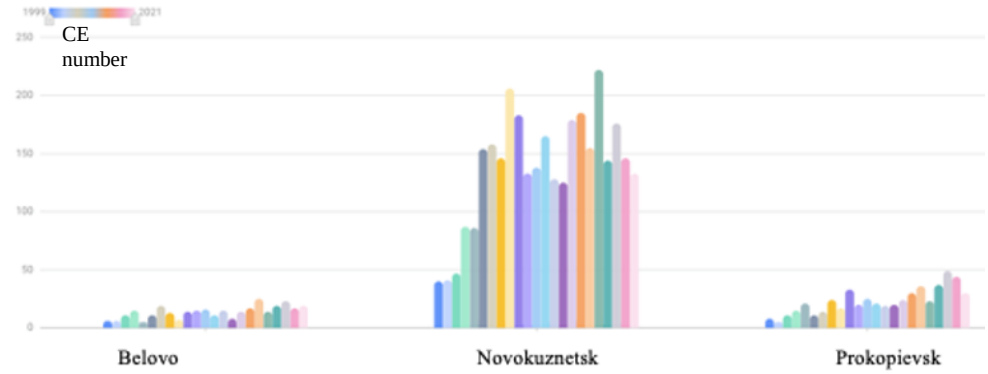

Fig. 5. The dynamics of the number of created enterprises (CE) of the creative industries in the second-tiered cities of the Kemerovo region, 1999-2021.

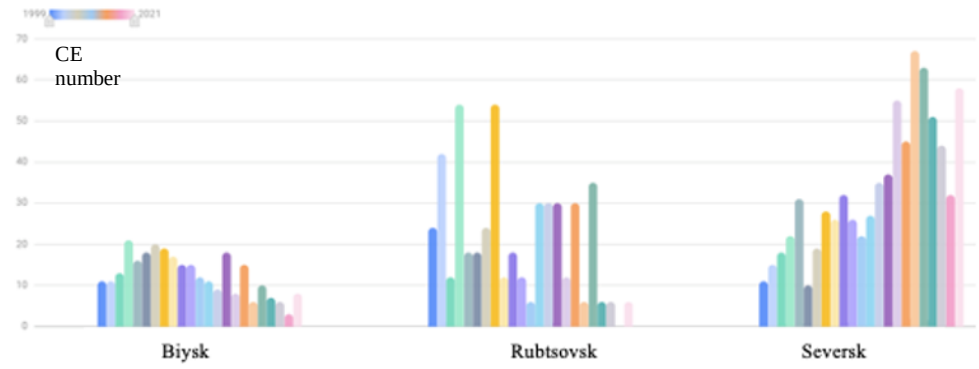

Fig. 6. The dynamics of the number of created enterprises (CE) of the creative industries in the second-tiered cities of Altai Krai and Tomsk region 1999-2021.

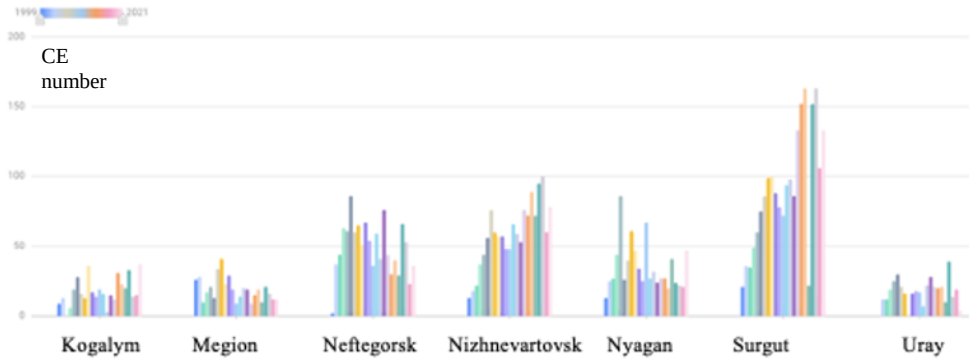

Fig. 7. The dynamics of the number of created enterprises of the creative industries in the second-tiered cities of Khanty-Mansiysk autonomous okrug, 1999-2021.

The establishment of large regional industrial centres engenders more conducive circumstances for the flourishing of innovative enterprises. Of the cities that have been taken into account, Verkhnyaya Pyshma, Sysert and Nyagan stand out based on the metric of the quantity of enterprises established per capita.

6 Discussion

The study proposes the decision-making support tool for spatial and dynamic visualization of concentration points that form the digital footprint of creative industries in the Urals and Siberia. The systematic analysis and theoretical interpretation of the collected, processed, and visualized data provide scientific validity to the conclusions and publications. The increasing trend of utilizing digital data visualization tools, specifically those that are open-ended, requires further scientific scrutiny. Nonetheless, the integration of such IT-based tools with research tools in regional economies is becoming increasingly apparent [16].

The theoretical implications of this research contribute to the broader concept of creative industries and its development concerning the role of creativity as a vital factor that evolves across different demography trends and is characterized by a wide range of diversity in the creative economy.

The findings arising by the research on second-tiered cities and creative industries reveal that these cities possess varying degrees of inherent activity distinctiveness. Cities that display a relatively higher level of economic activity diversification encompass Novokuznetsk, Biysk, Nyagan, Prokopyevsk, Rubtsovsk, Sysert, and Uray, with slightly lower ranks in Seversk, Nefteyugansk, Megion, and Kogalym (Herfindahl-Hirschman Index of the cities' enterprise revenue is no more than 0.11). Furthermore, Kopeysk, Nefteyugansk, Rubtsovsk, Nyagan, Uray, Novokuznetsk, Biysk, and Sysert similarly display a Herfindahl-Hirschman Index of fixed assets of the creative enterprises, which does not exceed 0.1.

In a broad sense, it is possible to discern a higher degree of variety pertaining to entrepreneurial operations within the creative industries sector in municipalities reliant on oil and gas activities, such as Nefteyugansk, Nyagan, and Rubtsovsk, situated within the confines of the Khanty-Mansi autonomous okrug, alongside the Altai Krai region. Referring to the Herfindahl-Hirschman Index, a metric that estimates industry concentration based on revenue, the aforementioned cities presented a score of no more than 0.06. Moreover, Kogalym, Kopeysk, and Seversk exhibit a relatively diversified entrepreneurial landscape.

7 Conclusion

According to economic analysis, large industrial centers in regions, which are essentially scaled-down versions of regional administrative centers, provide more favorable conditions for the development of creative enterprises. These industrial centers include Magnitogorsk, Nizhny Tagil, Surgut, and Novokuznetsk. Additionally, when considering the number of enterprises created per capita, Verkhnyaya Pyshma, Sysert, and Nyagan stand out from the overall list of cities. This indicates a polarized development of creative industries, which is consistent with the findings of [17]. Suvorova's research concludes that the distribution of creative capital in Russia is suboptimal, and as a result, it cannot serve as the main driver of the country's economic growth. Therefore, this heterogeneity at the national level is reflected in regional and local disparities.

In accordance with Simonton's research regarding the necessity of cultivating a creative personality from an early age by means of exposure to a creative ambiance and mentorship [18], the present research identifies cities characterized by specific demographic traits and patterns of population movement, namely, a negative migration balance combined with positive population dynamics. The selected cities comprise Megion, Nefteyugansk, Nizhnevartovsk, Nyagan, and Uray, which the author deems highly suitable for the promotion and expansion of creative industries, with the potential to enhance living standards and mitigate population outflow. Thus, the first obvious strategical step in municipal development using creative reindustrialization is using the essential opportunities highlighted by demography conditions, mainly in oil and gas towns. Whereas large industrial centers in regions could use more favorable conditions for the development of creative enterprises for its further development.

Acknowledgements

The research was supported by RSF (project No. 22-18-00679)

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