Measuring Effects of Investment Polycentricity on Economic Development of Municipalities

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Abstract. Polycentric matters are becoming popular under spatial agenda and regional policies across developing and advanced countries. Having put the polycentricity concept into normative plans, key shareholders found out fuzzy results in empirical body of experiences which could be explained by territorial heterogeneity, chosen measures, and techniques. The article aims on testing hypothesis whether a polycentric pattern in terms of investments in fixed assets has a positive effect on economic development in municipalities. The bivariate Moran’s indexes were calculated using data on investments in fixed assets and the volume of shipped own production goods, performed works, and services from 2015-2019. Our results showed that investments in fixed assets associated with economic development in different ways due to the presence of assisted regions in examined case study and scattering of investments in fixed assets due to regional disparities. These results might be taken into account while elaboration of new spatial strategies within regions in terms of resource distributions.

1. Introduction

Polycentric issues have become important across European spatial structure developments both in academic and research circles. Being a complex form of the spatial organization its application has arisen many questions regarding measuring, advantages in comparison with monocentric patterns and its shortcomings. This concept initially was created to reduce regional disparities within EU-countries, provide equal access to social and transport infrastructure while the empirical results show a mixed scene. The polycentricity essence is about forming a set of independent, size-comparable centers with diverse complement functions, which enable them to compete with bigger ones. Therefore, the set of centers could create the same economic conditions as a bigger center whereas matters of pollutions, traffic jams inherent in any monocentric area do not exist.

The Russian Federation is a huge country with extremely socio-economic disparities impeding economic development and improving social well-being. So, the target of translating this concept into Russian context seems to be actual and vital due to identification and assessment polycentric patterns that can lead to sustainable and balanced development. Taking into account the consequences of planned soviet economy, unequal placement of capital investments the next hypothesis is tested whether more polycentric municipalities in terms of capital investments show a higher level of economic development as against less polycentric ones. The choice of these indicators based on the assumption of the positive influence of investments in fixed assets on the region’s economic development. We provide depth-in testing of this hypothesis in terms of spatial structure.
2. Literature review

Davoudi S. [4] traces back to the roots of polycentricity concept and analyzes different types of spatial structure from monocentric to polycentric ones that are closely linked with broad population decentralization caused by the evolution of economic relationships between and within firms. She notes that notion of polycentricity became widespread across academic and political circles treating it as scale-dependent concept.

Malya J. [11] treats the polycentric urban system as a greater number of centers situated in the same area while none of them is significantly dominant. She aims to find out if there are benefits of polycentric patterns in decreasing regional disparities. She examines the relationship by focusing on local centers, using functional regions of the Czech Republic. Her paper defines polycentric urban systems at the micro-regional scale. Gained results show the absence of correlation between intra-regional disparities (represented by unemployment rate and active firms per inhabitant) and the polycentricity.

Li, Y., & Liu, X. [9] explore the link between urban spatial structure and economic development of Chinese cities involving twofold dimensions «concentration-dispersion» and «polycentricity-monocentricity». They explore per capita fixed asset investment of a city, input factor of human capita and degree of monocentricity and dispersion. The research highlights reveal that economic productivity is strongly associated with urban spatial structure whereas the polycentricity effects depend on population density. Cities that are more monocentric have high productive level, exploiting their agglomeration effects, in comparison with economies which have low levels of population density.

Brezzi M. & Veneri P. [3] consider polycentric structure of OECD urban systems at three geographic scales (a metropolitan area, a region, and a country). Their empiric experiences demonstrate that more polycentric countries are characterized by higher GDP per capita. At the same time, at the regional level, more monocentric regions have higher GDP per capita in comparison with more polycentric areas. They elaborated next measures for polycentricity at each spatial scale: intra-metropolitan (sprawl index, share of people and jobs in urban centers); regional (relative importance of the largest city, size distribution of cities); national (connectivity among cities, relative importance of the largest city, size distribution of cities).

But not only economic effects of the spatial structure are in the focus of the investigation, but social well-being matters are important as well. For instance, Rauhut D. & Komornicki T. [14] find out that polycentricity at the national scale has no impact on low-, middle- and high centrality social services. To identify spatial patterns of social services authors use certain indicators – the number of hospital beds per 100,000 inhabitants, the number of pharmacies per 100,000 inhabitants, and the number of universities per 500,000 inhabitants. The findings indicate that polycentrism on a national level appears to have no impact on low, medium or high centrality services but GDP/capita has the strongest impact on the social services.

Russian scientists also contributed to spatial development issues across resource distribution, regional patterns (Yusupov K. et al [20]; Novikov S. et al [13]; Fattakhov R. et al [6], Marinina O. [12], Litvinenko I.L. et al [10], Krasnoselskaya D. et al [8], Ivanov P., Sahapova G. [7], Danilova I., Karetnikova T. [5]). For instance, Yusupov K. et al [20] explored distribution of profitable firms’ location using the methods of spatial and hierarchical linear analysis. Their work demonstrated existence both spatial and hierarchical relationships between firms' profitability within municipalities.

With focusing in mind above-mentioned developments on polycentric matters and translating it in the Russian spatial framework, the problems of identifying investment centers capable to form the foundation of effective territorial management are awoken. This target requires the solution to the next questions. How do investments effect on economic results of the area? How polycentric structure in terms of investments is linked with the economic performance of the region? This paper differs from the others because it fulfills stated gaps.
3. Methodology
The initial unit of spatial analysis in our article is municipality included in particular region. Republic Bashkortostan and outlying regions are served as a case study.

Our analysis based on data for 271 municipalities in six regions covers 2015-2019 years. The data came from official web site of Rosstat statistics. The first pivotal question to be dealt with is to how measure polycentricity. In general, there are two established lines of solving this task. It can be done in morphological and functional dimensions. Traditionally, morphological approach is associated with employment density, which is engaged to determine the size of territorial unit (Ruguelle F., Thomas I., Verhertsel A. [15], Aguilera A., Mignot D. [2], Taubenböck H. et al. [16]). Functional approach primarily orientated on commuting patterns (Vasanen, A. [17], Yang, L., Wang, Y., Bai, Q., & Han, S. [19]. Vasanen [17] considers measures of functional polycentricity and highlights connectivity fields which means surfaces of interaction indicating how a particular center is functionally connected to the rest of the polycentric system.

Given available statistic data we have to use morphological approach, there we use Veneri P., Burgalassi D. [18] technique, adapting it to investments in fixed assets.

Our study takes morphological approach, within which we measure polycentricity using next equation (eq.1)

\[
weight\ (inv) = \frac{inv\ (i)}{\sum_{n=1}^{N} inv\ (n)}
\]

(1)

where weight (inv) – the share of municipality over total investments in fixed assets in region;
To rank our regions according to the level of polycentricity we calculate the standard deviation of investments in fixed assets. Russian spatial structure is characterized by astronomical disparities (table1) in terms of these dimensions. To explore space-time relationships between the chosen variables a bivariate spatial autocorrelation analysis took place that was conducted on GEO DA Software. While estimating spatial lags there is a necessity to fix two points of time due to established methodology. Therefore, we investigate investments in fixed assets in 2015-2017 while the value of shipped own production goods, performed works, and services are figured out in 2018-2019.

Table 1. Descriptive statistics of variables.

| Variable | Mean   | Min    | Max     | Coefficient of variation |
|----------|--------|--------|---------|--------------------------|
| Prod 2018| 56765903,39 | 164593,00 | 719861061,00 | 4373,582479 |
| Prod 2019| 38006270,25 | 319787,00 | 576681692,00 | 1803,330629 |
| Inv     | 2603353,61 | 2638,42 | 115023288,00 | 43595,59 |

Source: Rosstat statistics (processed by the author)

Bivariate Moran’s indexes were calculated on next equation [2]:

\[
I_B = \frac{\sum_i (\sum w_{ij} inv_j \times prod_j)}{\sum_i (prod_i)^2}
\]

(2)

Where \( w_{ij} \) - elements of the distance-based spatial weights matrix between the i-th and j-th municipalities;
\( inv_j \) – average volume of investments in fixed assets in j-th municipality over 2015-2017 years;
\( prod_j, prod_i \) – values of shipped own production goods, performed works, and services in j-th and i-th municipalities in 2018 or 2019 respectively.
4. Results
Having ranked investments in fixed assets we could infer that Orenburg region, Bashkortostan Republic and Republic of Tatarstan are at the top of policentricity rank.

| Region                  | Standard deviation | Policentricity rank |
|-------------------------|--------------------|---------------------|
| Orenburg region         | 0.04441            | 1                   |
| Bashkortostan Republic  | 0.05913            | 2                   |
| Republic of Tatarstan   | 0.06293            | 3                   |
| Chelyabinsk oblast      | 0.08547            | 4                   |
| Perm region             | 0.09107            | 5                   |
| Udmurdi region          | 0.12843            | 6                   |

*Source: processed by the author*

Concerning Moran’s index linking both investments in fixed assets and economic development it worth noting that there is an uncertain relationship. In 2018 global Moran’s I was 0.030, in 2019 it has slightly increased to 0.034; local Moran’s indexes are presented in table 3.

| Region                  | Local Moran’s I 2018 | Local Moran’s I 2019 |
|-------------------------|----------------------|----------------------|
| Orenburg region         | -1.585               | -0.272               |
| Bashkortostan Republic  | -0.004               | -0.004               |
| Republic of Tatarstan   | 0.005                | 0.007                |
| Chelyabinsk region      | 0.024                | 0.018                |
| Perm region             | 0.079                | 0.071                |
| Udmurdi region          | 0.027                | 0.026                |

*Source: processed by the author*

Table 3 shows local Moran’s indexes are negative for Orenburg region and Bashkortostan Republic that can be explained by the scattered nature of the investments in fixed assets in Bashkortostan Republic while Orenburg region is considered as an assisted area with investments in non-production assets. As for rest regions being less polycentric where a stronger association between investments in fixed assets and economic development has been distinguished, we conclude a positive relationship caused their traditional industrial specialization.

5. Conclusions
Conducted exploratory analysis revealed the uneven impact of spatial investment patterns on economic developments in municipalities. Calculated bivariate Moran’s global and local indexes mainly reflected entrenched regional disparities and scattering features of investment processes. At the same time, assisted areas (Orenburg region and Udmurdi region) showed different ways of being influenced by investment patterns that could be explain disparities in shares of non-production assets. Russian spatial structure stands out from the others countries due to its astronomical socio-economic disparities which makes issues of polycentric patterns relevant. At the same time entrenched relationship between settlement patterns and production is rather stronger than association attributed to investment and production. The matters of center identification are out of study focus because of statistical data which are available within traditional regional administrative division. But centers may be viewed across complex regional dimensions, taking into account production diversity, social and transport infrastructure, education what help distinguish low-, medium-, high- functions of territorial units. Resource distributions is also pivotal as it shows potential of growth and boosting development.
Moreover, center connectivity remains a vital challenge in terms of fragmented regional structure thus further studies should be aimed on in-depth understanding how existing spatial structure might be reshaped towards integrated spatial approach.

6. References

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