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SPATIAL DISTRIBUTION OF GRANTED INVESTMENT INCENTIVES IN THE CZECH REPUBLIC

[Prostorové rozložení přislíbených investičních pobídek v České republice]

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Abstract: First investment incentives in the Czech Republic were granted in 1998. From 1998 to 2021 there were 1,319 granted investment incentives in total with 1,444 locations of implementation of the investment projects. The total amount of the supported investment projects reached nearly 983 billion CZK, and the applicants promised to create more than 203,000 new jobs. This paper evaluated the spatial distribution of the investment projects with granted investment incentive in the Czech Republic in the period 1998-2021. The spatial distribution was examined on the basis of three indicators calculated for the district level – the amount of investment per capita, the number of newly created jobs per 1,000 inhabitants and the state aid ceiling per capita. As the spatial distribution was investigated, spatial autocorrelation of each indicator was tested using the Moran test. In terms of calculated indicators, granted investment incentives in the Czech Republic were distributed unequally and tended to be clustered especially in the districts of the Ústí Region, the Central Bohemian Region and the Moravian-Silesian Region. The Moran test confirmed the presence of statistically significant spatial autocorrelation across all indicators related to granted investment incentives on the district level in the period 1998-2021.

Keywords: investment incentives, spatial analysis, spatial autocorrelation, spatial data.

JEL classification: C21, H81, R12

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Introduction

Investment incentives in the Czech Republic are an instrument of economic policy, which should motivate domestic and foreign companies to invest and develop their business in order to support economic development. The first investment incentives in the Czech Republic were granted in 1998, however a comprehensive framework for granting investment incentives set up by Act No. 72/2000 Coll., on Investment Incentives came into force in May 2000 (MPO 2006, NKÚ 2021). The system of investment incentives in the Czech Republic has undergone several changes during its operation, with a total of 1,319 decisions to grant investment incentive during the period 1998-2021.

The aim of this paper is to evaluate the spatial distribution of the investment projects implemented in the Czech Republic with granted investment incentive in the period 1998-2021. Related data analysis is based on the calculation of three relative indicators for the district level: the amount of investment per capita, the number of newly created jobs per 1,000 inhabitants and the state aid ceiling per capita. Since the spatial data are analysed, spatial autocorrelation is also tested using the Moran test of residual correlation with nearby residuals. To analyse the spatial data, specialized software is used - QGIS 3.16 (Hannover) Geographic Information System (QGIS.org 2020) for creating choropleth maps and Stata 15 (StataCorp 2017) for testing spatial autocorrelation (the Moran test).

The paper is organized as follows. Section 1 contains brief literature review related to the investment incentives in the Czech Republic and to the phenomenon of spatial autocorrelation.

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Section 2 is focused on the data and methodology. Section 3 is dedicated to the empirical results of the analysis. Finally, conclusion points out the most important findings of the paper.

1 Literature review

This section is divided into two thematically different parts. The first subsection briefly summarizes the main aspects of the current system of investment incentives in the Czech Republic. The second subsection is devoted to the phenomenon of spatial autocorrelation.

1.1 Investment incentives in the Czech Republic

First investment incentives in the Czech Republic were provided in 1998 based on the Government Resolution No. 298 of April 29, 1998[1]. In May 2000 came into force Act No. 72/2000 Coll., on Investment Incentives which provided comprehensive framework for granting investment incentives in the Czech Republic (MPO 2006, NKÚ 2021). This Act has undergone several amendments until the current Act No. 72/2000 Coll., on Investment Incentives and on Amendments to Certain Acts (Investment Incentives Act), as amended by Act No. 450/2020 Coll. (CzechInvest 2022a).

The Act lays down the general conditions for granting investment incentives such as implementation of the investment project in the territory of the Czech Republic. Other general conditions for each type of investment projects are laid down in a government regulation. The other general conditions are related for example to the acquisition of tangible and intangible fixed assets within 3 years of the date of the investment incentive decision, creation of new jobs within 3 years of the date of the investment incentive decision etc. (CzechInvest 2022a).

According to the Act, investment incentive means state aid in the form of:

1. income tax relief,
2. transfer of land including the related technical infrastructure at a reduced price,
3. financial aid for the creation of new jobs,
4. financial aid for the retraining or training of employees,
5. financial aid for the acquisition of tangible and intangible fixed assets for a strategic investment project, or
6. exemption from tax on immovable property in special industrial zones (CzechInvest 2022a).

According to the Act, there are three types of investment projects in the Czech Republic which are eligible for investment incentives: manufacturing industry, technology centre, strategic services centre (software development centre, data centre, repair centre, shared services centre) (CzechInvest 2022a).

All applicants for investment incentives in the Czech Republic submit the investment incentive application to the Business and Investment Development Agency CzechInvest which hands the application over to the Ministry of Industry and Trade. The application subsequently undergoes an approval round at other concerned ministries such as the Ministry of Finance, the Ministry of the Environment etc. After the approval round at ministries the application is submitted to the assessment and approval by government. The Ministry of Industry and Trade grants an investment incentive if the application is approved by the government (CzechInvest 2022b).

[1] Usnesení Vlády České republiky ze dne 29. dubna 1998 č. 298, k návrhu investičních pobídek pro investory v České republice.

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There are many studies focused on impacts of investment incentives on the Czech economy and its selected aspects such as Schwarz et al. (2007), Adámek and Rybková (2015) or Blaschke (2022) etc. However, conclusions of the studies may differ. While Adámek and Rybková (2015, p. 13) state that: "*Investment incentives seem to be proper instrument of economy policy and it is one of the key factors which decrease unemployment and improve regional productivity.*", then Blaschke (2022, p. 19) states that: "*The results in this study confirm that investment incentives contribute to an inflow of investments into the host economy, but their impact on positive economic development is statistically negligible.*" From recent international studies related to investment incentives can be mentioned for example Celani, Dressler and Wermelinger (2022).

1.2 Spatial autocorrelation

This article is devoted to the spatial distribution of granted investment incentives in the Czech Republic in the period 1998-2021. The analysed data are for district level which means that one of the data characteristics is geographic location. As Spurná (2008) states, one of the big analytical issues which needs to be considered within the spatial data analysis is spatial autocorrelation.

According to Anselin and Bera (1998, p. 241): "*Spatial autocorrelation can be loosely defined as the coincidence of value similarity with locational similarity. In other words, high or low values for a random variable tend to cluster in space (positive spatial autocorrelation), or locations tend to be surrounded by neighbors with very dissimilar values (negative spatial autocorrelation).*"

Phenomenon of spatial dependence or spatial autocorrelation can arise in spatial datasets because of interactions between geographical units. Le Gallo, Ertur and Baumont (2003, p. 106) state that *"Spatial dependence means that observations are geographically correlated due to some processes, which connect different areas, like for example diffusion or trade processes. Several economic factors, like labor force mobility, capital mobility, technology and knowledge diffusion, transportation or transaction costs may be particularly important because they directly affect regional interactions."*

Presence of spatial autocorrelation within spatial data can be tested for example by the Moran's I statistic (Spurná 2008, Arbia and Basile 2005, LeSage 2008). This statistic is described in the subsection 2.2 dedicated to the methodology of this paper.

The key role in modelling spatial patterns plays a spatial weights matrix. The spatial weights matrix is based on a spatial weighting function by which is examined whether two geographical units are neighboring or not. The spatial weights matrix is positive and symmetric matrix with $n \times n$ dimensions, where n is number of geographical units. Each matrix element $w_{i,j}$ indicates the spatial proximity between geographic units i and j ($0 \leq w_{i,j} \leq 1$). The diagonal elements of the spatial weights matrix are equal to zero ($w_{i,i} = 0$) (Spurná 2008; Le Gallo, Ertur and Baumont 2003; Anselin and Bera 1998; Anselin, Le Gallo and Jayet 2008). There are different types of spatial weights matrices such as simple binary contiguity matrices, inverse distance matrices etc. (Le Gallo, Ertur and Baumont 2003; Elhorst 2014). The simple binary contiguity matrix is described in the subsection 2.2 dedicated to the methodology.

2 Data and methodology

This section describes the data and methodology used in this paper. Subsection 2.1 is devoted to the data used in this paper. The second subsection describes the methodology.

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2.1 Data

The data on granted investment incentives in the Czech Republic analysed in this paper cover the period 1998-2021. This implies that the data include investment incentives granted under the Act No. 72/2000 Coll., on Investment Incentives (and its amendments) as well as investment incentives granted under the Government Resolution No. 298 of April 29, 1998. The dataset is comprised of publicly available and internal data of the Business and Investment Development Agency CzechInvest (CzechInvest 2022c). The internal part of the dataset contains additional information about the cancelled investment incentive decisions.

Among the decisions to grant investment incentive, it is necessary to bear in mind also the decisions which were cancelled. In this paper, all 300 cancelled decisions with 325 locations of the implementation of the investment projects in the period 1998-2021 were excluded from the analysis. The cleaned dataset based on the data from the CzechInvest (2022c) thus contains 1,019 granted investment incentives with 1,119 locations of implementation of the investment projects. Total amount of the supported investment projects (without the cancelled decisions) reached 817,533.84 mill. of Czech koruna (CZK) with the state aid ceiling of 252,977.44 mill. CZK. Applicants for investment incentives promised to create 163,285 new jobs within the supported investment projects. Table 1 depicts fundamental descriptive analysis of the data on granted investment incentives in the Czech Republic in the period 1998-2021.

Table 1: Granted investment incentives in the Czech Republic (1998-2021)

1998-2021		Granted investment incentives	Number of locations
All decisions			
Implementation of investment project	single location	1,232	1,232
	multiple locations	87	212
	in total	1,319	1,444
Investment (mill. CZK)		982,965.57	
State aid ceiling (mill. CZK)		316,192.8	
Jobs created		203,050	
Cancelled decisions			
Implementation of investment project	single location	282	282
	multiple locations	18	43
	in total	300	325
Investment (mill. CZK)		165,431.73	
State aid ceiling (mill. CZK)		63,215.36	
Jobs created		39,765	
Cleaned data (cancelled decisions excluded)			
Implementation of investment project	single location	950	950
	multiple locations	69	169
	in total	1,019	1,119
Investment (mill. CZK)		817,533.84	
State aid ceiling (mill. CZK)		252,977.44	
Jobs created		163,285	

Source: own calculations based on the data from CzechInvest (2022c)

2.2 Methodology

Methodology of this paper is based on two aspects. First aspect is calculation of three relative indicators related to granted investment incentives for the district level and depiction of the indicators using choropleth maps. Second aspect is testing for presence of spatial autocorrelation.

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The spatial data analysis regarding the investment projects with granted investment incentive is based on the calculation of three relative indicators for the district level:

- the amount of investment per capita (CZK),
- the number of newly created jobs per 1,000 inhabitants,
- the state aid ceiling per capita (CZK).

All the relative indicators were calculated for the district level. The procedure of the calculation was as follows. At first, the values of each individual variables (the amount of investment, the number of newly created jobs, the state aid ceiling) were summed for the entire period 1998-2021 for each of 76 districts of the Czech Republic and Prague. Subsequently, these total values for the individual districts were divided by the corresponding arithmetic mean of the district population during the period 2000-2021. The data on the population for the district level published by the Czech Statistical Office (ČSÚ 2022) are available since 2000. The calculated relative indicators were depicted through choropleth maps using QGIS (QGIS.org 2020) what enables to preliminarily evaluate the spatial distribution of the indicators related to the investment projects with granted investment incentive.

As mentioned in the section devoted to the literature review, spatial autocorrelation can be tested by the Moran's I statistic. According to Arbia and Basile (2005) or Kazar and Celik (2012) the Moran's I statistic is defined as:

$$I = \frac{n}{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{i,j}} \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{i,j}\,(x_i-\bar{x})(x_j-\bar{x})}{\sum_{i=1}^{n}(x_i-\bar{x})^2}, \qquad (1)$$

where n is the number of observations, $w_{i,j}$ is the element of the spatial weights matrix W, x_i and x_j are observations for locations *i* and *j* and $\bar{x}$ is the mean of all observations (Arbia and Basile 2005). Positive values of the Moran's I statistic show positive spatial autocorrelation (spatial clustering) and negative values indicate negative spatial autocorrelation (spatial dispersion) (Arbia and Basile 2005; Spurná 2008).

As mentioned, $w_{i,j}$ is the element of the spatial weights matrix W. In this paper a simple binary contiguity matrix based on the first-order contiguity criterion is used. This type of spatial weights matrix is defined according to the rule below (2) (Anselin, Le Gallo and Jayet 2008; Anselin and Bera 1998):

$$w_{i,j} = \begin{cases} 1 \text{ when } i \text{ and } j \text{ are neighbors} \\ 0 \text{ when } i \text{ and } j \text{ are not neighbors} \end{cases} \qquad (2)$$

Thus, the elements $w_{i,j}$ of the spatial weights matrix can obtain only two values (1 or 0). The diagonal elements $w_{i,i}$ are equal to zero. An illustrative example of the spatial weights matrix *C* is shown below (3), containing seven imaginary regions from R_1 to R_7 (LeSage and Pace 2009):

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$$C = \begin{array}{c} \\ R_1 \\ R_2 \\ R_3 \\ R_4 \\ R_5 \\ R_6 \\ R_7 \end{array} \begin{array}{c} \begin{array}{ccccccc} R_1 & R_2 & R_3 & R_4 & R_5 & R_6 & R_7 \end{array} \\ \begin{pmatrix} 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 \end{pmatrix} \end{array} \quad (3)$$

For interpretation reasons, the elements of the spatial weights matrix are usually row-normalized. Row normalization implies that the sum of the elements of each row equals to one. Thanks to the row-normalization, the spatial weighting operation can be interpreted as an averaging of neighboring observations (Anselin and Bera 1998, Anselin 2003, Elhorst 2014). The illustrative spatial weights matrix *C* (3) after the row-normalization is depicted through the row-normalized spatial weights matrix *W* (4) (LeSage and Pace 2009):

$$W = \begin{pmatrix} 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 1/2 & 0 & 1/2 & 0 & 0 & 0 & 0 \\ 0 & 1/2 & 0 & 1/2 & 0 & 0 & 0 \\ 0 & 0 & 1/2 & 0 & 1/2 & 0 & 0 \\ 0 & 0 & 0 & 1/2 & 0 & 1/2 & 0 \\ 0 & 0 & 0 & 0 & 1/2 & 0 & 1/2 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 \end{pmatrix} \quad (4)$$

3 Empirical results

This section contains empirical results of the spatial distribution analysis of granted investment incentives in the Czech Republic during the period 1998-2021. Three relative indicators for the district level were evaluated: the amount of investment per capita, the number of newly created jobs per 1,000 inhabitants and the state aid ceiling per capita.

As for the first indicator - the amount of investment per capita - the range of values is very wide. The highest value for the given period was reached by the district of Louny in the Ústí Region with the investment per capita of 530,749 CZK. Conversely, the lowest value was found in the district of Jeseník in the Olomouc Region (3,387 CZK per capita). The average value for the entire Czech Republic for the given period was 78,228.8 CZK per capita.

Regarding the second indicator - the number of newly created jobs per 1,000 inhabitants - the highest value was again reached by the district of Louny with 91.5 newly created jobs per 1,000 inhabitants. On the contrary, after Prague (0.4), which does not belong among districts, the Jeseník district (0.6) showed the lowest value. In this case, the average for the entire Czech Republic was 15.6 newly created jobs per 1,000 inhabitants.

The third indicator was the state aid ceiling per capita. Even in this indicator, the district of Louny reached the highest value (131,804 CZK per capita). The lowest values are again shown by Prague (877 CZK per capita) and by the district of Jeseník (1,643 CZK per capita). The average for the entire Czech Republic was 24,207.1 CZK per capita.

The spatial distribution of all three indicators in the period 1998-2021 was depicted through the choropleth maps below (figures 1-3). According to the data visualization, all three indicators show similar results. Above-average values were found especially in the districts of the Ústí

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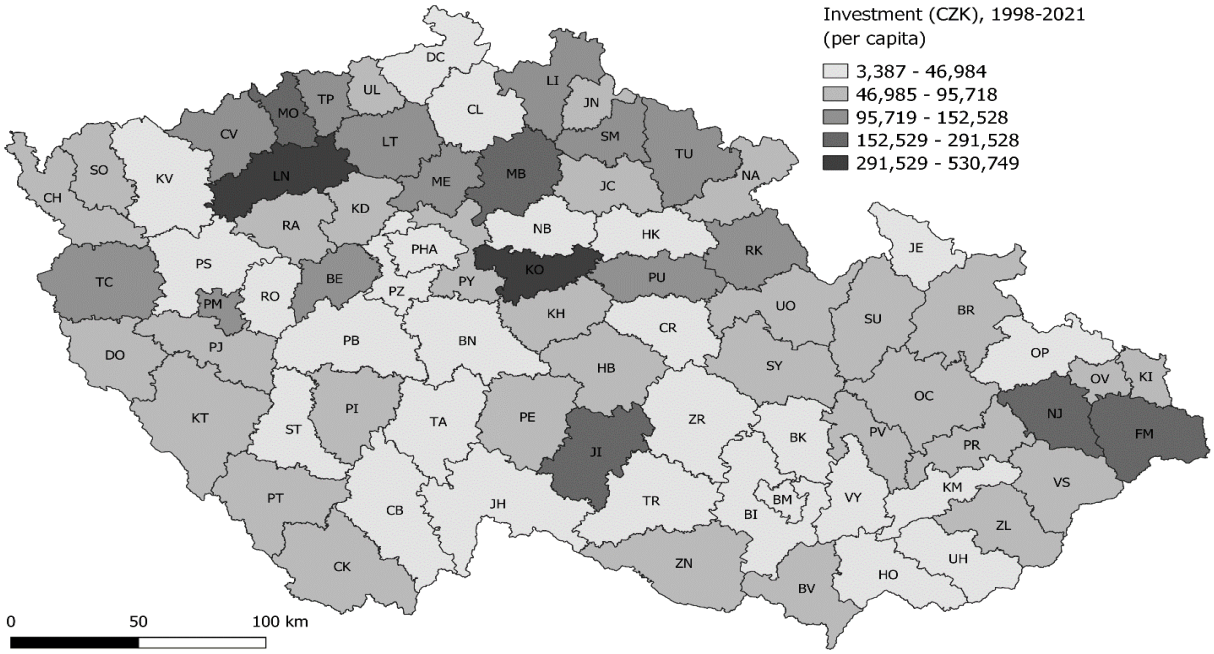
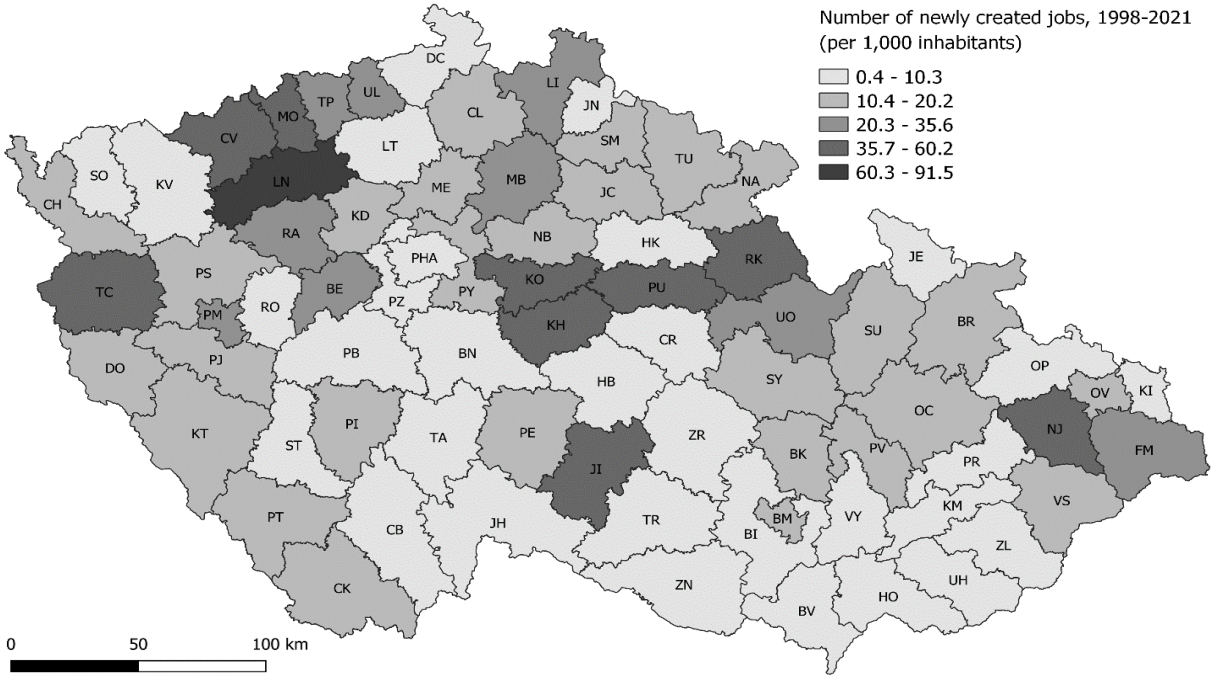
Region, the Central Bohemian Region, the Moravian-Silesian Region, the Liberec Region, the Hradec Králové Region and the Pardubice Region. On the contrary, the districts of the Karlovy Vary Region, the South Bohemian Region, the South Moravian Region and the Zlín Region showed below-average values.

Figure 1: Investment per capita (CZK), 1998-2021



Source: own calculations based on CzechInvest (2022c) and ČSÚ (2022), own elaboration in QGIS (QGIS.org, 2020), Mapový podklad – Soubor hranic, 2022 © Český úřad zeměměřický a katastrální, www.cuzk.cz (ČÚZK, 2022)

Figure 2: Number of newly created jobs per 1,000 inhabitants, 1998-2021



Source: own calculations based on CzechInvest (2022c) and ČSÚ (2022), own elaboration in QGIS (QGIS.org, 2020), Mapový podklad – Soubor hranic, 2022 © Český úřad zeměměřický a katastrální, www.cuzk.cz (ČÚZK, 2022)

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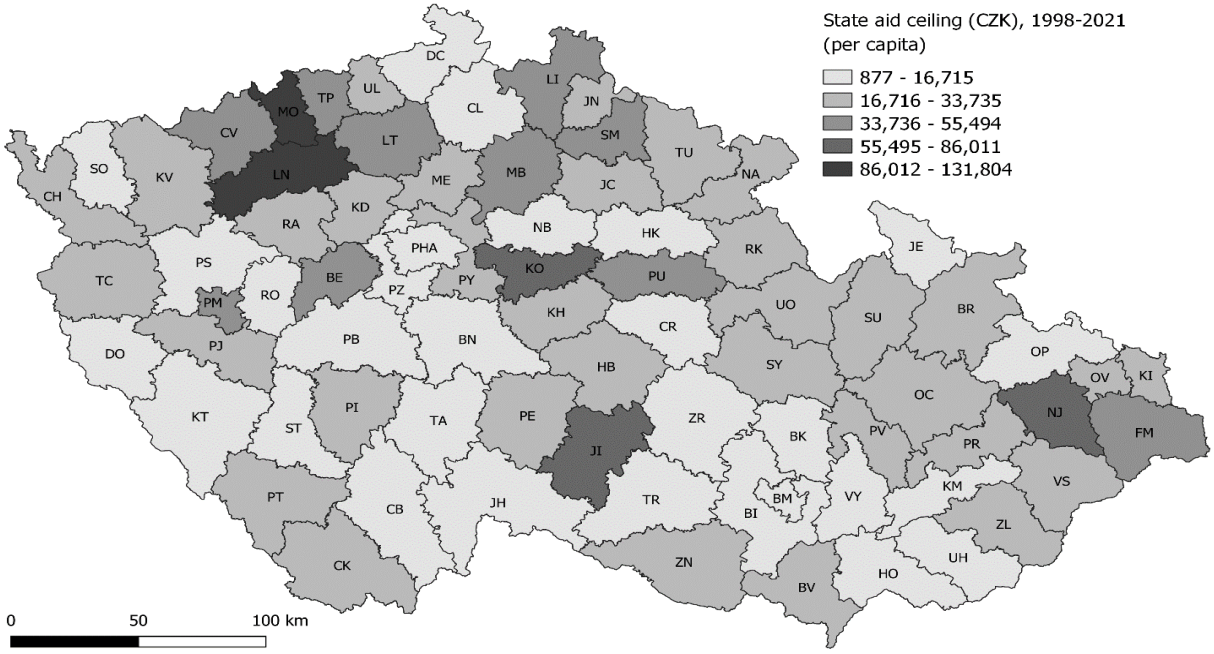
Figure 3: State aid ceiling per capita (CZK), 1998-2021



Source: own calculations based on CzechInvest (2022c) and ČSÚ (2022), own elaboration in QGIS (QGIS.org, 2020), Mapový podklad – Soubor hranic, 2022 © Český úřad zeměměřický a katastrální, www.cuzk.cz (ČÚZK, 2022)

According to the choropleth maps it seems that some of the districts tend to be clustered. Above-average values seem to be concentrated especially in the districts of the northern, central and eastern Bohemia (the Ústí Region, the Liberec Region, the Central Bohemian Region, the Hradec Králové Region and the Pardubice Region) and in the Moravian-Silesian Region. Conversely, below-average values are mainly concentrated in the Karlovy Vary Region, the South Bohemian Region, the South Moravian Region and the Zlín Region.

Spatial autocorrelation of each relative indicator was tested using the row-normalized simple binary contiguity spatial weights matrix W with the dimensions 77 x 77. The characteristics of the spatial weights matrix W are summarized in the table 2.

Table 2: Spatial weights matrix W

Type	contiguity
Normalization	row
Dimension	77 x 77
Elements	
minimum	0
minimum > 0	0.125
mean	0.012987
max	0.5
Neighbors	
minimum	2
mean	4.961039
maximum	8

Source: own calculations in Stata 15 (StataCorp, 2017)

Spatial autocorrelation was tested in Stata 15 (StataCorp 2017) using the Moran test of residual correlation with nearby residuals. The null hypothesis of the test states that error of tested

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variable is independently and identically distributed (i.i.d.). The results of the Moran test for each variable are summarized in the table 3.

Table 3: Moran test of residual correlation with nearby residuals

Moran test for spatial dependence H_0: error is i.i.d. Errorlags: W		
Amount of investment per capita	Number of newly created jobs per 1,000 inhabitants	State aid ceiling per capita
chi2(1) = 3.58	chi2(1) = 7.69	chi2(1) = 10.02
Prob > chi2 = 0.0586	Prob > chi2 = 0.0055	Prob > chi2 = 0.0016

Source: own calculations in Stata 15 (StataCorp, 2017)

The Moran test is statistically significant for all variables (at 1% significance level for the number of newly created jobs per 1,000 inhabitants and the state aid ceiling per capita and at 10% significance level for the amount of investment per capita). Thus, for all three variables the null hypothesis (H_0: error is i.i.d.) can be rejected. This means that spatial correlation among the residuals was identified. The preliminary evaluation of spatial autocorrelation based on the choropleth maps was confirmed.

Conclusion

The aim of this paper was to evaluate the spatial distribution of the investment projects implemented in the Czech Republic with granted investment incentive in the period 1998-2021.

The analysed dataset based on the data from CzechInvest (2022c) contained 1,019 granted investment incentives with 1,119 locations of implementation of the investment projects. Total amount of the supported investment projects (without the cancelled decisions) reached 817,533.84 mill. CZK with the state aid ceiling of 252,977.44 mill. CZK. Applicants for investment incentives promised to create 163,285 new jobs within the supported investment projects. The spatial data analysis was based on the calculation of three relative indicators for the district level: the amount of investment per capita, the number of newly created jobs per 1,000 inhabitants and the state aid ceiling per capita.

In terms of the spatial distribution of all three indicators in the period 1998-2021, it was found out that granted investment incentives in the Czech Republic were distributed unequally and that some of the districts tended to be clustered. The unequal spatial distribution may have been influenced by a combination of many factors such as labour availability, proximity to customers and to supply chains, state aid intensity, availability of business properties etc. The above-average values were concentrated especially in the districts of the northern, central and eastern Bohemia (the Ústí Region, the Liberec Region, the Central Bohemian Region, the Hradec Králové Region and the Pardubice Region) and in the Moravian-Silesian Region. Conversely, below-average values were mainly concentrated in the Karlovy Vary Region, the South Bohemian Region, the South Moravian Region and the Zlín Region. According to the choropleth maps of all three indicators, there was an indication that some of the districts tended to be clustered. Thus, spatial autocorrelation of each indicator was tested by the Moran test of residual correlation with nearby residuals using the row-normalized simple binary contiguity spatial weights matrix. The Moran test confirmed the presence of statistically significant spatial autocorrelation across all indicators related to granted investment incentives on the district level in the period 1998-2021.

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