Soaring unemployment in Czechia during the global economic crisis

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ABSTRACT
This study presents an analysis and visualisation of the evolutionary dynamics of unemployment at the municipal level in Czechia during the global economic crisis. The analysis is based on a monthly time series of unemployment data at a detailed territorial level. Namely, there are 6,258 municipalities in Czechia, which makes it particularly suitable for a detailed investigation of the unfolding and evolution of the recent crisis. Our focus is on analysing and mapping the spatiotemporal patterns of unemployment using variability and autocorrelation measures. Given the detailed territorial level of our analysis, large-scale maps will be presented to assist with interpretation and analytical conclusions. The Main Map (1:600 000) shows the categories of municipalities according to the rate of unemployment and its evolutionary dynamics. Three additional maps (1:1 400 000) visualise the results of spatiotemporal analyses.

1. Introduction
The global economic crisis ignited by excessive risks accumulated in the US banking system swiftly spread to Western and then Southern and Eastern European countries via intensive economic ties (Derudder, Hoyer, & Taylor, 2011; Martin, 2011). The roots of the crisis have been aptly described by Martin (2011) as a shift from a ‘locally originate and locally-hold’ paradigm of mortgage provision to a securitised ‘locally originate and globally distribute’ model. The financial innovation, consisting of the widespread securitisation of mortgage pools, altered the way financial markets operate (Martin, 2011). This is because it enabled higher returns than those anticipated in home markets (Lee, Clark, Pollard, & Leyshon, 2009) but entailed vast and uncured risks. An interlinked driver of the crisis was the rapid expansion of ‘buy-to-let’ housing in attractive locations, conceived as an income-generation machine (Martin, 2011). This resulted in profoundly territorial impacts of the crisis when repayment problems of sub-prime mortgages surfaced as a result of mortgage bonds losing their value. Severe losses were endured by banks which ultimately caused a collapse in confidence and general quelling of the economy (Jones, Clark, & Cameron, 2010; Martin, 2011).

Due to numerous underlying factors, the crisis evolved differently in different countries, reflecting inter alia the scale and nature of internal imbalances (Smith & Swain, 2010) and the type and intensity of policy responses employed by governments (e.g. cyclical or anti-cyclical fiscal policy). However, the crisis did not only unfold differently across various countries, it also exhibited highly distinctive territorial impacts within countries, especially in terms of unemployment rates (Blažek & Netrdová, 2012). For example, Kiss (2012) concluded that the highly industrialised northern part of Transdanubia (one of the most developed regions of Hungary, where manufacturing is largely foreign-owned and strongly oriented on exporting to global markets) was hit the hardest by the crisis. Nevertheless, the basic constraint of existing studies has been limited territorial detail. Previous studies were often based on data aggregated at the NUTS2 or NUTS3 level regions (e. g. Kiss, 2012; Marelli, Patuelli, & Signorelli, 2012), thus potentially concealing profound intra-regional disparities. Data from these large regions does not allow investigations of the detailed anatomy of a rapidly evolving crisis within countries. Consequently, evidence of socio-economic differentiation trends at the local level is largely absent.

The main aim of this study is to uncover the details of how the global economic crisis unfolded at the local (municipal) level in Czechia, which has been affected by the global economic crisis since September 2008. To this purpose, we use a monthly time series of unemployment data for Czech municipalities from 2006 to 2011. Luckily, unemployment is also broadly considered one of the key indicators of socio-economic trends, which, moreover, often correlates with the data on GDP and several other economic indicators at least at the regional level (Netrdová & Nosek, 2016). In contrast to data aggregated at the NUTS 2 or NUTS 3 level, analyses performed at the municipal
level enable us to capture spatial patterns in their full scope and to reveal local clusters and outliers, which could otherwise remain hidden. Moreover, the well-known Modifiable Areal Unit Problem (MAUP) which deals with the sensitivity of spatial analyses to the exact delimitation of areal units is mitigated. Using data for the smallest available units as a basic scale of analysis without any ad hoc aggregation addresses both issues of MAUP (the scale and zoning effect), but does not completely eliminate them (Openshaw, 1984; Wong, 2009). In our study, we aim to answer the following research questions: Has the global economic crisis altered the territorial pattern of unemployment existing in the pre-crisis period? Are there any distinctive trends or patterns in unemployment at the local level since the crisis hit Czechia? What is the overall territorial pattern of municipalities that performed significantly better or worse during the crisis than the national average? Do these municipalities form some spatial clusters or are they scattered around the whole country?

To fulfil these goals, a coherent database of unemployment data accommodating changes in territorial delimitation of municipalities for the study period was built on the basis of data provided by the Czech Ministry of Labour and Social Affairs. Secondly, the analysis of spatiotemporal patterns of mounting unemployment via variability and spatial autocorrelation measures was performed. Specifically, the Gini coefficient and Moran’s I were used to capture the distinct dimensions of general tendencies in differentiation of unemployment within Czechia. To analyse the spatial patterns and their visualisation, we used Local Indicators of Spatial Association (LISA) statistics (Anselin, 1995) and Getis-Ord Gi* statistics (Getis & Ord, 1992; Ord & Getis, 1995) and their extension to spatiotemporal analysis. All analyses were handled in an exploratory way to reveal emerging spatial patterns such as tendencies to spatial clustering of well or poorly performing municipalities, locations of outliers and their changes.

2. Data

In Czechia, unemployment data is the only indicator available with sufficient frequency at a detailed territorial level such as municipalities. In this study, we use official data for the number of unemployed people searching for jobs and registered at job centres (Labour Offices). The network of Labour Offices in the Czech Republic established by the Ministry of Labour and Social Affairs reports the number of unemployed job seekers registered at each Labour Office on the last day of each month. According to Czech labour legislation, which specifies the conditions for claiming unemployment benefits, the unemployment rate is defined as the number of job seekers in the 15–64 age group who are immediately ready to commence employment. Data on the number of people in this age group at the municipal level is available from the Czech Statistical Office on the 31st of December each year. To calculate monthly unemployment rates, average values are calculated from values related to the beginning and end of each year. We must acknowledge that this type of data yields a slightly lower rate of unemployment compared to survey-based data as not all unemployed persons register at Labour Offices (at the national level, the rate published by Labour Offices is approximately 0.5% lower). However, we are not aware of any factors which would lead to a bias in territorial patterns of registering at Labour Offices. Thus, we consider this data relevant to our analysis.

Czechia is characterised by a very fragmented structure of municipalities which represent the lowest level of local government. The median population of the more than 6,250 municipalities is less than 500 inhabitants and the mean area is less than 13 km². Therefore, an analysis of unemployment data at a territorial level provides a unique opportunity to study how the global economic crisis unfolded. During the investigated period, 45 municipalities experienced a change in spatial delimitation, 13 municipalities came into existence, and 13 municipalities ceased to exist. To reflect these changes, the unemployment rate was recalculated in accordance with the current territorial structure (i.e. the administrative division valid at the end of 2016). Czechia was administratively subdivided into 6,258 municipalities including four military areas, which were excluded from our analyses as they do not have permanent inhabitants. Thus, territorial coherency of data was ensured enabling us to compute indexes of changes for each municipality and explore the spatiotemporal tendencies in changes to the unemployment rate.

Our study aims to analyse the unfolding of the impact of unemployment caused by the global economic crisis from its beginning until the point where it reached its greatest intensity according to the unemployment rate. Therefore, we focus on a period of six years between 2006 and 2011, covering three years before and three years after the spike in unemployment due to the eruption of the global economic crisis, as documented in Figure 1.

On the one hand, exploring unemployment changes at the municipal level is an extremely effective way to reveal spatial patterns and changes which could be hidden when studying larger regional units at a detailed local level. On the other hand, analyses which are frequently based on small numbers of unemployed people in certain municipalities require special consideration. Monthly changes to the unemployment rate in small municipalities can be affected by life trajectories even of just a few individuals. Moreover, the unemployment
rate can reach extreme values in tiny municipalities with a value of zero not being an exception. To moderate these problems, quarterly and yearly averages based on monthly data were used in analyses performed at the municipal level.

The municipal and other territorial layers were excerpted from the digital vector geographic database of the Czech Republic ArcČR® 500 (https://www.arcdata.cz/produkty/geograficka-data/arccr-500).

3. Methods

All analyses performed belong to a large group of methods called Exploratory Spatial Data Analysis (ESDA). According to Anselin (1998), ESDA encompasses a set of techniques aimed at measuring and visualising spatial distributions and patterns. In particular, ESDA represents an extension of the Exploratory Data Analysis (EDA) concept introduced by Tukey (1977) that aimed to analyse spatial data that behaves specifically due to their spatial dependence and spatial heterogeneity (Anselin, 1998). Both of these exploratory approaches emphasise the importance of a descriptive component to statistical analyses without any formal hypothesis testing. Therefore, the formulation of hypotheses should be a result of the research on the geography of the phenomena, which could subsequently be further examined. When analysing spatial data, ESDA methods focus mainly on detecting spatial clusters or hot spots and upon identification of atypical localizations or spatial outliers.

Before performing the local analyses at the municipal level, the overall state of the evolution of spatial differences in the unemployment rate in Czechia during the studied period was examined. Two basic approaches to measuring spatial aspects of variability were used; regional variability and global spatial autocorrelation, as proposed by Netrdová and Nosek (2017). The first approach employs basic statistical measures of variability and shows the overall level of variability among municipalities. In particular, we employed the Gini coefficient as a relative measure of variability with a straightforward interpretation derived from the Lorenz curve. This coefficient is a widely used measure of variability in social sciences due to its statistical qualities, namely its independence of the mean and low sensitivity to extreme values (Cowell, 1977; Cowell & Flachaire, 2007). The formula for the Gini coefficient in its weighted form (GW) can be written as:

$$G_W = \frac{1}{2y} + \sum_{i=1}^{k} \sum_{j=1}^{k} \left( \frac{n_i n_j}{n^2} |y_i - y_j| \right),$$

where $k = \text{number of territorial units}$, $i, j = \text{index for territorial units}$, $y = \text{mean of unemployment}$ (weighted by the population aged 15–64 years), $y_i, y_j = \text{unemployment in units } i \text{ and } j$, and $n_i, n_j = \text{population aged 15–64 in units } i \text{ and } j$, $n = \text{the overall population aged 15–64}$. Weighting by population size is very important in the case of Czechia because of the great heterogeneity of municipalities according to their population size. For more on weighted and unweighted measures of
variability in Czechia and neighbouring countries, see Nosek and Netrdová (2014).

The shortcoming of the Gini coefficient as well as that of other standard variability measures is its insensitivity to spatial permutation across territorial units (Arbia, 2001). The so-called checkerboard problem stems from the fact that the geographic positions of territorial units are ignored in the calculation of these statistics (Guimaraes, Figueiredo, & Woodward, 2011). Therefore, to measure spatial clustering, i.e. to assess the level of concentration, dispersion or prevalence of random units with similar levels of unemployment, we use the concept of spatial autocorrelation. In particular, we calculate the Moran’s I statistic (Anselin, 1988; Cliff & Ord, 1973), which shares many similarities with Pearson’s correlation coefficient, according to the following formula:

$$I = \frac{k \sum_{i=1}^{k} \sum_{j=1}^{k} w_{ij}(y_i - \bar{y})(y_j - \bar{y})}{\sum_{i=1}^{k} \sum_{j=1}^{k} w_{ij} \sum_{i=1}^{k} (y_i - \bar{y})^2}, \quad (2)$$

where $k$ = number of territorial units, $i$, $j$ = index for territorial units, $y$ = mean of unemployment, $y_i$, $y_j$ = unemployment in units $i$ and $j$, and $w_{ij}$ = spatial weights matrix. The spatial weights matrix operationalises the position and proximity of geographical units (in our case, municipalities) and thus incorporates the neighbourhood effects into measuring. The choice of a spatial weights matrix, which is largely subjective, influences the calculated value of Moran’s I. However, for a study operating in one regional system with invariable areal units and dealing with one phenomena in time, the absolute values of Moran’s I are not as important as the relative changes of these values. Based on sensitivity testing, Stakhovych and Bijmolt (2009) claim that the simplest spatial weights matrix suffices in most cases. We confirmed this argument by testing numerous different spatial weights matrices in our previous research (Blážek & Netrdová, 2009; Nosek & Netrdová, 2014). Therefore, based on our previous research aimed at spatial autocorrelation measurement for different characteristics in the regional structure of Czechia (Blážek & Netrdová, 2009), a 10 km cut-off was selected as the method best fitting the territorial structure of Czechia.

Assessing the evolutionary dynamics of unemployment at the national level is insufficient for capturing sources of variability and identifying key interrelationships. Accordingly, the same shortcomings apply to all global statistics, which report the mean value for the whole area under study. Without seeing the map and identification of spatial clusters and outliers, the values yielded by global statistics are difficult to interpret. Therefore, visualisation of the rate of unemployment in the form of maps is crucial for identifying shifting spatial patterns.

Consequently, we explored the change in unemployment at the municipal level by simple descriptive statistics. All municipalities were categorised according to two characteristics of unemployment: (i) the relative position of municipality within Czechia before the crisis and (ii) the change of its relative position during the crisis. Czechia has been affected by the global economic crisis since September 2008. To capture the period before the crisis and directly after the highest peak of unemployment during the crisis, the 2006–2011 period has been selected for examination. The initial value of unemployment is computed as a three-year average unemployment rate between 2006 and 2008, which is related to the Czech mean value. Changes to the positions of each municipality during the crisis are quantified as a difference between the average relative position before (2006–2008), during, and after the crisis (2009–2011). A combination of these two views enables us to distinguish between municipalities with a favourable/unfavourable initial relative position according to the unemployment rate and its positive/negative relative change during the crisis. Categorisation of municipalities based on these two characteristics is shown in the Main Map.

We analysed spatial clustering patterns of unemployment and changes during the study period. For this purpose, local spatial autocorrelation and spatio-temporal analyses were employed. To identify spatial clusters and outliers, the LISA analysis, representing the local equivalent of Moran’s I (Anselin, 1995), was used. The LISA analysis is based on categorisation of municipalities into four categories based on Moran scatterplot according to high (above-mean) and low (below-mean) values of unemployment in a given municipality and in municipalities in its neighbourhood. A randomisation procedure was used to assess the significance of the LISA statistics against a null hypothesis of no spatial autocorrelation. The results of the LISA analysis for the year just before (2008) and just after (2010) the crisis are visualised in the form of cluster maps in Map 2 and Map 3.

To reveal evolutionary dynamics in terms of emerging and disappearing spatial clusters in a single map, the space–time version of standard local spatial autocorrelation statistics was applied. Specifically, we used the Emerging Hot Spot Analysis Tool available in Arcmap 10.5 working with Getis-Ord Gi* statistic (Getis & Ord, 1992; Ord & Getis, 1995), which enables you to identify statistically significant spatial clusters of high values (hot spots) and low values (cold spots). The analysis is based on the space–time cube, where each bin is analysed within the context of neighbouring bins to measure the intensity of clustering for both high and low values. Finally, each bin is categorised according to the duration and changes in emergence of hot/cold spots during the study period. In our case, the space–time cube has aggregated quarterly
data of all municipalities into 6,780 hexagon grid locations over 12 time step intervals (time step intervals were set to six months). Map 4 shows the resulting categorisation of bins (hexagons) into seven categories: no pattern detected and persistent, sporadic or oscillating hot or cold spots. Because the population is not evenly distributed across the space, some hexagons do not contain a municipal centre and do not enter the analysis.

4. Results

In Czechia, the economic crisis led to soaring unemployment between January 2009 and February 2010 when unemployment peaked (Figure 1). While the increase of unemployment affected all Czech regions, the crisis manifested with profoundly varying intensity at the municipal level. Figure 2 shows the evolution of variability (measured by the Gini coefficient) and of global spatial autocorrelation (measured by Moran’s I) of the unemployment rate at the municipal level. As explained above, the quarterly averages of unemployment were used to moderate huge variations in values for tiny municipalities, which might be induced even by individual cases. Overall, territorial disparities in the unemployment rate resulting from the economic crisis decreased in the studied period by about one third, which supports the argument of Blažek and Netrdová (2012) that the crisis resulted in a ‘convergence in misery’ (p. 51). Slightly decreasing values of spatial autocorrelation indicate significant spatial clustering. Nevertheless, tendencies of disaggregation of some spatial clusters were also clearly observable. Seasonal fluctuation of economic activities, such as tourism, agriculture, construction, and even manufacturing (especially due to summer holidays), resulted in periodicity of Moran’s I reflecting specifics of economic and labour structure of particular localities (Figure 2).

To reveal the distinctive trends or patterns in the evolution of unemployment on a municipal level, and to identify municipalities that were most affected by the economic crisis in terms of unemployment, the relative position of each municipality before the crisis and its change during the crisis are visualised in the Main Map. While units in a light shade represent municipalities with low unemployment rates before the crisis (years 2006–2008), units in green depict municipalities that succeeded in improving their relative position within Czechia during and after the crisis. Red indicates the worsening of a relative position of a municipality because of the crisis. Overall, only 43 municipalities (i.e. 2%) exhibiting low unemployment before the crisis (i.e. less than 80% of the national level) experienced an improvement in their relative position, while 198 (i.e. 11%) of municipalities suffering from a high unemployment rate before the crisis (i.e. more than 120% of the national average) experienced further worsening. On the contrary, 74% of municipalities that improved their relative position suffered from high joblessness at the onset of the crisis. Sixty percent of municipalities that worsened their relative position had low unemployment at the beginning of the crisis. The most interesting feature of the changes in spatial patterns of unemployment during the crisis is a remarkably widespread improvement to the relative position in both major structurally affected Czech regions (located in the north-western and north-eastern parts of the country) depicted in dark green in the Main Map. On the contrary, spatial patterns of those municipalities that were performing well before the crisis but were hit hard during the crisis, are highly fragmented and do not fit neatly with the typology of rural areas developed by Perlín, Kučerová, and Kučera (2010).

Figure 2. Territorial variability and global spatial autocorrelation of the unemployment rate, quarterly data, 2006–2011 period.
Source: Ministry of Labour and Social Affairs – Labour Office of the Czech Republic.
LISA cluster maps of unemployment (Map 2 and Map 3) depict spatial patterns of unemployment in the years 2008 and 2010 (i.e. just before and after the steepest spike in unemployment during the economic crisis during 2009, cfr. Figure 1). In 2009, the number of job seekers increased by more than 50%. Despite these changes, the territorial pattern of unemployment was not fundamentally altered as evident when Map 2 and Map 3 are compared. Nevertheless, clusters of low unemployment values changed in the Eastern part of Czechia (Moravia) near Olomouc, Zlín and Ostrava which indicates the worsening position of these territories. Overall, however, the largest changes concerned the clusters of municipalities with high values of unemployment. Namely, the largest cluster in the North-Western part of Czechia disintegrated completely by a relatively favourable performance of the regional capital city (Ústí nad Labem) and of municipalities in its hinterland. On the other hand, clusters in the south and north of the Western part of Moravia that remained isolated in 2008, merged in 2010 and created a belt broadly following the historical boundary between the western (Bohemia) and eastern (Moravia) parts of Czechia. This belt represents a prime example of inner periphery within Czechia (Musil & Müller, 2008). Therefore, this finding agrees with observations made by Novák and Netrdová (2011) who, before the crisis, identified mounting socioeconomic problems in the Czech peripheral areas including the border area between historical lands of Bohemia (in the west) and Moravia (in the east). This result also adheres to one of the key conclusions by Sokol (2013) that the non-core regions and peripheral economies were hit especially hard by the crisis.

The results of spatiotemporal analysis depicted in Map 4 also document the relatively high level of overall stability of the spatial pattern of unemployment during the crisis. Namely, 63% of cold spots (i.e. statistically significant spatial clusters of low values of unemployment) remained persistent for more than 90% of the quarterly intervals. The spatial pattern of these cold spots corresponds well with development areas and axes identified in previous research (Blážek & Netrdová, 2009; Novák & Netrdová, 2011). In contrast, hot spots (i.e. statistically significant spatial clusters of high values of unemployment) display a less stable spatial pattern, indicating that many municipalities were not suffering from high unemployment rates during the whole 2006–2011 period. In particular, while the hot spot in the mostly rural area located in the south-eastern part of Czechia (i.e. South Moravia) remained quite persistent, large clusters in the northwest and northeast of Czechia show much lower levels of stability.

5. Conclusions

Our analysis enabled a detailed examination of the territorial patterns of soaring unemployment rates due to the recent global economic crisis and an answer to the four research questions which guided our study. First, our research offers strong evidence that the global economic crisis has not profoundly altered the territorial pattern of unemployment from the pre-crisis period. Nevertheless, several alterations of the pre-crisis pattern are noticeable, especially in the case of clusters of municipalities suffering from high unemployment even before the crisis. These municipalities achieved relative improvement in their position within Czechia, which is at least partly a counter-intuitive result.

Second, and closely related to the first conclusion, a distinctive trend towards the convergence in unemployment at the municipal level has been observed since the crisis hit Czechia. However, given the hardships induced by the crisis and in line with our previous study, which analysed the evolution of unemployment variability at the regional level (Blážek & Netrdová, 2012), we can denote this convergence connected with the global worsening of the situation to a ‘convergence in misery’.

Third, while the territorial pattern of municipalities that worsened their relative position as a result of the crisis is highly scattered and thinly spread within rural areas, municipalities, which improved their relative position, formed distinctive clusters in two structurally affected Czech regions (Northern Bohemia in the northwest and Moravia, Silesia in the northeast of the country). Therefore, our fourth finding was a significant difference in the type of spatial clustering between municipalities with different starting conditions.

Each of these findings are based solely upon quantitative exploratory spatiotemporal analyses and, consequently, represent only the first step in a deeper comprehension of the evolution of unemployment during the crisis. This type of analysis allows a detailed visualisation and examination of shifting territorial patterns of unemployment, but does not allow for a rigorous causal analysis. Therefore, our results and the typology of municipalities performed can be used as a starting point for subsequent qualitative analyses of types or special cases such as outliers. The first study of this type based on our findings and focusing on underlying causal mechanisms of changing spatial patterns of unemployment in West Bohemia has already been performed (Jirman, 2018). Another avenue for future research could be to link the analysis performed at the detailed territorial level with recently developed concepts of adaptability and resilience. Namely, Eriksson and Hane-Weijman (2017) concluded their study on the evolution of employment in Swedish regions during the crises by arguing that while the largest and most diversified regions enjoy stable job creation, specialisation in peripheral regions decreases their resilience. From a policy perspective, our study documented not only a vast variation in the rate of
unemployment even among neighbouring municipalities, but also their opposite evolutionary trajectories; providing compelling arguments for reconsidering current practices in numerous countries to employ spatially blind policies. Thus, the evidence from Czechia may also be relevant to other countries in terms of stimulating further research and policy design.

Software

Microsoft Excel 2016 and SPSS 24 were used for initial data preparation and manipulation. All computations regarding the Gini coefficient were performed in EasyStat 1.0 (Novotný, Nosek, & Jelínek, 2014), while computations of spatial autocorrelation measures and spatio-temporal analyses were performed in ArcGIS 10.5. The final map layout was also prepared in ArcGIS 10.5.

Disclosure statement

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