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An interpretation of the changes in demographic behaviour at a sub-national level using spatial measures in post-socialist countries: A case study of the Czech Republic and Slovakia*

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Abstract. The transformation of fertility and family behaviour in post-socialist countries was quick and the changes were striking. An account of the changes is the subject of dispute and the mechanisms have still not been explained in a fully satisfying manner. Relatively little attention has been paid to the changes in spatial aspects concerning the broadening of changes in family behaviour. The aim of this paper is to answer the question as to whether changes spread stochastically in post-socialist countries or if there are obvious spatial patterns. The study tries to answer the questions whether there are any cores of changes which may be understood as innovations, if there is any spatial clustering and if the extent is hierarchically arranged.

JEL classification: C21, J11, J12

Key words: Family behaviour, regional diffusion, innovations, Czech Republic, Slovakia

1 Introduction

The transformation of reproductive and family behaviour after the political changes in Europe around 1990 is a frequent topic of demographic research, mainly at the national level. Most attention is paid to fertility, changes in timing and quantum, changes in fertility aspirations, and to general fertility factors. Nuptiality and the divorce rate are not disregarded either. New demonstrations of family behaviour such as cohabitation, weakening of the position of the traditional family, growth in non-marital childbearing, etc., are quite well-documented. Several studies bring a number of explanatory schemes, most frequently connected to economic factors, ideological shifts and the second demographic transition. The explanations are often only partial or mutually incompatible. Using fertility as an example, Billingsley (2011) says that no one theoretical explanation is sufficient in explaining complex fertility. Simply said, we still do not have a satisfactory answer to the question of why fertility and family behaviour in post-socialist countries have changed so dramatically and quickly, and why there are differences

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among them from the point of view of the extent and the nature of the changes. We know even less about how the changes spread inside the transforming countries. We have followed several revitalized trends in spatial demography which have been documented in recent studies by Gavalas et al. (2014) Klüsener and Goldstein (2016), Porter (2016) and Walford and Kurek (2016). Next, for Western European countries, there are descriptive studies and factual materials along with studies using more sophisticated methods which extend towards spatial sociology (Hank 2002), providing an overview of studies of German origin. In general, however, there is no coherent continuous research of reproduction and family behaviour which would combine the aspects of geography, demography or sociology of space for Western, Central and Eastern European countries.

This study tries to fill this gap. We have applied the concept of so-called relative regional and spatial differentiation (Besicovitch 1945; Ricklefs 1987; Netrdová and Nosek 2009). Such an approach is very convenient for assessing spatial changes in family behaviour since it enables us to precisely express external expressions of spatial diffusion of innovative elements, thus continuing with the older, but still topical, reflections of Hägerstrand (1967) and his followers. The study by Szreter (2002) was also very impulsive. We followed the authors Lesthaeghe and Neels (2002) somewhat as well. They tried to find so-called regional leaders (innovators) and laggards. A comparison of the regions in Belgium and Spain was made by Lesthaeghe and Lopez-Gay (2013). Klüsener et al. (2013) used the Theil index to put some regional changes in non-marital fertility in Europe.

In this case study, we have assessed three indicators: crude nuptiality rate, crude divorce rate and the share of non-marital births. They are not truly innovative as they appeared since historical times, but they more or less detect some 'break-points' in developments of societies around 1989. Therefore, we have to point out the possible limitations of using this concept in this study. The concept of innovation as the light of demographic development is disputed. This is strongly connected to the nature of demographic changes. It is hard to say what changes are truly innovative. Is the fall of the total fertility rate under 2 children one such example? Shall we discuss the quantitative indicators regarding this? There are of course, a couple of questions which do arise. Nevertheless, if some demonstrations of the second demographic transition (SDT) are to be seen as innovative, then selected indicators in this study may accomplish the potential for being innovative. The drop in fertility, non-marital births and high divorce rates are the most typical examples related to the second demographic transition. Furthermore, these features clearly distinguish Western and Eastern European population development before 1989. After the fall of the iron curtain, the changes were very quick and rapid and all the SDT-features immediately became a part of the population behaviour of post-socialist countries. In other words, if a political regime hindered the SDT-changes (being something completely new and never seen before in that extent), then post-1989 conditions activated these changes (inhibited for decades). If the SDT is something innovative in general, then the quick demographic changes in countries like Czechoslovakia could be seen as innovative. For instance, the share of non-marital births remained below 6 per cent in Slovakia until 1989, but rose to 40 per cent in the following 25 years. Thus, the marginal phenomenon expanded throughout the population unprecedentedly. In this context, non-marital births are quite a new phenomenon. It is definitely not innovative in the European context, but surely is so in the context of Central Europe. Of course, there are some 'clubs' or clusters within the group of post-socialist countries. One cannot generalize all the trends. When talking about the countries in the Visegrad group, the changes were very similar creating one common developmental sub-group. There are several reasons why these two countries were selected. First of all, both countries had been developing in one common state and under the same political conditions. However, there are several differences between the two such as higher fertility, a lower divorce rate or higher religiosity of the population in the case of Slovakia. Thus, the Slovak population could be denoted as the 'laggard'. Therefore, we can investigate whether the innovation cores occurred in the

Czech Republic earlier than in Slovakia. Second, we can track the changes before the split and after the countries separated in 1993. We can also investigate a relatively long period of more than 40 years, half of which from when they were together in the common state of Czechoslovakia, the other half as autonomous countries (common vs different policies and their potential impact on different demographical trajectories). Despite the split, there has so far been a strong relationship between the two countries. The designation 'brother nations' has been frequently used even after the split. The similarities between the languages and the possibility to study free of charge encourages more than 20,000 students from Slovakia to study in the Czech Republic. Migratory relations have been very strong in the long-term as well, even since 1993. Lastly, we are able to compare the data as the statistics are based on the same background and methods.

2 Background

2.1 A general view on the concept of innovation with respect to demographic trends

This section goes deeper into the problem of trying to interconnect the general concepts of innovations with their demographic displays. The term 'innovation' is most frequently connected to technological progress, but it may be adapted to any other area if it concerns the application of new forms in an existing system. The beginning of the spread of innovation research dates back to the end of the 19th century and the beginning of the 20th century. The study by Tarde (1903) is considered to be a milestone in this area. This paper defines crucial terms such as innovation, imitation (acquisition) and diffusion, which have been used up to the present. The paper also outlines the so-called S-curve of innovation spread. Rogers (1962) explains that diffusion is a process in which new forms are applied to an existing system. Four basic elements are required in the system to enable diffusion.

The first element represents the origin of innovation. There is nothing to spread unless a new idea, new procedure or device has been invented. In the case of reproduction, the introduction of hormonal contraceptives in the second half of the 20th century may very simply be considered as an innovation element. The second element is the existence of information channels. Information channels enable the spreading of the innovation. As an example of the limitation of information channels, we may mention the use of hormonal contraceptives in socialist countries. Contraceptives weren't used very often in these countries due to geopolitical limitations and barriers established by the pro-natality policies of socialist countries (Zakharov 1999). Time is the third element. Any innovation needs sufficient time in order to be applied. Time needed for diffusion of an innovation is inversely proportional to the permeability of communication channels, that is, the more permeable the communication channels are, the less time is needed to introduce an innovative element. Modern contraceptives began spreading in Western Europe as early as the 1960s. As a result of geopolitical barriers, contraceptives were introduced in the Czech Republic as late as the late 1980s and the early 1990s (Rychtaříková 2007). The fourth condition is the nature of the social system in which the innovation should spread. In this respect, the level of internal diversity of the particular social population is mainly important. Rogers and Shoemaker (1971) expressed that an innovation element spreads faster in a society which is internally homogeneous.

Cialdini and Goldstein (2004) divide the innovation spread into several stages. The authors have also prepared so-called characteristics of a population which gradually adopts innovation. They use the so-called S-curve which demonstrates the growth of the proportion of a population that gradually adopts the innovation element (Figure 1). The so-called break-even point – achieved when 16 per cent of the population has adopted the innovation – is important for

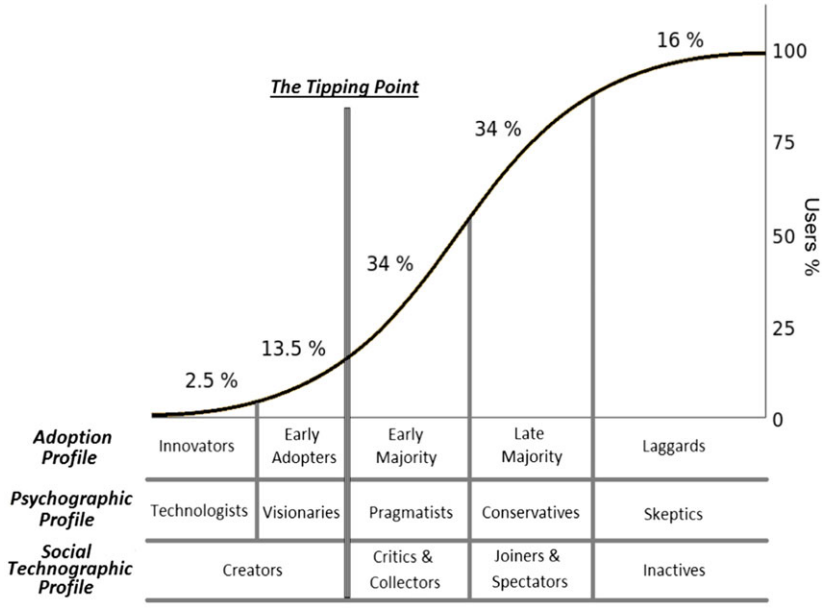

Fig. 1. S-curve demonstrating how an innovation spreads
Source: Cialdini and Goldstein (2004), customized by authors.

diffusion. It is the so-called Maloney's 16 per cent rule. After exceeding the user proportion of 16 per cent, innovation changes from 'unique' to 'established'.

Hampl (2010) states that an uneven course of application of innovative elements only reflects the hierarchical organization of society. He therefore indirectly emphasizes the fourth element of Rogers's study, namely the heterogeneity of the social system. Hampl (1998) also states that the hierarchical organization of society may be perceived from two different perspectives. The first one is represented by the so-called internal society structure, which may be understood as social stratification and the institutional structure of power. The second aspect is represented by external structure which corresponds to the geographical organization of society. In our study, we focus on the second aspect, that is, the changing level of inequality from a spatial point of view.

Several authors have dealt with how innovation spreads in space (Hägerstrand 1967; Golledge et al. 1972; Norton 1989; Strang and Meyer 1993; Audretsch and Feldman 1996; Haggett 2001; Huggins and Thompson 2013). One of the founders of the concept, Hägerstrand (1967) believes that the diffusion of innovation in geographical space may be twofold – the so-called neighbourly diffusion and hierarchic diffusion. Figure 2 outlines both forms of spatial diffusion of innovative elements. Neighbourly diffusion represents the gradual spatially-related spreading of innovation. Hierarchic diffusion is not spatially compact. Innovation spreads in leaps from hierarchically higher-ranked places (regions) to hierarchically lower-ranked places (regions). Haggett and Cliff (2005) state that both forms are applied when each innovation is spread evenly, although some types of innovation are spread in a more hierarchical form while others in a more neighbourly form.

There are some studies, which explicitly deal with diffusion in case of demographical processes within social systems and regions. Carlsson (1966) investigated innovation aspects of the fertility decline in Sweden. His results have not confirmed geographical diffusion with respect to the fertility drop. On the other hand, in the case of urban areas there are tighter

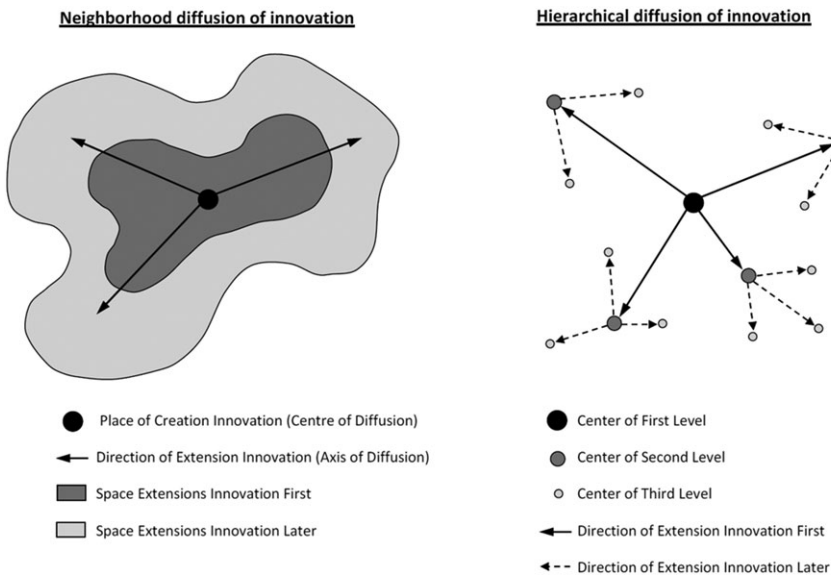

Fig. 2. Forms of spatial diffusion of innovation
Source: Cialdini and Goldstein (2004), customized by authors.

interconnections inside the populations. This could affect the changes in character of the fertility. Cleland (2001) postulates some important questions as follows. Is fertility regulation an innovation? Is the evidence concerning the timing of fertility transitions across societies more consistent with expectations derived from the innovation-diffusion framework or with those derived from economic theories? Once a certain threshold is reached, does contraception spread rapidly throughout homogeneous social systems?

The Princeton European Fertility Project (Coale and Watkins 1986; Watkins 1991) was oriented at many fertility aspects in the Western Europe. Among others, the diffusion of fertility changes from the French core (in the period 1870–1960) was discussed. The study of González-Bailón and Murphy (2013) focused on the effects of social interactions on fertility decline. It seems that the social structure in regions matters. We used this in the explanatory framework as several regions are likely reluctant due to their social specificities (Northwest of Czechia, Eastern Slovakia).

The diffusion concept in demography has not only be used in case of fertility. Mortality was the first one investigated for instance by Kermack and McKendrick (1927). The diffusion of epidemics was in the core of their interest. Further, Schmertmann et al. (2010) used Knox's space-time interaction test, commonly applied in epidemiology, criminology, and public health. The authors applied the modified test to data on the onset of fertility decline in Brazil over the period 1960 to 2000 and show how the modified method can produce maps indicating where and when diffusion effects seem strongest.

For our purposes, behavioural aspects are also very important. Among them, the cultural factors play a role and they have been stressed by several authors. A cultural innovation diffusion was discussed by Bocquet-Appel and Jakobi (1996). They tracked the zones exhibiting a major discontinuity in case of drop in fertility. Besides the cultural (language), physical (Alps, Pyrenees) and ideological (West vs East) barriers, they also attempted to verify the impact of the Hajnal line (Between Trieste and St. Petersburg). This line runs just between the Czech Republic and Slovakia.

Based on the above, our primary hypotheses are:

Proposition 1. *The pioneering regional populations are identical in the case of all three demographical indicators, because all three possibly demonstrate the oncoming of the SDT into the post-communistic demographic behaviour*.

Proposition 2. *The cores were discovered in the Czech Republic earlier, because it has always been ahead of Slovakia in a demographical respect. We can also assume from this that the first demographic transition started and ended several decades earlier than Slovakia since the 1970s baby-boom was delayed in Slovakia for 2–4 years*.

Proposition 3. *The regional patterns (expressed by using spatial entropy) have changed over time, and regional inequalities vary over time, especially when demographic changes occur (at some break points, when new cores of the new demographic regime emerged for the first time)*.

Proposition 4. *There is a clear effect of a spatial neighbourhood reflected in the shaping of a spatial image of interregional differences and the state border represents a barrier of diffusion (or induces spatial discontinuity)*.

2.2 Background in the Czech and Slovak Republics

From an economic point of view, both countries are among the most successful of all post-socialist countries. Studies on economic convergence (Borsi and Metiu 2013; Matkovski et al. 2016) emphasize that the convergence is relatively slow and occurs in clusters. On the other hand, three countries from the post-socialist group already exceeded the level of 70% of the EU-average GDP *per capita* in PPP – Slovenia, the Czech Republic and Slovakia (as of 31 December 2015). The Czech Republic is still a forerunner, but the difference has been decreasing since 1993. The GDP *per capita* (PPP) of the Slovak republic is about 95 per cent of the Czech Republic value (IMF 2016). There is a difference in unemployment rates, though the gap has been shrinking too. Slovakia adopted the euro in 2009. There are also significant regional differences in both countries. Whereas the regions of Bratislava and Prague ranked 5th and 6th in the EU in 2015 according to GDP *per capita*, the region of Eastern Slovakia ranked 247th and the weakest Czech region in the Northwest (often mentioned later in the Results section) placed 223rd. The differences grow markedly on the lower levels of NUTS 3 and LAU 2 (Korec and Ondoš 2006) dividing Slovakia into the 'richer Northwest and poorer Southeast'. In the case of the Czech Republic, the majority of the poorest districts lie in the Northwest and Eastern part (Moravia) of the country.

From a demographical point of view, both countries are positioned much closer to Western Europe than 30 years ago. The total fertility rate in the case of Slovakia fell below 2.0 just after 1989, which was already in the Czech Republic in 1982. The post-1989 drop was obvious in both countries (below 1.2 in 2002). A subsequent delay induced the substantial growth up to 1.55 children per woman in 2016 (being around the EU average). The values of indicators such as the share of non-marital births, mean age at first birth and divorce rate rose markedly, either touching or exceeding the European average. On the other hand, childlessness is still below average in both countries. Teenage fertility comprises more than 7 per cent in Slovakia, whereas it is less than 4 per cent in the Czech Republic (WCD 2016). In general, both populations undoubtedly demonstrate some features of the SDT. They are closer to the Western-European demographical regime than ever before.

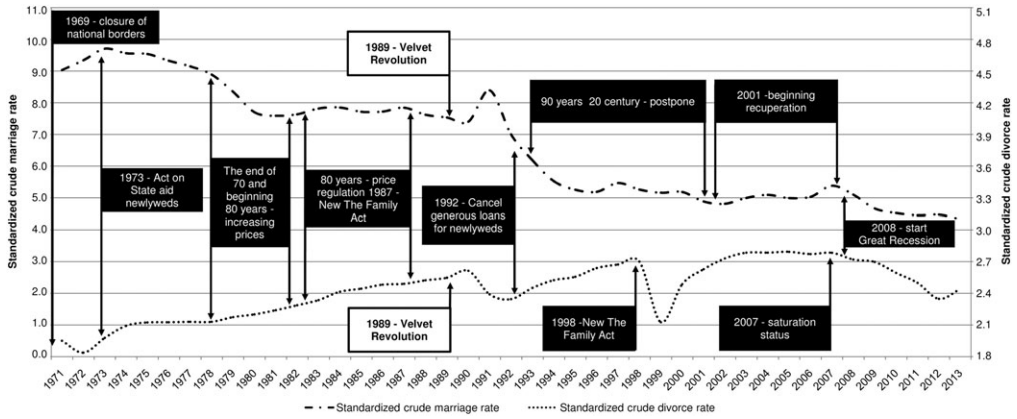

Fig. 3. Nuptiality and the divorce rate in 1971–2013 (Slovakia and Czech Republic average)
Source: Authors.

The background of changes in family behaviour in Czechoslovakia and later in the Czech and Slovak Republics has been affected by several political events and socio-economic measures. Each of the events may, when simplified, be understood as a potential impetus or impulse for innovation which gradually spreads in space. Individual events may accelerate or slow down the start of progressive stages in view of the overall development of society (Hampl 2005). In order to be able to better describe the dynamic changes in family behaviour since 1971 in the empirical part, we have included the most important events shaping (potentially) the population climate in Slovakia and Czech Republic in Figures 3 and 4. It is a simplified and generalized view which does not include certain less-significant legislative changes that may have had an impact on family behaviour, and some other external (mainly economical) factors. On the other hand, the impact of these measures has not been exactly identified and measured. We only presume some potential bigger or smaller impact on them.

We may state the measures implemented in the period 1969–1973 as the first 'kind-of' innovation element shaping the nature of family behaviour. In 1969, movement across the state border was considerably limited after normalization efforts had intensified. New amendments and new acts were gradually adopted in 1971–1973 (Act No. 14/1973 Coll. – Act on State

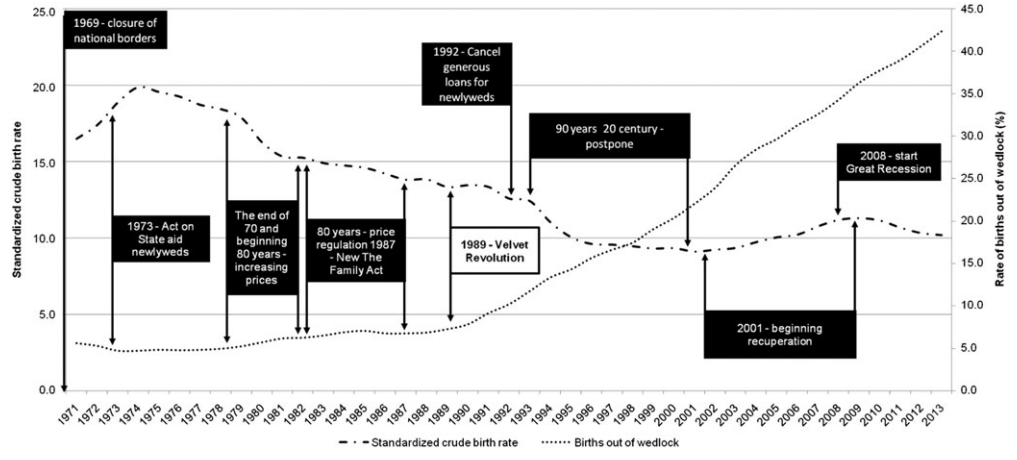

Fig. 4. Natality and non-marital childbearing in 1971–2013 (Slovakia and Czech Republic average)
Source: Authors.

Support of Newly Married Couples, Regulation No. 99/1971 Coll. the Family Act or other regulations) which promoted the starting of families (Češka et al. 1986; Vojáček et al. 2011). Migratory restrictions and the promotion of families were demonstrated by higher nuptiality and natality, peaking in the mid-1970s. New amendments to the Family Act also discouraged several types of broken in-practice marriages from divorcing formally. This is the reason why the divorce rate stabilized after having slightly increased. The level of non-marital childbearing was very low as a result of preferring childbearing in marriages. Several authors (Zakharov 1999; Kharkova and Andrew 2000) have identified such a condition as the artificial conservation of 'unnatural' demographic development. The socialist system encouraged people through legislative regulations to have children within marriage and thereby artificially reduced the number of children born outside marriage. Another factor which partly shaped the development of demographic behaviour was a decrease in the standard of living as a result of an increase in prices in the late 1970s and early 1980s (Sekanina 2007). Pro-natality measures set in the early 1970s were no longer sufficiently motivating, leading to a drop in natality and nuptiality in the early 1980s. At the same time, the divorce rate began to increase. With regard to the strong preference for childbearing in marriages, the level of non-marital childbearing is still low, even though we can see that it is slowly increasing.

In the 1980s, the regime promoted the construction of apartments as a part of its National Housing Policy (Ježdík 1986), making housing even more available. Combating the increase in prices, the regime enhanced its regulation of basic commodities, and an amendment of the Act on State Support of Newly Married Couples was adopted as of 1 July 1987, increasing the volumes of financial means awarded for contracting marriages and childbearing (Ježdík 1986; Kuklík 2009).

After the Velvet Revolution in 1989, changes in family behaviour, related to the theory of the second demographic transition, started to be fully manifested in Eastern European countries. In 1993, Czechoslovakia was split into two independent states. Subsequently, certain measures were demonstrated in only one of the states. An example of such a situation was the adoption of a new Family Act in the Czech Republic in 1998, laying down divorce-related standards (Hrušáková and Králíčková 2006).

The latest significant milestone with a potential impact on family behaviour and fertility was the economic crisis which started in 2008. A general worsening of housing availability, an increase in unemployment and a general drop in labour productivity negatively affected both nuptiality and natality (Schneider 2015). Certain studies confirm the impact of the crisis on fertility (Sobotka et al. 2011). Goldstein et al. (2013, p. 85) find 'that countries that were hit hard by the recession show a reduced fertility when compared with a continuation of recent trends'. Empirical data indicates that, in addition to fertility, the crisis also affected nuptiality and the divorce rate, although the impact was perhaps less straightforward.

3 Data and methods

We have analysed three regional levels. The lowest level is the level of districts. Districts are identified as LAU 2 in the EU nomenclature. All data have been calculated for districts starting in the first year 1971.[1] The level of administrative regions, corresponding to NUTS 3 regions, was a hierarchically higher level which we used. The last one was the level of the Czech Republic and Slovakia. This level is equal to NUTS 0 in EU nomenclature.

[1] Since the administrative units were changed in 1996, the re-calculation of current units to the previous structure has been done.

Since districts are quite small population units, we have used the method of 3-year[2] averages to decrease the impact of time irregularity. In order to eliminate the impact of different age structures, we have used the indirect method of standardization for both crude rates.[3] The standardization method was taken from Anderson and Rosenberg (1998).

For spatial analyses, we used the Theil index and Moran's *I* index. The Theil index is a hierarchical measure of spatial variation, while Moran's *I* is an adjacency-based measure of spatial clustering.

The Theil index is characterized by its resistance against extreme values, the possibility of weighing and mainly the ability of non-residual decomposition (Rogerson 2001; Subramanian 2004). The Theil index (*T*) is a generalized entropy rate and calculated like in the study by Theil (1979). The Theil index can be divided without a residue into an interregional component *B* (e.g. between-regions differences) and an intraregional component *W* (e.g. inside-regions differences). If we calculate the value of the interregional component and the global value (*B/T*), we acquire the proportion of the interregional component in the total inequality value. Similarly, if we calculate the value of the intraregional component and the global value (*W/T*), we acquire the proportion of the intraregional component in the total inequality value. In this manner, we can determine the global inequality value as well as the significance of different hierarchical levels, selected beforehand, in the total inequality. In the empirical part, we interpret three levels, namely, the state (R_{state}), region (R_{region}) and district ($R_{district}$) levels.

In order to express spatial clustering, we will use the Moran index, which is easy to interpret, covers both negative and positive correlations, and several GIS local statistics tools have been created for it (Robinson 1998; Getis and Ord 2001). Use of spatial autocorrelation has a great significance in the context of measuring inequality. The Theil index expresses inequality in previously defined regional structures, but expressions of spatial autocorrelation identify spatial patterns which may also cross previously delimited regional structures (Netrdová and Nosek 2009).

Calculation of the Moran index is taken from Goodchild (1986) and Chen (2013). Moran's *I* has many analogies with Pearson's correlation coefficient. When expressed globally, the Moran index may have values in the $<-1, 1>$ interval. Values close to 0 indicate the random nature or spatial non-autocorrelation of the particular variable in space. '1' represents the maximum positive spatial autocorrelation and '–1' the maximum negative spatial autocorrelation of the particular variable.

Anselin (1995) used the Moran Index, as a representation of a global statistic, to derive local statistics – LISA (local indicators of spatial association) – which enables identification of local clusters of positive and negative autocorrelation. LISA analysis enables division of the examined spatial units into five groups (hot spots, cold spots, 1st spatial outliers, 2nd spatial outliers, no significant).

The Moran index and LISA analysis were calculated for the district level. As weight matrix[4] has been used so called 'first order queen contiguity'. Significance at the level of 0.01 has been applied. ArcGis 10.1 program was used for calculations and visualizations.

We also created the semi-synthetic indicator.[5] This indicator is the sum of scores for three partial indicators in respective districts. The scores each partial indicator were calculated to be relative and non-dimensional. The score each partial indicator can vary from 0 to 1 (Robinson

[2] 3-years average is very likely efficient with respect to the population size of regional units.

[3] We had data available for calculation of crude rates and we also had data about the age structure of the particular regional levels. Therefore, the standardization only in an indirect manner was possible, but it does effectively eliminate the effects of various age-structures over space and time.

[4] Weight matrix can be generated by several attributes (Goodchild 1986; Slavík et al. 2011; Anselin and Florax 2012).

[5] This indicator is not comprehensive, but several studies (Lesthaeghe and Neels 2002; Van Bavel 2007) argue that decreasing nuptiality, growing divorce and non-marital births are 'accurate' and represent the essence of the SDT.

1998). Correlation coefficients in the matrix result from mutual comparison of all periods.[6] The significance correlation and regression analysis was confirmed using ANOVA (with a confidence level of 0.01).

In order to get additional information on the processes in time and space, we used the 'IDW' raster interpolation to display the geographical diffusion of the values of the semi-synthetic indicator. This enabled us to get a new and fruitful picture of the regional diffusion. This tool is available in the advanced ArcGis 10.1 programme package. Centroids of relevant districts were used for interpolation in space. Values of the 12 nearest neighbours were assessed for every single centroid. The 'Power' function was set to 2; the border of the former Czechoslovakia served as the 'input barrier'. In order to express spatial change (diffusion), we monitored the following threshold values.[7]

4 Results

4.1 Nuptiality

Total inequality expressed by the Theil index did not change significantly in the analysed period. At the same time, contributions at the interstate, interregional and inter-district levels to global inequality were changing. Implementation of new measures in the 1970s, expressed by a growth in nuptiality intensity, was probably uneven. This is proven by the increased global values of the Theil index (Figure 5). Such a finding does not correspond with the statements of Rogers (1962) who assumes that each innovative element first increases the heterogeneity of a group's values, be they regions or other virtual entities. Inequality between both states contributed to the increased value of global inequality to only a limited extent. Inequality inside the states, mainly inequality between districts inside administrative regions, greatly contributed to global inequality. An increase in nuptiality intensity was demonstrated most in the Northwest of the Czech Republic (and the outermost Northeast of Slovakia (Figure 6). Such a finding is not in concordance with Hägerstrand's statements that innovation is first adopted by areas which are highest in the regional hierarchy. On the contrary, Hampl (2005) and Korec (2005) identified areas with the highest nuptiality intensity as being regions of medium or low hierarchical order. Furthermore, the Northwest part of the Czech Republic was preferred until 1989 because it greatly supported the existing regime (Šimon 2015).

While elements related to the second demographic transition were accepted more by progressive regions (see the analysis below), conservative regions seem to have been more sensitive to pro-family measures. According to official statistics, poorer inhabitants with lower education reside there, although social and regional disparities were not as obvious during the socialist regime as they are today. This corresponds to the outcomes of studies which analyse the sensitivity of various social groups to pro-natality and family measures (Boccuzzo et al. 2008), although the overall effect of pro-natality measures is often not apparent (Gauthier 2007).

Nuptiality was quite high in the second half of the 1970s. We can identify that period as a condensation or saturation stage of new measures introduced in the early 1970s. A decrease in global inequality confirms that it was the gradual termination of the diffusion process. It is important to note that differences between districts are reflected more and more in the decreasing global inequality. The falling values of the Moran index indicate that the spatial picture started to become fragmented (Figure 6). Compared to the previous period, there were certain changes in

[6] The same method used Kurkin and Šídlo (2012).

[7] The threshold value is 1.26. This value is the coefficient of interception having derived from the regression model in case when all three indicators are zero.

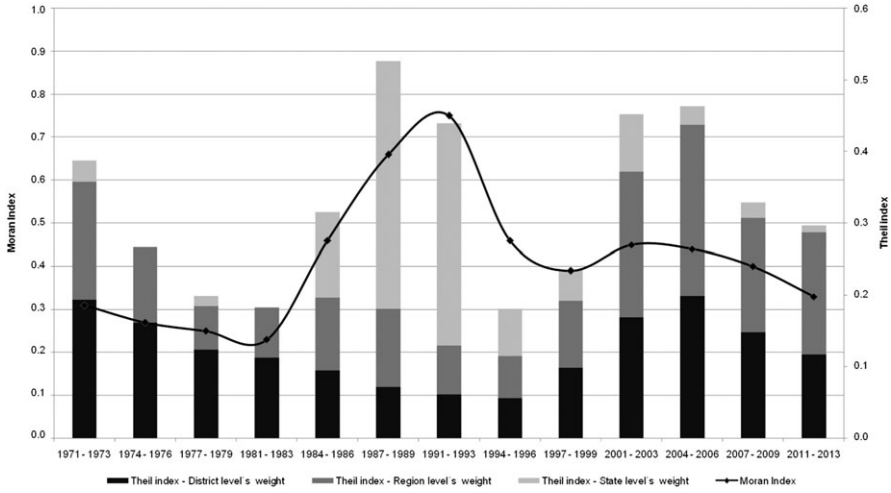

Fig. 5. Values of the Theil index and the Moran index for standardized crude nuptiality rate
Source: Statistical Office of Slovakia (2014) and Czech Statistical Office (2014), own calculations.

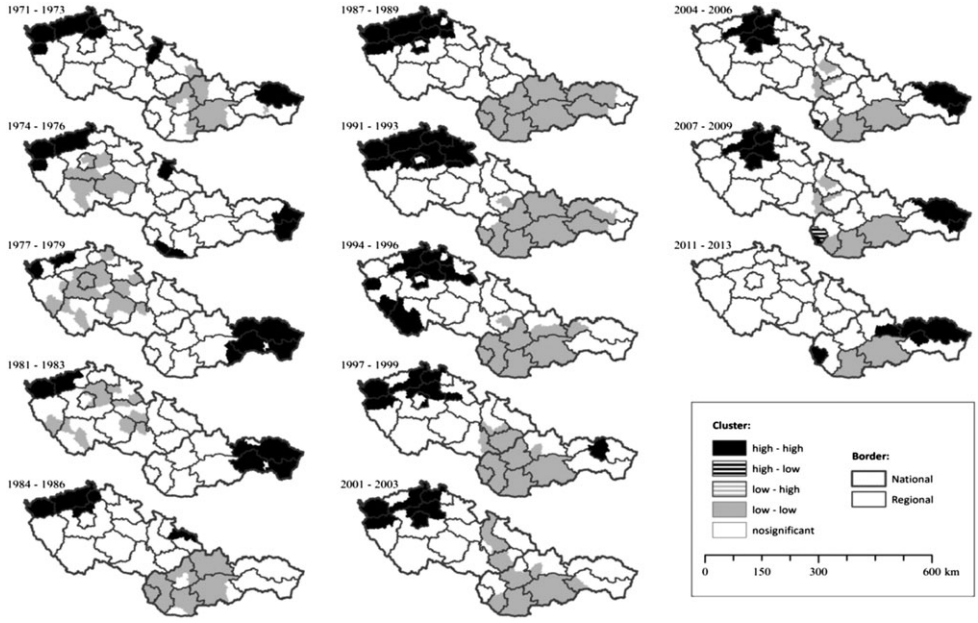

Fig. 6. LISA analyses for standardized crude nuptiality rate
Source: Statistical Office of Slovakia (2014) and Czech Statistical Office (2014), own calculations.

the spatial picture in the periods of 1974–1976 and 1977–1979. The cluster of high values in the Northwest of the Czech Republic was becoming weaker and the cluster of low values in the Slovakia and in the East of the Czech Republic was disappearing. At the same time, a new cluster of low values was being formed in the central part of the Czech Republic. This means that this area probably became more resistant against the stabilization of nuptiality at higher values. Despite certain 'social engineering' done by the communist establishment, this finding is in harmony with the theory of civilization waves about the start of progressive changes in economic, cultural or family life (Toffler 1980). The fact that the central area of the Czech Republic has the highest

positions (Hampl 2005), the regional hierarchic structure may explain such relative resistance. Changes in value preferences related to the theory of the second demographic transition, which could have started to be applied in central Czech Republic without any limitations even before 1989, can be identified as truly innovative ideas in this area. Zaharov (1999), or Kharova and Andreev (2000) write about the analogous penetration of family behaviour elements, typical for the second demographic transition, into Eastern-Bloc countries.

The district level has had the highest contribution to global inequality since the early 1980's. This indicates that a nuptiality decrease should spread relatively evenly without major changes in the spatial picture. The cluster of low values in central Czech Republic was gradually disappearing. This very likely means that this area with low nuptiality was ceasing to be in such contrast to its surroundings, since populations of neighbouring regions actively decrease the nuptiality intensity.

From the mid-1980s, nuptiality increased again as a result of new regulations. The nuptiality level increased until the early 1990s, with the exception of certain fluctuations. The growth in nuptiality intensity was also accompanied by a growth in global inequality (in the early 1990s we can see partial condensation and a drop in inequality). Ironically, it is mainly inequality between countries which causes an increase in global inequality, although it is the final period of development in a common state. However, the period before and after the split of the state is significantly turbulent from many perspectives, and it is impossible to make isolated clear explanations. Two large regional clusters are formed in the periods of 1984–1986, 1987–1989 and 1991–1993. It is a cluster of low values spreading practically across the entire territory of Slovakia, and a cluster of high values in the western part of the Czech Republic which gradually extends in space. Clustering is also demonstrated in the high values of the global autocorrelation rate. Generally speaking, changes in family behaviour may be considered conserved until 1989 and in harmony with the theory of civilization waves; such a situation may be identified as artificial postponement of the start of an organic stage (Pothan 1992).

4.2 Divorce

In contrast to nuptiality, global inequality in the case of the divorce rate was continually decreasing. In the early 1970s, one can see the lowest divorce rate intensity within the analysed period. On the contrary, the level of inequality is highest for this period (Figure 7). This indicates that one may expect great regional differences in the divorce rate. Disaggregation of the Theil index provides us with more information. To approximately one half, global inequality is formed by inequality at the state level, which means that a large part of inequality is formed by differences only between the countries. The increased global values of the Moran index indicate that there is more intensive clustering, and the LISA analysis helps identify particular clusters (Figure 8). The Northwestern part of the Czech Republic recorded generally high values, and low values can be seen in almost all Slovak regions. None of the identified clusters crosses the state border, which only confirms that the differences between both countries largely contribute to the creation of global inequality. It is generally true that the divorce rate is higher in towns and cities (Shelton 1987). This is also confirmed by our results because the regions of Prague, Brno and Ostrava show high divorce rates and similarly, the Slovak cities of Bratislava and Košice recorded higher divorce rates than their surroundings. Legal standards and regulations related to the divorce rate may be generally considered as an innovative element of family behaviour, which has been demonstrated since the late 1940s in the territory of Czechoslovakia. The 'urban' factor is joined by another factor, although this is only a hypothesis which requires further examination. It could be called' eradication of traditions'. After the Second World War, a part of the original population in the southern border area of the Czech Republic (Sudetenland) was moved out and a new population from across the whole of Czechoslovakia arrived there (Šimon

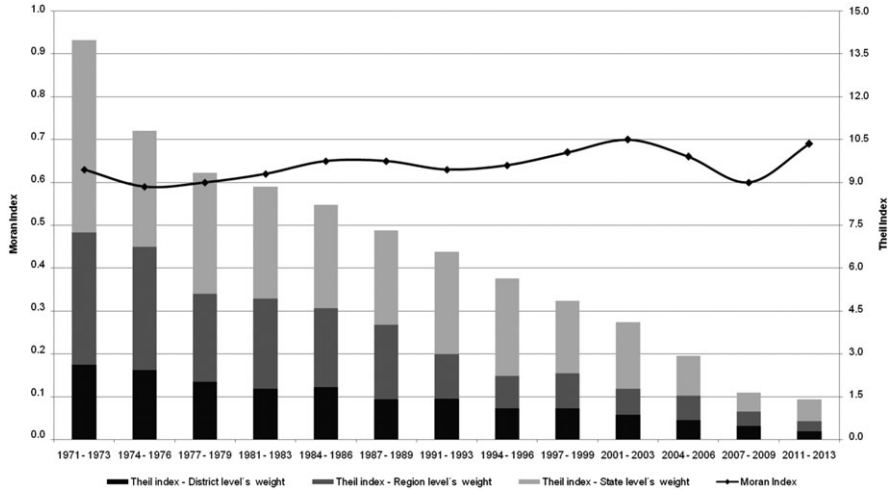

Fig. 7. Values of the Theil index and the Moran index for standardized crude rate divorce rate
Source: Statistical Office of Slovakia (2014) and Czech Statistical Office (2014), own calculations.

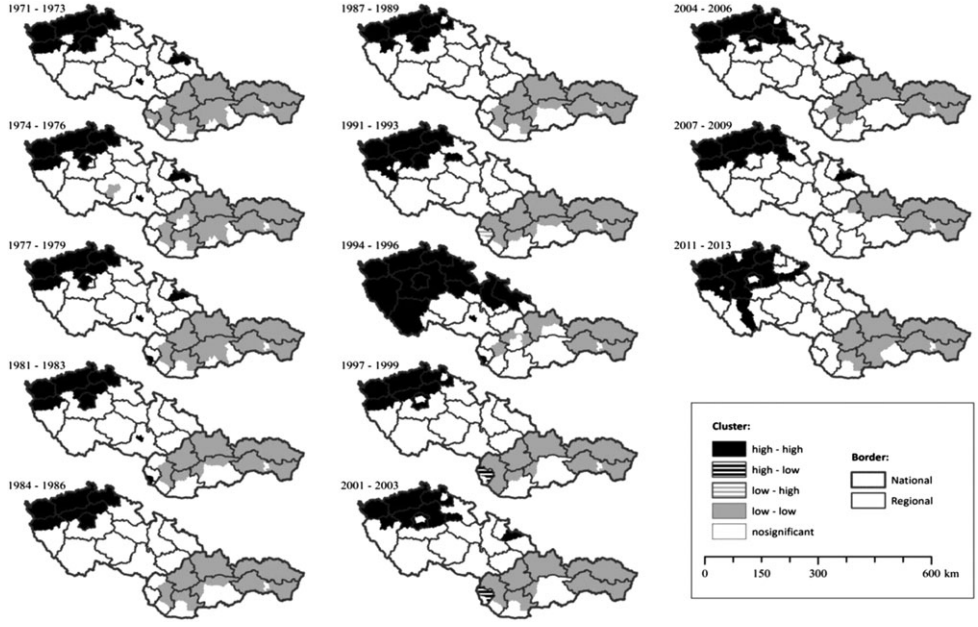

Fig. 8. LISA analyses for standardized crude divorce rate
Source: Statistical Office of Slovakia (2014) and Czech Statistical Office (2014), own calculations.

2015). Such a mechanical movement cut its traditionalistic ties and the population in this area lost its social coherence. This explains the fact that it is precisely the Northwest of the Czech Republic which recorded a higher divorce rate intensity throughout the entire period analysed in the study. Similar patterns of family behaviour, when a newly-arriving population is integrated in a limited manner only, and therefore adopts innovative elements of family behaviour generated by the governing elite very quickly, may also be found in other countries of the Eastern Bloc (Moskoff 1986). At the same time, the 'eradication of traditions' factor may also

strengthen another factor – the features of the employment structure. The Western part of the Czech Republic, as well as the outermost Northeast of the Czech Republic, is characterized by a high proportion of persons employed in mining and heavy industry. According to Greer and Stokes (2011), a higher divorce rate may be expected in such a population.

4.3 Non-marital births

To start with, it should be noted that the number and proportion of non-marital births saw the most dynamic changes. The proportion of non-marital births grew from roughly 5 per cent in 1971 to over 40 per cent in 2013. The 8-fold increase is striking and spatial differences must also be assessed in the context of such rapid dynamics. In the mid-1970s, the ratio of non-marital childbearing was very low. According to Kiernan (2001), the proportion of non-marital births was slightly over one fifth in some countries of Western Europe (Denmark, Iceland, Sweden), but in Czechoslovakia it was less than 1/20. This also confirms that the start of more progressive characteristics in view of the theory of civilization waves (Toffler 1980) was conserved both by regulations of the Communist regime and by persisting traditionalistic dogmas. In the early 1970s, the nature of non-marital childbearing was characterized by high regional inequality (Figure 9). In the period 1971–1973, the Theil index reached its highest values and its partial components indicate that global inequality is formed almost fully by differences inside states, mainly by interegional differences. It seems that non-marital natality was most affected by changes after 1989, when the values of the Theil and Moran indexes dropped considerably.

Several clusters were formed in the period 1971–1973 (Figure 10). The largest of these is a cluster of low values spreading from the central part of the Czech Republic across the state border to the Northwestern part of Slovakia. Contrary to the divorce rate, interstate differences play a minor role in the entire period under review. In contrast to nuptiality, the low weight of interstate differences is stable, while, in the case of nuptiality, the weight of interstate differences differed significantly over time.

Another aspect, which also confirms why the level of inequality is formed only by differentiation inside states, is the existence of clusters of high values in both states. Localization of both

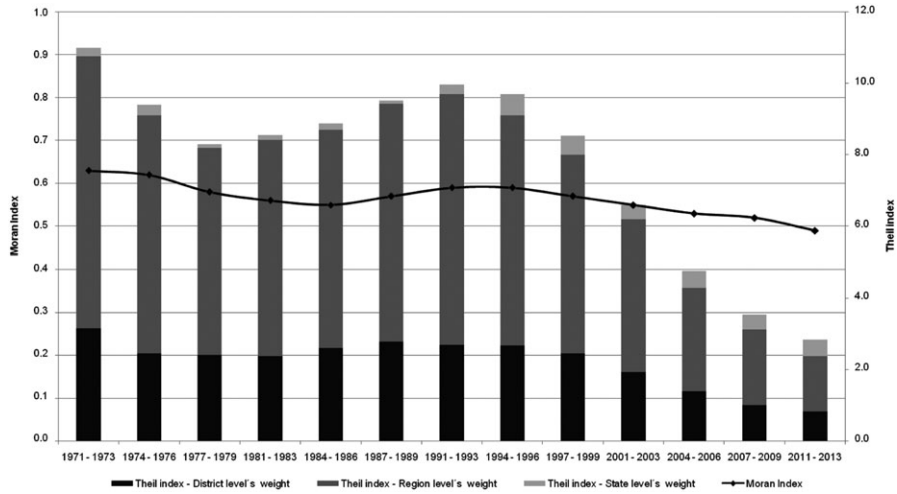

Fig. 9. Values of the Theil index and the Moran index for the proportion of non-marital births
Source: Statistical Office of Slovakia (2014) and Czech Statistical Office (2014), own calculations.

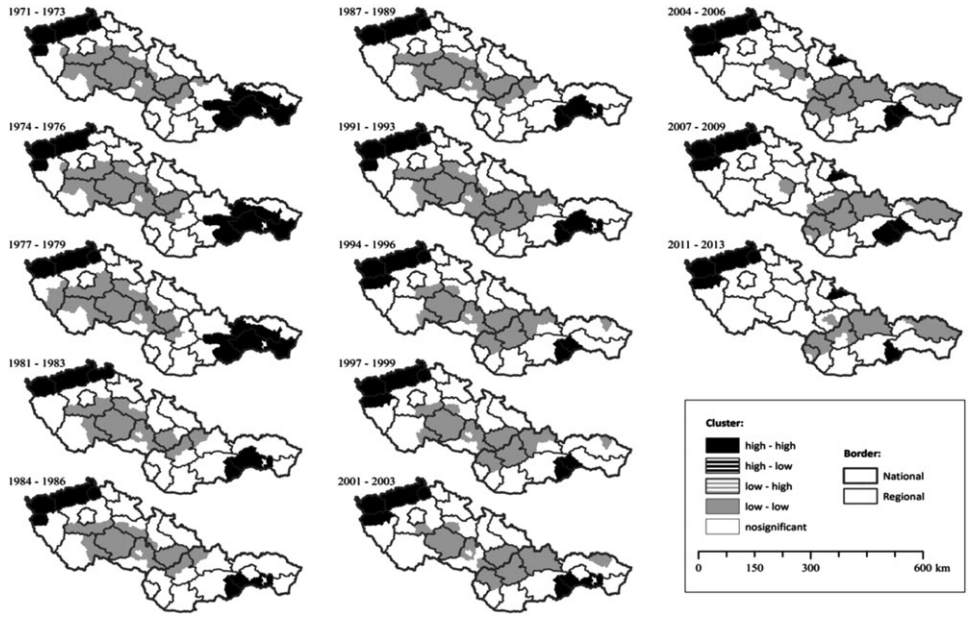

Fig. 10. LISA analyses for the proportion of non-marital births
Source: Statistical Office of Slovakia (2014) and Czech Statistical Office (2014), own calculations.

these clusters of high values has its specific genesis. Again, the cluster of high values in the West of the Czech Republic may be the result of the so-called eradication of traditions (Šimon 2015). This area saw a major population exchange after the Second World War, leading to the destruction of the established value preferences. Moreover, this area is characterized by a high employment rate in heavy industry and mining. Such a population is usually characterized by a less traditional approach (Shorter et al. 1971). This factor could also be reflected in the higher non-marital childbearing in the Southeast of Slovakia. In the 1970s and 1980s, this area was also characterized by high employment in mining and ore mining. In addition, there is probably another very specific factor – the Roma minority. According to Potančoková et al. (2008), the Roma minority is characterized by higher non-marital childbearing compared to the majority population. It is important to note that non-marital childbearing should be demonstrated mostly in urban regions (Van Bavel 2007). Our findings correspond to such a statement only partially. Urban regions of the biggest cities such as Prague, Brno or Košice are characterized by a higher intensity of non-marital childbearing than their surroundings, but the highest values are found in hierarchically lower regions with a lower level of urbanization.

By the late 1970s, the level of non-marital childbearing drops even more. Such evolution is accompanied by a drop in global inequality (Figure 9). After 1989, the growth of non-marital childbearing starts to accelerate. This growth occurred at the time of a temporary increase in inequality. Innovation may be understood as the increasing acceptance of non-marital childbearing, which had already started during the socialist regime (Rychtaříková 2007).

5 Discussion

Following the empirical results, we have tried to bring a more synthetic view. Figure 11 shows the period when the index of intercept exceeded 1.26 (see Section 3). This map synthesizes the partial results. These results can be understood as the period when cardinal changes of family

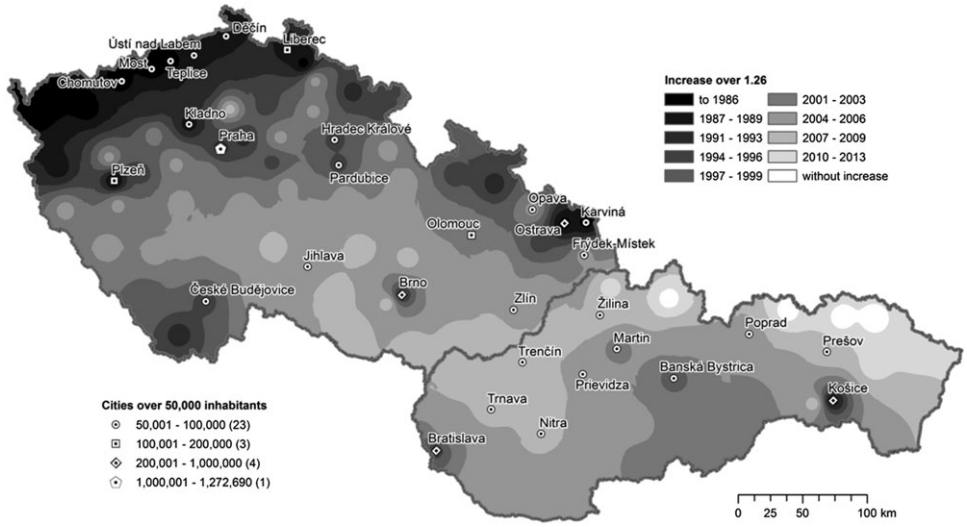

Fig. 11. Period of starting 'cardinal' changes in family behaviour
Source: Statistical Office of Slovakia (2014) and Czech Statistical Office (2014), own calculations.

behaviour definitely occurred, and how they spread inside the countries. The results displayed in the map confirmed that, in the case of changes in family behaviour, the Czech population was an obvious forerunner, while many regional populations in Slovakia were resistant, and that there were only certain cores which 'competed' with regions in the Czech Republic. Those are the most urbanized regions with larger urban nodes. Several regional factors are effective here, for example, in the southern part of central Slovakia with its specific ethnic structure. All indicators lag behind considerably in the North of central and Eastern Slovakia, which are culturally specific, highly religious and traditionalistic regions. In the case of the Czech Republic, there are certain differences between Bohemia and Moravia, but the dividing line is not obvious. This result is caused mainly by non-marital births. On the contrary, as proved by our previous findings, the populations of large cities are in the forefront of changes of the divorce rate as well as nuptiality. At the same time, as stated by Carlsson (1966) and Cleland (2001), the populations of capitals behave more progressively due to 'urban features' such as older populations, a more educated work force and a higher share of progressive sectors in economics. Some of the demographical innovations certainly occurred before 1971. On the other hand, some traditionalistic regions in Moravia and Eastern Slovakia do not go through innovations at all, not only on account of being lower in the regional hierarchy, but also due to the resistance that is caused by the local specificities (e.g. segregated Roma settlements).

To go deeper, we have made regression analysis. Equation 1 describes how influencing the components of the synthetic indicator are:

$$\mathrm{SSI} = 1.2645 - 0.1042\mathrm{CNR} + 0.1901\mathrm{CDR} + 0.0156\mathrm{NMF}, \tag{1}$$

where, SSI is the semi-synthetic indicator, CNR is the crude nuptiality rate, CDR is the crude divorce rate, NMF is the share of non-marital births.

The equation is interpreted as follows. The process of divorce shows the biggest impact on the change in family behaviour. When the crude divorce rate grows by 10 per cent, the semi-synthetic indicator will grow by 1.9 points. When the crude nuptiality rate grows by 10 per cent, the semi-synthetic indicator will be reduced by 1.04 points. The smallest impact demonstrates the non-marital fertility.

Table 1. Coefficient of correlation for semi-synthetic indicator of family behaviour (Czech Republic and Slovakia, LAU 2)

Period	1971-73	1974-76	1977-79	1981-83	1984-86	1987-89	1991-93	1994-96	1997-99	2001-03	2004-06	2007-09	2011-13
1971–73	*1.00**	*0.96**	*0.94**	*0.93**	*0.92**	0.89*	0.87*	0.87*	0.86*	0.80*	0.77*	0.71*	0.69
1974–76	*0.96**	*1.00**	*0.96**	*0.95**	*0.92**	0.87*	0.85*	0.88*	0.86*	0.78*	0.74*	0.67*	0.67
1977–79	*0.94**	*0.96**	*1.00**	*0.97**	*0.93**	0.88*	0.86*	0.87*	0.87*	0.81*	0.78*	0.71*	0.72*
1981–83	0.93*	*0.95**	*0.97**	*1.00**	0.96*	0.91*	0.88*	*0.91**	0.87*	0.83*	0.80*	0.73*	0.73*
1984–86	*0.92**	*0.92**	*0.93**	*0.96**	*1.00**	*0.94**	*0.91**	*0.92**	*0.90**	0.83*	0.80*	0.74*	0.72*
1987–89	0.89*	0.87*	0.88*	*0.91**	*0.94**	*1.00**	*0.93**	*0.91**	*0.90**	0.86*	0.83*	0.77*	0.74*
1991–93	0.87*	0.85*	0.86*	0.88*	*0.91**	*0.93**	*1.00**	*0.95**	*0.90**	0.87*	0.85*	0.82*	0.78*
1994–96	0.87*	0.88*	0.87*	*0.91**	*0.92**	*0.91**	*0.95**	*1.00**	*0.94**	0.89*	0.88*	0.84*	0.83*
1997–99	0.86*	0.86*	0.87*	0.87*	*0.90**	*0.90**	*0.90**	*0.94**	*1.00**	*0.96**	0.89*	0.88*	0.87*
2001–03	0.80*	0.78*	0.81*	0.83*	0.83*	0.86*	0.87*	0.89*	*0.96**	*1.00**	*0.97**	*0.93**	*0.92**
2004–06	0.77*	0.74*	0.78*	0.80*	0.80*	0.83*	0.85*	0.88*	0.89*	*0.97**	*1.00**	*0.97**	*0.96**
2007–09	0.71*	0.67	0.71*	0.73*	0.74*	0.77*	0.82*	0.84*	0.88*	*0.93**	*0.97**	*1.00**	*0.97**
2011–13	0.69	0.67	0.72*	0.73*	0.72*	0.74*	0.78*	0.83*	0.87*	*0.92**	*0.96**	*0.97**	*1.00**

Notes: *1% significance level. Coefficient of correlation is more than 0.9 in italic. ▬ Periods with the over-averaged-stability of the spatial patterns.

The regression analysis is used for showing to what extent the spatial patterns are stable over time and what periods could be seen as the break-points in terms of changes of spatial arrangements (Table 1). In other words, if there is an appearance of the new elements in family behaviour (or their significant increase), the spatial stability and arrangement will immediately start to change. In the long-term, the spatial arrangement is relatively unstable, the values of coefficient have been decreasing from one period to another. In spite of this, the overall period could be divided into three sub-periods, in which the stability is relatively high (the frames in Table 1). The period up to1986 is the period of paternalism and slow diffusion of changes from one regional population to another. The subsequent period of 1987–1999 is the period of the quickest changes. The majority of changes was introduced in this stage – the deepest drop in nuptiality and the highest growth in divorce and non-marital births. A new-millennium development is the stage of returning stabilization of spatial picture and most regional populations have already been incorporated into the changes.

6 Conclusion

Although the concept of innovation is very useful in geographical research, we must be very careful when using the term in demography and population geography. One may argue that

the divorce rate and non-marital births were only innovative when they occurred in the country/region for the first time and no more. On the other hand, the very low level of divorce and non-marital births as compared to Western Europe allow us to mark them as innovations when they started to grow quickly around 1989. This study dealt with only two countries with only 15 million inhabitants. Therefore, the generalization for the whole of Central Europe is fragile. But the study as such, is pioneering in terms of time range, spatial detail and the framework of post-socialist countries. Therefore, further research in other countries is needed to confirm whether the pre-1989 and post-1990 spatial patterns are analogous or similar to the cases of the Czech Republic and Slovakia, or if the time-space trajectories vary among the post-socialist countries. Irrespective of that, the statistical methods bring some significant results. Czechoslovakia (Czech Republic and Slovakia) is also an interesting research subject because of its common and free-standing history before and after 1993.

The empirical results have shown, or at least indicated in certain cases, that changes do not spread stochastically throughout the regions and obvious spatial patterns are demonstrated, and that there are certain cores of changes from which innovations spread in space. While in certain periods or parts of the states we can see obvious spatial patterns, they are not apparent in other periods. In any case, in all processes, although mainly in the case of the divorce rate and non-marital childbearing, the period around 1989 represents a certain break-even point, for example, from the point of view of representation of the weight of interstate, interregional and inter-district differences beyond which new regional factors occurred. Some results were expected, some were more surprising. Some of them confirm the ideas presented in previous research, some not at all.

As for the first hypothesis, the cores and pioneering populations are not always the strongest urbanized regions, particularly in the case of nuptiality. This is mainly true in the period up until 1989 when national and regional development was transpiring in a completely different population climate and natural changes were hampered. If we unconditionally accepted Hägerstrand's statements about spatial diffusion, then the hierarchically highest regions should be the first to adopt an innovation and the lower-ranked regions should respond to the innovation later. Until 1989, this rule applied only partially and, in a certain sense, there was a different form of spatial diffusion of new elements. New pro-family and pro-natality measures were demonstrated mainly in hierarchically lower-ranked regions. This proves that measures increasing nuptiality and natality are not 'progress' or 'innovation' in the true sense of the word. They only maintain an artificial condition as Rychtaříková (1991) also concluded. Simply said, certain poorer and more conservative regions only responded to the Communist central government's measures more sensitively, or these measures largely hampered certain developmental changes, for example, a drop in nuptiality. Mainly in the case of Slovakia, there was a significant increase in socio-economic disparities and there is a clear dividing line between the 'rich Northwest and the poor Southeast' (Korec 2014). It also seems that the nature and substance of population processes matter. The cores are not identical for the three analysed processes. There is a difference between nuptiality on the one hand and the divorce rate and non-marital childbearing on the other. The divorce rate process saw a continuous convergence – decreasing inequality – in the whole period under review, while in the case of nuptiality, the inequality indicators did not show such a clear development trajectory.

Hypothesis 2 was *de facto* confirmed. This means the 'innovation' cores occurred in the Czech Republic sooner and they are more frequent. In regards to Hypothesis 3, and stemming from the regression analysis, it seems that three major periods could be delimited, although this is only a crude generalization. As expected, the pre-1989 stage is the first one. The spatial patterns were relatively stable. They changed quickly in the following decade and the spatial diffusion happened in just 12–14 years. Then the spatial patterns stabilized again. If the state border is a barrier for diffusion, that depends on which indicator is taken into account

(Hypothesis 4). Only in the case of non-marital births did the clusters cross the state border, whereas in the case of nuptality and divorce they did not.

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