Spatial differences in sustainable development components in Nordic regions

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Abstract

Geographical proximity, common historical roots and collaboration within the Nordic Council make the Nordic countries, often wrongly treated as monoliths. However, in reality, Nordic regions differ in terms of broadly defined socio-economic development. The aim of this study is to analyze the spatial differences in sustainable development components in Nordic NUTS-3 regions in the period 2006-2014. Each sustainability dimension is measured using Pietrzak's spatial taxonomy measure of development. Analyzed problem seems to be important since Nordic countries are currently implementing the Fourth Nordic Strategies for Sustainable Development. The analysis showed that the achievement of sustainable development goals manage much better in the Swedish and Norwegian regions. The analysis showed as well that the Nordic countries are not as homogeneous as it might seem at first glance

Keywords: *sustainable development, spatial taxonomy measure of development, Nordic counties*
JEL Classification: Q01, C10, C43

1 Introduction

The concept of sustainable development links socio-economic issues with environmental problems. A widely-used definition of sustainable development is that one presented in World Conservation Strategy Living Resource Conservation for Sustainable Development (1980): 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs'. According to this definition sustainable development contains two main concepts: the concept of needs and the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs. Starting from 1992 when the first United Nation Conference on Environment and Development (UNCED) was held in 1992 in Rio de Janeiro, the sustainable development concept was widely discussed in world conferences not only in Johannesburg in 2002 and in Rio de Janeiro in 2012, but furthermore in many other smaller conferences and meetings (Sustainable Development Timeline, 2012). Currently one can still see growing international interest in green sustainable economy, even thought the concept has evolved over time (Du Pisani, 2006).

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The main goal of this study is to analyze the spatial differences in sustainable development components in Nordic NUTS-3 regions in the period 2006-2014. It is worth mentioning here what Nordic countries are: Nordic countries consist of not only Scandinavian countries (Denmark, Norway and Sweden) but as well Finland, and autonomous territories Greenland, Åland and the Faroe Islands. Nordic regions have been selected as object of interest for several reasons. The first reason is the fact, that since many years Nordic countries are leaders in the worldwide sustainable development rankings (Country Sustainability Report, 2013; SDG Index & Dashbords. A global report, 2017). The second reason is the fact, that Nordic countries cooperate in the framework of Nordic Council and Nordic Council of Ministers which are responsible for the agreements within the Nordic countries and the pursuit of the sustainable development of associated regions. The third reason is the fact that, due to their geographical proximity and common historical roots, the Nordic countries are often wrongly treated as unity. However, in reality, different regions of the Nordic countries are diverse in terms of widely understood socio-economic development. Author of this article want to show that even thought Nordic countries are leaders in sustainable development and they have common sustainability policy, there are still substantial differences among Nordic NUTS-3 regions. Therefore the simplification to perceive that all regions have equally strong sustainability level is misleading.

To analyze the spatial differences in sustainable development dimensions in Nordic NUTS-3 countries the spatial taxonomy measure of development (Pietrzak, 2014) was used. It seems that the inclusion of spatial relationships is justified because nowadays no region develops in isolation. Therefore, the situation in each region is influenced by neighbourhood. The impact of geographic surroundings is especially noticeable in the ecological dimension of sustainable development; it can be noted here quite obvious example of air pollutions that do not recognize administrative boundaries and move to the neighbouring regions along with the air movements.

The analysis was conducted for 67 NUTS-3 regions of Nordic countries (excluding: Höfuðborgarsvæði, Landsbyggð, Grønland, Føroyar, Åland, Gotland and Bornholm) in 2006-2014 period. Empirical material was taken from the national statistical offices of analysed countries.

2 Sustainable development discourses in Nordic countries

Governments of Nordic countries give high priorities to reduce pressure on the natural environment while pulling out millions of people out of poverty. It seems that sustainable

development and development of the Nordic welfare model go hand in hand. Denmark, Finland, Norway and Sweden not only have their national sustainability programmes but additionally collaborate with each other on that field. In 1952, Denmark, Iceland, Norway and Sweden formed the Nordic Council, which was later joined by Finland and also by the autonomous territories Greenland, Åland and the Faroe Islands. In 1962, the Nordic countries signed the so-called 'Helsinki Treaty' (The Helsinki Treaty, 1962), which regulates cooperation between them.

The importance of sustainability issues expresses the fact that the Nordic countries are currently implementing a fourth strategy for the sustainable development of the Nordic region (A Good Life in a Sustainable Nordic Region. Nordic Strategy for Sustainable Development, 2013) which complements national sustainable development strategies. The time frame of this strategy covers the period up to 2025. In this strategy, the emphasis is on: stable, healthy and sustainable economic growth; cooperation leading to higher employment and reduction of structural unemployment; healthy and decent life on inhabitants; elimination of poverty and trafficking in human rights; strengthening the role of culture in sustainable development. Financing the implementation of fourth sustainable development strategy falls under the budget of the Nordic Council of Ministers. (Sustainable Development. New Bearings for the Nordic Countries, 2001).

The first Nordic strategy for sustainable development was adopted 16 years ago. However it was initiated by the prime ministers declaration in 1998. Thus it can be seen that the issues associated with the combination of sustainable development and welfare model have quite long traditions in the Nordic countries.

3 Empirical analysis using spatial approach

To analyze spatial differences in sustainable development among Nordic NUTS-3 regions taxonomy spatial measure of development was used (Pietrzak, 2014). There are several reasons to include spatial factors into this kind analysis. Firstly, according to Waldo Tobler: 'Everything is related to everything else, but near things are more related than distant things' (Tobler, 1970). Secondly the use of a regional dataset implies consideration of the possibility that observations may not be independent, as a result of the inter-connections between neighbouring regions (Buccellato, 2007). Thirdly, it is better to use the simplest weight matrix than assume the independence in advance (Griffith, 1996). Fourthly, the diversification of economic phenomena in an established group of regions is highly affected by the spatial conditions (Pietrzak et al., 2014a; Pietrzak et al., 2014b). In polish literature one can find

different attempts to include spatial factor into taxonomy measure of development constriction (Antczak, 2013; Pietrzak, 2014, Sobolewski et al., 2014; Pietrzak, 2016). Pietrzak's (2014) proposition has the advantage over alternative methods that in that approach it is necessary to test spatial autocorrelation for each variable and it is possible to diversify the potential power of spatial interaction for each variable. There are different approaches to analyse sustainable development but as a research shows a synthetic measure is still a good solution (Vu et al., 2014; Balcerzak and Pietrzak, 2016; Pietrzak and Balcerzak, 2016).

To analyze the sustainable development in Nordic NUTS-3 regions a following set of variables was used (S - stimulant, D - destimulant):

- Social dimension: life expectancy at birth (S), upper-secondary attainment in total population (S), research and development expenditures as percentage of GDP (S), urbanisation (S).
- Environment dimension: air pollution emission (D), forestry level (S), share of renewable energy in gross energy supply (S), greenhouse gas emission (D), gross energy consumption (D)
- Economic dimension: unemployment rate (D), gender pay gap (D), Gini-coefficient (D), risk of poverty among families with children (D), GDP per capita (S).

Based on variables presented above the spatial taxonomy measure of development was calculated for each dimension of sustainable development. The taxonomy spatial measure of development according to Pietrzak (2014) was calculated as follows:

1. Testing the presence of spatial autocorrelation using Moran's I statistics:

$$I = \frac{n}{\sum_i \sum_j w_{ij}} \cdot \frac{\sum_{i=1}^{n} \sum_{j=1}^{n} w_{ij}\left(x_i - \bar{x}\right)\left(x_j - \bar{x}\right)}{\sum_{i=1}^{n}\left(x_i - \bar{x}\right)^2} \quad (i = 1,..,n;\ j = 1,...,n) \tag{1}$$

where: I - the value of Moran's I statistics; n - number of observations; w_{ij} - spatial weight matrix; x_i, x_j - the value of analysed variable in i and j objects; $\bar{x}$ - the mean average of analysed variable.

The variables for which the value of Moran's I statistic are statistically significant are included in the group of 'spatial' variables and otherwise - in the group of variables having no spatial character ('non-spatial' variables). In this research, spatial contiguity weight matrix was used, since it is a matrix that appears most frequently in the studies, taking into account

the spatial relationship. These weights basically indicate whether regions share a common boundary or not.

$$w_{ij} = \begin{cases} 1, & bnd(i) \cap bnd(j) \neq \varnothing \\ 0, & bnd(i) \cap bnd(j) = \varnothing \\ 0, & i = j \end{cases}. \quad (2)$$

1 refers to the situation in which region *i* and *j* have a common boundary; 0, if not. Diagonal elements in matrix W have value equal to 0 as the object cannot be its own neighbour. Spatial weight matrix was row standardised.

2. Estimating the SAR model for each variable from 'spatial' group of variables (LeSage, 1999):

$$\mathrm{X_j} = \rho \mathrm{W X_j} + \varepsilon \quad (3)$$

where: $\mathrm{X_j}$ - the vector of analysed *j* variable; ρ - the spatial autoregression parameter; W - the spatial weight matrix; ε - the spatially correlated residuals.

3. Preparing the set of diagnostic variables:

3.1. Adjusting the values of variables from 'spatial' group according to formula:

$$\mathrm{S}_j = (I - \rho \mathrm{W})^{-1} \mathrm{X}_j \quad (4)$$

where: S_j - the vector of spatially adjusted *j* variable; I - identity matrix; ρ - the spatial autoregression parameter, W - the spatial weight matrix.

3.2. Remaining unchained the values of variables from 'non-spatial' group.

4. Changing destimulants for stimulants and standardise variables according to Hellwig's formula:

$$z_{ij} = \frac{x_{ij} - \bar{x}_j}{s_j} \quad (i = 1,..., n;\ j = 1,..., m) \quad (5)$$

where: z_{ij} - standardised value of *j* variable in *i* object; x_{ij} - the value of *j* variable in *i* object; $\bar{x}_j$ - the mean average of *j* variable; s_j - the standard deviation of *j* variable.

5. Calculating the distance between the i object and 'ideal' object:

$$d_i = \sqrt{\sum_{j=1}^{m} \left(z_{ij} - \varphi_j\right)^2} \quad (i = 1,..., n;\ j = 1,..., m) \quad (6)$$

where: z_{ij} - standardised value of *j* variable in *i* object; φ_j - value of *j* variable in the 'ideal' object.

6. Calculating the spatial taxonomy measure of development (sTMD) according to formula (Pietrzak, 2014):

$$sTMD_i = 1 - \frac{d_i}{d_{i-}} \quad (i = 1,..., n) \tag{7}$$

where:

$$d_{i-} = \bar{d} + 2s_d \quad (i = 1,..., n). \tag{8}$$

$sTMD_i$ - the taxonomy spatial measure of development for the county *i*; d_i - the distance between object *i* and 'ideal' object; $\bar{d}$ - the average value of *d* vector ($d = d_1,..., d_n$); s_d - the standard deviation of *d* vector.

The higher the value of $sTMD_i$ the better from the point of view of analysed phenomena. The analysed regions were also grouped on the basis of similar values of synthetic measure. Those groups were constructed as follows:

- the highest sustainability level: $sTMD_i \geq \bar{s}TMD + sd_{sTMD}$,
- medium sustainability level: $\bar{s}TMD + sd_{sTMD} > sTMD_i \geq \bar{s}TMD$,
- low sustainability level: $\bar{s}TMD > sTMD_i \geq \bar{s}TMD - sd_{sTMD}$,
- the lowest sustainability level: $sTMD_i < \bar{s}TMD - sd_{sTMD}$.

The result of analysis are presented in Figure 1-3.

2006 2014

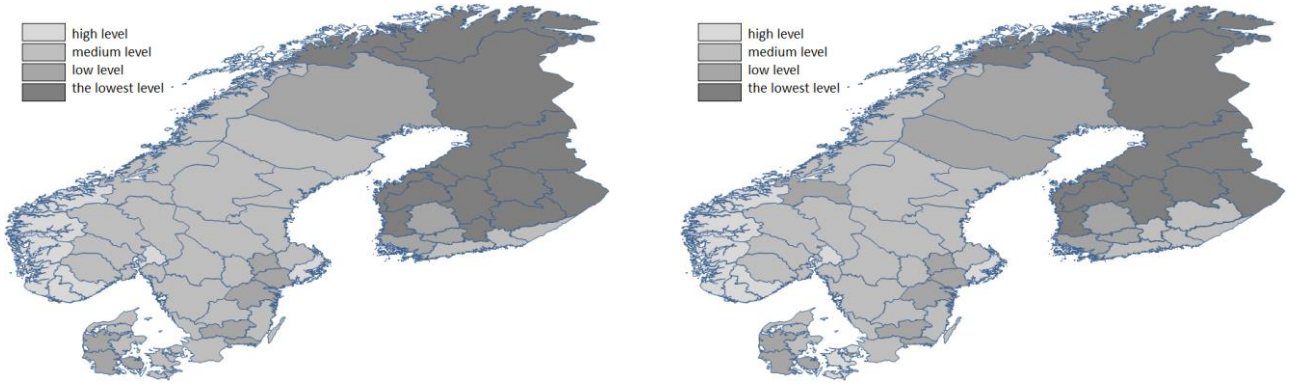

Fig. 1. Similar group of Nordic NUTS-3 regions in terms of social sustainability level in 2006 and 2014.

2006 2014

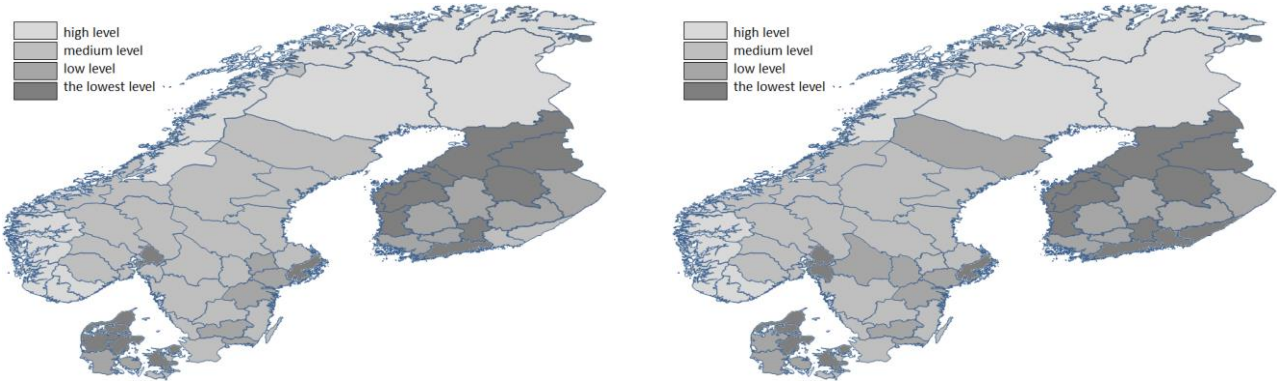

Fig. 2. Similar group of Nordic NUTS-3 regions in terms of ecologic sustainability level in 2006 and 2014.

Analysing figures 1-3 it can be seen that not only there are differences in the level of sustainability between regions but also particular regions differ in degree of balance in a particular sustainable development dimension. Northern regions show a high level of environmental sustainability, which is not surprising, since the harsh climate and low population density translates into low degree of urbanization and industrialization, which in turn is connected to the relative low air pollution emissions and energy consumption, and often with high forestry level and a small land use. On the other hand, the harsh living conditions and the lack of a developed industry results in low or very low level of sustainability due to the economic and social conditions.

2006 2014

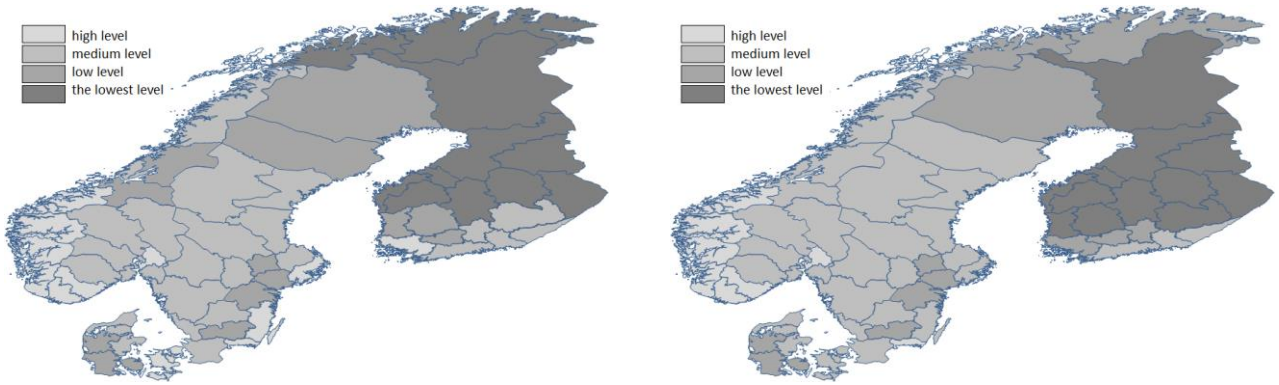

Fig. 3. Similar group of Nordic NUTS-3 regions in terms of economic sustainability level in 2006 and 2014.

The opposite of northern regions are the regions including capitals of analyzed countries, as well as northern Denmark and southern Finland. The high population density and strong

industrialization place those regions as a low-balanced due to ecological conditions; however, those regions have much better sustainability level in economic and social areas. It should be also noted that, in general, Norway and Sweden realise sustainable development aim better than other countries. Swedish and Norwegian regions in the majority of cases were classified into high or medium level groups. While in most cases Finnish regions were usually classified into low or the lowest level groups.

Conclusions

In this study the spatial differences in components of sustainable development in Nordic NUTS-3 regions were analyzed. For this purpose a spatial taxonomy measure of development proposed by Pietrzak was used. The usage of this methodology seems to be justifies, as 9 out of 14 diagnostic variables showed the presence of spatial autocorrelation. The analysis showed that the achievement of sustainable development goals manage much better in the Swedish and Norwegian regions. One should also pay attention to the differences in balance in different areas of sustainable development. Central and highly industrialized regions still have problems with elements related to the protection of the environment, which is over-used to achieve social and economic objectives. While regions located in the area of the Arctic Circle realize ecologic objectives, while still exhibit difficulties in socio-economic areas.

The analysis showed that the Nordic countries are not as homogeneous as it might seem at first glance. It also indicates that despite the occupied high places in the rankings of sustainable development there is still much to do. Therefore, it should not be surprising, that in addition to the implementation of national sustainability development programs, Nordic countries have also decided to establish international cooperation in this area.

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