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The structural and geographical analysis of occupational diseases in Poland in the years 2003–2010

Abstract: The paper uses the advanced spatial shift-share method to examine the tendency of some occupational diseases to occur in particular regions and sectors of the economy. The analysis, conducted in the years 2003–2010, concerned groups of diseases, and was based on regional data on occupational disease incidence in Poland according to disease groups. The analyzed variables were relative increments (of rates of changes) of the number of diagnosed occupational diseases, whereas the reference variable was the share of the diagnosed occupational diseases (in particular regions and groups of diseases) in the general number of diagnosed occupational diseases in the country (regional weights). The results of that research were then used to compare classical and non-classical methods of shift-share analysis.

Keywords: occupational diseases, structural and geographical analysis, spatial shift-share analysis.

Analiza strukturalno-geograficzna występowania chorób zawodowych w Polsce w latach 2003–2010

Streszczenie: W artykule zaprezentowano zastosowanie zaawansowanych i przestrzennych metod analizy przesunięć udziałów do badania tendencji występowania określonych chorób zawodowych w poszczególnych regionach i działach gospodarki. Analiza została przeprowadzona na danych dotyczących grup chorób w latach 2003–2010. Badaną zmienną były przyrosty względne (tempa zmian) liczby stwierdzonych chorób zawodowych, zaś zmienną referencyjną – udział liczby stwierdzonych chorób zawodowych w danym regionie i grupie chorób w ogólnej liczbie stwierdzonych chorób zawodowych w kraju (wagi regionalne). Na podstawie otrzymanych wyników przeprowadzono analizę porównawczą zastosowania nieklasycznych metod w odniesieniu do wyników pozyskanych z klasycznej analizy *shift-share*.

Słowa kluczowe: choroby zawodowe, analiza strukturalno-geograficzna, przestrzenna analiza przesunięć udziałów.

1. Introduction

Health hazards in the workplace are of interest to many international organizations, including the United Nations, the World Health Organization, and the International Labour Organization. According to regulations, every person has the right to work in a healthy and safe environment and not to risk their health or fitness for work. The institutions responsible for the supervision of the working conditions in Poland are the State Labour Inspectorate, the State Sanitary Inspectorate and the Office of Technical Inspection. To make their activities more useful and effective, they gather reliable and up-to-date information on the health status of employees and on the factors that could affect it.

The objective of this paper is to describe the application of advanced and spatial shift-share methods to examine the tendency of occupational diseases to occur in particular regions and sectors of the economy. At the same time, the analysis may indicate areas where the working conditions contribute to occupational pathologies, and therefore help to promote activities which could improve working conditions in Poland and make work safer. The statistical data and the analyses may also be used to assess particular policies by highlighting their successes and failures and by targeting measures undertaken by relevant state institutions.

The health status of the employee depends, to a large extent, on the occupational hazards existing in the workplace, such as harmful physical, chemical and biological factors. These hazards are reflected in the occupational disease incidence. A disease may be diagnosed as occupational by a sanitary inspector if there is proof that it was indisputably or very likely caused by health-hazard factors present in the work environment, or that it resulted from the work performed (Marek 2004). The disease must also be included on the occupational diseases list – an appendix to the current Regulation of the Council of Ministers of 30 June 2009 on occupational diseases (Dz.U. [Journal of Laws] of 2009, Nº 105, item 869).[1]

2. The shift-share approach

In terms of regional development, it is important for the health care system to maintain spatial cohesion (Rozpędowska-Matraszek 2010). The cohesion policy involves measures aimed at the development and modernization of regions through health promotion, prevention, and education. With easy access to information, regions can apply solutions already introduced elsewhere. To analyze and assess the implemented health programmes, one has to examine spatial changes concerning e.g. the structure of occupational disease incidence.

The analysis of structural changes in economic and social phenomena that occur in a region over a specific period is based on a shift-share analysis (Suchecki, Antczak 2010). Shift share, a popular technique of regional economics/science analysis, is typically used to describe various economic changes in a region over a given time period (Hoppes 1997). This method was created by Creamer (1942) and developed by Dunn (1960) and Perloff, Dunn, Lampard and Muth (1960) at the end of the 1950s and the beginning of the 1960s. It is also known

[1] Regulation of the Council of Ministers of 30 June 2009 on occupational diseases (Dz. U. [Journal of Laws] of 2009, Nº 105, item 869).

as a structural and geographical shift-share analysis, and it is used to analyze and assess the scope of development of a given region in comparison to the scope of development of a reference area (country), taking into consideration the dynamics and structure of the changes (Baltagi, Arbia 2009; Lesage, Kelley Pace 2009).[2]

The shift-share analysis consists in dividing the shift of the identified variable X, which is usually of a relative nature (rate or pace of changes): $tx_{ri} = \frac{x^*_{ri} - x_{ri}}{x_{ri}}$ (1)
where:

x_{ri} – variable value for r – this region, and i – this sector, in the initial period,

x^*_{ri} – variable value for r – this region, and i – this sector, in the final period,

into three components (Merrifield 1980):

– reference area growth (RG),
– industrial mix (IM),
– regional share (RS).

The three components together make up the actual change (AC):

AC = RG + IM + RS

In order to ensure standardization, the values of the analyzed variable are weighted (Suchecka, Żółtaszek 2011).

We can distinguish three weights:

– regional weight (r = 1, 2, …, R) $w_{r\bullet(i)} = \frac{z_{ri}}{z_{r\bullet}} = \frac{x_{ri}}{x_{r\bullet}}$, (2)

– sectoral weight (i = 1, 2, …, S) $w_{\bullet i(r)} = \frac{z_{ri}}{z_{\bullet i}} = \frac{x_{ri}}{x_{\bullet i}}$ (3)

– individual weight (r = 1, 2, …, R; i = 1, 2, …, S) $w_{ri} = \frac{z_{ri}}{z_{\bullet\bullet}} = \frac{x_{ri}}{x_{\bullet\bullet}}$ (4)

where z_{ri} and $z_{r.}$ are the shares of the chosen reference variable.

Apart from the individual increase rate of the variable X in the i-sector and r-region, the following aggregate measures are applied in the shift-share analysis:

– average growth rate in the r-region: $tx_{r\bullet} = \sum_i \frac{z_{ri}}{z_{r\bullet}} * tx_{ri} = \sum_i w_{r\bullet(i)} * tx_{ri}$, (5)

– average increase rate of the variable X in the i-sector:

$$tx_{\bullet i} = \sum_r \frac{z_{ri}}{z_{\bullet i}} * tx_{ri} = \sum_r w_{\bullet i(r)} * tx_{ri}, \quad (6)$$

– average increase rate of the variable X in the country in a given period of time:

$$tx_{\bullet\bullet} = \sum_{r=1}^{R}\sum_{i=1}^{S} \frac{z_{ri}}{z_{\bullet\bullet}} * tx_{ri} = \sum_{r=1}^{R}\sum_{i=1}^{S} w_{\bullet\bullet(r,i)} * tx_{ri}. \quad (7)$$

When calculating the regional averages for each of the three components of the $tx_{ri} - tx_{..} = (tx_{.i} - tx_{..}) + (tx_{ri} - tx_{.i})$ equation, the classical shift-share equation takes the following form (3):

$$tx_{r\bullet} - tx_{\bullet\bullet} = \sum_i w_{r\bullet(i)}(tx_{\bullet i} - tx_{\bullet\bullet}) + \sum_i w_{r\bullet(i)}(tx_{ri} - tx_{\bullet i}). \quad (8)$$

[2] For more information on shift-share analysis, see: Baltagi, Arbia 2009; and LeSage, Kelley Pace 2009.

where:

– $(tx_{r\bullet} - tx_{\bullet\bullet})$ is a pure regional effect $\mathbf{C_r}$ (the difference between the regional and national growth rate) which determines the potential of the analyzed area. It measures the expected growth of the analyzed variable on the assumption that the development of the analyzed area is at the same or similar level as the development of the reference area,

– $\sum_i w_{r\bullet(i)}(tx_{\bullet i} - tx_{\bullet\bullet})$ is a structural effect $\mathbf{S_r}$ which shows the scope of changes in the analyzed area (each section) with reference to the general developmental trend of this section in the reference area. A positive value suggests that the analyzed area is growing faster than the reference area, and a negative value suggests a lower development level of the analyzed area compared to the reference area.

– $\sum_i w_{r\bullet(i)}(tx_{ri} - tx_{\bullet i})$ is a geographical effect $\mathbf{G_r}$ which reflects the competitiveness of the region[3] and the difference between the growth rate of the analyzed and the reference areas. It shows an increase or decrease of the analyzed variable caused by the competitive position of each activity within the analyzed area.

However, E. S. Dunn's classical shift-share method is not without flaws, so in subsequent regional analyses the following modifications were proposed:

a) Recursive-dynamic model – in order to eliminate statistical weights from the shift-share analysis model and to carry out analyses for extended periods of time, at the end of the 1980s, Barff and Knigh made the classical approach to the shift-share analysis more dynamic by introducing calculations based on the classical methods, carried out for each pair of the consecutive periods, followed by the aggregation of the particular effects in relation to time. This way, it was possible to take into consideration regional structure changes and, as a result, to distinguish particular effects more clearly and make more accurate inferences (e.g. inference on the existing change tendencies):

$$\sum_t (tx_{r\bullet t} - tx_{\bullet\bullet t}) = \sum_t \sum_i w_{r\bullet(i)t}(tx_{\bullet it} - tx_{\bullet\bullet t}) + \sum_t \sum_i w_{r\bullet(i)t}(tx_{rit} - tx_{\bullet it}), \qquad (9)$$

where **t** is the time index (pairs of consecutive periods).

b) Shift-share analysis based on the spatial weight matrix (*Spatial SSA*) – in 2004, in order to show the spatial relations between regions and assess local competitiveness, S. Nazara and G. J. D. Hewings introduced the spatial weight matrix to the classical shift-share analysis.

[3] In occupational disease analysis, competitiveness is understood as the capability of matching the average level of occupational disease prevalence in the country.

$$tx_{r\bullet} - tx_{\bullet\bullet} = \sum_i w_{r\bullet(i)}(\mathrm{W}tx_{\bullet i} - tx_{\bullet\bullet}) + \sum_i w_{r\bullet(i)}(tx_{ri} - Wtx_{\bullet i}), \tag{10}$$

where **W** is the weight matrix.

The spatial relation factor is a component of the structural or the geographical effect, or both of them at the same time. The modified structural effect shows whether the pace of change of a variant of a phenomenon (e.g. in a particular sector) is faster in the analyzed region or in adjacent areas. The geographical effect, also known as the local competitiveness index, is used to assess whether a given region and its adjacent areas might compete with each other in terms of the analyzed variable (or sector). The global effect is constant for each region and does not take the spatial weight matrix into account.

c) The dynamic model based on the spatial weight matrix – to take into account spatial interactions and regional weight adjustments, the modifications introduced by R. A. Barff and P. L. Knight, or S. Nazara and G. J. D. Hewings may be applied at the same time (Antczak, Żółtaszek 2010):

$$\sum_t (tx_{r\bullet t} - tx_{\bullet\bullet t}) = \sum_t \sum_i w_{r\bullet(i)t}(Wtx_{\bullet it} - tx_{\bullet\bullet t}) + \sum_t \sum_i w_{r\bullet(i)t}(tx_{rit} - Wtx_{\bullet it}) \tag{11}$$

Like in the previously applied methods, the analysis suggested by Nazar and Hewings has to be repeated for each pair of the consecutive periods, and the changes and effect have to be aggregated. Although spatial weights do not usually change over time, differences in the static and dynamic approach do occur. The compilation of the spatial and dynamic approach indicates that – unlike the spatial weight matrix – rates of changes in the analyzed variable, and therefore structural and geographical effects, vary from period to period and not only between the final and the initial moment of the analysis, whereas spatial weights (interactions, proximity) are considered constant in the entire period.

The technique has been frequently used to analyze regional and international growth impacts, but not in the health care system. Hoppes (1997) used a shift-share model to investigate, describe, and analyze disease and death rates in Missouri. Using statistical data on death rates by type of disease, shift-share components of change were estimated at the national, structural and regional level. The results are useful in allocating health care funding and targeting specific diseases for funding.

3. The regional characteristics of working conditions in Poland that contribute to occupational pathologies

The analysis of the prevalence of occupational diseases revealed strong correlation with types of economic activities carried out in particular regions. This is why it is so important to identify the sectors of the economy that have a negative influence on the employees' health. It has been observed that pathologies like pneumoconiosis and hearing loss occur more often in regions with high employment rate in mining and quarrying. In 2010, there were 1005 cases of diagnosed occupational diseases in the Silesian Province, out of which over 60% where connected with respiratory system disorders, and 13% with hearing loss. Almost 370 for every 100 thousand workers in the sector suffered from occupational disorders. Agriculture, hunting, forestry and fishing revealed to be even more morbific. Incidence rate[4] reached the level of 418 cases for each 100 000 workers. People performing these professions are exposed mostly to infectious and parasitic diseases and their sequels, or the vibration syndrome. As expected, these groups of disorders were the most frequent pathologies in provinces like Lubusz, Podlaskie and Świętokrzyskie, because of the agricultural character of their activity. The analysis indicated strong correlation between manufacturing and pneumoconiosis, hearing loss and chronic diseases of the peripheral nervous system. The incidence rate reached the level of 35.3. A similar ratio (almost 33) has been observed in human health workers and in social workers, who mostly suffer from infectious and parasitic diseases and their sequels. On the other hand, information, communication, finances and insurance offer less hazardous work conditions.

Statistical data confirm the assumption that the type of activity influences the number and kind of pathologies not only in a particular region but also its neighbouring provinces. The geographic dependence or interdependence of regions is the result of migrations, technology and knowledge diffusion, interregional commuting to work, and trade between regions.

4. Application of advanced shift-share methods in occupational disease prevalence in Poland

The shift-share analysis presented in this paper was carried out on the basis of regional data on occupational disease incidence in Poland, according to disease groups, in the years 2003–2010. The following seven sectors were studied:

1) pneumoconiosis (and other respiratory system diseases),
2) chronic diseases of the locomotor system and chronic diseases of the peripheral nervous system,
3) chronic voice disorders,
4) skin diseases,
5) hearing loss,
6) infectious and parasitic diseases and their sequels,
7) other diseases (e.g. acute general allergic reactions, malignant neoplasm, vibration syndrome).

All the information comes from the Local Data Bank of the Central Statistical Office and from records compiled by Professor J. Nofer from the Occupational Medicine Institute in Lodz. The analyzed variable was relative increments (paces of change) of a number of diagnosed occupational diseases, while the reference variable was the share of diagnosed occupational diseases (in a given region and disease group) in the general number of diagnosed occupational diseases in the country (regional weights).

[4] Incidence rate is the number of new diagnosed cases within a specified time period, divided by the size of the population initially at risk (Bochenek 1997).

First, the classical shift-share analysis was carried out to compare the years 2003 and 2010. Then calculations based on recursive-dynamic model were conducted (comparison of the years: 2003 and 2004, 2004 and 2005, 2005 and 2006, 2006 and 2007, 2007 and 2008, 2008 and 2009, 2009 and 2010). The next stage of the analysis involved the spatial weight matrix (**W**), determined on the basis of a row-standardized binary proximity matrix.[5] In the final stage, the above procedure was applied to each pair of the consecutive years, based on the dynamic model with spatial weights.

Table 1 and 2 present the results of the application of the classical and dynamic shift-share analysis model to the calculation of changes of the number of occupational diseases diagnosed in Poland in the years 2003–2010. The tables show individual cross-regional growth rates, average rates of changes and effects: regional, structural and geographical.

Both in the classical and the dynamic method, the national average rate has a negative value (txr. = **-32,7** i Σtx.. **= -36,1,** respectively), and suggests a gradual decrease in the occupational disease incidence.

The differences between the analyzed variable rates in the case of both methods arise from the fact that we are dealing not only with the changes that occurred within the period of 2003–2010, but also with those observed on a year-to-year basis (shift-share analysis that takes into account recursion in time).

To assess the level of development of a given province in relation to the country, i.e. to verify how much the regional growth rate diverges from the national rate (reference area), we use the $\mathbf{C_r}$ pure regional effect. Comparing the rates of changes of the analyzed variable obtained during the classical analysis carried out for particular provinces in the years 2003 and 2010, we can distinguish regions with the highest incidence rate (total effect value > 34.00) and those with the lowest incidence rate, which is below the average level in the country (total effect value < -32.00). The described differences could arise either from the changes within the incidence structure, with a division into disease groups in particular provinces (structural effects $\mathbf{S_r}$), or from internal changes due to their competitive position and being part of the analyzed region (geographical effects $\mathbf{G_r}$). A positive example might be the Greater Poland Province with the highest drop in the occupational disease incidence: by 67.5% of the diagnosed cases (34.78 percentage points below the average national rate). The situation in the province was not the result of changes in the disease group structure (-8.56 p.p.), but was mainly caused by internal competitiveness-related changes (-26.22 p.p.). The opposite situation occurred in the West Pomeranian Province, where we recorded the highest increase in the number of diagnosed occupation diseases (6.61%; 39.35 percentage points above the national average rate). This was mainly the consequence of changes in international competitiveness (44.91%). It can be easily noticed that apart from the Podlaskie and the Silesian Provinces, changes concerning the analyzed variable were mainly due to being part of the analyzed region.

[5] The proximity matrix includes elements $w_{ij} = 1$, provided that the units *i* and *j* have a joint border, otherwise $w_{ij} = 0$.

Table 1. Shift–share analysis of changes of the number of occupational diseases in Poland in the years 2003–2010 with a division into disease groups and provinces: classical method

Provinces	**Growth rates (%)**							**Average rates of changes (%)**	**Effects**		
	Respiratory system	Locomotor and peripheral nervous system	Voice disorders	Skin diseases	Hearing loss	Infectious and parasitic diseases	Others		Global ($\mathbf{C}_r$)	Structural ($\mathbf{S}_r$)	Geographical ($\mathbf{G}_r$)
Lower Silesian	–34.4	273.3	–75.9	–53.8	–76.9	68.4	–62.8	–24.8	7.9	1.4	6.5
Kuyavian-Pomeranian	–75.0	54.5	–17.6	–61.5	–61.5	290.0	–55.6	6.3	39.1	1.0	38.1
Lublin	–64.9	–35.7	–83.3	–8.3	–100.0	–27.5	–46.7	–65.7	–33.0	–2.7	–30.3
Lubush	–40.0	–16.7	–78.7	–84.6	–70.0	4.5	–42.9	–54.57	–21.8	–2.1	–19.7
Łódź	–48.5	–58.3	37.5	–46.7	–60.0	–50.0	–89.6	–62.5	–29.8	5.5	–35.3
Lesser Poland	–52.9	323.5	–75.0	–50.0	–8.1	114.3	–33.3	–29.47	3.3	–7.3	10.6
Mazovian	–2.0	100.0	–66.7	–23.1	–52.9	40.4	–13.3	–7.7	25.0	11.0	14.1
Opolskie	–62.5	–75.0	–66.7	–71.4	–80.0	100.0	–53.8	–37.7	–4.9	1.9	–6.8
Subcarpathian	–75.0	80.0	–33.3	–50.0	–70.8	26.3	–69.2	–32.0	0.7	9.3	–8.5
Podlaskie	–60.0	100.0	–79.4	–50.0	–33.3	69.0	–87.5	1.8	34.5	22.0	12.5
Pomeranian	9.1	–18.2	–80.0	–66.7	1.3	–61.7	–87.5	–46.0	–13.3	–3.3	–10.0
Silesian	9.0	27.1	–44.8	–62.2	–62.0	–20.9	–50.4	–22.6	10.2	3.2	7.0
Świętokrzyskie	41.7	100.0	–87.0	33.3	–89.3	25.0	–28.6	–39.4	–6.7	–9.2	2.6
Warmian-Masurian	–60.0	166.7	–94.4	–28.6	–90.0	221.1	–83.3	–9.9	22.8	–1.1	24.0
Greater Poland	–55.8	0.0	–68.8	–77.8	–69.6	–77.5	–70.6	–67.5	–34.8	–8.6	–26.2
West Pomeranian	–33.3	100.0	–82.1	–33.3	–41.7	338.1	–78.8	6.6	39.4	–5.6	44.9
Average growth rate in the country								**–32.7**			

Source: own calculation.

Table 2. Shift-share analysis of changes of the number of occupational diseases in Poland in the years 2003–2010 with a division into disease groups and provinces: dynamic method

Provinces	**Growth rates (%)**							**Average rates of changes (%)**	**Effects**		
	Respiratory system	Locomotor and peripheral nervous system	Voice disorders	Skin diseases	Hearing loss	Infectious and parasitic diseases	Others		Global ($\mathbf{C}_r$)	Structural. ($\mathbf{S}_r$)	Geographical ($\mathbf{G}_r$)
Lower Silesian	–0.4	166.1	–110.2	–51.8	–78.4	234.2	–70.2	–7.5	28.6	7.4	21.2
Kuyavian-Pomeranian	–107.1	291.8	1.7	291.8	–65.8	272.1	104.1	12.2	48.3	–19.1	67.4
Lublin	6.7	–26.9	–141.5	136.2	–197.5	24.3	–44.3	–76.8	–40.7	1.9	–42.6
Lubush	23.8	108.3	131.3	–106.3	–61.7	215.9	247.3	–52.2	–16.0	–10.0	–6.0
Łódź	–39.7	–14.7	83.5	–20.9	–5.0	–26.8	–181.3	–83.4	–47.3	2.2	–49.5
Lesser Poland	–62.0	201.6	–53.4	–58.0	61.7	112.9	–19.4	–18.9	17.2	–12.7	29.8
Mazovian	35.9	117.3	–70.4	93.2	63.6	69.3	24.4	3.3	39.5	17.6	21.9
Opolskie	73.3	58.3	–10.4	71.9	56.7	125.3	57.6	–26.9	9.2	0.2	9.0
Subcarpathian	218.9	205.2	48.1	113.3	–101.8	191.6	31.2	7.8	44.0	10.8	33.2
Podlaskie	98.3	744.0	–25.4	116.7	147.6	101.9	–110.2	34.0	70.2	49.3	20.8
Pomeranian	89.8	73.4	–81.5	74.6	164.5	–43.3	–145.2	–29.2	6.9	–0.3	7.2
Silesian	20.9	99.1	–10.5	–77.0	–59.1	14.7	–61.8	–17.8	18.4	1.6	16.8
Świętokrzyskie	83.6	311.9	–33.5	159.9	–65.9	109.0	–2.1	–23.6	12.5	15.9	–3.4
Warmian-Masurian	–45.0	313.0	–190.1	68.6	–93.3	222.7	–21.9	15.4	51.6	28.2	23.4
Greater Poland	–13.4	217.9	–68.3	–82.7	–91.8	–50.3	–31.5	–80.2	–44.1	–34.6	–9.4
West Pomeranian	350.1	124.0	–81.7	55.0	84.5	296.7	–85.6	33.2	69.3	–6.1	75.4
Average growth rate in the country								**–36.1**			

Source: own calculation.

Regional growth rates in particular provinces show that there are areas of higher and lower occupational disease incidence. However, positive growth rates have only been observed in several provinces. Taking the classical analysis model into consideration, the provinces are as follows: Kuyavian-Pomeranian (6.34%), Podlaskie (1.80%) and West Pomeranian (6.62%). The analysis carried out on the basis of the dynamic method shows positive rates in the above-mentioned provinces, but also upward trends in other provinces, including: Mazovian (3.33%), Subcarpathian (7.83%), and Warmian-Masurian (15.44%).

The analysis carried out on the basis of the recursive-dynamic model (where the obtained results are used to capture changes that occur in the analyzed phenomena on a year-over-year basis) proved a negative growth rate in the Greater Poland Province (-80.2%), although the highest drop in disease incidence (-83.4%) was recorded in the Łódź Province (47.28 percentage points above the average national rate). This negative value is the result (as in the case of the classical analysis) mainly of the fact that the province was a part of the analyzed territory (geographical effect -49.49 percentage points). In the case of the positive values, there are considerable differences arising from the application of the dynamic method. Positive growth rates have also been recorded in the Kuyavian-Pomeranian, the Podlaskie and the West Pomeranian Provinces, but the values for these regions were definitely higher (12.17%, 34.05%, and 33.20%, respectively). Positive growth rates have also been recorded in the Mazovian, Subcarpathian and Warmian-Masurian Provinces. The high growth rate recorded in the Podlaskie Province (70.18 percentage points above the average national rate) was mainly due to changes in the disease group structure (49.34 percentage points) and, to a smaller degree, to the internal competitiveness-related changes of the regions (20.84 percentage points). The advantage of the structural effect over the geographical one was also noted in the following provinces: Lublin, Silesian, Warmian-Masurian and Greater Poland.

The results obtained from the dynamic model make it possible to capture changes in the analyzed phenomena throughout the entire period of the analysis (on a year-to-year basis), whereas the static approach only takes into consideration changes in the value of the feature from the beginning and the end of the analyzed period. As the changes that occur in the particular years (e.g. changes due to the seasonal nature of the phenomena) are omitted, the results obtained from the static method are less accurate. Moreover, the classical shift-share method ignores the fact that a region is not a separate geographical area and that the economic development as well as the structure of a particular province is determined by its spatial interactions with adjacent regions. Therefore, the analysis of the inter-regional relations should take into consideration the spatial weight matrix.

The application of the row-standardized **W** spatial weight matrix[6] to the above-mentioned methods resulted in changes in the structural and geographical effect values (the total $\mathbf{C}_r$ effect remains the same in case of both the classical and dynamic model). Changes in the disease group structure in relation to adjacent

[6] Spatial interactions are not subject to changes in time, the W weight matrix is constant.

regions (proximity arising from the application of the weight matrix in the classical analysis) are seen mainly in Lower Silesia, Lublin, Łódź and Pomerania. The highest structural effects for the dynamic analysis based on the spatial weight matrix were obtained once again in the Lower Silesian and Pomeranian Provinces, as well as in the Kuyavian-Pomeranian and Greater Poland Provinces.

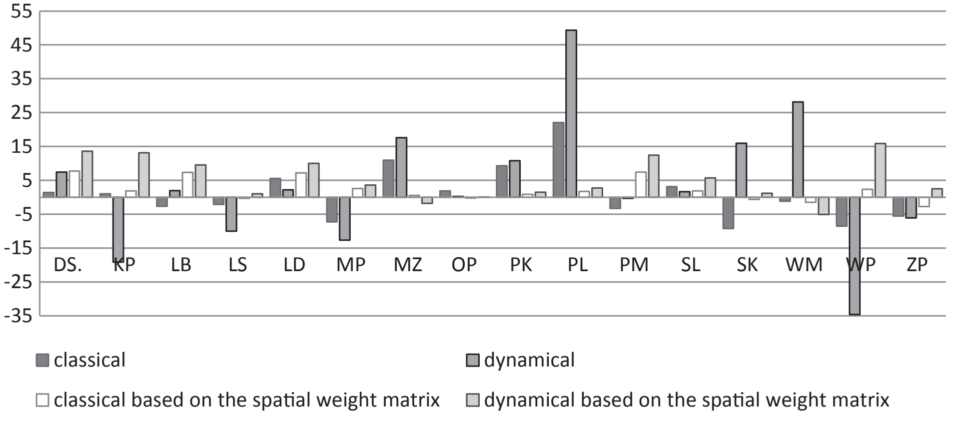

Figure 1. Structural effects: a comparison of the results obtained from all the methods

Legend: **DS** – Lower Silesian Province; **KP** – Kuyavian-Pomeranian Province; **LB** – Lublin Province; **LS** – Lubusz Province; **LD** – Łódź Province; M**P** – Lesser Poland Province; **MZ** – Mazovian Province; **OP** – Opolskie Province; **PK** – Subcarpathian Province; **PL** – Podlaskie Province; **PM** – Pomeranian Province; **SL** – Silesian Province; **SK** – Świętokrzyskie Province; **WM** – Warmian-Masurian Province; **WP** – Greater Poland Province; **ZP** – West Pomeranian Province.

Source: own calculation.

In the case of the geographical effect, its negative value might indicate a negative impact of adjacent territories on the development of a given region in the scope of the analyzed feature. In the case of Lublin and Pomerania (in methods based on the W matrix), the proximity of the regions has a negative impact on the disease incidence in a given province, which implies that the regions are not a competition for the adjacent areas. In the case of the structural effect, the described growth rates (in both methods based on the spatial weight matrix), are much lower than in the dynamic method, and in a majority of cases they have a positive direction (Fig. 1). On the other hand, the geographical effects indicate a considerable diversification in both the direction and the scope of the changes (Fig. 2).

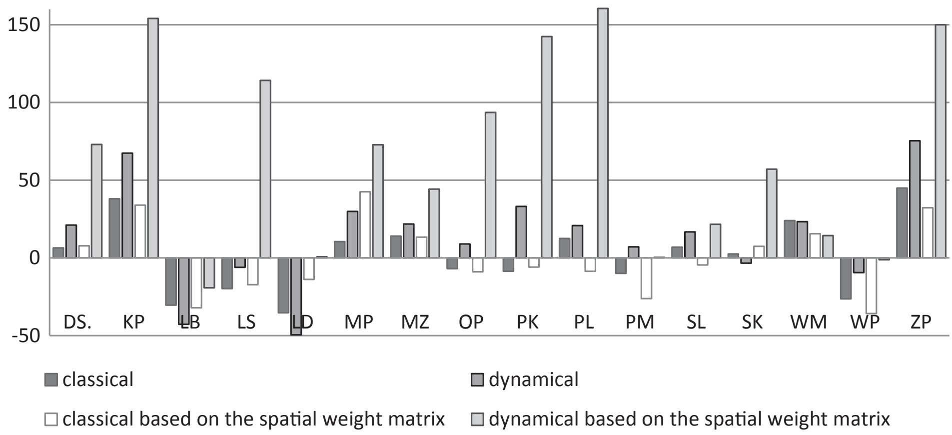

Figure 2. Geographical effects: a comparison of results obtained from all the methods

Source: own calculation.

A correspondence between the obtained results (in the case of competitiveness-related effects of regions) is visible both in the classical static analysis and in the same method based on the spatial weight matrix. Apart from the Podlaskie and the Silesian Provinces, geographical effects have much the same direction and value. In the case of analyses that take into consideration year-to-year changes (dynamic method and dynamic method based on the spatial weight matrix), their direction is the same in 12 provinces, but the value of the geographical effect is considerably higher in the case of the W matrix-based method. This means that taking into consideration spatial interaction, even in the form of the simplest weight matrix, results in significant discrepancies in the assessment of changes in the geographical effect for particular provinces.

5. Summary

The classical shift-share analysis is a simple statistical tool for studying the evolution of economic and socioeconomic magnitude within two periods. It involves three components: regional, structural, and geographical effects, and its usefulness is due to the fact that it makes it possible to analyze dynamic and spatial interactions.

The dynamic approach makes it possible to analyze changes in the number of occupational diseases not only between the first (2003) and the last (2010) year of the analyzed period, but also those that occur on a year-to-year basis. However, the approach considers regions in comparison to the evolution on the national level, without taking into account interrelations between geographical units, even though there are many factors (migrations, trade between regions, technology and knowledge diffusion) that can lead to geographically dependent regions. What is more, the increasing availability of spatial data, together with the development of econometric techniques, makes it worthwhile to incorporate spatial effects in shift-share analysis.

The trajectory of the analysis is also definitely changed by the introduction of the weight matrix to both the classical and dynamical method. The results of the spatial and spatio-temporal approach, which are considerably different compared to the classical method, depend on the individual pattern of a specific region and on the common pattern in the neighbouring regions.

For regional policies that affect neighbouring regions, it would be very important to know what results could produce the introduction of a spatially modified geographical effect (internal changes resulting from the competitive position and being part of the analyzed region) and a structural effect (changes within the incidence structure, with a division into disease groups in particular provinces).

In the end, the researcher should be aware that these measures have certain limitations, mainly due to their deterministic character and to the arbitrariness inherent in the spatial relations (like the form of the weight matrix). Therefore, further research is necessary that would involve both a stochastic formulation and a comprehensive study of the spatial weights matrices.

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