CORRELATION BETWEEN SPATIAL AND POPULATION CHANGES

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Abstract

The main subject of the paper is a proposal presenting the co-existing dynamic phenomena occurring in an urbanised area. The proposed method is based on an analysis of the trend and the intensity of changes concerning geolocation data. The input data were obtained from state statistical registers kept for administrative units (communes). The method was verified for a group of communes, creating a uniform urbanized area (a city and neighbouring communes). The data selected for the analysis include total population (demographic data) and residential floor space per person. The research assumes that the analysis of the dynamics of changes in the residential floor space per person provides the best indicator of changes occurring in the urbanised area. On the other hand, the population supplements information concerning changes in the urbanised area. In practice, a given area might become depopulated, and an increase in residential floor space per person will be observed. The growth of residential floor space per person can be also accompanied by an increase in population. Because of such complex dependencies, indicators have been proposed to visualise the dynamic changes occurring on the map.

Key words: population changes, dynamics of phenomena, comparison of growth rates, residential floor space

JEL Code: J1

Introduction

Poland, like the rest of Europe, represents a variety of form of urban layouts, with changes in the structure of residential areas to be observed depending on the period and demand (Bajwoluk,2008). Currently, all European cities face 21st century challenges in the form of globalization, economic restructuring, social changes and related problems of social

exclusion. Another significant aspect of urban spatial development is the problem of putting pressure on areas incorporated within their boundaries (Rząd, 2005).

An opposite trend in urban development is "going out" beyond the administrative boundaries of cities. A suburban zone, remaining strongly related to the urban centre, therefore becomes an attractive place for investing. At present, regardless of the assumed direction of development, the ease of land acquisition, the possibilities to develop many functions and other economic reasons make investors increasingly willing to locate new projects outside the boundaries of developed urban areas. Additionally, residential development in these areas is becoming increasingly popular because they provide an attractive location which, according to current trends and because of the nearness of nature, is the fulfilment of dreams about one's own house for many people (Stachura, 2012).

Disregarding the direction of urban development, i.e. internal or external, the questions emerge: Is the city growing? What is the growth rate and direction? While looking for an answer, certain paradigms must be assumed. Unquestionably, the growth itself must be strongly correlated to the standard of living in cities. While using the notion of growth, it should be always remembered that it is very strongly related to the quality of life, aspirationsand desires of the inhabitants, their civilization level and the level of satisfying their needs. The first group of growth factors is related to the size of the city area, the second – with its size in the demographic sense and the third group – with broadly understood economic and social development. The analysis of each factor helps to define very interesting phenomena occurring in contemporary cities (Mironowicz, 2010).

The analysis of the demographic growth of cities and urbanised areas in individual historical periods presents well tendencies in economic development, provides a reflection of historical events and long-term trends and helps to better understand both the sense and the background of the development (Chandler 1987).

1 Research area - urbanised space

Anindicator reflecting the level (standard) of living is the usable floor space per person. It has been assumed that the change of this indicator reflects a change in urban development. Only examining the changeability of usable floor space per person might lead to an error, since ifthe population in subsequent years starts to diminish, we will observe that usable floor space per person will start to grow. In such a case, this will not mean an improvement in people's living conditions, but even something quite the opposite – the living conditions have

deteriorated so much that people begin to migrate from cities, leaving free residential space. To avoid erroneous interpretation, the city population and the total residential area are analysed at the same time (Chamon, Prasad, 2010).

While examining demographic phenomena in time, dynamics of changes can be observed. Many researchers examining various geographical phenomena have noted the significance of the analysis concerning the dynamics of changes of individual phenomena as input data for forecasting purposes (Saether, Engen, Matthysen, 2002). The study of the dynamics of changes also helps to answer such questions as "how fast does the time dependent variable change?" and "what is the pace of changes"? Such questions can be answered with the use of indicators (rates) of dynamics.

The research was conducted in an area covering six communes: the city of Olsztyn and the communes located directly along its boundaries. The urbanised area for which the data from statistical yearbooks were obtained includes the administrative area of the town and the areas of the communes directly adjoining the town area.

2. Methods for analysing the dynamics

The statistics definean index (indicator) as a measure characterized in time or space by a dependent variable when time is assumed to be an independent variable. Indices as characteristics of dynamics are commonly applied in research to measure the reality of social and economic life (Golley, Wei, 2015).

A reason for choosing indices (indicators) was their basic feature, i.e. since they are relative and irregular measures, they are comparatively independent of the type of the process and its scale and thus appealing to intuition and imagination (Thompson, Cunningham, 2002).

In the first step of examining the dynamics, we calculate a sequence of chain indices, where the assumed basis in a time series is an expression preceding the examined expression.

$$X_{1/0} = \frac{X_1}{X_0};\ X_{2/1} = \frac{X_2}{X_1}; \ldots\ldots; X_{n/n-1} = \frac{X_n}{X_{n-1}}$$

At a subsequent stage, the dynamics (index change) of examined variables within the time bracket was determined, assuming the initial year of observation as the basis of the time unit (a series of one-base indices). It was assumed that in the initial year of the analyses, i.e. 2009, the examined phenomena (population, residential floor space per person and the total

residential floor space) had the value of one, and the values of the indicator in subsequent years were the product of the abstract number in a given year and the change index.

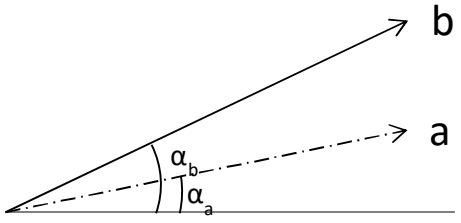
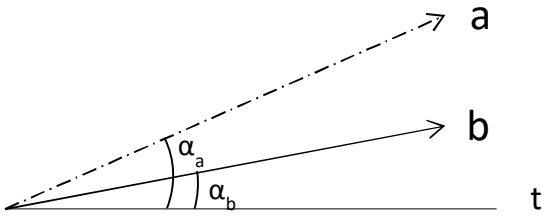
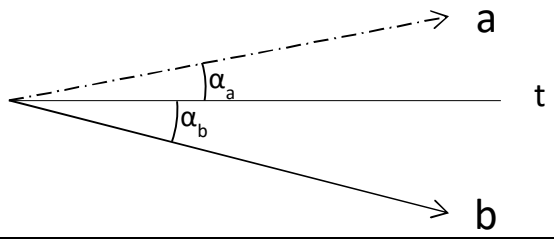
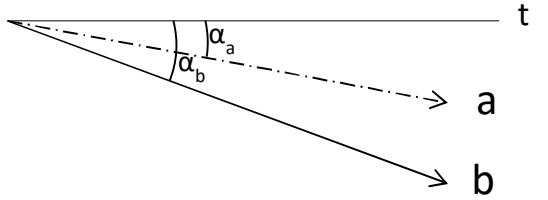
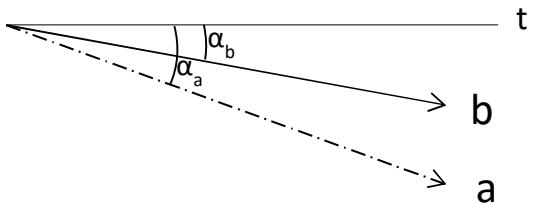
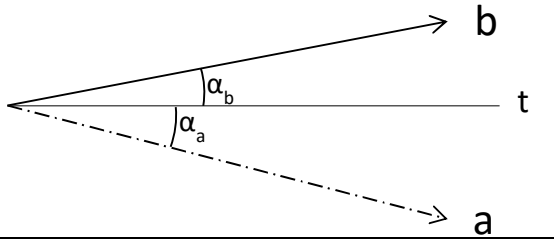
Table 1. Algorithm for describing change dynamics

	Year 1	Year 2	Year 3	…….	Year 11
Observed value	X_1	X_2	X_3		X_{11}
Sequence of chain indices	-	$X_{2/1} = \frac{X_2}{X_1}$	$X_{3/2} = \frac{X_3}{X_2}$	…….	$X_{11/10} = \frac{X_{11}}{X_{10}}$
Change dynamics since the initial time of observation	1	$1 * X_{2/1}$	$1 * X_{2/1} * X_{3/2}$	……	$1 * X_{2/1} * X_{3/2} * \ldots * X_{11/10}$

Source:Own study

With a small number of compared phenomena, the difference in the change dynamics can be interpreted using a line chart. Table 2 presents a proposal for an algebraic method of determining differences in dynamics of various phenomena. Vectors **a** and **b** show thedirection of change of the observed phenomenon, while $\boldsymbol{\alpha_b}$ and $\boldsymbol{\alpha_a}$ are angles between the horizontal line and the direction of change of the given phenomenon. While comparing two dynamics of various phenomena or the same phenomena observed in other areas, the phenomena in relation to which the calculations will be performed should be specified. In the case presented in Table 2, it is vector **a**. A difference between the dynamics of phenomena was specified as ΔY. When ΔY >0 it means that change dynamics of the phenomenon represented by vector **a**arelarger (thevector angle is larger). The situation when ΔY<0 means that the angle of vector $\boldsymbol{\alpha_a}$ inclination representing dynamics is smaller than the angle of $\boldsymbol{\alpha_b}$.

Table2. Difference between dynamics of two phenomena, a and b.

No.	Direction of phenomenon change	Difference in phenomenon dynamics
1		$\alpha_a < \alpha_b$ $\alpha_a - \alpha_b = -\Delta\alpha$ $\alpha_a > 0$ and $\alpha_b > 0$ $\frac{Xa_{n+1}}{Xa_n} - \frac{Xb_{n+1}}{Xb_n} = -\Delta Y$
2		$\alpha_a > \alpha_b$ $\alpha_a - \alpha_b = \Delta\alpha$ $\alpha_a > 0$ and $\alpha_b > 0$ $\frac{Xa_{n+1}}{Xa_n} - \frac{Xb_{n+1}}{Xb_n} = \Delta Y$
3		$\alpha_a > \alpha_b$ $\alpha_a - \alpha_b = \Delta\alpha$ $\alpha_a > 0$ and $\alpha_b < 0$ $\frac{Xa_{n+1}}{Xa_n} - \frac{Xb_{n+1}}{Xb_n} = \Delta Y$
4		$\alpha_a > \alpha_b$ $\alpha_a - \alpha_b = -\Delta\alpha$ $\alpha_a < 0$ and $\alpha_b < 0$ $\frac{Xa_{n+1}}{Xa_n} - \frac{Xb_{n+1}}{Xb_n} = \Delta Y$
5		$\alpha_a < \alpha_b$ $\alpha_a - \alpha_b = -\Delta\alpha$ $\alpha_a < 0$ and $\alpha_b < 0$ $\frac{Xa_{n+1}}{Xa_n} - \frac{Xb_{n+1}}{Xb_n} = -\Delta Y$
6		$\alpha_a > \alpha_b$ $\alpha_a - \alpha_b = \Delta\alpha$ $\alpha_a < 0$ and $\alpha_b > 0$ $\frac{Xa_{n+1}}{Xa_n} - \frac{Xb_{n+1}}{Xb_n} = -\Delta Y$

Source: Own study

2. Practical application of multiple phenomena dynamics analysis

2.1. Analysis of a small number of observed areas

The first stage consisted in comparing the dynamics of changes occurring in five towns (the area within administrative boundaries) as regards: population (Chart 2), residential floor space (Chart 3) and residential floor space per person (Chart 4).

Table 3 An example of calculating the dynamics of a change in residential floor space in Olsztyn

	Year				
	2009	2010	2011	2012	2013
Residential floor space [m^2]	4104666	4123273	4178663	4255205	4325341
Sequence of chain indices	----	1,005	1,013	1,018	1,016
Change dynamics since 2009	1	1,005	1,018	1,037	1,054

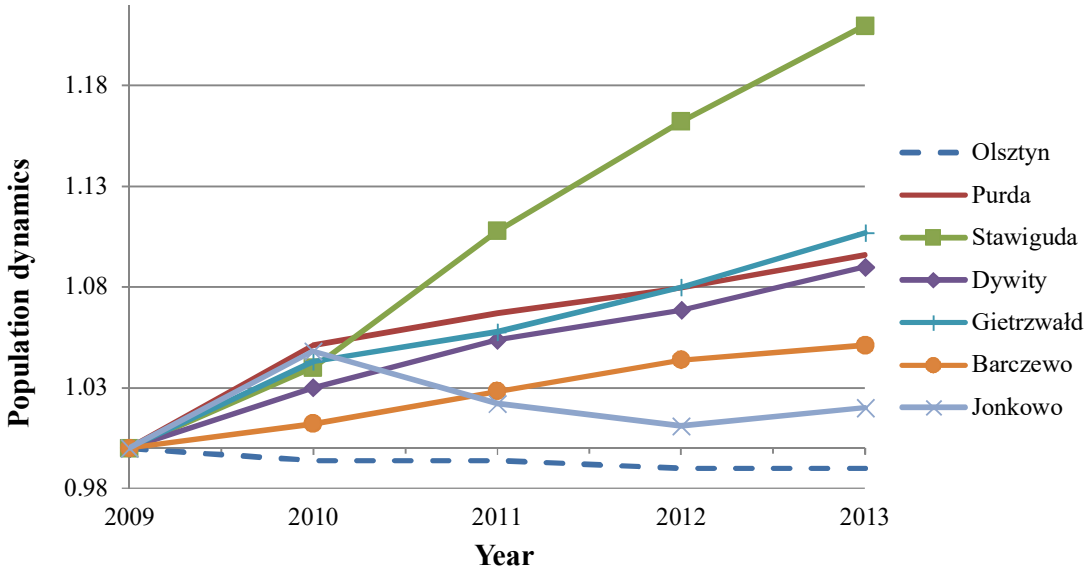
Source: Cezary Kowalczyk

Table 4.An example ofcalculating the dynamics of change in residential area per person in Olsztyn

	Year				
	2009	2010	2011	2012	2013
Residential floor space per person [m^2]	23.26	23.51	23.82	24.37	24.76
Sequence of chain indices	----	1.011	1.013	1.023	1.016
Change dynamics since 2009	1	1.011	1.024	1.048	1.064

Source: Cezary Kowalczyk

Chart 1. Dynamics of a change in population in seven municipalities



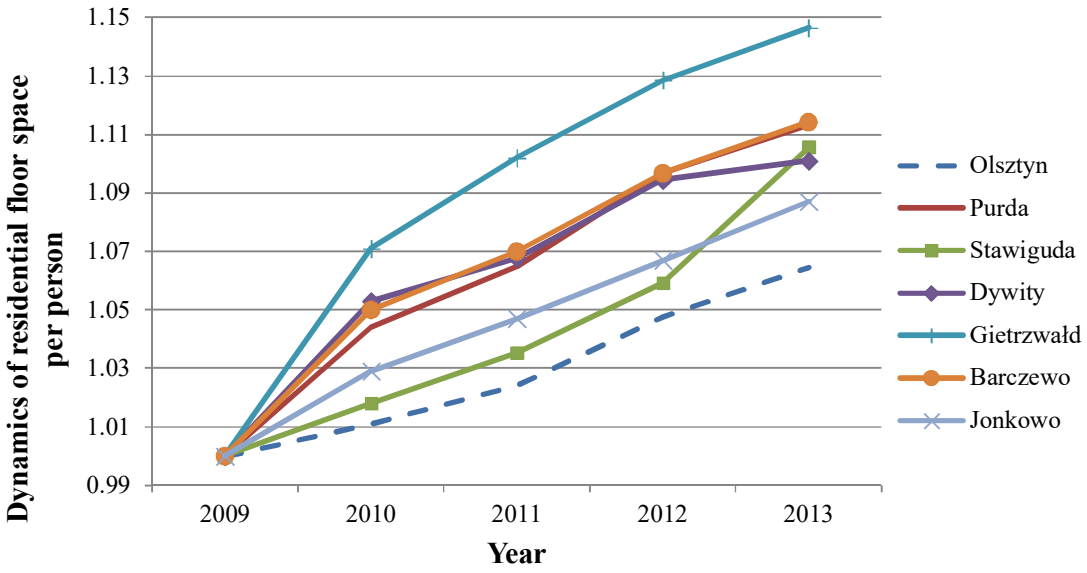
Source: Own study

In the period between 2009 and 2013 under analysis, the most dynamic population growth (about 20%) was observed in Stawiguda Commune.

Changes that were more stable in time were observed in Barczewo. The population in Olsztyn systematically decreased from 2009 to 2013, with a decrease of 1% observed in the period under analysis. Other communes adjoining the city of Olsztyn recorded strong population growth (5% to 11%), but not as high as in Stawiguda.

By applying the same method for representing the dynamics, Chart 2 shows the dynamics of a change in the residential floor space per person.

Chart 2. Dynamics of a change in residential floor space per person in seven municipalities



Source: Own study

The highest growth index for the floor space per person (about 15%) was observed in Gietrzwałd Commune and the lowest was in Olsztyn (about 6%). Other communes recorded an increase at the level of about 10%.

With the dynamics of two phenomena calculated, we can carry out a comparative analysis in order to determine the coexistence of the dynamics of population and of floor space per person. Numerous questions emerge at the current stage of analyses.

Will a decrease in the town population consequently generate a larger floor space per person?

Can a reduction in a town's population be an indicator of town "dying" out?

Will a constant population value a given area correspond with an increase in the residential floor space per person?

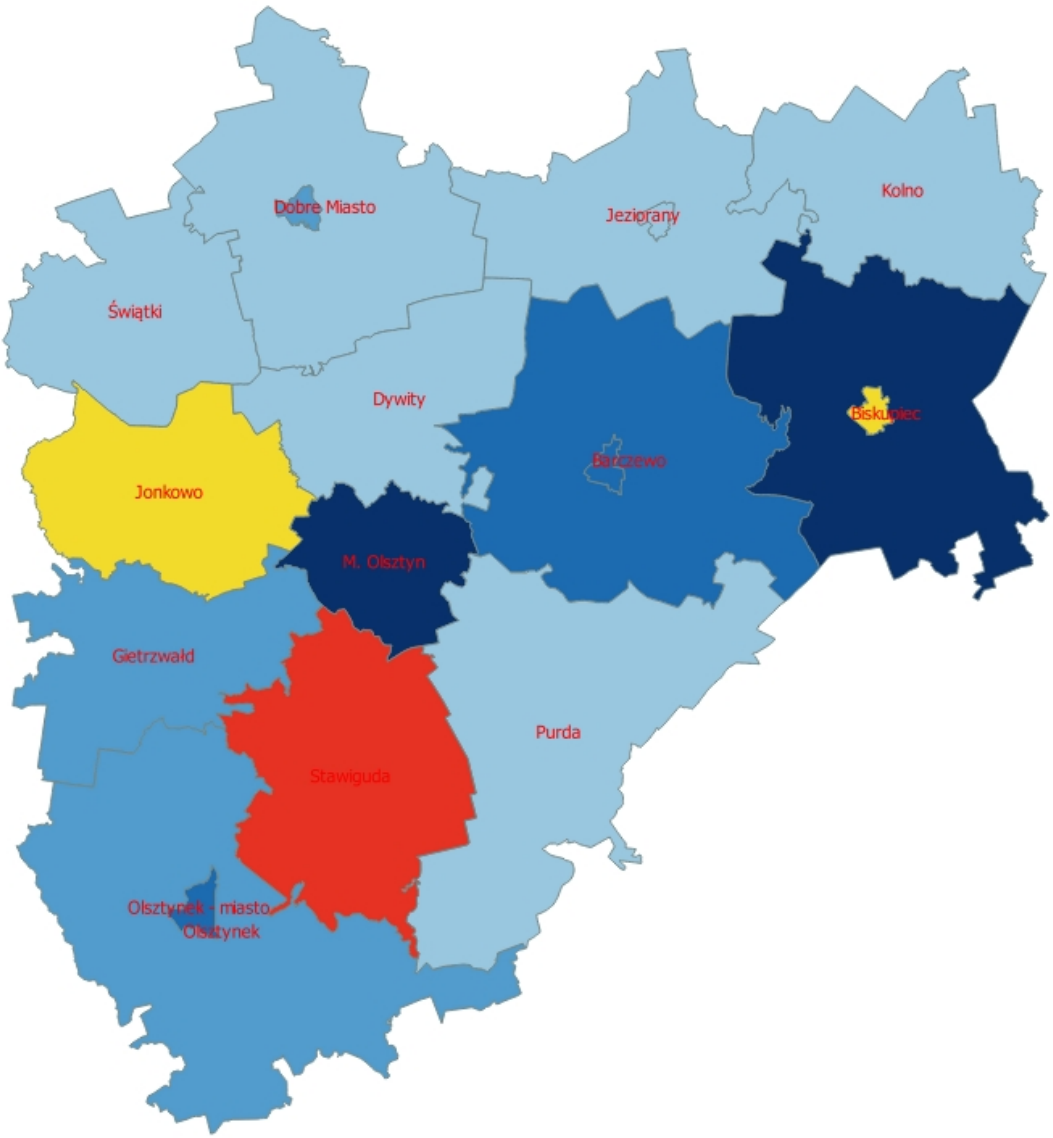
2.2. Difference in dynamics

With a large number of examined areas, whenwe compare the dynamics of many phenomena, graphic analyses are not clearly legible and the lines mapping the dynamics of changes overlap. Thispaper proposes an analytical solution, namely,ananalysis of the differences in the dynamics of individual phenomena **ΔY**. However, it should be remembered that the results of these calculations do not provide an answer to the question of whether the compared

dynamics have a positive or a negative direction and whether their directions are consistent (which results from the examples are presented in Table 2).

The dynamics of residential floor space per person were assumed as base dynamics (against which a difference was calculated).

Figure 1. Communes of the Olsztyn District with determined marked changes in the dynamics of residential floor space per person and population in 2009 - 2013



Source: Own study

The blue colour reflects asituation in which the dynamics of an increase in the residential floor space per person is higher than the dynamics of a change in population. Stawiguda Commune ismarked with red, with the dynamics of a population increase higher by 10% than the dynamics of an increase in the residential floor space per person.

Conclusion

The research proved a decrease in the population in Olsztyn, which constitutes the core of the spatialarrangement.In neighbouring communes in the sameperiod,the population grew from 5% in Barczewo Commune and21% in StawigudaCommune. The observed trend does not indicate depopulation of the city, but a change in the preferences of living conditions. Such changes are related to the development of the urbanisation area, while a city, as an element of the urbanised area, is limited by its administrative borders and cannot provide citizens with areas as attractive as neighbouring communes (thepossibility to buildsingle-family houses in an attractive surrounding of forest and lakes).

Additionally, the performed analysis of dynamics of changes in residential floor space per person indicates an improving standard of living.

An increase in residential floor space per person coexisting with a decrease in population was observed only within the area of the town. In the case of Olsztyn, it cannot be clearly claimed that the standard of living is improving, asmeasured by theavailable residential floor space.

Acomparison of the dynamics of two phenomena showed that only in the case of two communes did the population grow faster than the residential floor area per person (communes of Stawiguda and Jonkowo). Exactly the opposite situation could be observed in the area of the communes of Olsztyn and Barczewo, where a large increase in the residential floor area per person is accompanied by a low increase in population.

Spatial presentation of the differences in the dynamics indicates a diversity in the development directions of the entire urbanised area (a cityand neighbouring communes).

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