

Spatial differences in the level of population and settlement development in Wielkopolskie voivodship (1)

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Abstract. Population and settlement are among aspects determining the level of socio-economic development. This paper analyses spatial differences in the level of development of the population and settlement in Wielkopolskie voivodship in Poland. The period studied embraces the years 2000-2010 and the units examined are those of the local NUTS 4 level, i.e. poviats.

Two modes differing in the reference system were employed for the analysis, which was carried out (a) at the level of the population and settlement development of poviats in Wielkopolskie voivodship against all the poviats in Poland, and (b) again at the level of the population and settlement development of Wielkopolska poviats, but in abstraction from the rest of the country. In each of those reference systems a study was made of (a) the spatial distribution of the development level of Wielkopolskie voivodship in population and settlement terms to identify its growth and stagnation areas by poviat, at the levels of the country and the voivodship, and (b) the development trajectories of those two types of areas over the study period, at the voivodship level. The paper ends in a comparison of the results obtained using the two modes of analysis.

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1. Introduction

Socio-economic development can be studied in a holistic approach and a partial one, i.e. in terms of its selected aspects (Bagdziński, et al., 1995; Chojnicki, 1999). Population and settlement are aspects of the level of socio-economic development.

A human community is a collection of individuals that make up a population distinguished for the purposes of a concrete demographic analysis. A community can be the population of a specified area, e.g. a region, a poviát, a commune. The level of population development is given by the population's size and dynamics, its social and occupational structure, the figures and dynamics of vital statistics and migration, and labour resources (Jędrzejczyk, 2001; Holzer, 2003; Okólski, 2005). Today an important element of a population is also the quality of human and social capital of the inhabitants of an area (Węclawowicz, 2000; Chojnicki, Czyż, 2005; Trutkowski, Mandes, 2005; Janc, 2009).

A settlement system is a set of settlement units that are its elements. Settlement systems occur in two forms: elementary, i.e. towns and villages, and complex, i.e. at the local, regional and national levels (Maik, 1992; Chojnicki, 1999). A well-crystallised settlement system, with towns as basic nodes, plays a significant role in the socio-economic development of the given area. Of special importance are functions of towns and their interrelations. Towns the most important elements of the settlement system integrate various socio-economic activities, determine the location of economic activity, mould the population's housing situation, and crystallise economic links in the form of local and regional goods and service markets as well as labour markets (Chojnicki, Czyż, 2005).

This paper analyses spatial differences in the level of population and settlement development in Wielkopolskie voivodship in Poland. The period studied

embraces the years 2000-2010 and the units examined are those of the local NUTS 4 level, i.e. poviats.

The basic characteristic of poviats encompassing features such as: surface, population number and density is as follows. An average surface of poviát in Poland amounts 825 km², whereas an average number of inhabitants accounts for 102 thousand (2012). With regards to the surface the biggest poviát in Poland is Białostocki poviát (2,976.44 km²), while the smallest is bieruńsko-lędzki (158 km²). Within a group of urban poviats the biggest surface is of Warszawa city (517 km²), and the smallest – of Świętochłowice (13 km²). Among land poviats the biggest number of population inhabits the Poznański poviát (327 110) and is exceeding 15-times the lowliest populated Sejneński poviát (20,934). However, the greatest differentiation of population numbers is observed across urban poviats. The biggest number of population is settled in capital city of Warszawa (1,720,398), while the lowest in 45-times smaller town of Sopot (38,141). Poviats display considerable variations of population density. Most densely populated among land poviats is Pruszkowski poviát (615 persons/km²), and the lowest is the density in Bieszczadzki poviát (20 persons/km²). In the group of urban poviats the biggest density characterises the smallest city of Świętochłowice (4,154 persons/km²), and the smallest in Świnoujście (207 persons/km²).

Two modes differing in the reference system were employed for the analysis, which was carried out (a) at the level of the population and settlement development of poviats in Wielkopolskie voivodship against all the poviats in Poland, and (b) again at the level of the population and settlement development of Wielkopolska poviats, but in abstraction from the rest of the country. In each of those reference systems a study was made of: (a) the spatial distribution of the development level of Wielkopolskie voivodship in population-settlement terms to

identify its growth and stagnation areas by powiat, at the levels of the country and the voivodship, and (b) the development trajectories of those two types of areas over the study period, at the voivodship level. The paper ends in a comparison of the results obtained using the two modes of analysis.

The basic study area was Wielkopolskie voivodship, which embraces 35 poviats, including four municipal poviats, i.e. powiat-ranking towns: Poznań, Kalisz, Konin and Leszno, and 31 non-municipal poviats.

2. Study methods

To analyse differences in the level of population-settlement development in Wielkopolskie voivodship by powiat (NUTS 4 units), use was made of the index method and mathematical-statistical methods.

2.1. The index method

Indices of socio-economic phenomena are necessary to make a correct assessment of processes taking place in the social and economic spheres. In the methodological sense, an index is a feature, occurrence or phenomenon on the basis of which we conclude with certainty, or with a specified degree of probability, that the phenomenon of interest to us is actually present (Nowak, 1970). The basic classification of indices employed in this study looks as follows:

- structural indices, which present the ratio of the number of units with the given value of a variable to the size of the sample. Structural indices are expressed in per cent (%), e.g. the percentage (proportion) of the urban population;
- intensity indices, which present the number of cases of the phenomenon examined in relation to the total number of units in the statistical population from which the phenomenon derives, e.g. the number of towns per 100 km²; and
- growth indices, which define the relation between figures characterising some quantity (phenomenon) in two periods or moments of time and are expressed in per cent, e.g. total population growth in % against a reference year.

The initial set of indices containing all the full, publicly available statistical data concerning the population and settlement aspect at the local (powiat) level embraced 19 variables. In the process of reduction, 7 of them were removed by eliminating those that described this aspect the poorest. This left 12 for further analysis. Next, correlations among those indices were examined (statistical reduction), which resulted in the elimination of another 2 indices. The remaining 10 population and settlement indices were adopted for further research at the powiat level (Table 1).

It should be emphasised that most of the indices are stimulants of the level of population-settlement development that show a positive correlation with its level in poviats. Only in the case of the dependency rate, x_7 , is this relation negative, and the index is treated as a destimulant of development.

Table 1. List of population-settlement indices employed

Aspect	Index
Population	x_1 – total population dynamics against reference year (%)
	x_2 – population density in persons/km ²
	x_3 – natural change in ‰
	x_4 – net migration in ‰
	x_5 – total population change in ‰
	x_6 – birth-to-death ratio (number of births to number of deaths)
	x_7 – dependency rate (persons of non-working age per 100 persons of working age)
	x_8 – population of pre-working age (%)
Settlement	x_9 – urbanisation level: proportion of urban population (%)
	x_{10} – urbanisation level: number of towns per 100 km ²

Source: Own tabulation on the basis of the Central Statistical Office (GUS)

2.2. Mathematical-statistical methods

To obtain a linear arrangement of poviats in terms of their population-settlement development, use was made of Perkal's synthetic index in the following form (Runge, 2007: 214):

$$W_s = \frac{\sum_{j=1}^p z_{ij}}{p}$$

where:

W_s : synthetic index

j : number of a variable, 1, 2,...,p,

p : total number of variables considered,

z_{ij} : standardised value of the j -th variable for the i -th object.

To use the synthetic index, it was necessary to start with standardising the values of indices describing the intensities of individual variables in poviats. For variables of a stimulant nature, standardisation was performed on the basis of the formula:

$$Z_{ij} = \frac{x_{ij} - \bar{x}}{S_j}$$

where:

z_{ij} : standardised value of the j -th variable for the i -th object,

x_{ij} : value of the j -th variable for the i -th object,

\bar{x} : arithmetic mean of the values of the j -th variable,

S_j : standard deviation of the values of the j -th variable.

For the destimulant type of variables, standardisation followed the formula:

$$Z_{ij} = \frac{\bar{x} - x_{ij}}{S_j}$$

The classification method employed was k-means clustering in which the units poviats were interpreted as one-dimensional objects characterised by synthetic W_s indices. On the basis of their values three clusters of units were identified which were then analysed to determine which of them were growth and stagnation areas in terms of population-settlement development, and which were in a state of transition. The idea of

such classification underlies an assumption that values of W_s indices properly characterise the level of population and settlement development – the greater the value of W_s , the better the unit is developed.

3. Differences in poviats of Wielkopolska voivodship in terms of population and settlement development

3.1. Analysis with reference to the national level

The research procedure referring to the national level embraced all poviats in Poland and allowed putting them into three classes in terms of population and settlement: of growth, transition and stagnation. The classification showed transition areas to form the largest class over the entire study period (Table 2). Their share of the total number of poviats was fairly stable and ranged from 46.4% (176 units) in 2001 to 52.5% (199 units) in 2003 (Table 3). Next came the class of stagnation areas. Its proportion in the total number of poviats varied between 29.3% (111 units) in 2009 and 26.4% (100 units) in 2000. The class of growth areas was the smallest, embracing from 24.8% of poviats in 2001 (94 units) to 20.6% (78 units) in 2003. Over the entire study period there were slight fluctuations involving an increase or a decrease in the number of poviats in each of the classes that did not produce any major changes in their shares.

The spatial distribution of growth and stagnation areas in terms of population and settlement by poviat showed great stability over the study period (Fig. 1). There was a large concentration of growth areas in Pomorskie, Małopolskie, Wielkopolskie and Mazowieckie voivodships (where those poviats clustered primarily in agglomeration areas). Poviats at a low level of population-settlement development concentrated largely in the voivodships: Łódzkie, Świętokrzyskie and Lubelskie, and to a lesser extent, Opolskie. The analysis of the distribution of stagnating poviats additionally revealed a pattern coinciding with relict boundaries (political boundaries from the years 1815-1919), still readily visible in the country's socio-economic space, also in

population-settlement terms (2). Areas with the highest concentrations of poviats representing the transition class could be found in north-western and southern Poland, mainly in Zachodniopomorskie, Lubuskie and Dolnośląskie voivodships, as well as in Wielkopolskie, Kujawsko-Pomorskie and Warmińsko-Mazurskie voivodships, and in Podkarpackie voivodship. Smaller groups of transition ar-

reas occurred in Opolskie, Śląskie and Małopolskie voivodships. When analysing the distributions obtained, one can find that growth areas mostly coincided with poviat-ranking towns, i.e. municipal poviats, and with non-municipal poviats adjacent to them, which is well illustrated by the examples of the Warsaw, Cracow, Tri-City, Poznań or Toruń-Bydgoszcz agglomerations.

Table 2. Number of population-settlement growth, transition and stagnation areas in Poland over the years 2000-2010

Class of areas	Number of poviats										
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Growth	86	94	79	78	81	85	85	83	89	86	81
Transition	193	176	191	199	197	189	186	188	181	182	190
Stagnation	100	109	109	102	101	105	108	108	109	111	108

Source: Own tabulation

Table 3. Structure of poviats by classes of population-settlement growth, transition and stagnation areas in Poland over the years 2000-2010

Class of areas	Share of class in total number of poviats in %										
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Growth	22.7	24.8	20.8	20.6	21.4	22.4	22.4	21.9	23.5	22.7	21.4
Transition	50.9	46.4	50.4	52.5	52.0	49.9	49.1	49.6	47.8	48.0	50.1
Stagnation	26.4	28.8	28.8	26.9	26.6	27.7	28.5	28.5	28.8	29.3	28.5

Source: Own tabulation

In Wielkopolskie voivodship, as in the country, the largest class of poviats over the entire study period was that of transition areas. Its size varied from 29 units in 2002 to 22 in 2005 and 2008 (Table 4). The second largest class (unlike in the country) was that of growth areas, from 4 units in 2002 to 13 in 2008. The smallest class was that of stagnation areas, which included from 3 units in 2000 to 0 (none) in the years 2008-2010. The region showed an upward tendency in the number of poviats making up the class of growth areas, a relative stabilisation of the class of transition areas, and a drop to zero of the class of stagnation areas. As Figure 1

shows, in 2000 the class of stagnation areas included three non-municipal poviats of Kalisz, Koło and Środa, in 2005 its member was Koło poviat, and in 2010 there were no such poviats. In 2000 growth areas included three municipal poviats of Kalisz, Konin and Leszno, and two non-municipal ones: Poznań and Śrem. In 2005 they were joined by six poviats: Leszno, Nowy Tomyśl, Wągrowiec, Oborniki, Rawicz, and the city of Poznań. In 2010 the class of growth areas included 11 poviats: Gniezno, Września, Grodzisk, Leszno, Nowy Tomyśl, Rawicz, Poznań, Szamotuły and Śrem, and the town of Leszno.

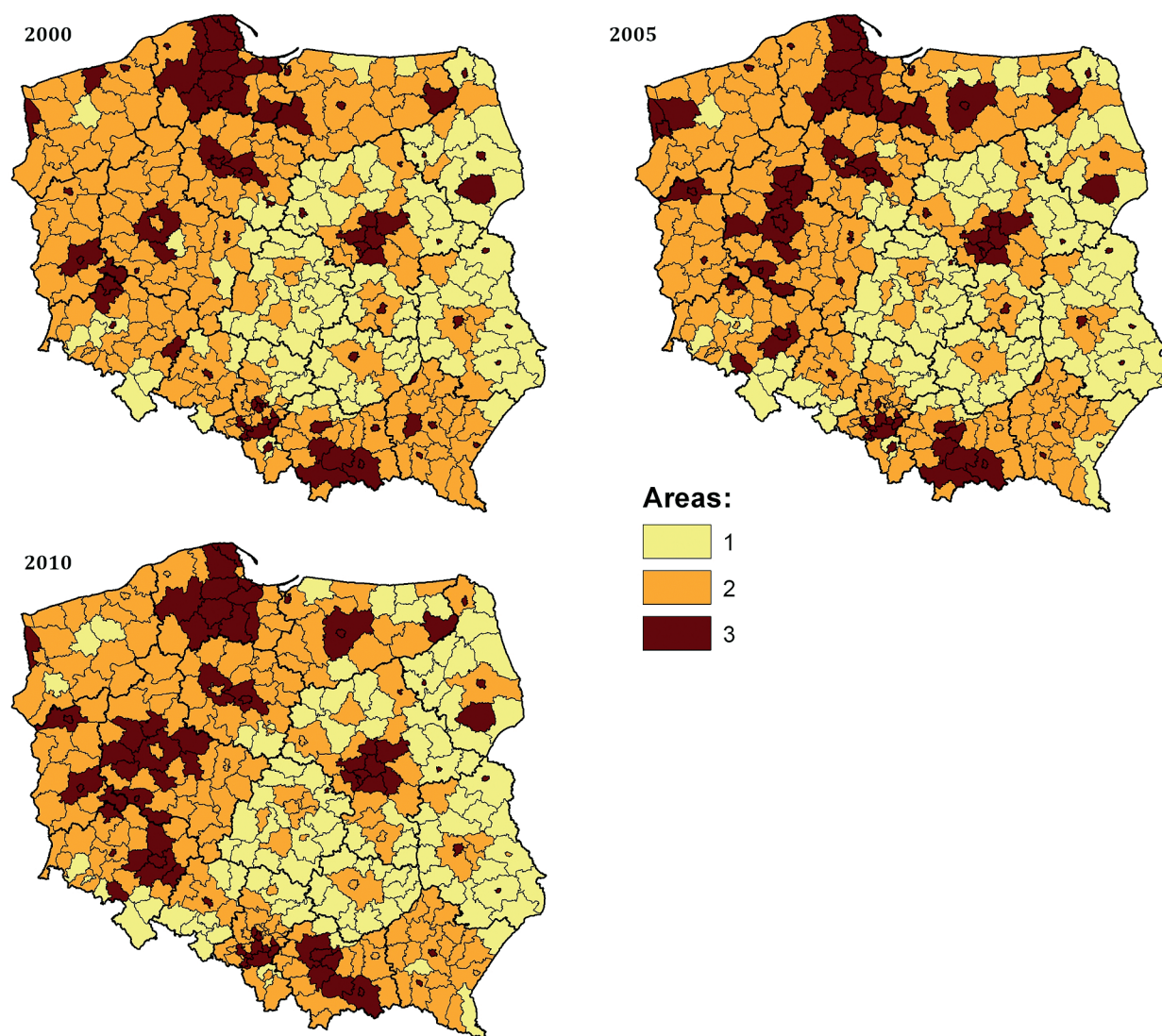


Fig. 1. Spatial distribution of growth, transition and stagnation areas in population-settlement terms in Poland by poviats in the years 2000, 2005 and 2010

Explanation: 1 stagnation areas; 2 transition areas; 3 growth areas

Source: Own compilation

Table 4. Number of population-settlement growth, transition and stagnation areas in Wielkopolskie voivodship over the years 2000-2010: the national level

Class of areas	Number of poviats										
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Growth	5	9	4	6	6	12	9	11	13	10	11
Transition	27	24	29	28	27	22	25	23	22	25	24
Stagnation	3	2	2	1	2	1	1	1	0	0	0

Source: Own tabulation

In the Poznań agglomeration, readily visible is an interesting process of rapid development of poviats neighbouring on the core city accompanied by advancing de-urbanisation of the city. As a result, the city itself the municipal Poznań powiat was classified as a transition area (being a growth area only in 2005 and 2006). The city registered a marked regression in the total population (a 4% drop in the years 2000–2010) brought about by a net out-migration and the resultant negative population change. In comparable period of analysis in Poznański powiat, directly surrounding the city of Poznań, the number of inhabitants grew by 23%. The area is undergoing a process of suburbanisation connected with concentration of population, housing and economic potential what is typical for suburban zone of greater city (Liszewski, 1987; Śleszyński, 2006; Parysek, 2008; Jakóbczyk-Gryszkiewicz, 2011). In the case of the Poznań agglomeration, there was a clearly marked (since 2005) expansion of areas at a high level of population-settlement development towards the north-east and west. This can be explained by a beneficial effect of the agglomeration on the surrounding non-municipal poviats: Oborniki and Wągrowiec to the north of Poznań, Gniezno and Września to the east, and Nowy Tomysł and Grodzisk to the west. Those poviats registered a distinct population increase since 2005, as shown by their relatively high values of population dynamics against the reference year 2000 (on average, 102). Presumably, those areas were attractive for the immigrant population to settle in because of the nearness and relatively good accessibility of the Poznań agglomeration (e.g. Oborniki powiat is crossed by the national road no. 11, Gniezno powiat, the national road no. 5, and Nowy Tomysł powiat, the A2 motorway).

3.2. Analysis with reference to the level of Wielkopolskie voivodship

At the level of Wielkopolskie voivodship, the research procedure embraced all the poviats of the voivodship and led, as in the case of the national level, to dividing them into three classes in terms of population and settlement: of growth, transition and stagnation. Here too, as in the country as a whole, the largest class over the entire study period was

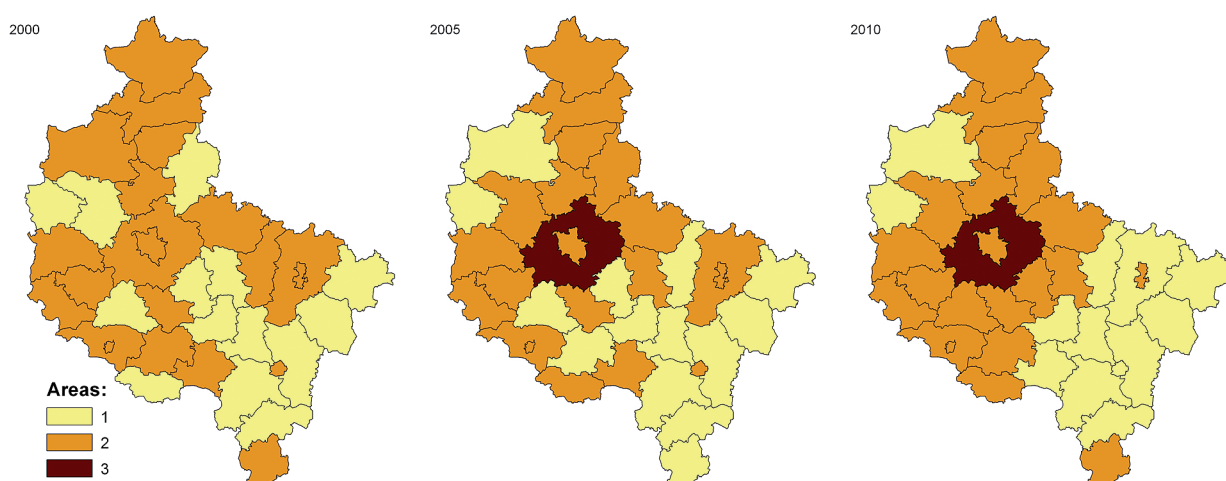
that of transition areas. However, it was slightly smaller and numerically more stable than at the national level, and varied from 21 units in the years 2000, 2007 and 2010 to 17 units in 2001 (Table 5). Next came the class of stagnation areas (unlike at the national level cf. Tables 4 and 5), gathering from 16 units in the years 2001, 2002 and 2008 to 13 in 2007 and 2010. The smallest and numerically most stable was the class of growth areas, in marked contrast to the much larger and steadily growing class of such areas separated at the national level. In 2000 there was no powiat belonging this class, in 2001 it comprised 2 units (Poznań powiat and the town of Leszno), and in the years 2002–2010, only one, viz. Poznań powiat. There were slight fluctuations over the study period in the number of poviats belonging to the transition and stagnation classes which, however, did not lead to any major changes in their size. In 2000, as Figure 2 demonstrates, 14 poviats qualified as stagnation areas: Jarocin, Kalisz, Koło, Kościan, Międzychód, Ostrów, Ostrzeszów, Pleszew, Rawicz, Szamotuły, Środa, Turek, Wągrowiec, and Września. In 2005 the number stayed the same, at 14, but four poviats: Rawicz, Szamotuły, Wągrowiec and Września, had advanced to the class of transition areas, while four other had taken their place: Czarńków-Trzcianka, Gostyń, Kępno and Słupca. In 2010 the class of stagnation areas had 13 units. In comparison with the 2005 state, it had been left by Gostyń, Kępno, Kościan and Środa, and entered by Konin, Krotoszyn and the town of Kalisz.

The spatial distribution of the transition and stagnation areas distinguished in Wielkopolskie voivodship tended to change between 2000 and 2010 (Fig. 2). The concentration of transition areas increased around Poznań, in the direct vicinity of the non-municipal Poznań powiat and in the south-western part of the voivodship. This was due to the advancement of several poviats to the class of transition areas: Wągrowiec situated north of Poznań, Szamotuły to the west, Września to the east, and Kościan, Środa and Rawicz to the south. At the same time, four poviats in the eastern and south-eastern parts of the voivodship lost their positions in the group of transition areas: Konin, Słupca, Krotoszyn and the town of Kalisz, as well as Czarńków-Trzcianka powiat north-west of Poznań.

Table 5. Number of population-settlement growth, transition and stagnation areas in Wielkopolskie voivodship over the years 2000-2010: the voivodship level

Class of areas	Number of poviats										
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Growth	0	2	1	1	1	1	1	1	1	1	1
Transition	21	17	18	20	19	20	19	21	18	19	21
Stagnation	14	16	16	14	15	14	15	13	16	15	13

Source: Own tabulation

**Fig. 2.** Spatial distribution of growth, transition and stagnation areas in population-settlement terms in Wielkopolskie voivodship by poviats in the years 2000, 2005 and 2010: the voivodship level

Explanation: 1 stagnation areas; 2 transition areas; 3 growth areas

Source: Own compilation

As a result of the above changes, the only poviats in the south-eastern part of the voivodship that belonged to the class of transition areas in terms of population-settlement development in 2010 were Kępno and the town of Konin (Fig. 2). The class of stagnation areas, apart from the south-eastern units, only embraced Międzychód and Czarńków-Trzcianka poviats. The only unit classed as a growth area was Poznań poviats with its best values of six population indices: population dynamics, natural change, net migration, total population change, birth-to-death ratio, and dependency rate (Table 6). This poviats also showed the highest population density among non-municipal poviats. It looked a bit worse

in terms of its proportion of inhabitants of pre-working age (7th place in the voivodship) and number of towns per 100 km² (10th place), and the worst in terms of the proportion of the urban population (24th place). The lowest level of population-settlement development in Wielkopolskie voivodship was demonstrated by Koło poviats in its eastern part (Table 6). This poviats, occupying the last position in the class of stagnation areas in 2010, had average figures only in terms of population density (18th place in the voivodship) and number of towns per 100 km² (16th place). By all the other indices, it took very distant places (from 26th to 35th).

Table 6. Values of selected indices in 2010

Index	Mean for Wielkopolska poviats	Non-municipal Poznań powiat	Non-municipal Koło powiat
x_1 total population dynamics against reference year (%)	102.08	125.68	97.79
x_3 natural change in ‰	2.99	6.34	1.25
x_4 net migration in ‰	-0.002	17.87	-2.33
x_5 total population change in ‰	2.98	24.21	-1.09
x_6 birth-to-death ratio	1.34	1.90	1.12
x_7 dependency rate	54.70	50.90	57.80

Source: Own tabulation

3.3. Development trajectories of growth and stagnation areas at the level of Wielkopolskie voivodship

The analysis of the development trajectories of growth and stagnation areas at the level of Wielkopolskie voivodship and the calculated ranges of the synthetic W_s index allow tracing tendencies of change in the differences in population-settlement development by powiat over the years 2000-2010. The highest values of the synthetic W_s index were recorded in non-municipal Poznań powiat (Table 7, Fig. 3): in 2000 it was 1.06, with the extreme of 2.16 in 2010. The unit with the lowest W_s figures (except in 2007) was Koło powiat: in the entire period they were negative and varied from -0.98 in 2003 to -0.71 in 2000. A comparison of poviats assuming extreme

values of the synthetic index shows that the range in 2000 was 1.77 and by 2010 it increased to 2.96 (Table 7). This increase over the decade indicates ever widening differences in the population-settlement development level of Wielkopolska poviats, i.e. a tendency towards its divergence. It should be noted, however, that this situation is a result of the highly dynamic population-settlement development of Poznań powiat. On its exclusion from analysis, the calculated range dividing municipal Leszno powiat occupying second place in terms of its W_s values over the entire period from the powiat with the lowest values varied from 1.77 in 2000 to 1.43 in 2010 (Table 7, Fig. 3). The narrowing of the range indicates a narrowing of differences in the level of population-settlement development, which justifies the claim that in the case of the remaining poviats one can observe a tendency towards a convergence.

Table 7. Comparison of the values of the synthetic W_s index for selected Wielkopolska poviats in the years 2000-2010

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
A	1.06	1.60	1.52	1.62	1.86	1.87	1.93	1.97	2.00	2.15	2.16
B	-0.71	-0.90	-0.83	-0.98	-0.80	-0.84	-0.91	-0.81	-0.75	-0.75	-0.80
C	1.77	2.50	2.35	2.59	2.66	2.71	2.84	2.78	2.75	2.90	2.96
D	1.06	1.14	1.03	0.95	0.95	0.84	0.76	0.65	0.68	0.83	0.63
E	1.77	2.03	1.87	1.92	1.75	1.68	1.68	1.46	1.43	1.58	1.43

Explanation: A Poznań powiat; B powiat with lowest W_s value in given year; C range between A and B; D municipal Leszno powiat; E range between D and B

Source: Own tabulation

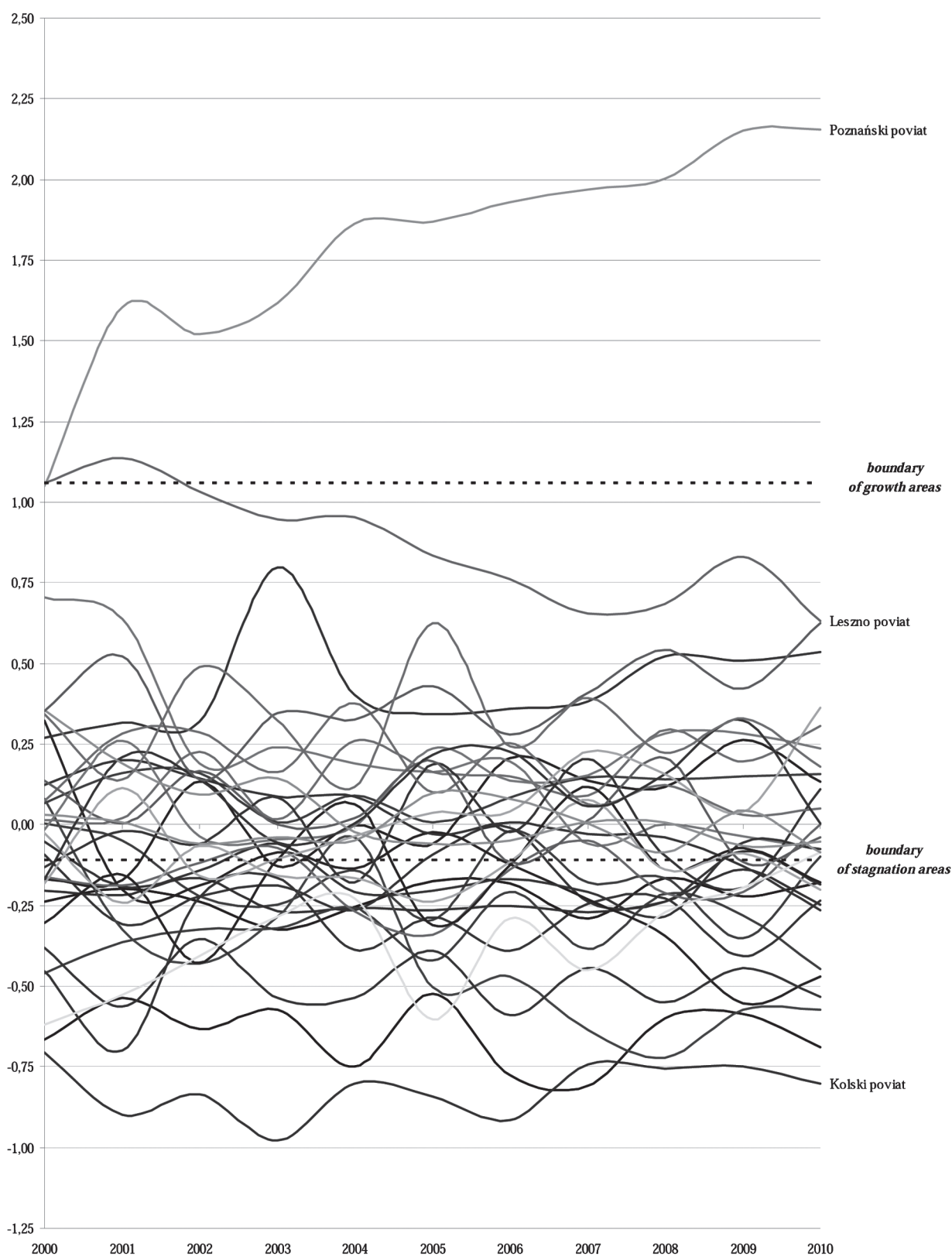


Fig. 3. Development trajectories of growth and stagnation areas in Wielkopolskie voivodship by powiat over the years 2000–2010

Source: Own compilation

4. Conclusions

The conducted analysis of spatial differences in the level of population-settlement development of Wielkopolskie voivodship by powiat leads to the following conclusions:

(A) Readily visible over the entire study period are differences in the sizes of the individual classes: of growth, stagnation and transition areas. At both levels of analysis, the largest class was that of transition areas, but at the voivodship level its size was more stable. At this level the second in terms of size was the class of stagnation areas, unlike at the national level where it was an empty set between 2008 and 2010. The smallest and most stable at the voivodship level was the class of growth areas (basically this was only Poznań powiat), while at the national level this class was more sizeable and showed an upward tendency.

(B) At both levels of analysis, there were changes in the spatial distribution of growth, stagnation and transition areas over the study period. Poviats located around Poznań city in the direct neighbourhood of non-municipal Poznań powiat showed development. This led to an increase in the concentration of growth areas when analysed at the national level, and of transition areas when analysed at the voivodship level. Visible at the national level was the process of de-urbanisation of the core city of Poznań, which in consequence had to be classed as a transition area. The only unit included in growth areas in 2010 at both levels of analysis was Poznań powiat.

(C) The analysis of the development trajectories of growth and stagnation areas at the Wielkopolskie voivodship level and the calculated ranges of the synthetic W_s figures indicate ever widening differences (a divergence) among Wielkopolska poviats in their level of population-settlement development. It should be stressed, however, that this is a result of the dynamic development of Poznań powiat. In the remaining units one can observe a tendency for the differences to narrow (a convergence).

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- (2) A range of relict boundaries (former political boundaries) is still visibly marked. A period of over 100 years, when the territory of Poland had been divided into three political powers (Russia, Prussia and Austria), influenced the various evolution patterns of towns and villages. Each power exercised a different financial and investment policy, while creating different conditions for socio-economic growth, including the settlement and population aspects. The various effects of these ancient policies are still to be seen in the socio-economic space of Poland.

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Notes

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