Grażyna Karmowska
West Pomeranian University of Technology
e-mail: grazyna.karmowska@zut.edu.pl
ORCID: 0000-0002-2264-3176

Andrzej Sobczyk
West Pomeranian University of Technology
e-mail: andrzej.sobczyk@zut.edu.pl
ORCID: 0000-0002-3235-4407

THE INFLUENCE OF DEMOGRAPHIC CHANGES ON THE DEVELOPMENT POTENTIAL OF COMMUNES OF THE WEST-POMERANIAN PROVINCE

WPŁYW ZMIAN DEMOGRAFICZNYCH NA POTENCJAŁ ROZWOJOWY GMIN WOJEWÓDZTWA ZACHODNIOPOMORSKIEGO

Summary: Development potential depends primarily on the area's demographic situation, its capacity to attract new residents and the local community's reproductive capacity. From the perspective of social and economic development, the demographic potential of local communities is an important element of the region's development opportunities. This paper makes an attempt to evaluate the demographic situation of the communes of the West- -Pomeranian province and their potential for development. To achieve that goal, a synthetic variable was used and Webb's method was employed to create a typology of communes of similar demographic potential. The research conducted confirmed the variance in development potential between communes. Municipalities with a better demographic potential use 'positional pension' at the larger urban centers. The result is a 'suction' of the population, which affects the growth of budget revenues from real estate tax and the share of income tax from individuals.

Keywords: local development, development potential of communes, Webb's classification, synthetic variable.

Streszczenie: Potencjał rozwojowy zależy przede wszystkim od sytuacji demograficznej ob- szaru, od zdolności „przyciągania" nowych mieszkańców oraz od zdolności odtworzeniowej lokalnej społeczności. Z punktu widzenia rozwoju gospodarczego i społecznego potencjał

demograficzny tkwiący w społecznościach lokalnych jest ważnym elementem szans rozwojowych danego regionu. W opracowaniu podjęto próbę oceny sytuacji demograficznej gmin województwa zachodniopomorskiego oraz ich potencjału rozwoju. W tym celu wykorzystano zmienną syntetyczną oraz podział gmin na grupy typologiczne o podobnym potencjale demograficznym (z wykorzystaniem metodologii Webba). Przeprowadzone badania potwierdziły zróżnicowanie potencjału rozwojowego gmin. Gminy o lepszym potencjale demograficznym wykorzystują „rentę położeniową" przy większych ośrodkach miejskich, czego efektem jest „zasysanie" ludności, co wpływa na wzrost wpływów do budżetów z tytułu podatku od nieruchomości oraz udziału w podatku dochodowym od osób fizycznych.

Słowa kluczowe: rozwój lokalny, potencjał rozwojowy gmin, klasyfikacja Webba, zmienna syntetyczna.

1. Introduction

Demographic potential is a significant determinant of regional growth. It is most commonly defined as the 'driving force' inherent in human resources, that is primarily in the population size and its age structure.[1] An area's population is affected by three processes: the ageing of workforce, the birth rate decline and migration processes. Demographic changes have and will continue to influence decision processes in a particular region and its socio-economic condition.[2]

There is a close relationship between population processes and the level of socio-economic development. Reliable information about the size of the local population and its spatial distribution is a prerequisite for an adequate and effective development policy. The actual size of population in a given area, along with its qualitative features such as, in particular, age structure, is a fundamental variable that conditions the demand for certain public services. From the perspective of socio-economic development, the demographic potential of local communities is an important component of the region's development opportunities. Areas that show relatively advantageous sex and age structure and positive population dynamics are in the best situation [Szymańska, Michalak 2011; Sobczyk 2014]. If local government units are to successfully develop plans for strategic growth they need not only be familiar with basic demographic processes and structures, but also be able to astutely foresee the coming changes [Holzer 2003].

In light of the above, the aim of the paper is to evaluate the demographic situation of West-Pomeranian communes based on a typological classification grouping communes into classes of similar demographic potential. The paper also aims to verify the thesis that communes adjacent to large cities enjoy the highest development potential.

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[1] Wpływ potencjału demograficznego i gospodarczego miast wojewódzkich na kondycję województw. Mazowiecki Ośrodek Badań Regionalnych 2013.

[2] *Wpływ zmian demograficznych w Polsce na rozwój lokalny*. Projekt NCN, manager P. Śleszyński, 2015.

2. Demographic situation in West-Pomeranian province

As of 31 December 2017, the West-Pomeranian province had a population of 1,705,533 people. In comparison to 1995 (the Local Data Bank of the Central Statistical Office collects data from that year on) the population declined by 15,249. Figure 1 shows the changes in the total number of inhabitants over the period 1995--2017. A sharp decline in the population size in 1998-1999 could have been the result of the political transformation in Poland, whereas the increase in 2008-2009 may be attributed to the global economic crisis and return-from-work migration.
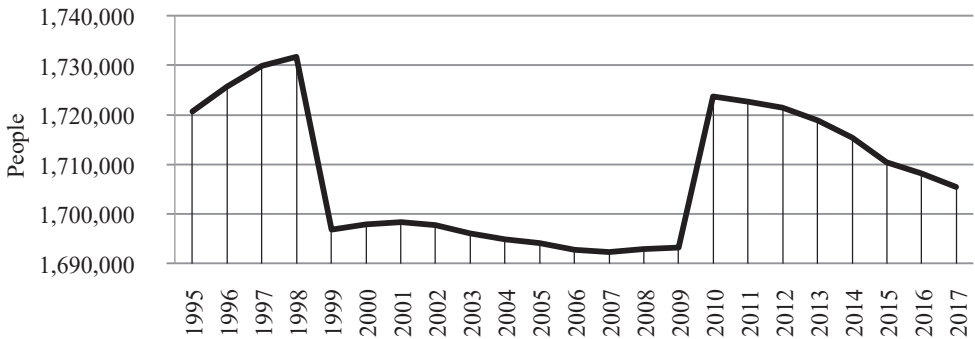
Fig. 1. Total number of inhabitants of West-Pomeranian in the period 1995-2017

Source: own study based on data from the Central Statistical Office.

$y = 10{,}100x + 209{,}603$
$R^2 = 0.9664$

$y = -4{,}576x + 351{,}638$
$R^2 = 0.9465$
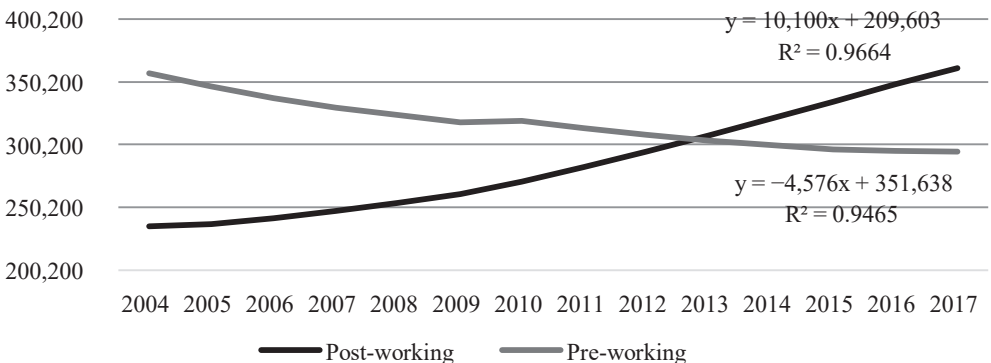
Post-working   Pre-working

Fig. 2. Pre-working and post-working age population in West-Pomeranian in the period 2004-2017

Source: own study based on data from the Central Statistical Office.

Regarding socio-economic development and the efficiency of public services, it is essential to track the changes in population size in the so-called functional age groups – pre-working, working and post-working age groups. One can observe a continuous decline in the pre-working-age population and a simultaneous increase

in the post-working-age population in the research period (a phenomenon that was identified long before 2004) (Figure 2).

In the period 2004-2017 the differences in absolute values were, respectively: in the pre-working age group – minus 62,110 people, working age – minus 53,066, and post-working age – increased by 125,884 people. These changes were systematic as shown by the trend lines. In the post-working age group, an average annual increase of approximately 10 thousand people was observed, whereas in the pre-working age group there was an average annual drop of approximately 4.6 thousand people.

The above values mean that the three important processes affecting the size and structure of the population can be observed all across West-Pomeranian (and in other provinces of Poland) i.e. workforce ageing, birth rate decline and negative migration balance. Population ageing, that is the difference between extreme age groups, is a direct result of the components of the natural trend – mainly the dynamics of child birth and mortality rates (especially infants) and the migration balance.

Insofar as the birth and mortality rates can be foreseen based on long-term trends, migration trends are tricky to predict since people relocation is a more complex and impetuous process, and therefore, often unpredictable [Długosz, Kurek, Kwiatek--Sołtys 2011].

Figure 3 illustrating migration balance in the West-Pomeranian province certainly confirms that.
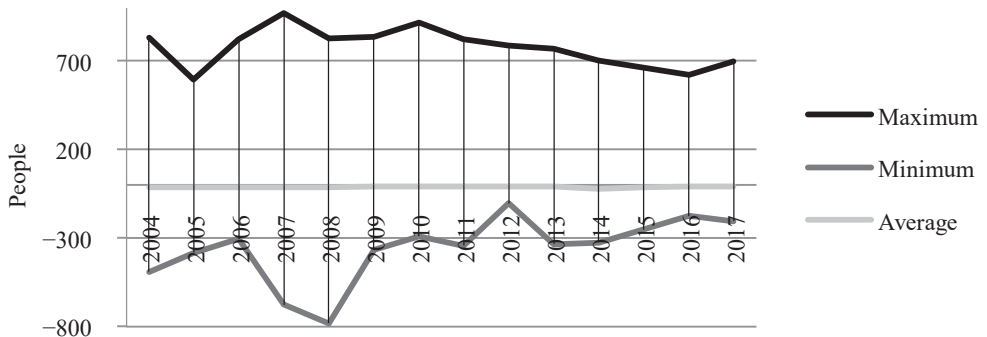

Fig. 3. Migration balance in West-Pomeranian in 2004-2017

Source: own study based on data from the Central Statistical Office.

3. Characteristics of selected indicators

The development potential of a region depends on many factors of which the most important are its demographic situation, state budget funds and revenue of local government units. Since the major part of a commune's revenue comes from taxes,

and is thus dependent on the local population, this was reflected in the selection of variables for 2004-2017 regarding West-Pomeranian communes.

The research period was determined by the duration of Poland's membership in the EU which significantly affected the country's demographics, West-Pomeranian in particular, due to its geographical location.

The indices used to determine the demographic potential include birth rate, migration balance, total dependency ratio, ageing index and demographic old age ratio. These indicators not only affect the size of population in a given area, but also shape its age structure which in turn conditions the pace of demographic changes and affects future birth and mortality trends.

When assessing demographic potential, it is important to consider the total dependency ratio i.e. the proportion between the number of "dependents" (people of non-working age) per 100 working age people, an indicator which reflects the burden carried by working age people and is determined with the use of the economic dependency indicator (EDI). A relatively high dependency ratio means that the population is ageing and the working age group is burdened by a large number of people who are not economically active (e.g. paying the pensions of post--working age people through pension contributions paid by people of working age).

Selected demographic indices for 114 West-Pomeranian communes for the period 2004-2017 were analyzed. The indicators are measured per 1,000 inhabitants (W1 – W6), the demographic indicators are expressed in percentage terms:

W1 – corporate income tax per 1,000 inhabitant,

W2 – personal income tax per 1,000 inhabitants,

W3 – property tax per 1,000 inhabitants,

W4 – tax on civil law transactions per 1,000 inhabitants,

W5 – birth rate per 1,000 inhabitants,

W6 – migration balance per 1,000 inhabitants,

W7 – total dependency ratio (TDR) (ratio of dependent people, i.e. not of working age to working age people),

W8 – ageing index (AI) (ratio of post-working age people to pre-working age people),

W9 – demographic old age ratio (ratio of post-working age people to total population).

Figures 4 to 7 present the trends of the mean values for selected variables over the 2004-2017 period. These trends are statistically significant and are empirically derived.

Revenue arising from tax on civil law transactions (W4) increased unevenly over the period 2004-2017, the rise in revenue being particularly sharp in 2006-2008 and 2016-2017.

Revenue from corporate income tax (W1) clearly showed a linear trend with an average annual increase of 666 PLN per 1,000 inhabitants.
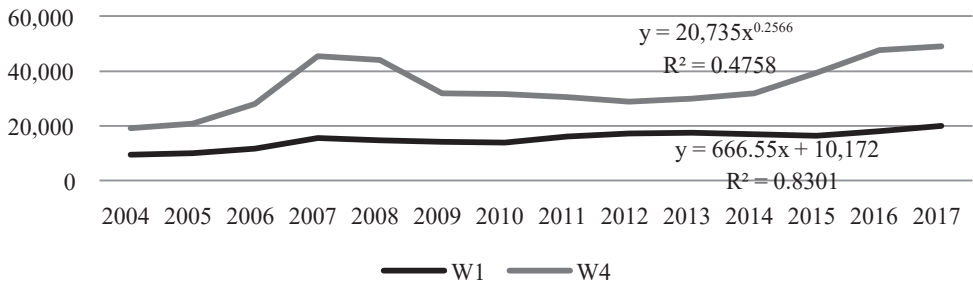
$y = 20,735x^{0.2566}$
$R^2 = 0.4758$

$y = 666.55x + 10,172$
$R^2 = 0.8301$

W1   W4

Fig. 4. Mean values of corporate and personal income tax per one thousand inhabitants of West-Pomeranian in the period 2004-2017

Source: own study based on data from the Central Statistical Office.
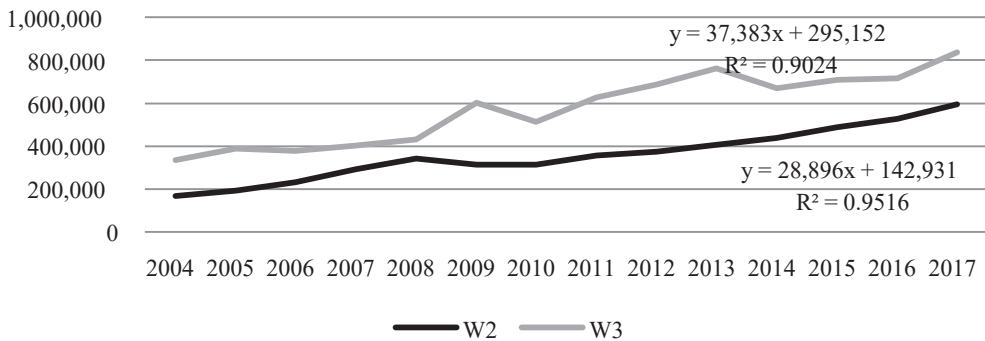

$y = 37,383x + 295,152$
$R^2 = 0.9024$

$y = 28,896x + 142,931$
$R^2 = 0.9516$

W2   W3

Fig. 5. Mean values of personal income tax and property tax per 1,000 inhabitants of West-Pomeranian in the period 2004-2017

Source: own study based on data from the Central Statistical Office.

$y = -0.0168x^2 + 0.0383x + 1.5598$
$R^2 = 0.8437$

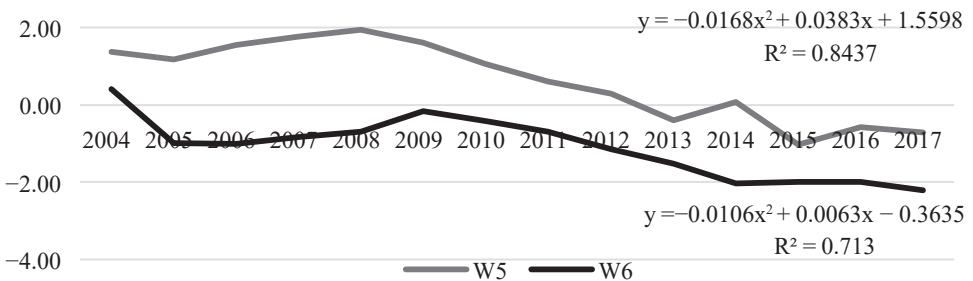$y = -0.0106x^2 + 0.0063x - 0.3635$
$R^2 = 0.713$

W5   W6

Fig. 6. Mean values of birth rate and migration balance per 1,000 inhabitants of West-Pomeranian in the period 2004-2017

Source: own study based on data from the Central Statistical Office.

Revenue from personal income tax PIT (W2) also showed a linear trend with an average annual increase of approximately 28,000 PLN per 1,000 inhabitants. Revenue from property tax (W3) grew more dynamically with an annual average of approximately 37,000 PLN per 1,000 inhabitants.

Birth rate (W5) and migration balance (W6) showed distinct declining trends described by quadratic trends.

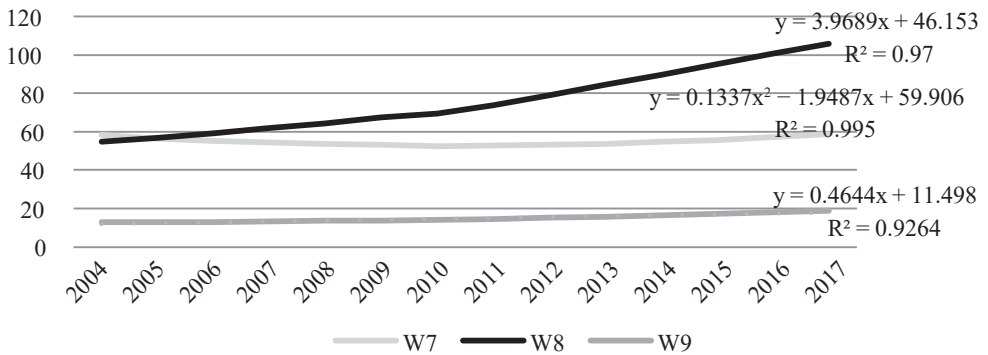Demographic indicators were analyzed in the following step.

$y = 3.9689x + 46.153$
$R^2 = 0.97$

$y = 0.1337x^2 - 1.9487x + 59.906$
$R^2 = 0.995$

$y = 0.4644x + 11.498$
$R^2 = 0.9264$

Fig. 7. Mean values of demographic indicators in West-Pomeranian communes in the period 2004-2017

Source: own study based on data from the Central Statistical Office.

Table 1. Statistics for research variables in 2004 and 2017

Statistics	2004								
	W1	W2	W3	W4	W5	W6	W7	W8	W9
Maximum	143,810	503,977	2,005,793	234,299	6.4	74.4	69.1	98.1	16.6
Minimum	−379	66,311	84,220	−82,399	−2.6	−16.6	44.3	29.9	7.8
Mean	9,985	166,352	333,316	19,069	1.4	0.4	58.2	54.7	12.9
Deviation	15,732	87,969	315,171	32,209	2.0	10.7	5.2	10.3	1.5
Variability	158%	53%	95%	169%	147%	2556%	9%	19%	12%
Range	144,189	437,666	1,921,574	316 698	8.9	91.0	24.8	68.2	8.8
Asymmetry	5.77	1.76	3.32	3.71	0.10	3.79	1.14	−0.48	5.77
Fluctuation amplitude	379.4	7.6	23.8	2.8	2.5	4.5	1.6	3.3	2.1
	2017								
Maximum	134,637	1,850,008	3,807,161	322,584	7.8	31.1	69.8	174	25.1
Minimum	−434	322,996	179,835	14,295	−8.0	−13.5	50.7	51	11.4
Mean	20,054	594,396	836,662	49,088	−0.7	−2.2	58.8	106	18.9
Deviation	22,663	254,448	658,928	53,966	2.5	6.4	3.9	23	2.5
Variability	113%	43%	79%	110%	352%	290%	7%	22%	13%
Range	135,071	1,527,012	3,627,326	308,289	15.9	44.6	19.1	123	13.7
Asymmetry	2.38	1.90	2.18	3.27	0.29	1.78	0.49	0.71	0.24
Fluctuation amplitude	310.2	5.7	21.2	22.6	1.0	2.3	1.4	3.4	2.2

Source: own study based on data from the Central Statistical Office.

Throughout the study period, the total dependency ratio (W7) remained on roughly the same level and in 2017 demonstrated the same value as in 2004. The other two indicators showed linear trends. The ageing index (W8) demonstrated an average annual growth of approximately 4%, and the demographic old-age ratio (W9) grew by approximately 0.5%.

Since the aim of the paper was to assess the potential of West-Pomeranian communes in 2004 and 2017, the basic statistics for the variables analyzed are presented in Table 1.

From among the research variables only one indicator, i.e. the total dependency ratio (W7), did not meet the criterion of variability above 10%. Therefore, it was excluded from further research.

Migration balance (W6) showed particularly high variability: in 2004 it was 2556% and dropped to 290% in 2017. In 2004 average migration balance was positive (0.4 people per 1000 inhabitants), whereas in 2017 it was negative (−2.2 people per 1000 inhabitants).

4. Research method

A range of different measures of regional development can be used to assess the potential of a region. Essentially, two types of measures can be distinguished [Koźmiński, Wysocka 2000]:

1. Basic measures – measure absolute values of various socio-economic phenomena and processes (e.g. population size, the total number of companies, the total number of unemployed persons).

2. Relative measures – expressed as the quotient of a selected value divided by another selected value (e.g. demographic indicators, unemployment rate).

Selected regional development indicators should meet the three following criteria:

1. they capture the basic facts and aspects of regional development,
2. they are not excessively numerous,
3. they are interconnected, that is they form a certain system. The system should take into account the overarching role of the human factor as it is the people living in a region that create its growth, and ultimately, it is the people who are the target of all developmental activities.

Demographic and social indicators do not suffice to illustrate the complex issue of development, and other measures of economic potential, technical infrastructure and specific supplementary indicators should be used [Szymla 2000].

Webb's method was used to assess population changes, and in order to construct the Commune Potential Index (CPI), multidimensional comparative analysis was applied. The typology of total population growth was conducted with the use of Webb's method which is based on the Cartesian coordinate system. This allows to determine the level of population growth in communes taking into account the

interdependence between positive/negative population growth (BR) and positive/ negative migration balance (MB).

Depending on the intensity and shape of both features, eight main classes for the classification of spatial units can be distinguished [Runge 2007]:

A – positive birth rate outweighs negative migration balance (+BR > −MB);

B – positive birth rate is higher than positive migration balance (+BR > +MB);

C – positive migration balance is higher than positive birth rate (+BR < +MB);

D – positive migration balance dominates over negative birth rate (−BR < +MB);

E – negative birth rate is not offset by positive migration balance (−BR > +MB);

F – negative migration balance paired with even larger negative birth rate (−BR > −MB);

G – negative birth rate paired with even larger negative migration balance (−BR > −MB);

H – negative migration balance dominates over positive birth rate (+BR > −MB).

The methods of multidimensional comparative analysis are helpful in the study of complex phenomena since they allow to:

- create rankings of objects according to the complexity of the phenomenon thanks to the application of a synthetic measure;
- analyze the variance between objects and form clusters of typologically similar objects.

Quasi-fixed diagnostic variables with a variability index lower than 10% were eliminated. In addition, the indicator of the variable's relative fluctuation amplitude was used (quotient of maximum and minimum values) [Kukuła 2000], which shows (for stimulants) how many times the feature value of the best object is higher than the worst object.

The comparability of diagnostics variables was achieved through standardization. A synthetic measure was computed with the use of the zero unitarization method (ZUM) which adopts a fixed point of reference, namely the distribution of the variable subject to normalization.

The taxonomic development measure adopted values in the range [0, 1]. The closer to the benchmark the feature values of a given commune, the higher its level of development, and vice versa, the bigger the distance – the lower the development.

Depending on how the variables affect the research phenomenon, they were standardized with the use of the following formula:

stimulants:

$$z_{ij} = \frac{x_{ij} - \min_i x_{ij}}{\max_i x_{ij} - \min_i x_{ij}}; \quad \max_i x_{ij} \neq \min_i x_{ij},$$

destimulants:

$$z_{ij} = \frac{\max_i x_{ij} - x_{ij}}{\max_i x_{ij} - \min_i x_{ij}}; \quad \max_i x_{ij} \neq \min_i x_{ij}.$$

For stimulants (S) – high value of the variable means better performance, that is the higher development of the feature. For destimulants (D) – low values of the variable indicate better performance.

The obtained variables z_{ij} adopt values in the range [0, 1], but 1 is assigned to the object of the most favourable variable value and 0 to the least favourable.

The synthetic variables obtained were used to create a *Commune Potential Index* (*CPI*):

$$CPI = q_i = \frac{1}{s}\sum_{j=1}^{s} z_{ij}; \quad \overline{q} = \frac{1}{r}\sum_{i=1}^{r} q_i; \quad S(q) = \left[\frac{1}{r}\sum (q_i - \overline{q})^2\right]^{0.5}$$

and to group objects according to ranges determined by the arithmetic mean of $\overline{q}$ variable and standard deviation $S(q)$.

The classification of regions reflects the assessment of the objects' potential (Table 2).

Table 2. Grouping of regions by communes' potential (CPI)

Class	Range	Region's potential
1	$q_i \geq \overline{q} + S(q)$	high
2	$q_i \in \langle \overline{q}, \overline{q} + S(q) \rangle$	above average
3	$q_i \in \langle \overline{q} - S(q), \overline{q} \rangle$	below average
4	$q_i < \overline{q} - S(q)$	low

Source: own study based on [Kukuła 2000].

The Commune Potential Index was used to create development rankings which allow to compare developmental changes that occurred in West-Pomeranian communes over time. The measure was constructed with the use of quantitative data obtained from the Local Data Bank of the Central Statistical Office.

5. Results of analyses

Throughout the study period of 14 years, the average development potential of communes underwent many changes and in 2017 it was around 18% higher than in 2004. Its variability oscillated around 30%. The positive asymmetry indices point to the presence of right-skewed asymmetry which means that the CPI was above average in most communes (Figure 8).

In 2004, high development potential was demonstrated by 14 communes, including ten rural and four urban-rural communes. In 2017 two more rural communes joined this group, and one urban-rural commune left it. In both research years not even a single municipality fell into that group.
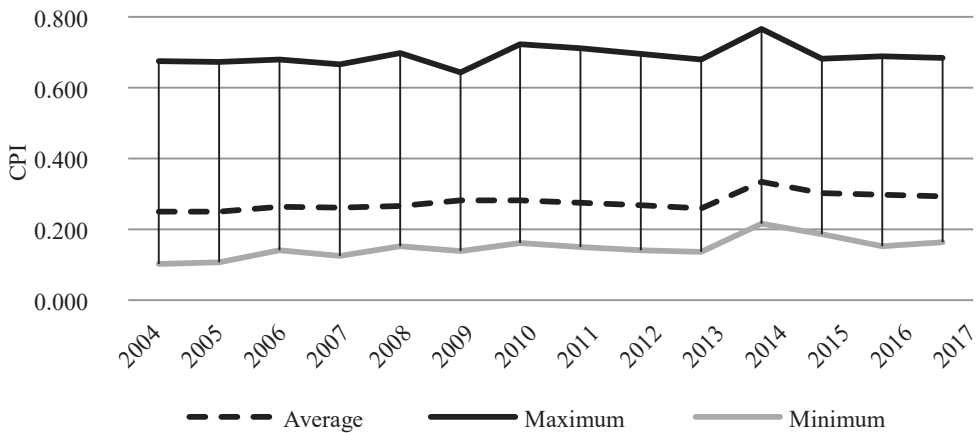
Fig. 8. Statistics for CPI in the period 2004-2017

Source: own study.

In 2004, ten communes demonstrated low development potential, and in 2017 that number grew by two more communes (Table 3).

Table 3. Classes and types of West-Pomeranian communes in 2004 and 2017

Class potential	Types of communes in 2004			Total
	municipal	rural	urban-rural	
1. high	0	10	4	14
2. above average	1	14	14	29
3. below average	8	24	29	61
4. low	2	1	7	10
Total	11	49	54	114
Class potential	Types of communes in 2017			Total
	municipal	rural	urban-rural	
1. high	0	12	3	15
2. above average	1	14	13	28
3. below average	7	21	31	59
4. low	2	3	7	12
Total	10	50	54	114

Source: own study.

In 2017 the first class grouping communes with the highest potential included 15 communes from the total of 114 communes, whereas in 2004 the number was 14, ten of which were rural and four urban-rural. In 2017 the number of rural communes grew by two, but the number urban-rural communes decreased by one.

Table 4. Classification of West-Pomeranian communes according to Webb's typology
and the Commune Potential Index

		Classes – *Commune Potential Index*			
		1	2	3	4
Classes – Webb's typology	A	Police	Gryfino, Sławno, Stara Dąbrowa, Wałcz	Osina, Brojce	
	B	Ustronie Morskie	Maszewo, Siemyśl, Manowo	Bielice	
	C	Goleniów, Rewal, Gościno, Kołobrzeg, Biesiekierz, Świeszyno, Dobra (Szczecińska), Kołbaskowo, Darłowo, Kobylanka, Stargard	Dygowo, Będzino, Sianów		
	D	Mielno	Stepnica	Boleszkowice, Borne Sulinowo	
	E	Świnoujście		Międzyzdroje	
	F		Dziwnów	Drawno, Krzęcin, Drawsko Pomorskie, Przybiernów, Trzebiatów, Moryń, Golczewo, Wolin, Kołobrzeg, Suchań, Szczecinek, Wałcz, Tuczno, Dobra, Łobez, Resko, Węgorzyno, Koszalin	Bierzwnik, Trzcińsko-Zdrój, Myślibórz, Lipiany, Darłowo, Sławno, Ińsko, Połczyn-Zdrój, Rąbino
	G		Szczecin	Białogard (municipal), Nowe Warpno, Sławoborze	Kamień Pomorski
	H	Postomino	Białogard, Karlino, Czaplinek, Kalisz Pomorski, Wierzchowo, Cedynia, Stare Czarnowo, Dębno, Malechowo, Nowogródek Pomorski, Chociwel, Marianowo, Szczecinek, Mirosławiec	Tychowo, Choszczno, Pełczyce, Recz, Ostrowice, Złocieniec, Stargard, Nowogard, Gryfice, Karnice, Płoty, Widuchowa, Kozielice, Przelewice, Pyrzyce, Warnice, Świerzno, Rymań, Bobolice, Polanów, Barlinek, Banie, Chojna, Mieszkowice, Dolice, Barwice, Biały Bór, Świdwin (municipal), Brzeżno, Świdwin, Człopa, Radowo Małe	Dobrzany, Grzmiąca

Source: own study based on data from the Central Statistical Office.

Population size is affected by two fundamental factors: birth rate and migration. To assess a region's demographic situation it is advisable to collate the birth rate with migration balance according to Webb's typology. It distinguishes eight classes: four progressive (A, B, C, D) and four regressive classes (E, F, G, H). The most favourable situation occurs in spatial units classified as types B and C in which case both components – birth rate and migration – are positive. Spatial units classified as types F and G – population drop and migration outflow – demonstrate the least favourable indicators.

A juxtaposition of the two typologies reveals that the largest number of communes was categorized in class H with the below average value of the Commune Potential Index (Table 4).

A comparison of the 2004 and 2017 rankings demonstrates that only six communes did not change their classification, 53 recorded a drop, and 55 showed an increase. The largest decline – by 83 positions – was observed for Nowe Warpno commune (from 19 to 102 position in the ranking). The most considerable shift upwards – by 66 positions – was recorded for Suchań commune (from 113 to 47 in the ranking).

In total, 26 communes were classified in the progressive classes that pair positive birth rate with positive migration balance (A-D) and a CPI above average; they mostly they fall into class C.

The commune of Mielno (class D) has a negative birth rate, yet counteracts it with a higher positive migration (it is located at the seaside near Koszalin, which is an attractive investment spot). The commune of Ustronie Morskie (class B) demonstrates the highest positive outcome (a positive birth rate higher than a positive migration balance). Finally, the commune of Police (class A) shows a positive birth rate but a negative migration balance.

The case of the commune of Postomino is most interesting. In 2017 it ranked 11th in the CPI ranking although it is classified in class H with a negative migration balance which is not offset by a positive birth rate. The question is therefore: what is the reason behind such a high position in the ranking? The reasons are to be found in the sources of income (real estate taxes or income tax receipts).

Finally, the ranking ends with communes classified mainly in class F and H. The exception here are the communes of Wałcz – 99 position (class A) and Darłowo – 103 position (class C). The two communes that come across as the weakest in both classifications are Dobrzany and Grzmiąca (class H and 4), with respectively 107 and 108 position in the ranking.

6. Conclusions

The demographic potential of the West-Pomeranian voivodeship has been gradually decreasing since 1995. There was a negative balance throughout the entire period. The natural increase was positive, but it systematically decreased, and it has been

negative since 2011. The year of 2012 was the last year in which the number of people of pre-productive age was greater than the number of people of the post--working age. This confirms the assumption that the region is depopulating and ageing.

The analysis shows that the demographic situation in individual municipalities in West-Pomeranian is varied, but most of them characterized by adverse changes in quantitative population.

Communes classified as types B and C (a positive birth rate and a positive migration balance) with their CPI above average are in the best situation. This was true for 18 communes in West-Pomeranian, and in most cases they were adjacent to large cities.

The least favourable situation was observed in 33 communes classified as types F and G (a birth rate decline and a migration outflow) with a CPI below average. The most surprising discovery is that this group includes seven municipalities: Szczecin, Kamień Pomorski, Kołobrzeg, Koszalin, Wałcz, Białogard and Szczecinek.

Municipalities with better demographic potential use 'positional pension' at the larger urban centers. The result is a 'suction' of the population, which affects the growth of budget revenues from real estate tax and the share of income tax from individuals. The increase in population in these communities for the most part this is due to the increase in internal migration.

The hypothesis that communes which are contiguous to large cities have the highest development potential was confirmed only in part.

In the context of analyzing the influence of a commune's demographic situation on its development potential, it is definitely recommended to investigate the situation in the neighbouring regions and its possible effects on the research subject.

More research would be required to verify the thesis that the "analyzed features are more similar in areas that are proximate to one another than in areas that are more distant from one another" [Tobler 1970].

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