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Demographic determinants of the regional development in Eastern Poland

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Abstract: Demographic potential is one of the crucial factors creating human capital as the population structure, vital statistics and migration determine the quality and quantity of human resources. Demographic factors create opportunities or limit broadening of knowledge and skills and condition socio-economic activity. In other words, demography can foster or block regional development. In the article, the following hypothesis will be verified: Demographic processes are a barrier to the development of regions in Eastern Poland. The main objective of the article is to analyse the spatial diversity of demographic phenomena in Eastern Poland, along with identifying areas with unfavourable demographic conditions of development. The latter objective will be implemented by carrying out the analysis at the level of subregions, not regions, which will enable a more precise analysis of negative demographic phenomena. The article uses the method of linear ordering of objects in compliance with Z. Hellwig's taxonomic measure of development. In addition, a comparative analysis of the main demographic processes in 2010, 2013 and 2016 in Eastern Poland was carried out. The main source of the data used in the article was Statistics Poland (Local Data Bank). The analysis makes it possible to conclude that in the years between 2010 and 2016 an increase in the demographic burden resulting from the aging population was observed in Eastern Poland. In addition, the ratio of net migration is negative and sub-replacement fertility rate is common in the majority of subregions. However, the study at the level of subregions allows concluding that Eastern Poland is diverse in terms of the intensity of demographic processes related to depopulation and ageing of the population.

Keywords: regional development, demographic process, demographic structure, natural population increase, migrations, Eastern Poland

JEL codes: J10, O15, R10

1. Introduction

Regional development is determined by both external factors as well as internal resources of an individual region. Nowadays, the role of the latter group of factors (endogenous) is crucial. Even though external support (e.g. the European Structural and Investment Funds) is of great

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importance, the regional development strategy cannot be implemented in isolation from regional economic and social conditions. The potential of a given region is also significantly affected by demographic processes, which are one of the elements shaping human capital. Thus, demographic processes create conditions for regional development. Nowadays, negative demographic trends, i.e. mainly long-term selective emigration, low fertility rate, and ageing of population, are observed in many Polish and European regions, which can be seen as a barrier to development. As a consequence, the analysis of a base of endogenous factors should cover, among others, demographic processes as opportunities or barriers to development.

While aging of population is a common problem of European regions, these processes are particularly intensive in economically peripheral regions. Their relatively lower level of development than in the so-called growth poles triggers the negative net balance of migration. It influences the age structure of the population. Consequently, demographic dependency ratio becomes a growing problem. It is especially true for Eastern Poland, including the following voivodships (i.e. administrative regions): Lubelskie, Podkarpackie, Podlaskie, Świętokrzyskie and Warmińsko-Mazurskie. According to the project "Ekspercki Projekt Zagospodarowania Przestrzennego Kraju" (Expert Spatial Development Plan of the Country), Eastern Poland is one of the two so-called problem areas at the national level, i.e. there is an accumulation of economic and social problems in the macro-region (Śleszyński et al., 2017: 44). However, the question remains to be answered whether the intensity of negative demographic processes is at a similar level throughout Eastern Poland. In other words, is it possible to distinguish subregions in which there are no such processes as population ageing or depopulation.

Taking into account the above considerations, the following hypothesis will be verified: Eastern Poland is heterogeneous in terms of demographic processes responsible for depopulation process and ageing of the population. The diverse intensiveness of the above processes enables to distinguish subregions, in which depopulation together with ageing of the population significantly decrease human resources in terms of quantity and quality. Consequently, it constitutes a barrier to development, as human capital is one of the four capitals that are crucial to development, according to the 4 Capitals Model (Ekins and Dahlstrom, 2005). As a consequence, the main goal of the article is to assess the spatial variation of chosen demographic processes in Eastern Poland. The analysis is carried out at the level of subregions, not regions, which allows conducting a more detailed analysis of the Eastern Poland.

In order to achieve the above goals the method of Z. Hellwig's taxonomic measure of development was used. In addition, a comparative analysis of the main demographic processes in 2010, 2013 and 2016 in Eastern Poland was carried out. The main source of the data used in the article was Statistics Poland (Local Data Bank, which is Poland's largest database of the economy, society and the environment; relevant data are available at the local, regional and national level as well as refer to units according to the NTS nomenclature; https://bdl.stat.gov.pl/BDL/start).

2. Regional development factors and demographic processes

The development of an individual region results from quantitative and qualitative changes that take place at the economic, social, technical and technological level. It is necessary to distinguish between the development of a region, i.e. changes occurring in a given area, which is characterized by specific human and material resources, and the regional development, which is the result of an impact of certain economic, social and technological factors shaped by an appropriate policy at the regional, national and European level (Przygodzki, 2007: 44). As a consequence, certain characteristics of the region become factors in its development and have an active and controllable nature by entities responsible for the regional policy (Churski, 2008: 27). Therefore, all elements beyond the sphere of influence of specific regional policymakers will not be included in the factors behind the regional development.

The breakdown of development factors depends on their external or internal character. In other words, regional development is determined by exogenous and endogenous factors (Strojny, 2010: 17). The former group includes the macroeconomic environment, which may pose opportunities or threats to the regional development. The second group concerns the internal resources of the region, which are mainly responsible for the long-term regional development. Moreover, the region's development strategy should primarily be based on internal resources specific to a given area (Barquero, 2006). Nowadays, the need to strengthen the region's internal potential is emphasized, which is a more effective method of reducing the spatial diversity of development than external investments (Grosse, 2004: 30). Among the internal factors, the most important are endogenous material capital and endogenous human and social capital (Churski, 2008: 56). In particular, the quality of human capital may be described by indicators referring to the resources of knowledge and skills (education, the ability to use ICT technologies, knowledge

of foreign languages, etc.) and socio-economic indicators (activity on the labour market, entrepreneurship, unemployment rate, etc.).

Human capital theory assumes that, in general, one of the elements determining its level are demographic processes (Domański, 2006: 25; Churski, 2008: 68). It can therefore be concluded that demographic processes are an important factor in the regional development and they are part of the group of social factors (Kosiedowski, 2009: 235). Consequently, it is indispensable to cover demographic factors while assessing human capital as they create opportunities or limit broadening of knowledge and skills as well as condition socio-economic activity. It should be noted that the quality of human resources in a given territory is the result of long-term demographic changes taking place under the influence of many factors. (Zdrojewski, 2010: 178). On the one hand, population phenomena (their character and course) are correlated with socio-economic relations and the level of development of a given area (Stokowski, 2015: 10). On the other hand, they may directly foster or block the socio-economic development (Gałązka, 2016: 18); thus, two-way connections arise.

The above considerations make it possible to confirm that demographic processes affect economic and social activity, which has a direct impact on the quantitative and qualitative aspects of the regional development. One of the reflections of these links is the so-called demographic dividend, referring to the consequences of the changing age structure, which originally referred to the theory of demographic transition and its consequences on the economic growth. In general, two channels of demographic influence on the economy can be distinguished (van der Gaag and de Beer, 2015: 94-109). The first one refers to the labour market, that is to the relation between the inactive and the employed. In other words, demographic processes shape the employment rate, which, as an element of the economic structure, is one of the main components of the regional development. In addition, contemporary aging processes are the reason for distinguishing the second area of interdependence. The longer the average life expectancy is, the bigger the precautionary savings are, as a response to a longer period without sources of income after the end of professional activity (Prskawetz et al., 2007: 5), which is the so-called the second demographic dividend. On the regional development level, changing savings rate is of a great importance as it links to the current standard of inhabitants' living.

As a consequence, demographic processes affect the regional policy. In particular, they concern the regional labour market, spatial planning, the structure of consumed goods and services

and social polarization, i.e. spatial concentration of vulnerable social groups (Ferry and Vironen, 2010: 5-6). It should be emphasized that a regional policy should pay special attention to population aspects in regions with intense demographic change. The issue is raised that policy-makers at the regional level pursue a wrong policy towards regions experiencing demographic changes, which may result in demographic stagnation (Matuschewski et al., 2016: 225-254). There used to function a two-prong approach towards the problem of linkages of demography and economy in areas with a relatively low level of development in the past. Firstly, plans and programs aimed at stimulating economic development were implemented. Secondly, the falling mortality rate with a simultaneous increase in the fertility rate was a challenge, as it led to overpopulation (Coale and Hoover, 1958: 3). Nowadays, the negative impact of demographics should be seen primarily in factors causing depopulation, among which the negative ratio of net migration and low fertility rate are the most important. As a consequence, the age structure is changing as the aging process becomes stronger. In Poland, it poses a problem both on the national and regional levels, but it is impossible to change the trend under the circumstances (Majdzińska, 2016: 178). However, particularly intensive depopulation processes can be observed in voivodships with a lower development level than in the leading regions in a given state. The above phenomenon has a direct impact on the economy and society, in particular it may worsen the socio-economic development. For example, contrary to intuition, aging of population may reduce the dynamics of the decline in the unemployment rate rather than strengthen it, which could be observed in eastern Germany in the years 1996-2014 (Fuchs, 2016: 165). There are similarities between the eastern German lands and the eastern regions of Poland, in particular when it comes to the decline in the fertility rate after the collapse of the centrally planned economy, which should be taken into account by the policy-makers in Poland.

Summing up, demographic processes have a significant impact on the quality and quantity of the factors in the regional development. Demographic processes should therefore make an important element determining the regional policy, the aim of which will be a long-term development.

3. Characteristics of the demographic processes in Eastern Poland

In the 1990s, Eastern Poland was defined as the territory which is now composed of the areas of the Lubelskie, Podlaskie, Podkarpackie voivodships and eastern counties of Mazowieckie and

Warmińsko-Mazurskie voivodships. The definition of Eastern Poland as a macro-region consisting of five voivodships, i.e. Podkarpackie, Lubelskie, Świętokrzyskie, Podlaskie and Warmińsko-Mazurskie, was proposed in the Operational Program Eastern Poland (Plawgo, 2007: 5). As a result, Eastern Poland appears in research and analyses as a separate area, although it should be noted that the main connection between these regions is their relatively lower level of economic development in comparison with other regions in Poland. In the analysis, there were included three years (2010, 2013, 2016). In the second decade of the 21st century, demographic processes that influence aging of the population have become more intense. In particular, in Poland there have been a co-occurrence of three processes that hold a major impact on the demographic dynamics: fertility decline, intensification of emigration and lack of immigration (Okólski, 2010: 69).

The area of Eastern Poland was inhabited by a total of 8 137 thousand people in 2016 (Table 1), which represents a decrease by 1.33% compared to 2010. In the analysed period, the most dynamic drop was observed in Łomżyński (-3.4%) and Sandomiersko-Jędrzejowski (-2.9%) subregion, while relatively small depopulation processes were recorded in Ełcki subregion (-0.4%) and Lubelski subregion (-0.8%). The exceptions among the surveyed units are Rzeszowski and Białostocki subregions, where the population increased by 2.4% and 0.5%, respectively. This is a result of population concentration in regional capitals and suburbs. Despite the decline in the population, Lubelski subregion is characterized by the largest number of inhabitants (712 thou.), while the smallest population characterizes Ełcki (290 thou.) and Suwalski (274 thou.) subregions. However, official data may overestimate the population, which in fact is probably smaller.

There is a large spatial diversification of population density in the macro-region, i.e. from 44 people per 1 km^2 in Suwalski subregion to 179 people per 1 km^2 in Rzeszowski subregion. In addition, subregions with low urbanization level, such as Sandomiersko-Jędrzejowski (28%) and Krośnieński (34%), can be distinguished in Eastern Poland. On the other hand Białostocki (74%), Lubelski (62%) and Olsztyński (60%) subregions had the highest percentage of urban population, which can be explained by the fact that the capitals of these particular regions are at the same time the largest cities in Eastern Poland.

One of the main demographic relations affecting regional development is the demographic dependency ratio, which is expressed by the ratio of the non-working age population to the number of people of working age. An indicator of significant informative value is also the indicator referring the population at post-working age to the number of people at working age, which

expresses the demographic burden being the result of the number of elderly people. Similarly informative is the indicator relating post-working age population to pre-working age population, which refers to the two groups of the non-working population and suggests a change in the demographic dependency ratio in the future.

Table 1. Main demographic parameters in Eastern Poland in 2010, 2013 and 2016

Subregion	Population			Population density (persons per 1 km^2)			Urban population as % of total population		
	2010	2013	2016	2010	2013	2016	2010	2013	2016
ELBLĄSKI	538 474	534 510	529 814	72	71	71	58.2	58.1	57.8
EŁCKI	291 361	290 952	290 058	46	46	46	57.9	58.0	58.3
OLSZTYŃSKI	623 947	621 453	616 495	60	60	60	61.3	60.8	60.4
KIELECKI	783 358	776 556	768 400	156	154	153	55.7	55.2	54.8
SANDOMIERSKO-JĘDRZEJOWSKI	499 188	491 683	484 500	75	74	73	28.5	28.3	28.4
BIALSKI	310 586	307 475	304 212	52	51	51	39.4	39.5	39.5
CHEŁMSKO-ZAMOJSKI	652 603	643 525	632 891	70	69	68	37.9	37.9	38.4
LUBELSKI	717 676	713 691	711 960	170	169	169	63.3	62.6	62.0
PUŁAWSKI	497 746	491 459	484 277	88	87	86	37.9	37.7	38.2
KROŚNIEŃSKI	487 340	485 911	483 447	88	88	87	34.4	34.0	33.7
PRZEMYSKI	398 933	396 312	392 900	93	92	92	38.1	38.6	38.1
RZESZOWSKI	619 565	627 206	634 432	174	177	179	43.0	43.2	43.4
TARNOBRZESKI	622 110	619 865	616 877	139	139	138	47.1	46.7	46.8
BIAŁOSTOCKI	509 016	510 785	511 546	99	100	100	74.5	74.4	74.4
ŁOMŻYŃSKI	414 941	407 497	400 907	47	46	45	46.2	46.9	47.2
SUWALSKI	279 491	276 683	274 172	45	44	44	54.2	54.4	54.7

Source: Local Data Bank 2018a.

In subregions of Eastern Poland, the average demographic dependency ratio is approximately 60 people and it is characterized by low variability (about 3%), i.e. it ranges from 58 people in Olsztyński and Suwalski subregions to 64 people in Puławski subregion (Table 2). It should be noted that the indicator increased in all the subregions, especially in Lubelski (13.2%) and Olsztyński (12.8%) subregions, where dynamics were the highest. It can therefore be concluded that the growing percentage of non-working inhabitants, who are dependent on the working population, is a significant demographic problem in Eastern Poland. Similarly, demographic dependency can be described by the ratio of post-working age population (65 and

more for males, 60 and more for females) per 100 people at working age (males aged 18-64, females aged 18-59). In 2016, it ranged from 28 people in Ełcki subregion and 29 people in Rzeszowski subregion to approx. 35 people in Kielecki and Sandomiersko-Jędrzejowski subregions. The dynamics of the post-working age population growth was high (from 33% in Olsztyński subregion to 11% in Łomżynski subregion). On this basis, it was concluded that aging of the population is a growing problem in Eastern Poland, which is expressed by the demographic dependency ratio. What is more, only in Elbląski, Ełcki and Rzeszowki subregions there are more people at pre-working age (up to the age of 17) than post-working age. In other cases the ratios range from 104 people in Bialski subregion to 131 people in Kielecki subregion. In addition, the situation is worsened by the low effective age of retirement. It ranged from 62.8 years in Podkarpackie voivodship to 63.2 in Podlaskie voivodship in 2016. The average effective age of retirement in Poland was 62.6, and the lowest effective age of retirement was observed in Śląskie voivodeship, i.e. 60.6 years (Statistics Poland, 2017: 11).

Table 2. Demographic dependency ratios in Eastern Poland in 2010, 2013 and 2016

Subregion	Non-working age population per 100 persons at working age			Post-working age population per 100 persons at working age			Post-working age population per 100 persons at pre-working age		
	2010	2013	2016	2010	2013	2016	2010	2013	2016
ELBLĄSKI	54.1	55.7	59.1	22.4	25.3	29.3	70.8	83.4	98.3
EŁCKI	53.9	55.0	57.8	22.3	24.8	28.1	70.3	82.2	94.9
OLSZTYŃSKI	51.4	53.5	58.0	22.4	25.4	29.7	77.4	90.3	104.6
KIELECKI	55.6	58.1	62.1	27.7	31.1	35.2	99.3	115.0	131.1
SANDOMIERSKO-JĘDRZEJOWSKI	59.9	60.3	62.7	29.8	32.1	35.2	99.3	113.8	128.3
BIALSKI	58.9	59.3	61.3	26.5	28.4	31.3	81.6	92.3	104.2
CHEŁMSKO-ZAMOJSKI	58.7	59.0	61.1	28.4	30.5	33.7	93.7	107.4	123.3
LUBELSKI	55.2	58.2	62.5	26.7	29.8	33.6	93.6	104.9	116.0
PUŁAWSKI	61.2	61.9	64.0	29.1	31.5	34.4	90.6	103.3	115.8
KROŚNIEŃSKI	56.9	57.6	59.7	25.1	27.5	30.6	79.1	91.1	105.3
PRZEMYSKI	57.8	57.4	58.8	25.6	27.4	30.1	79.3	91.3	104.9
RZESZOWSKI	57	57.5	59.5	25.0	26.7	29.0	78.4	86.7	95.2
TARNOBRZESKI	55.3	56.0	58.2	24.1	26.7	29.9	77.3	91.2	105.4
BIAŁOSTOCKI	54	55.4	58.8	26.3	28.5	31.4	94.8	105.8	114.9
ŁOMŻYŃSKI	61.3	60.1	61.3	30.2	31.4	33.6	96.9	109.1	121.7
SUWALSKI	57.8	56.7	58.0	25.5	27.1	29.6	78.6	91.5	104.5

Source: Local Data Bank 2018b.

The total population is also affected by migration for permanent residence, both internally and abroad. It should be noted that Eastern Poland has for decades been an area characterized by the outflow of population to more developed regions, while foreign emigration is still an important demographic phenomenon. Similarly, in the period between 2010 and 2016, the ratio of net migration was negative in the majority of subregions. The exceptions were Rzeszowski, Białostocki and Lubelski subregions (Table 3). However, in view of the fact that the paper uses official statistics, these values could be underestimated. Considering separately the net permanent internal migration, in 2016 the population decline was recorded in all subregions with the exception of Rzeszowski (690 inhabitants), Białostocki (342 inhabitants) and Lubelski subregion (215 inhabitants).

Table 3. Internal and foreign migration in Eastern Poland in 2010, 2013 and 2016

Subregion	Ratio of net migration (per 10000 population)			Net migration internal			Net migration international		
	2010	2013	2016	2010	2013	2016	2010	2013	2016
ELBLĄSKI	-26.92	-35.56	-30.39	-1403	-1536	-1433	-23	-379	-177
EŁCKI	-18.96	-21.55	-19.38	-650	-539	-600	100	-89	38
OLSZTYŃSKI	-11.84	-18.51	-13.01	-668	-632	-670	-62	-523	-132
KIELECKI	-18.77	-21.02	-10.88	-1421	-1501	-1008	-21	-146	172
SANDOMIERSKO-JĘDRZEJOWSKI	-22.77	-23.28	-18.9	-1146	-1117	-963	43	-45	49
BIALSKI	-29.12	-37.48	-26.26	-907	-1071	-879	21	-93	80
CHEŁMSKO-ZAMOJSKI	-31.13	-34.16	-33.43	-1969	-2018	-2178	-1	-211	62
LUBELSKI	-5.63	-5.04	6.21	-342	-144	215	-59	-218	227
PUŁAWSKI	-34.03	-37.61	-32.92	-1649	-1721	-1610	1	-151	16
KROŚNIEŃSKI	-12.56	-24.77	-19.82	-552	-1016	-992	-55	-191	34
PRZEMYSKI	-18.89	-26.82	-24.03	-825	-996	-1068	83	-74	124
RZESZOWSKI	11.76	15.03	25.25	690	1089	1398	56	-158	204
TARNOBRZESKI	-21.50	-28.23	-21.71	-1286	-1350	-1385	-40	-406	46
BIAŁOSTOCKI	10.22	3.81	12.82	342	398	495	181	-204	161
ŁOMŻYŃSKI	-35.07	-42.01	-30.68	-1331	-1586	-1327	-75	-157	97
SUWALSKI	-23.09	-34.42	-26.01	-627	-865	-733	-6	-97	20

Source: Local Data Bank 2018c.

As far as net migration international is concerned, in 2010 the majority of subregions were characterized by negative values. Reversely, in 2016 net migration international was positive in all the subregions, with the exception of Olsztyński and Elbląski subregions. The reason for this phenomenon may be the influx of emigrants from Eastern European countries or the return of economic emigrants, but this hypothesis requires additional research. All in all, the outflow of population resulted in a negative ratio of the net migration in the years 2010, 2013 and 2016 in the vast majority of subregions, but this phenomena did not apply only to subregions with the biggest agglomerations (Lublin, Białystok, Rzeszów).

Not only migrations, but also vital statistics of the population affect the number of inhabitants of a given region. Vital statistics can be described among others by the fertility rate, expressed in the average number of children born to a woman at reproductive age (15-49 years). Its low value is a nationwide problem. Similarly, in the case of Eastern Poland, the ratio is much lower than the replacement fertility rate and in 2016 it ranged from 1.15 in Chełmsko-Zamojski subregion to 1.39 in Bialski subregion (Table 4). What is more, there was a decline in the fertility rate compared to 2010, with the exception of Rzeszowski and Białostocki subregions.

Table 4. Fertility, reproduction and natural population increase in Eastern Poland in 2010, 2013 and 2016

Subregion	Total fertility rate			Gross reproduction rate			Natural population increase per 1000 population		
	2010	2013	2016	2010	2013	2016	2010	2013	2016
ELBLĄSKI	1.46	1.30	1.33	0.72	0.63	0.65	1.94	-0.1	-0.51
EŁCKI	1.38	1.23	1.24	0.66	0.58	0.62	1.95	0.1	-0.63
OLSZTYŃSKI	1.33	1.18	1.27	0.65	0.58	0.62	1.95	-0.45	-0.3
KIELECKI	1.28	1.15	1.19	0.61	0.57	0.58	-0.35	-2.06	-2.32
SANDOMIERSKO-JĘDRZEJOWSKI	1.34	1.18	1.22	0.65	0.56	0.60	-2.58	-3.79	-3.2
BIALSKI	1.5	1.31	1.39	0.70	0.64	0.68	0.23	-1.54	-0.6
CHEŁMSKO-ZAMOJSKI	1.31	1.18	1.15	0.63	0.59	0.56	-1.44	-2.67	-2.81
LUBELSKI	1.31	1.19	1.28	0.64	0.58	0.64	0.79	-0.09	0.16
PUŁAWSKI	1.46	1.28	1.33	0.70	0.61	0.66	-0.2	-1.73	-1.58
KROŚNIEŃSKI	1.38	1.27	1.22	0.67	0.62	0.60	1.92	0.76	-0.1
PRZEMYSKI	1.31	1.22	1.19	0.64	0.60	0.58	0.67	-0.11	-0.62
RZESZOWSKI	1.33	1.28	1.36	0.65	0.62	0.65	2.45	1.92	2.22
TARNOBRZESKI	1.26	1.16	1.21	0.60	0.57	0.59	1.57	0.41	0.07

BIAŁOSTOCKI	1.25	1.14	1.28	0.57	0.57	0.62	0.87	-0.18	0.41
ŁOMŻYŃSKI	1.36	1.20	1.29	0.62	0.58	0.63	-1.31	-2.85	-2.59
SUWALSKI	1.35	1.20	1.34	0.65	0.58	0.66	0.77	-0.99	-0.24

Source: Local Data Bank 2018d.

The gross reproduction rate, which means the average number of daughters born by a woman during her entire reproductive age, is also of significant informative value concerning vital statistics. In 2016, the indicator in question was below the figure 1, which suggests a drop in the number of population in the future, and ranged from 0.56 in Chełmsko-Zamojski subregion to 0.66 in Suwalski subregion. Vital statistics would be incomplete without the ratio of natural population increase per 1000 population. In 2016, it was negative in the majority of subregions (from -2.81 in Chełmsko-Zamojski subregion to -0.24 in Suwalski subregion), with the exception of the following subregions: Tarnobrzeski (0.07), Lubelski (0 ,16), Białostocki (0.41) and Rzeszowski (2.2).

The number of population and the age structure is also influenced by two further indicators, i.e. deaths of persons under the age of 65 years per 1000 population in this age group, and infant deaths per 1000 live births (Table 5).

Table 5. Deaths of infants and persons under the age of 65 years along with population change in Eastern Poland in 2010, 2013 and 2016

Subregion	Deaths of persons under the age of 65 years per 1000 population in this age group			Infant deaths per 1000 live births			Population change per 1000 inhabitants		
	2010	2013	2016	2010	2013	2016	2010	2013	2016
ELBLĄSKI	3.69	3.60	3.48	5.49	6.72	5.18	16.7	-3.6	-2.8
EŁCKI	3.34	3.39	3.40	5.17	9.99	3.83	26.2	-1.5	-1.2
OLSZTYŃSKI	3.36	3.53	3.39	3.91	3.15	5.33	16.9	-2.3	-2.3
KIELECKI	3.42	3.48	3.3	6.18	4.84	4.30	9.7	-3.8	-2.6
SANDOMIERSKO-JĘDRZEJOWSKI	3.59	3.40	3.31	6.40	4.87	4.15	9.9	-5.6	-4.7
BIALSKI	3.37	3.40	3.14	2.92	5.80	2.65	11.6	-4.2	-3
CHEŁMSKO-ZAMOJSKI	3.38	3.37	3.18	5.38	4.92	3.48	8.8	-4.5	-5.7
LUBELSKI	3.35	3.15	2.74	4.77	4.10	3.72	6.2	-4.9	0.7
PUŁAWSKI	3.46	3.25	3.19	4.87	4.01	3.78	15.8	-3.7	-4.8
KROŚNIEŃSKI	2.45	2.57	2.56	4.84	4.72	4.85	11.5	-1.8	-1.6
PRZEMYSKI	2.61	2.66	2.55	4.95	3.80	5.74	10.7	-2.6	-2.7
RZESZOWSKI	2.38	2.22	2.21	6.17	4.48	4.10	13.7	3.8	4.6

TARNOBRZESKI	2.69	2.58	2.59	4.72	4.87	3.92	13.2	-1.8	-1.7
BIAŁOSTOCKI	2.91	2.85	2.72	3.36	4.49	2.16	8.3	0.7	1.3
ŁOMŻYŃSKI	3.1	3.19	3.14	4.70	4.91	3.62	14.9	-7	-5.2
SUWALSKI	2.98	3.23	3.15	6.37	4.43	5.23	12.6	-4.3	-2.7

Source: Local Data Bank 2018e.

As far as the former indicator in concerned, in 2016, it fluctuated from 2.21 deaths per 1000 inhabitants in this age group in Rzeszowski subregion to 3.48 deaths in Elbląski subregion. However, Bialski subregion is characterised by the lowest infant mortality (2.65 deaths per 1000 live births), whereas the highest was recorded in Przemyski subregion (5.74). Taking into account both natural statistics and other factors, there are depopulation processes in thirteen out of sixteen subregions, which is described by population change per 1000 inhabitants.

4. Spatial variation of the intensity of the demographic processes in subregions of Eastern Poland

The main goal of this section is to analyse the spatial variation of chosen demographic variables in Eastern Poland at the subregions level. The analysis was carried out using the method of linear ordering of objects. On the basis of sub-indicators, a synthetic indicator was developed in accordance with the taxonomic measure of development. This method was developed by Z. Hellwig (1968) and includes the following stages: defining diagnostic features, standardization and calculation of individual observation distances from the standard value with the use of the Euclid measure. The final stage is the calculation of the taxonomic measure of development for the i-th unit. As a result, a multidimensional comparative analysis was carried out and the ranking of objects was determined by a synthetic indicator.

In order to assess whether subregions of Eastern Poland are heterogeneous considering demographic processes that result in depopulation and ageing of the population, a set of sub-indicators was selected (Table 6). They describe the main aspects of ageing of the population, emigration and depopulation process. The data refers to 2016.

Table 6. Sub-indicators

	Sub-indicator
x1	non-working age population per 100 persons of working age
x2	post-working age population per 100 persons of pre-working age
x3	natural population increase per 1000 population
x4	ratio of net migration
x5	total fertility rate
x6	deaths of persons under the age of 65 years per 1000 population in this age group
x7	infant deaths per 1000 live births
x8	population change per 1000 inhabitants

Source: Own elaboration.

The sub-indicators are described in Tables 1-5. In the case of sub-indicators x1 and x5 the variation did not exceed 10%, hence they were not included in further analysis. Regarding those of x2, x6 and x7, a procedure of transforming a de-stimulant into a stimulant has been carried out. At the next stage, a correlation matrix was used, which allowed assessing whether the set of features creates the information aggregate. Features should be positively and possibly strongly correlated (a correlation matrix with positive high values of coefficients creates a strongly positive aggregate). The stronger the correlation between individual features, the more stable the structural links are. Consequently, the data matrix forms an information aggregate, i.e. it is not a set of independent variables if the structural relations between features are strong enough (Hellwig et al., 1994: 38-40).

Table 8. The correlation matrix

	x2	x3	x4	x6	x7	x8
x2	1.00	0.75	0.15	0.30	-0.22	0.50
x3	0.75	1.00	0.65	0.68	0.05	0.88
x4	0.15	0.65	1.00	0.61	0.30	0.91
x6	0.30	0.68	0.61	1.00	0.05	0.70
x7	-0.22	0.05	0.30	0.05	1.00	0.18
x8	0.50	0.88	0.91	0.70	0.18	1.00

Source: Own elaboration.

The correlation matrix presented in Table 8. meets the assumptions of the strongly positive aggregate, so none of the variables has been rejected. Admittedly the matrix has variables negatively correlated with some other variables, i.e. variable x7, but negative values of correlation are few and insignificantly different from zero. The final stage is the calculation of the taxonomic

measure of development based on sub-indicators. The values of the taxonomic measure of development depends on many variables concerning various aspects of a phenomenon and allow for its composite description (Pietrzak 2014: 182). The classification of subregions in Eastern Poland according to the value of the composite indicator is included in Table 10.

In ten subregions the indicator values belong to a typical range of variation <0.16; 0.48>. It contains about 2/3 of the observation and determined by the arithmetic mean (x) and the standard deviation (S) according to the formula: <x - S; x + S>. As a result, subregions were divided into four groups depending on the value of the composite indicator (Figure 1), that is:

- above 0.48 – Rzeszowski, Białostocki and Lubelski,
- (0.32, 0.48> – Tarnobrzeski, Krośnieński, Bialski and Ełcki,
- (0.16, 0.32> – Przemyski, Olsztyński, Suwalski, Elbląski, Puławski and Kielecki,
- below or equal 0.16 – Łomżyński, Chełmsko-Zamojski and Sandomiersko-Jędrzejowski.

As a result, it can be stated that Eastern Poland is not homogenous as far processes responsible for depopulation and ageing of the population are concerned. The synthetic indicator was based by subindicators concerning vital statistics, migration and relation between working and non-working population. The statistics concerning these processes in Eastern Poland lead to the conclusion that depopulation and ageing of the population pose a serious problem to the majority of sub-regions, however the exception is the first group (Rzeszowski, Białostocki and Lubelski subregions). Additionally the changing relation between working and non-working population is a reflection of the depopulation process which is strengthened by emigration and low fertility rate. The exception is, again, the first group that includes subregions with the agglomerations of Eastern Poland, whereas the most unfavourable demographic conditions occurred in the fourth group grouping the following subregions: Łomżyński, Chełmsko-Zamojski and Sandomiersko-Jędrzejowski. As a result, the analysis of chosen demographic processes at the subregions level revealed spatial diversity of Eastern Poland, which is not clear at regional level.

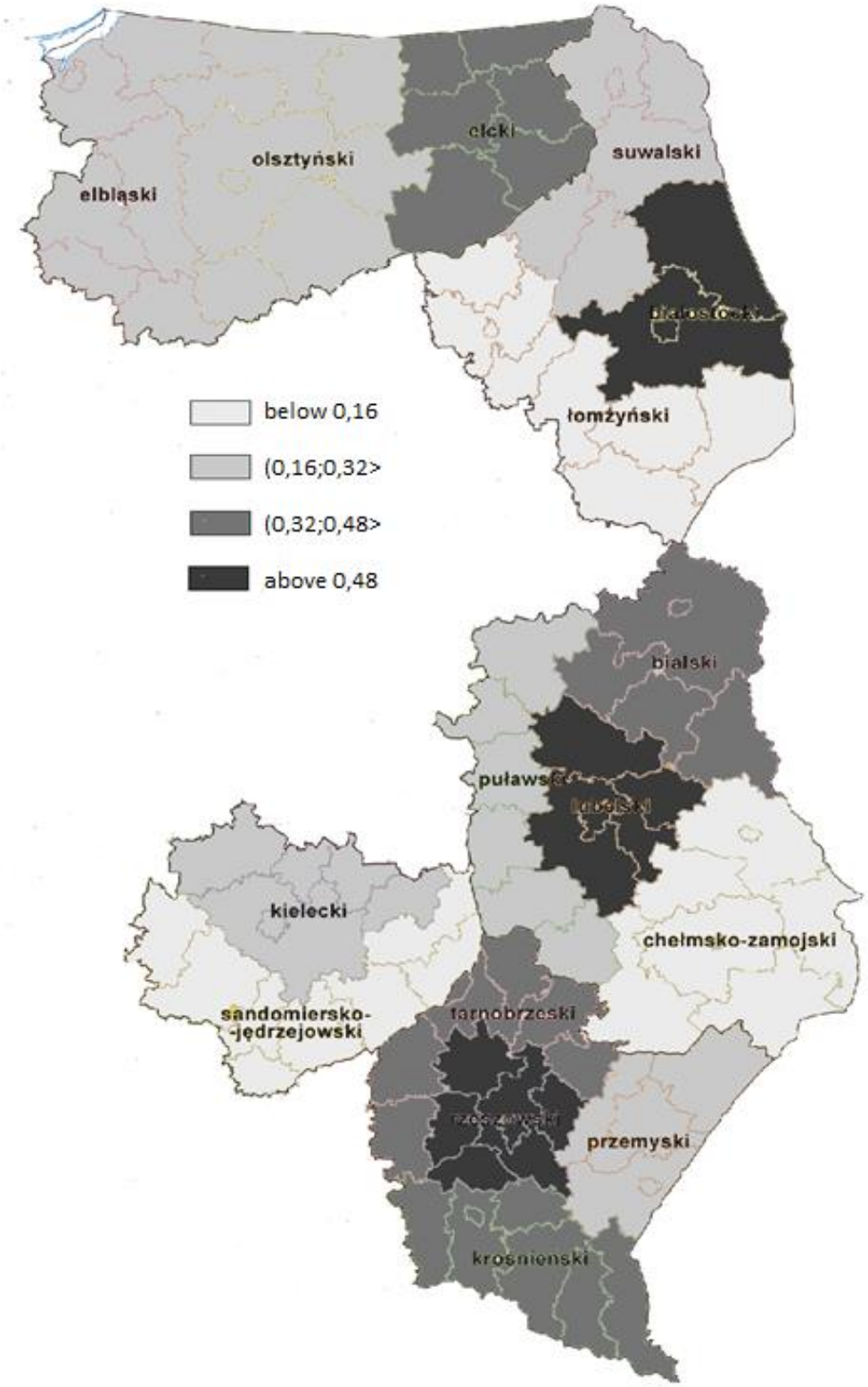
Table 10. Composite indicator – TMR 2016

	Sub-region	TMR
1	RZESZOWSKI	0.667
2	BIAŁOSTOCKI	0.628
3	LUBELSKI	0.494
4	TARNOBRZESKI	0.419
5	KROŚNIEŃSKI	0.383

6	BIALSKI	0.367
7	EŁCKI	0.343
8	PRZEMYSKI	0.308
9	OLSZTYŃSKI	0.281
10	SUWALSKI	0.269
11	ELBLĄSKI	0.224
12	PUŁAWSKI	0.193
13	KIELECKI	0.190
14	ŁOMŻYŃSKI	0.153
15	CHEŁMSKO-ZAMOJSKI	0.124
16	SANDOMIERSKO-JĘDRZEJOWSKI	0.116

Source: Own elaboration.

Figure 1. Demographic processes in Eastern Poland in 2016 (composite indicator)



Source: Own elaboration.

4. Conclusion

Based on the analysis, it can be concluded that the following processes can be observed in Eastern Poland: the growing share of non-working age population, in particular that at post-production age, a negative natural population increase, a low fertility rate and reproduction rate. To a small extent, the demographic situation of Eastern Poland is improved by the falling mortality rate of infants and persons under the age of 65. The above demographic changes have significant consequences, i.e. ageing of the population, shrinking of labour force, decreasing local demand and lowering the quality of human capital (Flaga, 2018: 324). What is more, Eastern Poland is the so-called demographic problems area, which manifests itself in, among others, depopulation, ageing of the population, reproduction problems (Śleszyński et al., 2017: 38). The conclusions following from the article correspond to this thesis as in the vast majority of subregions these processes can be observed. However, based on the analysis, it can be stated that Eastern Poland is not homogenous when it comes to processes leading to depopulation and ageing of the population. Coefficient of variations of most of the sub-indicators are high, i.e. significantly above 10% (Tables 1-5). The range of composite indicators amounts to 0.551 (Table 10) and there are six sub-regions in which composite indicators extend typical range of variation (0.16;0.48). As a result, the hypothesis that Eastern Poland is heterogeneous in terms of demographic processes responsible for the depopulation process and ageing of the population should be verified positively. Based on Section 2 concerning the relations between development factors and demographic processes, it can be concluded that the diverse intensity of the researched processes influences the regional development of the subregions of Eastern Poland to a varying extent and in different directions.

As far as the composite indicator is concerned it reached the lowest value in the case of Łomżyński, Sandomiersko-Jędrzejowski and Chełmsko-Zamojski subregions, where the demographic processes related to depopulation and ageing of the population pose a serious burden to the regional development and require immediate actions on the part of the authorities. Here, the rural character of these subregions must be emphasized, which corresponds to the conclusion that the most of the so-called vanishing villages are located in the non-agglomeration areas of the Świętokrzyskie, Lubelskie and Podlaskie voivodships (Wesołowska, 2018: 200). Slightly better demographic conditions occur in Przemyski, Olsztyński, Suwalski, Elbląski, Puławski and Kielecki subregions. On the other hand, it is possible to distinguish subregions where favourable

demographic processes take place, which is reflected in a positive natural population increase, a positive net migration internal and external and, consequently, an increase in the population. This group includes Rzeszowski, Białostocki and Lubelski subregions, although in all of them the fertility rate is well below the level of replacement rate.

Relatively favourable demographic conditions can be observed in the following subregions: Tarnobrzeski, Krośnienski, Bialski and Ełcki. Tarnobrzeski subregion belongs to the group of four subregions with a positive natural population increase, while in Krośnienski subregion the indicator is close to zero (which is an advantage in comparison to the value definitely below zero in other subregions). As far as Bialski subregion is concerned, it is characterized by the highest fertility rate among all the subregions. In the case of Ełcki subregion, there is the lowest demographic dependency ratio, expressed as the relation between the non-working population to the working-age population. This subregion is also characterized by the most favourable relation between the post-working age population to the pre-working age population. Nevertheless, favourable demographic processes are offset by a negative net migration and – consequently – depopulation which determines the position of these subregions in the ranking according to the composite indicator.

To sum up, demographic processes pose a burden to the regional development in Eastern Poland as a whole, as they lead to depopulation and ageing of the population. However, the method of taxonomic measure of development made it possible to distinguish four groups of regions characterised by different values of demographic indicators. This allows us to conclude that Eastern Poland is heterogeneous in terms of dynamics and direction of demographic processes and that there are considerable spatial variations in this area, which was the main goal of the article. Therefore, the following practical conclusions should be drawn. Firstly, the regional policy should take into account the demographic diversity of regions at the subregional level. Secondly, subregions like Łomżyński, Sandomiersko-Jędrzejowski and Chełmsko-Zamojski are unlikely to be able to cope with negative demographic processes without support at the regional and national levels. Above all, all tools and instruments supporting the demographic development should be linked to the socio-economic policy. The example of Bialski and Ełcki subregions shows that despite high fertility, these subregions are characterized by a high level of emigration, which results from the low level of socio-economic development. Therefore, demographic policy should be one of the elements of a comprehensive approach to the issue of regional development.

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Demograficzne uwarunkowania rozwoju regionalnego w Polsce Wschodniej

Streszczenie

Potencjał demograficzny jest jednym z kluczowych czynników tworzących kapitał ludzki, ponieważ struktura populacji, ruch naturalny ludności i migracja decydują o jakości i ilości zasobów ludzkich, które współcześnie stanowią jeden z najistotniejszych czynników rozwoju regionalnego. Czynniki demograficzne stwarzają bowiem możliwości (lub ograniczają) poszerzenia zasobu wiedzy i umiejętności oraz warunkują aktywność społeczno-ekonomiczną, co w konsekwencji oddziałuje na poziom rozwoju regionalnego W artykule zostanie zweryfikowana następująca hipoteza: procesy demograficzne są barierą rozwoju regionów Polski Wschodniej.
Głównym celem artykułu jest analiza przestrzennego zróżnicowania zjawisk demograficznych w Polsce Wschodniej, zaś celem cząstkowym jest identyfikacja obszarów o niekorzystnych demograficznych uwarunkowaniach rozwoju. Realizacji drugiego celu służy przeprowadzanie analizy na poziomie podregionów, nie zaś regionów, co pozwoli na dokładniejsze określenie obszarów o niekorzystnych zjawiskach demograficznych. W artykule została zastosowana metoda liniowego porządkowania obiektów z wykorzystaniem taksonomicznej miary rozwoju Z. Hellwiga. Ponadto została przeprowadzona analiza porównawcza głównych zjawisk demograficznych w 2010, 2013 i 2016 w Polsce Wschodniej. Podstawowym źródłem danych wykorzystanych w artykule był Główny Urząd Statystyczny (Bank Danych Lokalnych).
Przeprowadzona analiza pozwala stwierdzić, że w latach 2010-2016 w Polsce Wschodniej zaobserwowano wzrost obciążenia demograficznego będącego rezultatem starzenia się społeczeństwa. Ponadto współczynnik salda migracji przyjął wartości ujemne w większości podregionów, zaś współczynnik dzietności jest znacznie poniżej progu zastępowalności pokoleń. Jednakże badanie na poziomie podregionów pozwala stwierdzić, że Polska Wschodnia jest zróżnicowana pod względem intensywności procesów demograficznych powiązanych z procesem depopulacji i starzenia się społeczeństwa.

Słowa kluczowe: rozwój regionalny, procesy demograficzne, struktura demograficzna, naturalny ruch ludności, migracje, Polska Wschodnia