Elżbieta Sojka

# Multidimensional comparative analysis of demographic growth of voivodeships in Poland

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ELŻBIETA SOJKA

ACADEMY OF ECONOMICS IN KATOWICE

# MULTIDIMENSIONAL COMPARATIVE ANALYSIS OF DEMOGRAPHIC GROWTH OF VOIVODESHIPS IN POLAND

**ABSTRACT:** The article presents results of a multidimensional comparative analysis of the level of demographic development of voivodeships in Poland in years 1999–2006. Hellwig's synthetic measure of a development pattern was applied and on its basis the classification of voivodeships into homogenous typological groups was carried out with regard to demographic development.

The results of the research have pointed to a significant influence of socio-economic factors on the extent of advancement of given voivodeships in reaching a modern type of population reproduction.

**KEY WORDS:** demographic growth, demographic transformation, synthetic variable, Polish voivodeships.

## INTRODUCTION

This study aims at a multidimensional comparative analysis of the level of demographic growth of Polish voivodeships in years 1999–2006. Even though the course of changes in demographic processes is certainly diversified in different voivodeships, it is still subjected to a general mechanism of demographic transition. However, the extent of advancement of voivodeships in reaching a modern type of population reproduction may be diverse. It is associated with biological and socio-economic differences of the voivodeships. In this connection, there is a need for comparative researches into demographic growth for smaller spatial units within the same phase of demographic transformation.

The author tried to verify the hypothesis of the different extent of advancement of voivodeships in reaching a modern type of population reproduction as well as the hypothesis concerning the influence of socio-economic factors on the extent of advancement of the demographic transformation process. A dynamic approach has enabled to define position changes of the studied administrative units against one another and has also allowed to compare the values of synthetic variables describing a demographic growth in relation to their values calculated for the research initial year, i.e. 1999.

Literature presents diversified definitions of a demographic growth. Sokołowski A. and Zając K. think that demographic growth means "(...) quantitative and qualitative changes of population in a given area" (Sokołowski and Zając, 1987: 81). Baran A., Panek T., Pustała E. define demographic growth as "(...) quantitative and qualitative changes in demographic processes leading to the increase of population number. Development is not identified with demographic growth, which is understood as the increase of population number resulting exclusively from quantitative changes of births, deaths, and migration" (Baran, Panek and Pustała, 1987: 10).

Due to the requirements of this study the author used a definition of demographic growth given by M. Cieślak, who understands demographic growth as "a complex process which consists of mortality and reproduction processes in their quantitative and qualitative aspects" (Cieślak, 1985: 35). According to this definition the processes of marriage contract and breakdown, migration movements, structural factors, as well as other population processes remain beyond the process of development. As M. Cieślak says, they are "conditions that define demographic growth but they do not constitute its essence". A theoretical basis for a definition of demographic growth is the theory of demographic transformation. It provides a universal historical description of population changes, depicting relations between mortality and reproduction in the form of separate phases as well as association of demographic changes with alterations within a socio-economic sphere. The necessity for a close connection between the notion of demographic growth and the theory of demographic transition was observed by M. Cieślak (Cieślak, 1985). For the need of the following study, demographic growth will be defined as *the given population's extent of advancement in the process of demographic transformation.*

To study the level of demographic growth it is not possible to rely merely on one feature; many variables determining this development should also be considered (Pociecha, 1990: 27). Thus, one should strive to express the level of demographic growth by means of synthetic variable which would aggregate information that is carried by all determinants of this development. This issue may be solved by the use of multidimensional comparative analysis.

Reproduction and mortality levels depend on many factors. They are of both purely demographic and of socio-economic nature, and they are closely associated with the process of socio-economic transformation. In this connection, a synthetic measure of demographic development should include, as its components, not only demographic variables but also those of socio-economic nature, which influence the formation of demographic processes, testifying to the extent of advancement in the process of demographic transformation. Demographic variables used to be defined as internal factors (Henry, 1972), while socio-economic variables as external factors.

The research into demographic growth of voivodeships was carried out in two substantial versions. The first version considers merely the influence of external factors on the demographic development of voivodeships, while the second version takes into account the influence of both internal and external factors. The research was based on empirical data from the period of 1999–2006.

The results gained in the research enabled to order voivodeships according to a synthetic development measure and to distinguish homogenous typological voivodeship groups, as far as demographic development is concerned in the light of this development components adapted to the research.

## SELECTION OF DIAGNOSTIC FEATURES

In empirical researches it is essential to define variables which should be taken into consideration in order to formulate demographic development in qualititative categories. These measures are sought among the measures constructed for the needs of demographic analysis and they are mainly based on well-known and verified demographic coefficients.

Twelve variables characterizing reproduction and mortality (internal factors), and three socio-economic variables (external factors), closely connected with the process of demographic transformation, were assumed as a space for ordering and classifying Polish voivodeships with regard to the demographic development level. They represent external factors that define the level of demographic development. Urbanization, women's work activity, or society education level constitute these factors which influence the advancement of demographic transformation course (Sokołowski, and Zając, 1987; Baran, Panek and Pustała, 1987; Pociecha, 1990). The set of these potential variables used in the research will be called a set of demographic development components and their specification is as follows (1):

$X_1$ – raw coefficient of births per 1,000 population,
$X_2$ – overall fertility coefficient per 1,000 population,
$X_3$ – mother's average age at the moment of child's birth,

$X_4$ – number of children below the age of 5 in relation to the number of women at the reproductive age per 1,000 women,
$X_5$ – raw coefficient of deaths per1,000 population,
$X_6$ – infants' death coefficient per 1,000 live births,
$X_7$ – average further life duration of boys at the age of 0 accomplished years,
$X_8$ – average further life duration of girls at the age of 0 accomplished years,
$X_9$ – gross reproduction coefficient,
$X_{10}$ – number of population at the unproductive age per 100 people at the reproductive age,
$X_{11}$ – synthetic coefficient of premature deaths (at the age of 15–64) for men (2),
$X_{12}$ – synthetic coefficient of premature deaths (at the age of 15–64) for women,
$X_{13}$ – women's work activity in %,
$X_{14}$ – number of students per 10,000 population,
$X_{15}$ – town population percentage.

Potential diagnostic variables may be connected with one another to a different degree, which means that they are carriers of similar information. In order to avoid repeating information, this postulate is performed by elimination of high-correlated variables. To select diagnostic features faintly correlated with one another a taxonomic method of grouping was applied. First, coefficients of initially adapted diagnostic variables were calculated. The number of observations every time equaled n=16 for all analyzed years. By using the method of k-averages (Gatnar and Walesiak, 2004; Pociecha, Podolec, Sokołowski, Zając, 1988), i.e. iterative procedure of dividing objects into k-groups so as to minimize the value of intergroup variance, a selection of diagnostic variables was carried out in two substantial arrangements for each year of the analysis. After the features had been divided into separate groups of variables, a representative variable was selected out of each subset. For that purpose the center of gravity method was applied (Pociecha, Podolec, Sokołowski, Zając, 1988: 105–108).

The set of variables characterizing the demographic development of Polish voivodeships eventually included the following variables:

1. I arrangement of features
– mother's average age at the moment of child's birth ($X_3$),
– number of children below the age of 5 per 1,000 women at the reproductive age ($X_4$),
– raw coefficient of deaths per 1,000 population ($X_5$),
– synthetic coefficient of premature deaths for men ($X_{11}$).
2. II arrangement of features
– number of children below the age of 5 per 1,000 women at the reproductive age ($X_4$),

- raw coefficient of deaths per 1,000 population ($X_5$),
- synthetic coefficient of premature deaths for men ($X_{11}$).
- women's work activity coefficient in % ($X_{13}$),
- number of students per 10,000 population ($X_{14}$).

Pursuant to the theory of demographic transformation, it was acknowledged that in arrangement I mother's average age at the child's birth ($X_3$) should be considered as a stimulant (3) to demographic development, while three other variables as destimulants. In the second arrangement of variables the first three were regarded as de-stimulants, while the other two, i.e. $X_{13}$ and $X_{14,}$ as stimulants to this development.

## DEMOGRAPHIC DEVELOPMENT MEASUREMENT

Demographic development of voivodeships was measured by means of Z. Hellwig's synthetic measure of development on the basis of previously selected diagnostic variables. Development measure will further enable to order voivodeships in the view of analyzed complex phenomenon. In the following research one of the methods for linear ordering of objects was used, namely Z. Hellwig's method of a development pattern (Hellwig, 1968: 324).

The starting point is X matrix of diagnostic features' values, which takes a different form each year :

$$X = \begin{bmatrix} X_{11t} & \cdots & X_{1jt} & \cdots & X_{1nt} \\ \vdots & & \vdots & & \vdots \\ X_{i1t} & \cdots & X_{ijt} & \cdots & X_{int} \\ \vdots & & \vdots & & \vdots \\ X_{m1t} & \cdots & X_{mjt} & \cdots & X_{mnt} \end{bmatrix} \qquad (1)$$

where i =1,2,..., m – number of objects (16 voivodeships); j =1,2,..., n – number of variables.

In order to lead variables to a reciprocal comparability, i.e. to free them from names, the process of normalization was applied and they became standardized according to the following formula:

$$z_{ij} = \frac{x_{ij} - \overline{x}_j}{S_j} \qquad (i = 1,\ldots,m;\ j = 1,\ldots, n) \qquad (2)$$

where: $z_{ij}$-standardized value of j-time diagnostic variable for i-time object, $\overline{x}_j, S_j$ - arithmetic mean and standard deviation of j-time variable.

Hellwig's method of development pattern is based on the construction of an abstract object called a development pattern with 'the best' values for each variable, which is geometrically represented by the point:

$$z_0 = [z_{01}, z_{02}, ..., z_{0j}, ..., z_{0n}] \quad (3)$$

Coordinates of this point are defined by means of following relations:

$$z_{0j} = \begin{cases} \max \{z_{ij}\} & if \quad X_j \quad is\ a \quad stimulant \\ \min \{z_{ij}\} & if \quad X_j \quad is\ a \quad de-stimulant \end{cases} \quad (4)$$

While knowing development pattern (3) it is possible to calculate a synthetic measure of development:

$$SMR_i = 1 - \frac{D_{io}}{D_o} \quad (5)$$

where: $D_{io} = \sqrt{\sum_{j=1}^{n} (z_{ij} - z_{oj})^2}$ is Euclidean distance from voivodeship to pattern

while $D_o = \overline{D_o} + 2S_o$ $\quad \overline{D_o} = \frac{\sum_{i=1}^{m} D_{io}}{m}$ $\quad S_o = \sqrt{\frac{\sum_{i=1}^{m} (D_{iO} - \overline{D_o})^2}{m}}$

The development measure defined by formula (5) is normalized, i.e. it usually assumes values from range [0, 1] (4) and it relies on Euclidean distance. Higher values of the development measure mean a relatively higher level of analyzed complex phenomenon, while lower values a lower level of this phenomenon. The development measure calculated for the development pattern are equal.

## ANALYSIS OF RESULTS

Calculated values of the synthetic measure of demographic development enable to order voivodeships with respect to the analyzed phenomenon.Ordering that takes into account merely the influence of internal factors on demographic development is presented in Table 1. In all orderings Opolskie voivodeship occupied the first place and Łódzkie voivodeship was placed as the last one. There are significant changes in ordering of the analyzed objects (voivodeships) in time. While for some voivodeships these changes are more favourable, they become less advantageous for other voivodeships.

In the case of a dynamic analysis it is important to pay attention not only to positions occupied by given voivodeships in the rating but also to measure the value that it gained in successive years of the analysis. For a few voivodeships, in spite of their high position (in comparison with other voivodeships), development measure values in years 2001 and 2003 are lower than in 1999. Małopolskie and Pomorskie voivodeships may serve as examples. In most voivodeships development measure values in 2006 increased in comparison with 1999, which

Table 1. Ordering of voivodeships according to Hellwig's synthetic measure of demographic development in years 1999–2006 (I arrangement of features)

| No | Voivodeship | 1999 | Voivodeship | 2001 | Voivodeship | 2003 | Voivodeship | 2006 |
|---|---|---|---|---|---|---|---|---|
| 1 | Opolskie | 0.8495 | Opolskie | 0.9073 | Opolskie | 0.9058 | Opolskie | 0.8158 |
| 2 | Pomorskie | 0.7137 | Małopolskie | 0.6804 | Małopolskie | 0.6883 | Małopolskie | 0.7197 |
| 3 | Małopolskie | 0.6973 | Śląskie | 0.6647 | Śląskie | 0.6696 | Podlaskie | 0.6888 |
| 4 | Śląskie | 0.6011 | Mazowieckie | 0.6593 | Podlaskie | 0.6400 | Podkarpackie | 0.6819 |
| 5 | Podkarpackie | 0.5788 | Pomorskie | 0.6403 | Podkarpackie | 0.6356 | Śląskie | 0.6331 |
| 6 | Podlaskie | 0.5738 | Dolnośląskie | 0.6270 | Mazowieckie | 0.6152 | Mazowieckie | 0.5934 |
| 7 | Mazowieckie | 0.5668 | Podkarpackie | 0.6225 | Pomorskie | 0.6053 | Dolnośląskie | 0.5787 |
| 8 | Wielkopolskie | 0.4881 | Podlaskie | 0.6068 | Dolnośląskie | 0.5986 | Zachodniopomorskie | 0.5658 |
| 9 | Dolnośląskie | 0.4276 | Wielkopolskie | 0.5312 | Wielkopolskie | 0.5859 | Wielkopolskie | 0.5279 |
| 10 | Warmińsko-mazurskie | 0.3903 | Kujawsko-pomorskie | 0.5297 | Zachodniopomorskie | 0.4362 | Pomorskie | 0.4000 |
| 11 | Lubelskie | 0.3898 | Zachodniopomorskie | 0.5112 | Kujawsko-pomorskie | 0.4099 | Kujawsko-pomorskie | 0.3614 |
| 12 | Świętokrzyskie | 0.3883 | Świętokrzyskie | 0.4434 | Lubuskie | 0.4051 | Lubuskie | 0.3552 |
| 13 | Kujawsko-pomorskie | 0.3747 | Lubuskie | 0.4165 | Świętokrzyskie | 0.3357 | Świętokrzyskie | 0.3460 |
| 14 | Lubuskie | 0.3215 | Lubelskie | 0.3478 | Lubelskie | 0.2661 | Lubelskie | 0.3360 |
| 15 | Zachodniopomorskie | 0.3211 | Warmińsko-mazurskie | 0.2889 | Warmińsko-mazurskie | 0.1636 | Warmińsko-mazurskie | 0.1722 |
| 16 | Łódzkie | -0.1949 | Łódzkie | -0.2719 | Łódzkie | -0.1154 | Łódzkie | -0.1331 |

*Source*: own elaboration

means the increase of these voivodeships' extent of advancement in the process of demographic transformation. A fall of value of the development measure was recorded in such voivodeships as Opolskie, Pomorskie, Świętokrzyskie, Lubelskie and Warmińsko-Mazurskie. Table 2 presents major descriptions concerning the distribution of the synthetic measure of development.

Table 2. Description parameters for Hellwig's synthetic measure of development in years 1999–2006

| Description parameters | 1999 | 2001 | 2003 | 2006 |
|---|---|---|---|---|
| Arithmetic mean | 0.4680 | 0.5128 | 0.4903 | 0.4777 |
| Median | 0.4579 | 0.5690 | 0.5923 | 0.5469 |
| Standard deviations | 0.2340 | 0.2564 | 0.2452 | 0.2388 |
| Changeability coefficient | 0.5000 | 0.5000 | 0.5000 | 0.4999 |
| Assymetry | -1.2587 | -1.9058 | -0.9107 | -1.0485 |
| Minimum | -0.1949 | -0.2719 | -0.1154 | -0.1331 |
| Maximum | 0.8495 | 0.9073 | 0.9058 | 0.8158 |
| Space | 1.0444 | 1.1792 | 1.0212 | 0.9489 |

*Source*: own elaboration

Hellwig's development measure has increased as compared to the value in 1999. Downward tendency was observed in 2002, while in 2003 and 2006 the measure exceeded the level recorded in 1999. The median of development measures in all years assumes values that are higher than those in the first year of the analysis. Studied voivodeships are characterized by a high diversity of development measure value in the light of the changeability coefficient. Distributions of synthetic measures of development were characterized by a negative asymmetry, particularly strong in 2001; in the following years the strength of this asymmetry weakened. This means that the majority of voivodeships was characterized by a high level of the synthetic measure of demographic development (higher than the average), and that the distance between voivodeships with the highest level of the development measure (Opolskie) and other voivodeships was decreasing. Ordering of voivodeships with regard to the second arrangement of variables characterizing reproduction, mortality, as well as social-economic factors is presented in Table 3.

The group of voivodeships that are characterized by the highest level of the measurements of the demographic development in years 1999–2003 included the

Table 3. Ordering of provinces according to Hellwig's synthetic measure of demographic development in years 1999-2006 (II arrangement of features)

| No | Province | 1999 | Province | 2001 | Province | 2003 | Province | 2006 |
|---|---|---|---|---|---|---|---|---|
| 1 | Małopolskie | 0.6356 | Mazowieckie | 0.7865 | Mazowieckie | 0.6640 | Małopolskie | 0.6753 |
| 2 | Zachodniopomorskie | 0.6024 | Zachodniopomorskie | 0.7203 | Zachodniopomorskie | 0.6493 | Dolnośląskie | 0.6020 |
| 3 | Mazowieckie | 0.5610 | Świętokrzyskie | 0.5867 | Wielkopolskie | 0.5626 | Mazowieckie | 0.5894 |
| 4 | Opolskie | 0.5408 | Wielkopolskie | 0.5622 | Świętokrzyskie | 0.5346 | Podlaskie | 0.5326 |
| 5 | Dolnośląskie | 0.5287 | Dolnośląskie | 0.5209 | Pomorskie | 0.5066 | Wielkopolskie | 0.4848 |
| 6 | Podlaskie | 0.5171 | Podlaskie | 0.4908 | Dolnośląskie | 0.4859 | Podkarpackie | 0.4270 |
| 7 | Wielkopolskie | 0.4434 | Pomorskie | 0.4746 | Śląskie | 0.3843 | Śląskie | 0.4108 |
| 8 | Lubuskie | 0.4003 | Małopolskie | 0.4666 | Kujawsko-pomorskie | 0.3780 | Świętokrzyskie | 0.3801 |
| 9 | Lubelskie | 0.3808 | Kujawsko-pomorskie | 0.4231 | Małopolskie | 0.3189 | Zachodniopomorskie | 0.3762 |
| 10 | Pomorskie | 0.3713 | Opolskie | 0.3892 | Podlaskie | 0.3172 | Lubelskie | 0.3757 |
| 11 | Kujawsko-pomorskie | 0.3503 | Lubelskie | 0.3440 | Lubuskie | 0.2829 | Opolskie | 0.3543 |
| 12 | Świętokrzyskie | 0.3371 | Lubuskie | 0.3078 | Lubelskie | 0.2808 | Lubuskie | 0.3243 |
| 13 | Podkarpackie | 0.3073 | Podkarpackie | 0.2318 | Warmińsko-mazurskie | 0.2719 | Warmińsko-mazurskie | 0.2860 |
| 14 | Warmińsko-mazurskie | 0.1312 | Warmińsko-mazurskie | 0.2145 | Opolskie | 0.2110 | Pomorskie | 0.2674 |
| 15 | Śląskie | 0.0650 | Śląskie | 0.2100 | Podkarpackie | 0.1233 | Kujawsko-pomorskie | 0.1946 |
| 16 | Łódzkie | -0.0269 | Łódzkie | -0.0489 | Łódzkie | -0.0084 | Łódzkie | -0.1438 |

Source: own elaboration

following voivodeships: Mazowieckie, Zachodniopomorskie and Małopolskie. In all years of the analysis Łódzkie voivodeship was at the last position. In most voivodeships values of the measurement showed a significant fluctuation in successive years For instance, Dolnośląskie voivodeship moved from the fifth position in 1999 to the second position in 2006. Śląskie voivodeship also improved its position from the fifteenth place in 1999 to the seventh place in 2003 and 2006, which means that the level of demographic development increased in comparison with the level observed in the first year of the analysis.

Ipso facto, the level of Śląskie voivodeship's extent of advancement in reaching a modern type of population reproduction increased in relation to the level of the initial year. It is worthwhile to pay attention to the fact that Opolskie voivodeship, which according to the value of the synthetic measure calculated for variables of the first arrangement occupied the first position, after considering the influence of both external and internal factors occupied the fourth position in the rating in 1999 and in 2006 it moved to the eleventh position.

Some voivodeships, e.g. Śląskie or Podkarpackie, occupied significantly higher positions in the voivodeship rating, in the case of measures based merely on features characterizing reproduction and mortality, than in the case of measures based on both demographic and social-economic variables. Variable X13 from the arrangement II of diagnostic features, which defines women's work activity coefficient, decidedly influenced a decrease of Śląskie voivodeship position in the rating. It turns out that in years 1999–2002 Śląskie voivodeship was characterized by the lowest level of that coefficient. The number of students per ten thousand population in this voivodeship was also below the domestic average, though this distance tended to decrease with the course of years.

Constructed synthetic measures became the basis for classification of voivodeships into groups that are similar in relation to demographic development-understood as the population extent of advancement in the process of demographic transformation. The results of classification for the last year of the analysis, i.e. 2003, were gained by means of a criterion based on the basic descriptions of synthetic measure, i.e. arithmetic means ($\overline{SMR}$) and standard deviation ($S_{SMR}$).

The first group was composed of voivodeships whose synthetic measures were high and belonged to range: $[\overline{SMR} + S_{SMR}; \max_i \{SMR_i\}]$. The second group consisted of voivodeships with moderate measure values belonging to the range: $[\overline{SMR}; \overline{SMR} + S_{SMR})$. The third group included voivodeships with low measurement values belonging to the range: $[\overline{SMR} - S_{SMR}; \overline{SMR})$. The fourth group embraced voivodeships with very low measurement vales that could be found in the range:

$$[\min_i \{SMR_i\}; \overline{SMR} - S_{SMR}).$$

The results of classification of voivodeships into typological groups in accordance with the development measure are presented in Table 4 and their graphic representation is shown in Fig. 1 and 2. The first group includes

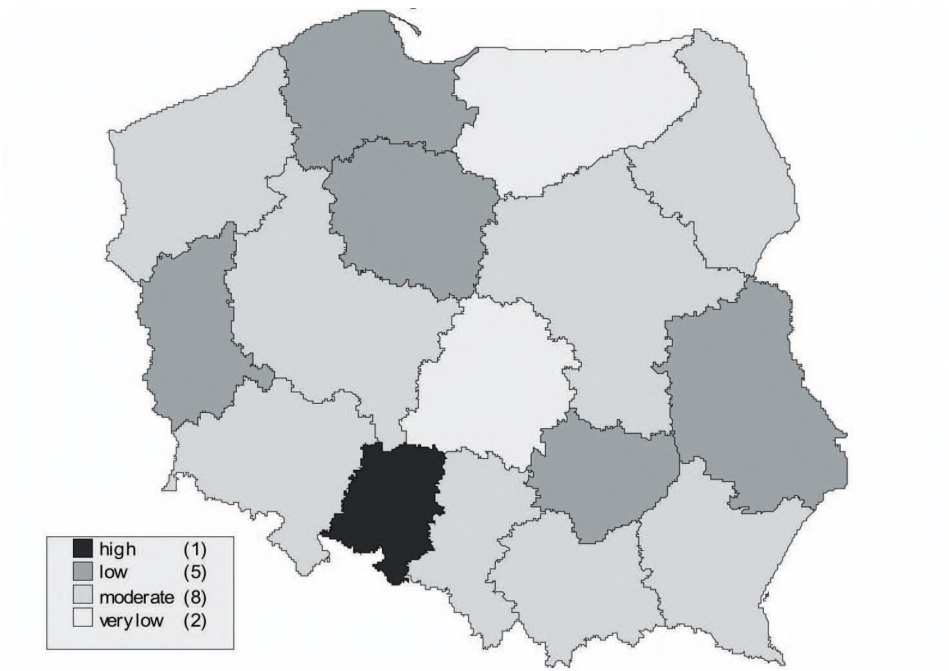


Fig. 1. Classification of voivodeships on the basis of development measure in 2006 (I Arrangement of features)

voivodeships characterized by a high level of the demographic development measure in the light of variables from the first arrangement of diagnostic features. Opolskie voivodeship, being a representative of the first group, was characterized by the lowest level of children below the age of 5 per 1,000 women at the reproductive age (X4) as well as by a low synthetic coefficient of premature deaths for men (X11). Features differentiating the fourth group of voivodeships (including Łódzkie and Warmińsko-Mazurskie voivodeships) from other groups were above all high level of overall mortality and mortality of men aged 15–64 (X5 and X11). Pomorskie, Śląskie and Dolnośląskie voivodeships, regardless of the way of creating a synthetic variable, were included into the second group,

Table 4. Results of province grouping performed by means of synthetic measure of development in 2006

| Group | Arrangement I | Arrangement II |
|---|---|---|
| I | Opolskie | Małopolskie<br>Dolnośląskie<br>Mazowieckie |
| II | Małopolskie<br>Podlaskie<br>Podkarpackie<br>Śląskie<br>Mazowieckie<br>Dolnośląskie<br>Zachodniopomorskie<br>Wielkopolskie | Podlaskie<br>Wielkopolskie<br>Podkarpackie<br>Śląskie |
| III | Pomorskie<br>Kujawsko-pomorskie<br>Lubuskie<br>Świętokrzyskie<br>Lubelskie | Świętokrzyskie<br>Zachodniopomorskie<br>Lubelskie<br>Opolskie<br>Lubuskie<br>Warmińsko-mazurskie<br>Pomorskie<br>Kujawsko-pomorskie |
| IV | Warmińsko-mazurskie<br>Łódzkie | Łódzkie |

*Source*: own elaboration

where the level of demographic development may be defined as moderate in the light of diagnostic features from arrangement I.

The first typological group in the case of the second extended arrangement of diagnostic features includes voivodeships with the highest level of women's work activity coefficient ($X_{13}$), a high number of students per ten thousand population ($X_{14}$), as well as a small number of children aged less than 5 years against the number of women at the reproductive age ($X_4$). High values of variables defining mortality ($X_5$, $X_{11}$) are the key features of group four, which includes Łódzkie voivodeship. Health situation of inhabitants of Łódzkie voivodeship adversely diverges from the national average. Most of epidemiological rates have reached the highest levels in the country, which makes the voivodeship occupy the last position in relation to other voivodeships in Poland.

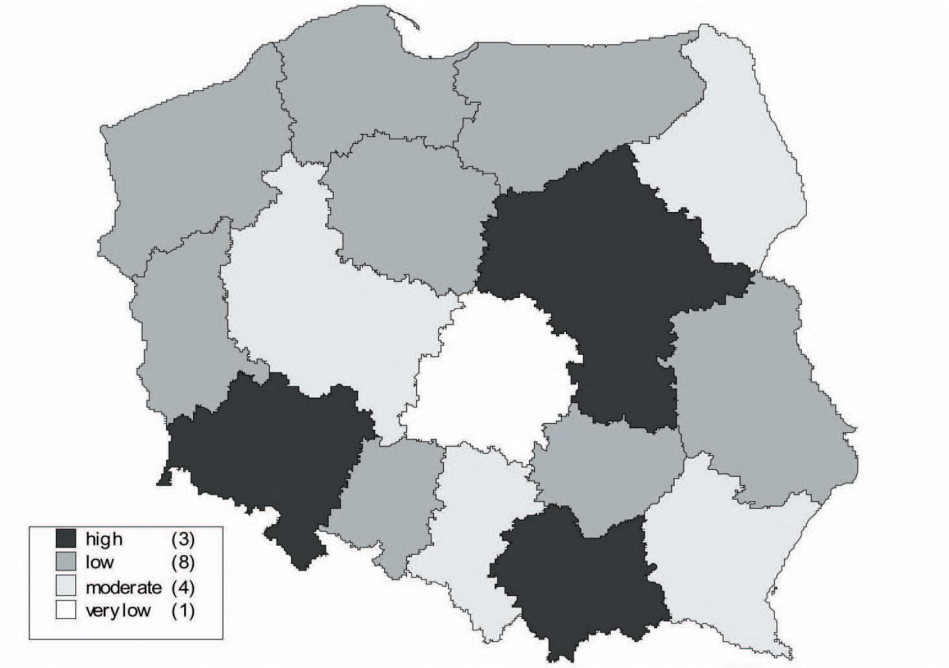


Fig. 2. Classification of voivodeships on the basis of development measure in 2006 (II Arrangement of features)

## SUMMARY

Multidimensional comparative analysis is a useful tool in studying demographic processes. A significant advantage of multidimensional comparative analysis methods is the fact that each of the accepted diagnostic features constitutes only a certain, more or less important, component of the aggregate feature. Dynamic presentation of changes in demographic development allowed to define position changes in the rating of studied voivodeships against one another.

Results achieved in the research point to a significant influence of socio-economic factors on the voivodeships' extent of advancement in reaching a modern type of population reproduction. An important factor that influences women's procreative behavior in the latest years is education, which is closely connected with work activity as well as the growth of work and financial aspiration of both men and women.

The performed empirical research enabled to verify the hypothesis of a various degree of advancement of Polish voivodeships in the demographic

transformation process, as well as to classify voivodeships into homogenous (similar) groups in relation to selected variables of purely demographic nature and also socio-economic factors.

## NOTES

(1) Such a set of variables is of course one of many possible. Its contents were determined by substantial reasons as well as statistical criteria.
(2) The synthetic coefficient of premature deaths of adult people should be understood as the total of partial coefficients of deaths at the age of 15–64. This is a peculiar measure of death threat to adult population.
(3) Variable $X_j$ is a stimulant, if the increase of its value testifies to the increase of complex phenomenon level. Variable $X_j$ is a de-stimulant, if the decrease of its value testifies to the increase of complex phenomenon level.
(4) A negative value of the development measure may occur when the development of a given object is definitely weaker than the development of other objects, and when the number of studied objects is too high. This inconvenience of the development measure may be eliminated by assuming not two but three standard declinations in the formula (5).

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## CORRESPONDENCE TO:

Elżbieta Sojka
Department of Statistical-Mathematical Methods in Economics
Academy of Economics in Katowice
Bogucicka 14, 40-226 Katowice, Poland
[e-mail: esep@plusnet.pl]