

SUSTAINABLE ECONOMIC DEVELOPMENT OF THE POLISH DUO- REGION POMERANIA

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The aim of this paper is to determine the degree of social and economic development of poviats in the duo-region Pomerania composed of two seaside voivodships: West Pomeranian and Pomeranian.

The methods used include descriptive statistics and multidimensional comparative analysis (the measure of aggregation and cluster analysis).

The results of the ranking obtained by applying two different taxonomic methods were not the same. The varied results of the ranking and evaluation of poviats prove the need for an in-depth analysis in order to find the objective causes of this situation.

The presented methods could be applied to plan and monitor regional strategy with regard to sustainable development.

Sustainable development, region, taxonomic method.

Poland is a country of big regional disparities although GDP per capita does not differ from other European countries. Regional economic disparities in Poland are, on one hand, of structural nature (they result from differences in regional socio-economic structures and big share of agriculture in economy), and on the other hand, are conditioned by economic collapse of industrial areas. To determine the extent of regional variation of Poland's seaside areas and for the purpose of this study the Duo-Region Pomerania was distinguished, comprising two neighboring seaside voivodships: West Pomeranian and Pomeranian. Both provinces have similar natural and cultural environment, territory and number of self-government units. The Duo-Region comprises 34 poviats (second-level units of local government and administration) and 7 urban poviats, and spreads over 13% of total Poland's territory (41 thousand km²), inhabited by over 4 mln people, that is 10,4% of Poland's overall population. The Duo-Region's share in the country's Gross Domestic Product (GDP) is approx.10%. Capital expenditure and gross fixed assets show comparable values. Tab. 1 provides general data about the Duo-Region in the context of national economy.

1. Duo-Region Pomerania in the context of national economy(2011)

Territorial units	GDP(2010) (in mln PLN)	Gross value of fixed assets (mln PLN)	Capital expenditure (in mln PLN)	GDP per capita (PLN)	Gross value added per capita (PLN)	National economy units per 10 thousand inhabitants (items)
Poland	1 416 585	2 701 110,7	243 346,2	37096	90 193	1 004
Duo-Region Pomerania	134 224	266 641,9	22 716,4	33504	91 853	1 180
Share of the Duo-Region in national economy	9,48 %	9,87 %	9,34 %	90,32 %	101,84 %	117,57 %

Source: own compilation based on data from GUS (Polish Central Statistical Office)

GDP per one inhabitant of the Duo-Region was below the national average, whereas gross value added was slightly above the average. The number of business entities was almost 17,5% higher than the national average, which is evidence of good entrepreneurship in the region. In order to specifically pinpoint the areas of the Region that develop properly, that is in line with the concept of sustainable development, it would be necessary to conduct a more in-depth analysis –ideally on the poviats level (NTS4). The objective of this study, however, is to assess socio-economic development of the poviats of Duo-Region Pomerania and their classification in terms of direction and level of development (kind of sustainability).

RESEARCH MATERIAL AND METHODOLOGY

Research material consisted of statistical data retrieved from GUS, Polish Central Statistical Office, and reference books. The set of diagnostic variables was divided into two sub-sets: Z_S – comprising variables which describe the social situation and Z_E – the economic situation. Diagnostic variables (x_{ij}) meet the following criteria: they have weak correlation, high degree of variance and relatively high information value. To assess social development the following data were considered: percentage of people in pre-working age, percentage of people in post-working age, unemployment ratio, population growth and migration balance per 1000 inhabitants. Economic development was determined on the basis of: total income per capita, capital expenditure per capita and total expenses per capita. Next the authors proceeded to determine the socio-economic development of the Duo-Region poviats by applying the Zero Unitarization Method and k -means cluster analysis. The Zero Unitarization Method [Kukuła 2000] consists in standardization of diagnostic variables into synthetic aggregate measure (q_i) so that each falls within a closed interval $[0;1]$ and takes into consideration the impact the variables have on the analyzed phenomenon (equations 1 and 2).

$$\text{stimulants} \quad z_{ij} = \frac{x_{ij} - \min_i x_{ij}}{\max_i x_{ij} - \min_i x_{ij}}; \quad \max_i x_{ij} \neq \min_i x_{ij} \quad (1)$$

$$\text{destimulants} \quad z_{ij} = \frac{\max_i x_{ij} - x_{ij}}{\max_i x_{ij} - \min_i x_{ij}}; \quad \max_i x_{ij} \neq \min_i x_{ij} \quad (2)$$

Synthetic aggregate measure (q_i) was calculated separately on each dimension (social factors and economic factors) for each research period and for each analyzed object (poviat) according to the following equations (3 and 4).

$$q_i = \frac{1}{s} \sum_{j=1}^s z_{ij} \quad , \quad \bar{q} = \frac{1}{r} \sum_{i=1}^r q_i \quad (3)$$

$$S(q) = \left[\frac{1}{r} \sum (q_i - \bar{q})^2 \right]^{0,5} \quad (4)$$

where: s - number of variables, r - number of instances (objects).

The resulting synthetic indicators were used to group the objects based on intervals determined by mean average $\bar{q}$ and standard deviation $S(q)$. In this way a classification of poviats, put into groups, according to their social and economic development was established (Tab.2).

2. Classification criteria and diagnostic significance of groups

Groups	Interval	Diagnostic significance
1	$q_i \geq \bar{q} + S(q)$	Most developed poviats
2	$q_i \in \langle \bar{q}, \bar{q} + S(q) \rangle$	Averagely developed poviats
3	$q_i \in \langle \bar{q} - S(q), \bar{q} \rangle$	Poorly developed poviats
4	$q_i < \bar{q} - S(q)$	Least developed poviats

Source: own compilation

The k -means cluster analysis takes into account means for every cluster on every dimension so as to evaluate how much the clusters differ from one another. In result of the k -means analysis, k clusters of greatest possible distinction are produced. The procedure commences with k random clusters and next objects are moved between those clusters so as to minimize variability within a cluster and maximize variability between clusters. In this study previously standardized diagnostic variables, with classification into 4 categories and distance-based classification with a fixed interval were applied. The classification of poviats produced with cluster analysis was performed separately for every category of variables (social and economic) and for each research period (2005 and 2011). The resultant categories were tagged analogically as the classification produced with the use of synthetic aggregate measures.

The next step was to classify the poviats according to the level of socio-economic sustainability based on mean values of synthetic variables (Sp and Ek). Poviats included in groups 1 and 2 meet the sustainability criterion, whereas others were assessed as unsustainable. (Tab. 3)

3. Classification criteria of poviats with regard to the type of sustainable development

Group	Type of sustainability	Classification criterion	
		social	economic
I	Socially and economically sustainable poviats	$qi \geq Sp$	$qj \geq Ek$
II	Socially sustainable poviats	$qi \geq Sp$	$qj < Ek$
III	Economically sustainable poviats	$qi < Sp$	$qj > Ek$
IV	Socially and economically unsustainable poviats	$qi < Sp$	$qj < Ek$

Source: own compilation

OVERVIEW OF RESEARCH FINDINGS

First the findings revealed by the classification of poviats by aggregate measure will be presented herein, to be followed by results of the *k*-means clustering analysis. The inclusion of individual objects in particular social development categories was performed on the basis of calculated aggregate measures. The classification of poviats according to aggregate measure for years 2005 and 2011 is presented in the charts below (Tab. 4 and 5).

4. Classification of poviats according to the synthetic social indicator for 2005

Groups	Intervals	Number of poviats	Poviats
1	$<0,53092; \infty)$	6	gdański, m.Szczecin, m.Gdynia, m.Sopot, m.Gdańsk, policki
2	$<0,456722;0,53092)$	9	kartuski, kołobrzeski, m.Świnoujście, m.Słupsk, m.Koszalin, pucki, goleniowski, tczewski, kwidzyński
3	$<0,382524;0,456722)$	23	kościerski, malborski, chojnicki, leborski, koszaliński, myśliborski, gryfiński, kamieński, szczecinecki, starogardzki, człuchowski, nowodworski, białogardzki, pyrzycki, słupski, gryficki, bytowski, sztumski, wejherowski,
4	$(-\infty;0,382524)$	3	drawski, choszczeński, łobeski, świdwiński

Source: own compilation

5. Classification of poviats according to the synthetic social indicator for 2011

Groups	Lower limit	Upper limit	Number of poviats	Poviats
1	0,646473		9	kartuski, kościerski, wejherowski, pucki, kwidzyński, tczewski, chojnicki, bytowski, starogardzki
2	0,571297	0,646473	10	gryfiński, słupski, wałecki, człuchowski, sztumski, goleniowski, policki, myśliborski, leborski, gdański m.Gdynia, kołobrzeski, stargardzki, m. Słupsk, m. Gdańsk, gryficki,
3	0,49612	0,571297	16	ślawieński, malborski, koszaliński, m. Koszalin, drawski, nowodworski, choszczeński, białogardzki, świdwiński, m. Świnoujście
4		0,49612	6	pyrzycki, szczecinecki, kamieński, łobeski, m.Szczecin, m.Sopot

Source: own compilation

Based on the classification results it was concluded that in 2005 approx. 50% of poviats scored below the regional average in terms of social development. As few as 15 poviats reached the level of social development which is

considered sustainable. In 2011 a regrouping of poviats took place in result of an increase in the number of poviats showing the highest and average development (18). Unfortunately, the rising trend was also seen in the least developed poviats, the number of which increased from three (in 2005) to six (in 2011). In eight poviats social development deteriorated and in result, the poviats were degraded into categories no 3 and 4. These were all poviat cities: the city of Szczecin, Gdynia, Gdańsk, Świnoujście, Słupsk, Koszalin and Kołobrzeg. However, 10 poviats were upgraded to the category of poviats showing sustainable social development, i.e.: kościerski, chojnicki, lęborski, myśliborski, gryfiński, starogardzki, człuchowski, słupski, bytowski and sztumski.

Results obtained for economic factors in 2005 with regard to the quantity of poviats in given categories were similar to the results of the social development classification. Chart 6 provides the results of classification of poviats according to synthetic economic measure in given years.

6. Classification of poviats according to the synthetic economic indicator

Groups	Lower limit	Upper limit	Number of poviats	Poviats
2005				
1	0,429433		6	m.Sopot, m.Świnoujście, m.Gdynia, m.Koszalin, człuchowski, m.Słupsk
2	0,37767	0,429433	7	nowodworski, m.Gdańsk, koszaliński, bytowski, łobeski, szczeciniecki, kwidzyński
3	0,325906	0,37767	28	białogardzki, sławieński, goleniowski, łobeski, gryfiński, myśliborski, pyrzycki, świdwiński, kartuski, stargardzki, białogardzki, wałecki, pucki, gdański, wejherowski, bytowski, gdański, chojnicki, człuchowski, lęborski, słupski, kościerski, malborski, starogardzki, tczewski, sztumski, m. Szczecin, kołobrzski, policki
4		0,325906	0	
2011				
1	0,407257		0	
2	0,35098	0,407257	8	nowodworski, kołobrzski, policki, kamieński, koszaliński, drawski, gryficki, choszczeński, sławieński, goleniowski, szczecinecki, łobeski, gryfiński, myśliborski, pyrzycki, świdwiński, kartuski, stargardzki, białogardzki, wałecki, pucki, gdański, wejherowski, bytowski, chojnicki, człuchowski, lęborski, słupski, m.Słupsk, kościerski, kwidzyński, malborski, starogardzki, tczewski, sztumski, m.Gdańsk, m.Sopot, m.Świnoujście, m. Szczecin, m.Gdynia
3	0,294702	0,35098	32	
4		0,294702	1	m.Koszalin

Source: own compilation

None of the poviats fell within the lowest category and as many as 28 were assigned to group 3 standing for poor economic development, that is below the region's average. Merely 13 poviats fell in the categories of average and high economic development. Moreover, in 2011 the economic situation in the region deteriorated. None of the poviats could be classified in the highest economic development category and as many as 33 poviats were classified in the category below the average. Only 2 poviats, that is nowodworski and koszaliński, remained in the same category of average economic development.

Finally, in accordance with the criterion of equalization of development, poviats were assigned to respective groups depending on the type and level of sustainability of socio-economic development (Tab. 7).

**7. Classification of poviats in the Duo-Region Pomerania
by type of development obtained through aggregate method**

Groups	Type of sustainability	Poviats	
		2005	2011
I	Socially and economically sustainable poviats	m.Świnoujście, m.Gdynia, m.Koszalin, m.Śłupsk, m.Gdańsk, kwidzyński	policki
II	Socially sustainable poviats	gdański, m.Szczecin, policki	Kartuski, kościerski, pucki, kwidzyński, chojnicki, bytowski, starogardzki, gryfiński, ślupski, wałecki, człuchowski, sztumski, goleniowski, myśliborski, gdański
III	Economically sustainable poviats	koszaliński, szczeciniecki, człuchowski, nowodworski, wejherowski	nowodworski, kołobrzesci, kamieński, koszaliński, drawski, gryficki, choszचेński, wejherowski
IV	Socially and economically unsustainable poviats	kościerski, chojnicki, myśliborski, gryfiński, starogardzki, człuchowski, białogardzki, pyrzycki, ślupski, bytowski, sztumski, świdwiński	The cities of Koszalin, Szczecin, Sopot, powiatślobeski, szczeciniecki, pyrzycki, starogardzki, city of.Śłupsk, city of Gdańsk, sławieński, malborski, białogardzki, the city of Świnoujście

Source: own compilation

Comparative analysis of the obtained results showed that none of the poviats managed to remain in the top category of socially and economically sustainable poviats. In 2005 out of six poviats only policki poviat met the criteria of group I. In 2011 the number of socially sustainable poviats rose from three to fifteen, but only one poviat – gdański – could be found in this category in

both periods. From five poviats which were grouped as economically sustainable in 2005, three remained in the category and five more joined it in 2011. The socially and economically unsustainable category increased by one poviat as compared to 2005, and two poviats: białogardzki and pyrzycki remained in this category in both years.

At the second stage of research, to compare the results of poviats' classification, a multidimensional data analysis using *k*-means clustering method was performed. Clusters were formed separately for social factors (Tab. 10) and economic factors (Tab. 8) in particular years using the same as before standardized diagnostic data.

8. Classification of poviats according to social factors with the use of *k*-means method

2005		
Cluster	Number	Poviats
Group no 1	9	Chojnicki, goleniowski, kołobrzesci, kościerski, kwidzyński, lęborski, pucki, starogardzki, tczewski
Group no 2	21	Białogardzki, bytowski, choszczeński, człuchowski, drawski, gryficki, gryfiński, kamieński, koszaliński, łobeski, malborski, myśliborski, nowodworski, pyrzycki, sławieński, słupski, stargardzki, szczecinecki, sztumski, świdwiński, wałecki
Group no 3	4	gdański, kartuski, policki, wejherowski
Group no 4	7	m.Gdańsk, m.Gdynia, m.Koszalin, m.Słupsk, m.Sopot, m.Szczecin, m.Świnoujście
2011		
Group no 1	10	Chojnicki, goleniowski, kościerski, lęborski, myśliborski, policki, pucki, słupski, stargardzki, starogardzki
Goup no 2	5	m.Gdańsk, m.Słupsk, m.Sopot, m.Świnoujście, malborski
Group no 3	16	Białogardzki, bytowski, choszczeński, człuchowski, drawski, gryficki, gryfiński, kamieński, koszaliński, łobeski, nowodworski, pyrzycki, sławieński, szczecinecki, sztumski, świdwiński
Group no 4	10	gdański, kartuski, kołobrzesci, kwidzyński, m.Gdańsk, m.Koszalin, m.Szczecin, tczewski, wałecki, wejherowski

Source: own compilation

Three poviats (kołobrzesci, tczewski and kwidzyński) from Group no 1 dropped to the lowest group and almost all poviats classified in Group no 2 (except for poviat malborski) were transferred to lower groups. However, three city poviats: Gdańsk, Słupsk, Sopot and Świnoujście moved up to Group No 2. Other urban poviats did not improve their position. A general deterioration of results was observed, with the number of poviats in the two top categories dropping by half, which may hint at implementation of inadequate social policy in most of the poviats.

Classification of objects based on standardized variables describing the economic situation of poviats showed less variance with regard to the size of particular groups. Tab. 9 presents list of clusters for these factors.

9. Classification of poviats according to economic factors with the use of *k*-means method

2005		
Cluster	Number	Poviats
Group no1	7	M. Gdańsk, m. Gdynia, m. Koszalin, m. Słupsk, m. Sopot, m. Szczecin, m. Świnoujście
Group no 2	8	Białogardzki, bytowski, człuchowski, koszaliński, kwidzyński, łobeski, nowodworski, szczecinecki
Group no3	19	Chojnicki, choszczeński, drawski, goleniowski, gryficki, gryfiński, kamieński, kołobrzesci, kościerski, lęborski, malborski, myśliborski, policki, pyrzycki, stargardzki, starogardzki, sztumski, świdwiński, tczewski
Group no 4	7	Gdański, kartuski, pucki, sławieński, słupski, wałecki, wejherowski
2011		
Group no 1	7	M. Gdańsk, m. Gdynia, m. Koszalin, m. Słupsk, m. Sopot, m. Szczecin, m. Świnoujście
Group no 2	15	Białogardzki, bytowski, choszczeński, człuchowski, drawski, gryficki, kołobrzesci, koszaliński, malborski, nowodworski, policki, starogardzki, szczecinecki, świdwiński, tczewski
Group no 3	18	Chojnicki, gdański, goleniowski, gryfiński, kamieński, kartuski, kościerski, kwidzyński, lęborski, łobeski, myśliborski, pucki, pyrzycki, sławieński, słupski, stargardzki, wałecki, wejherowski
Group no 4	1	sztumski

Source: own compilation

Detailed analysis of economic factors clustering revealed that none of the poviats changed their classification (Group no 1) which is proof of adequate economic policy being carried out by local government. Significant change was observed in Group no 2 since as many as nine poviats improved their economic results, whereas two poviats dropped to a lower category. In 2011 all poviats formerly classified in Group no 4 were upgraded to a higher category and only one (poviat sztumski from the West Pomeranian voivodship) remained in the lowest category. Since the number of poviats included in Group no 2 doubled, it can be assumed that region's self-government had embarked on more adequate economic policy which produced measurable economic effects.

At the final stage, classification of poviats according to the type and level of development was performed based on the number of clusters obtained (Tab. 10). Classification in the two top categories was considered desirable, whereas the remaining two categories signified poorer development. This cross-referencing of reclassified poviats for given years served as a basis to draw conclusions about directions for further development for given objects (poviats).

10. Classification of poviats of the Duo-Region Pomerania according to the type and level of development based on k-means clustering analysis

Group	Type of sustainability	Poviats	
		2005	2011
I	Socially and economically sustainable poviats	Białogardzki, bytowski, człuchowski, koszaliński, kwidzyński, łobeski, nowodworski, szczecinecki Chojnicki, choszczeński, drawski, goleniowski, gryficki, gryfiński, kamieński, kołobrzesci, kościerski, lęborski, malborski, myśliborski, pucki, pyrzycki, sławieński, słupski, stargardzki, starogardzki, sztumski, świdwiński, tczewski, wałecki	m.Gdynia, m.Słupsk, m.Sopot, m.Świnoujście, malborski, policki, starogardzki
II	Socially sustainable poviats		Chojnicki, goleniowski, kościerski, lęborski, myśliborski, pucki, słupski, stargardzki
III	Economically sustainable poviats	m.Gdańsk, m.Gdynia, m.Koszalin, m.Słupsk, m.Sopot, m.Szczecin, m.Świnoujście	Białogardzki, bytowski, choszczeński, człuchowski, drawski, gryficki, kołobrzesci, koszaliński, m.Gdańsk, m.Koszalin, m.Szczecin, nowodworski, szczecinecki, świdwiński, tczewski
IV	Socially and economically unsustainable poviats	Gdański, kartuski, policki, wejherowski	Gdański, gryfiński, kamieński, kartuski, kwidzyński, łobeski, pyrzycki, sławieński, sztumski, wałecki, wejherowski

Source: own compilation

None of the poviats was classified as socially and economically sustainable in both research periods. The poviat that definitely stood out was poviat policki, which moved from the unsustainable to sustainable category thus being the topmost example of successful and effective socio-economic policy in place. Three cities with poviat rights, that is Gdańsk, Koszalin and Szczecin, were classified each time as economically sustainable. Other cities (Gdańsk, Słupsk, Sopot and Świnoujście) were upgraded from the economically sustainable to the socially and economically sustainable category. Two poviats (kwidzyński and łobeski) initially classified as sustainable were reclassified as unsustainable, and six poviats from the top sustainable category were, in the successive year, degraded to the socially sustainable category. Three poviats (gdański, kartuski and wejherowski) had the worst record as in each analyzed year they were classified as unsustainable poviats.

Conclusions

1. The results of classifications obtained through aggregate measures revealed a similar trend in two cases (growth in the unsustainable category and decline in the socially and economically sustainable category). In case of sustainable categories the results show significant variance only on one dimension (social or economic). According to aggregate measure, the number of economically sustainable poviats rose, whilst the number of socially sustainable poviats fell down. Nonetheless, the results obtained through k-means clustering analysis showed a reverse trend.

2. Classification of poviats with the use of clustering method indicates that urban poviats develop towards social and economic sustainability which seems to confirm the general feeling.

3. The research conducted indicates that in 2005 the Duo-Region Pomierania was distinctly divided into central and peripheral poviats and that definitely it was the urban poviats that showed highest growth potential. In 2011 this division did not include powiat policki, home to Chemical Plant Police, which was the only powiat to meet the criteria of sustainable socio-economic development in each of the periods analyzed.

4. The variance revealed in the classification and poviats' overall assessment indicates that a more in-depth analysis should be undertaken in order to pinpoint the causes of such disparities within the Duo-Region.

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Определена степень социально-экономического развития районов в дуо-регионе Померания, состоящего из двух приморских областей: Западно-Поморское и Померания.

Использованы методы “описательная статистика” и “многомерный сравнительный анализ” (мера агрегации и кластерный анализ).

Получены различные результаты ранжирования, осуществленного путем применения двух различных таксономических методов.

Устойчивое развитие, регион, таксономический метод.

Визначено ступінь соціально-економічного розвитку районів в дуо-регіоні Померанія, який складається з двох приморських областей: Західнопоморське та Померанія.

Використано методи “описова статистика” та “багатовимірний порівняльний аналіз” (міра агрегації та кластерний аналіз).

Отримано різні результати ранжування, яке було здійснено шляхом застосування двох різних таксономічних методів.

Представлені методи можуть бути застосовані для планування та моніторингу регіональної стратегії в умовах сталого розвитку.

Сталий розвиток, регіон, таксономічний метод.