Demographic Potential as the Basis for Spatial Differentiation of the Financial Situation Communes of Eastern Poland in 2009-2018

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Abstract:

Purpose: The resources of labor and endogenous capital in these communes are shrinking due to wash-out effects. The aim of the article is an attempt to identify demographic factors influencing the spatial differentiation of the financial situation and an attempt to establish a relationship between the demographic situation of communes and their financial situation.

Design/Methodology/Approach: The choice of variables in 2009-2018 was largely conditioned by the availability of data collected in the municipal system at the Local Data Bank of the Central Statistical Office. The Technique for Order Preference by Similarity to an Ideal Solution method was used to build synthetic measures.

Findings: Communes located peripheral to the central center are characterized by, among others the effect of washing out the demographic potential. Their main problem is the scarcity of endogenous factors, which is a barrier to independent initiation of development. The research results indicate that a better demographic potential increases the diversity of individuals. Moreover, there is a relationship between the demography and the financial situation of communes. Demographic conditions are one of the basic factors in the development of communes. The financial situation and development opportunities change in the face of a progressive decline in the fertility rate, aging of the population and increasing population mobility.

Practical Implications: The results of the conducted research enable local governments to make comparisons. The conclusions drawn may allow local authorities to determine potential directions of optimization of fiscal and demographic policies.

Originality/value: The added value of the paper is the research findings focused on the assessment relationship between the financial situation and the demographic potential of municipalities. The research was conducted on a large group of communes (484) in eastern Poland.

Keywords: Demographic potential, financial situation, commune, spatial diversity.

JEL classification: G22, G32, M31, P25, R11, R12.
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1. Introduction

Communes operate and develop in an increasingly complex environment, their functioning must adapt to changes in the internal situation and external conditions. They become a place of concentration of economic activity and a creator of development, and they are also characterized by autonomy in making decisions. The determinants of the operation of municipalities are endogenous resources: financial, environmental, demographic and infrastructure, which are interconnected and create a multidimensional space.

The knowledge of demographic phenomena and processes is important for shaping the financial situation of an individual. Socio-economic development depends on demographic conditions: number of inhabitants, population density, age structure of inhabitants, net migration, natural increase. The impact of demographic factors also translates into the level and structure of funds accumulated in municipal budgets - their financial situation.

The communes perform the public tasks assigned to them from their own funds and mainly from the state. The right to participate in public income, adequately to the tasks assigned to them, is guaranteed by the Constitution of the Republic of Poland. The financial situation determines the possibilities of timely fulfillment of financial obligations and ensuring continuity in the provision of services. Finance allows for a comprehensive assessment of the commune's activities and its development possibilities or the implementation of public tasks. There is a feedback loop between the demographic, socioeconomic and financial variables (Dziekański and Prus, 2020; Bąk, Cheba, and Łącka, 2000).

The aim of the article is an attempt to identify demographic factors influencing the spatial differentiation of the financial situation and an attempt to establish a relationship between the demographic situation of communes and their financial situation. The aim of the work stated in this way allowed the authors to present research questions: Is the level of the financial situation of rural communes dependent on the level of demographic variables? What is the spatial distribution of the level of the financial situation and the demographic potential of rural communes in eastern Poland? Which variables of the demographic potential of communes shape the level of their financial situation? Empirical data was collected in the spatial terms of 484 rural communes in eastern Poland.

The choice of variables in the years 2009-2018 was largely conditioned by the availability of data collected in the municipal system in the Local Data Bank of the Central Statistical Office (BDL GUS). To build synthetic measures, the TOPSIS (Technique for Order Preference by Similarity to an Ideal Solution) method was used. in spatial and temporal terms, and their linear ordering - the construction of the ranking and classification. Contrary to partial measures, which use many numbers, inform about individual elements that make up the studied phenomenon, synthetic

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measures express the state of this phenomenon with only one number (Zimny, 2008).

2. The Influence of Demographic Variables on the Financial Situation of Communes (Literature Review)

The functioning of the local government in Poland is determined by various factors. They are economic, demographic, geographic, historical and political. Similar factors also shape the level and structure of financial resources at the disposal of local government units. The above-mentioned factors indicate that the condition of local finances depends, inter alia, on on the degree of economic development of a given unit, demographic variables, as well as factors of an economic, social or spatial nature. Social factors include, for example, educational issues, professional activity, the wealth and cohesion of the local community, and demographic factors (Monitoring rozwoju obszarów wiejskich…).

The demographic potential is one of the key factors determining the socio-economic development of territorial units, based on two basic phenomena: natural movement of the population (births and deaths) and migration (Pomianek, 2014). It is an endogenous factor of economic development, influencing the formation of human capital, which consists of the part of human resources that actively or potentially participates in socio-economic activity due to the possessed qualifications, skills or knowledge. P. Churski and R. Perdał define human capital as equipping the region with the resources of qualified and educated workforce, having access to the educational offer enabling lifelong learning in accordance with the needs of the labor market (Churski and Perdał, 2008). The condition and structure of human capital on a local scale are also determined by exogenous factors, especially the population situation in the region (Bański, Pantylej, Janicki, and Wesołowska, 2014). According to Rosner's research, there is a close relationship between population processes and the level of socio-economic development. There is a tendency to deepen the differentiation in this respect, as areas with low population density usually show a tendency to further depopulation, and this process causes a deterioration of budget revenues (Rosner, 2012).

In order to identify the demographic factors shaping the income situation of local government units, first of all, the fiscal significance of individual income groups should be determined, and then the determinants that affect these income should be analyzed in detail (Bitner, 2014). Knowledge of the social potential (human capital) and the labor market at the commune level and its changes is of great importance for identifying determinants of the development policy (Falk and Kilpatrick, 2000). Migration is a factor causing significant changes in the level of population, spatial distribution and in various structures of the population. The factors influencing migration included the level of entrepreneurship, the situation on the local labor market, the wealth of the commune and housing resources (Quaranta, Citro, and Salvia, 2016).

Demographic changes consisting in a gradual decrease in the number of inhabitants, as well as a deterioration of the demographic structure of societies, may also determine the narrowing of the local tax base. The number of inhabitants together with the amount of wages they earn are the key variables influencing the size of local government revenues, the main source of which is the share in revenues from personal income tax. However, the consequence of the aging of the population may be an increase in some local government expenditure, resulting from, inter alia, from the increase in the costs of care services and social benefits (Wójtowicz, 2018).

The financial situation is the ability to finance services using the accumulated income in the given socio-economic and institutional conditions. It is also the ability of local government authorities to generate sufficient funds necessary to settle liabilities in a given period (Majchrzak, 2012). The financial situation is a relative assessment of the commune's finances, i.e. the possibilities to ensure financial security. This security includes the ability to perform tasks and reliability in terms of the ability to pay off both current and future liabilities (Stanny and Strzelczyk, 2018). The financial position relates to the ability of the individual, including to raise sufficient funds, provide public services and manage debt. It is the municipality's ability to meet its own administrative and investment needs, which means maintaining and developing its own assets in line with the current and future public service needs (Hendrick, 2004).

The financial situation is complex and is influenced by many factors. Knowledge of the current state of finances allows local authorities to make comparisons with other entities and is helpful in making financial decisions. The financial situation cannot be described with one indicator, e.g., based on the financial statements or the budget (Cabaleiro-Casal, Buch-Gómez, and Vaamonde Liste, 2013). The financial situation is the state of finances that allows to cover: current bills, expenses without incurring debts in a given budget period, all costs of running a business in the long term and services at a level ensuring the safety and well-being of the local community (Groves and Valente, 1994).

Wang, Dennis, and Sen (2007) believe that the socio-economic environment is only one of the factors that should be taken into account when analyzing the financial situation. Berne and Schramm (1986) include the main determinants of the financial situation, inter alia, local community needs, supply and distribution directions of local public goods and services, labor costs, social affluence, financial policy. Ladd (1992) emphasizes the impact of demographic conditions on the condition of local government finances, proving, inter alia, that higher population density leads to an increase in local government spending. Excessive population growth leads to a weakening of the financial situation in local government units and a reduction in the scope of public services they offer. Rodríguez Bolívar and co-authors (2016) identified the main factors shaping the financial situation as the state and changes in the size of the population, conditions of the local labor market, increase in local government spending and public finance management.

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3. Material and Research Method

A synthetic measure was used to assess the spatial differentiation of the financial situation and demographic potential. This measure allowed for a multidimensional look at the level of the phenomenon in individual examined objects, conducting comparative analyzes of objects (in spatial and time terms) and their linear ordering (Lenormand, Deffuant, 2013). The construction of the synthetic meter required several stages: 1) selection of diagnostic features and determination of the manner of their influence on the studied phenomenon, 2) normalization of variables, aimed at making the variables, expressed in different scales and with different titers, comparable to each other, 3) selection of the type of synthetic measure and determination of the aggregating function, 4) ordering objects according to the value of the measure, 5) establishing typological groups of objects (Malina, 2020; Helwig, 1968).

At the beginning, a set of variables describing the studied phenomenon was selected. The description of the set is presented in the form of an observation matrix in the form:

$$x_{ij} = \begin{bmatrix} x_{11} & x_{12} & ... & x_{1m} \\ x_{21} & x_{22} & ... & x_{2m} \\ ... & ... & ... & ... \\ x_{n1} & x_{n2} & ... & x_{nm} \end{bmatrix} \tag{1}$$

where - denotes the values of the j-th feature for the i-th object, i - object number (i = 1, 2, ..., n), j - variable number (j = 1, 2, ..., m) .

In the case of communes, the choice of variables was largely determined by the availability of statistical data collected in the communal system. Some of the data within the BDL CSO was incomplete, and the data did not cover all communes. Therefore, the focus was on selected variables described in Table 1.

Table 1. List of variables describing the financial situation and demographic potential of communes.

Variables		Jedn.	S/D
	Financial situation		
X1	Operating surplus / total revenue (budget solvency ratio)	%	S
X2	Own income / total income (financial independence ratio)	%	S
X3	Share in taxes constituting state budget revenues * / number of inhabitants (fiscal wealth per capita indicator)	PLN	S
X4	Local tax / population income (per capita fiscal wealth)	PLN	S
X5	Local Tax Revenue / Current Revenue (Tax Autonomy Indicator)	%	S
X6	Investment expenditures / total expenditures (investment attractiveness index	%	S
X7	Transfer revenues / total revenues (financial state interference rate)	%	D
X8	Expenditure on education and upbringing / number of inhabitants	PLN	S
X9	Expenditure on the housing economy / number of inhabitants	PLN	S
X10	Spending on oh. health / number of inhabitants	PLN	S

X11	Expenditure on municipal economy and environmental protection / number of inhabitants	PLN	S
X12	Expenditure on public safety and fire protection / number of inhabitants	PLN	S
X13	Expenditure on public administration / number of inhabitants	PLN	D
X14	Agricultural and hunting expenditure / number of inhabitants	PLN	S
X15	Own interest / income (debt service ratio)	%	D
	Demographic potential		
X16	Demographic dependency rate for the elderly	osoba	D
X17	Natural increase per 1,000 inhabitants	osoba	S
X18	Balance of migration per 1,000 inhabitants	osoba	S
X19	The unemployed registered in communes per 1,000 inhabitants	osoba	D
X20	People working in communes per 1,000 inhabitants	osoba	S

*Note: S stimulant, D destimulant, operating surplus = total income - property income - current expenditure, REGON (Register of National Economy), National Official Register of Entities - register kept by the President of the Central Statistical Office. The notion of REGON is also understood as the REGON identification number, i.e. the nine-digit identifier given to the entity in this register. * Communes have a share in the personal income tax (PIT) and corporate tax (CIT)*
Source: Study based on data from the Central Statistical Office of Poland, and Stanny, Strzelczyk (2018), Wang (2007), Dziekański, Prus (2020).

After selecting the variables, the nature of each of them was examined. It was determined whether a given variable is a stimulant or a destimulant, i.e. whether high values of the index cause the development of a given individual or stagnation. Most of the variables are stimulants, their determination results from the substantive experience of the authors and the analysis of the literature. In doubtful cases, the procedure by Grabiński (1985) was applied, using the fact that stimulants should be positively correlated with each other, similarly to destimulants, and negatively with destimulants .

In order to ensure the representativeness of the variables, the final set was filled with variables that were characterized by a greater discriminant ability in a given category (higher coefficient of variation in the analyzed time interval, assuming the coefficient of variation as 0.10) and weak correlation with the variables remaining in this category (according to inverted correlation matrix). According to A. Malina (2004), a high value of the correlation coefficient causes duplication of information about the analyzed phenomenon and may lead to incorrect conclusions. Two features strongly correlated with each other are carriers of similar information, so one of them is redundant. Overcorrelated features (diagonal elements correspond to them) in the case of an inverse matrix with values greater than 10 are eliminated from the set of variables. The procedure is repeated until the stability of the R-1 matrix is achieved and diagonal elements appear, the values of which do not significantly exceed 10.

The variables selected for the analysis have sufficient discriminant ability. The values of the variables in the analyzed period were subject to preliminary statistical analysis, determining the values of the described parameters. The value of the coefficient of variation of the variables used in the study ranged from approximately -3.13 to 2.05. The greatest differentiation was noted in the variables characterizing the financial situation (health care expenditure 2.05; municipal management 1.66). The smallest was in the case of the demographic potential

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variables (birth rate -1.71 and net migration -3.13) see table 2. Moreover, almost all variables are characterized by positive asymmetry, which in the case of stimulants is not a favorable situation, as it means that a greater number of communes have values of these variables lower than their average value (Table 2).

Table 2. *Statistical characteristics of the diagnostic variables of rural communes in eastern Poland in 2018*

Variable	Gap	Average	Deviation	Variability	Asymmetry
financial situation					
X1	0.31	0.08	0.04	0.48	0.75
X2	0.59	0.28	0.10	0.34	1.55
X3	0.42	0.09	0.05	0.54	2.62
X4	2.11	0.10	0.14	1.36	8.14
X5	0.62	0.11	0.06	0.56	2.89
X6	0.47	0.21	0.09	0.45	0.42
X7	0.64	0.64	0.10	0.15	-1.05
X8	3301.95	1368.67	304.66	0.22	2.53
X9	933.04	65.77	108.86	1.66	4.04
X10	569.52	16.80	34.44	2.05	10.49
X11	3712.70	431.05	391.39	0.91	2.95
X12	684.28	60.87	51.40	0.84	5.27
X13	961.19	481.96	145.77	0.30	1.78
X14	2611.15	251.89	292.99	1.16	3.10
X15	0.09	0.02	0.02	0.79	1.16
Demographic potential					
X16	53.30	25.23	6.13	0.24	2.27
X17	38.78	-2.58	4.42	-1.71	-1.31
X18	93.60	-2.14	6.70	-3.13	3.72
X19	106.00	39.00	16.61	0.43	0.82
X20	1229.00	84.30	71.94	0.85	9.14

Source: Own study.

Subsequently, the destimulant was replaced with a stimulant according to the formula (Walesiak, 2005; Kolenda, 2003):

$$x_{ij} = \frac{1}{x_{ij}} \qquad (2)$$

The selected variables were subjected to the zero unitarisation procedure using the formula:

$$z_{ij} = \frac{x_{ij} - \min_i x_{ij}}{\max_i x_{ij} - \min_i x_{ij}} \text{ when } x_i \in S \qquad (3)$$

where: S - stimulant, - denotes the value of the j-th feature for the i-th object, max {} - the maximum value of the j-th variable, min {} - the minimum value of the j-variable, the normalized value of the *j*-th feature for the *i*-th object . The value is in the range [0; 1]. The

value of 1 means that the variable obtained the maximum value among all the examined objects in the whole period of time. A value equal to 0 means that the object took the minimum value (Wysocki, Lira, 2005; Kukuła, 2000). As a result of the transformations, a matrix of unitized values of variables was obtained:

$$z_{ij} = \begin{bmatrix} z_{11} & z_{12} & ... & z_{1m} \\ z_{21} & z_{22} & ... & z_{2m} \\ ... & ... & ... & ... \\ z_{n1} & z_{n2} & ... & z_{nm} \end{bmatrix} \tag{4}$$

where: denotes the unitary value of the j feature for the ith object.

A synthetic measure based on the TOPSIS (Technique for Order Preference by Similarity to an Ideal Solution) method was used in the analysis of the spatial differentiation of the financial situation and demographic potential of rural communes in eastern Poland. TOPSIS is a reference method in which the reference point of objects in a multidimensional space are the pattern and the anti-pattern. As part of the adopted method, the synthetic measure was calculated separately for each commune, taking into account the unit's distance from the standard (= 1) and the anti-standard (= 0). They were defined according to the following formulas:

$$z_j^+ = \left(max_i(z_{i1}), max_i(z_{i2}), ..., max_i\left(z_{ij}\right) \right) = \left(z_1^+, z_2^+, ..., z_j^+\right) \in (1,1, ..., 1) \tag{5}$$

$$z_j^- = \left(min_i(z_{i1}), min_i(z_{i2}), ..., min_i\left(z_{ij}\right) \right) = \left(z_1^-, z_2^-, ..., z_j^-\right) \in (0,0, ..., 0) \tag{6}$$

The Euclidean distances of individual objects from the pattern and anti-pattern were successively calculated according to the formulas:

$$d_i^+ = \sqrt{\frac{1}{n} \sum_{j=1}^{m} \left(z_{ij} - z_j^+\right)^2} \tag{7}$$

$$d_i^- = \sqrt{\frac{1}{n} \sum_{j=1}^{m} \left(z_{ij} - z_j^-\right)^2} \tag{8}$$

where n- stands for the number of variables forming the pattern or anti-pattern, - stands for the unitized value of the j feature for the tested unit, - stands for the pattern or anti-pattern object (Bąk, 2018).

The values of the synthetic variable are estimated with the use of aggregation functions, the analytical form of which may vary. The synthetic measure for individual objects was determined on the basis of the formula:

$$q_i = \frac{d_i^-}{d_i^- + d_i^+}, gdzie \ 0 \le q_i \le 1, i = 1, 2, ..., n; \tag{9}$$

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where: $\in [0; 1]$ - value of the synthetic measure; - means the distance of the object from the anti-pattern (from 0), means the distance of the object from the pattern (from 1). A higher value of the measure indicates a better situation of an individual in the analyzed area (Hwang, Yoon, 1981).

The TOPSIS method gives the opportunity to carry out an evaluation using an unlimited number of criteria, where the readability level of the obtained results is high and enables their presentation in numerical form. Presenting the level of a complex phenomenon in the form of one synthetic indicator allows for a linear ordering of objects, i.e. building a ranking of units in spatial terms. An important advantage of the classic TOPSIS method is its computational simplicity, indication of a positive and negative model, a large number of alternative criteria that can be used in the evaluation process, and global ordering of objects (Jahanshahloo, Lotfi, Izadikhah, 2006).

In the last stage of research, the division into typological groups was used to interpret the obtained measures. Percentiles were adopted as threshold values (which allowed to divide the studied group into 5 groups). The size of the synthetic measure in the first group means a better unit, in the next groups - weaker units. The correlation coefficient (Pearson) was also assessed, close to ± 1, which means that the quantities are well correlated and there is a functional relationship between them. A scatterplot with a fit line was also presented, and a linear regression analysis was performed (Wysocki, 1996; Zeliaś and Malina, 1997).

Regression analysis allowed to create a linear model, thanks to which it was checked how independent variables, also known as predictors, affect the dependent variable. When creating the regression model, it was decided which variables would be the dependent variable and which would become the dependent variable. The model allows to describe the relationships between the explanatory variables (Y) and the explained variables (X), between which there are more or less clear linear relationships. Linear regression analysis made it possible to calculate regression coefficients so that the model predicted the value of the dependent variable as well as possible and that the estimation error was as small as possible. The linear regression model is described by the following formula:

$$y_i = b\, x_i + a, \quad i = 1,2, ..., n, \tag{10}$$

where:
y - dependent variable (dependent)
x - independent (independent) variable
b - slope, regression coefficient y with respect to x (by how much the value of the variable y changes on average, if the value of the variable x increases by one unit),
a - intercept.

For the multiple regression model, with more predictors, we use the following formula for the regression line:

$$y = b_1\, x_1 + b_2\, x_2 + ... + b_i\, x_i + a, \quad i = 1,2, ..., n, \tag{11}$$

where:
b - is the regression coefficient calculated for individual predictors in the model,
x - predictor values, independent (independent) variable,
y - is the dependent variable, dependent variable,
a - is an intercept.

Regression analysis allows, on the one hand, to check whether the constructed model allows to significantly predict the value of the explained variable, and, on the other hand, to determine which predictors allow to significantly predict it. In the process of building a regression model, the autocorrelation of variables should be excluded. Therefore, the first step is to check the fit of the model using the analysis of variance. If it turns out to be statistically significant, we proceed to reading the beta standardized coefficients and their significance level. Next, determine the percentage of the variance explained by reading the (preferably corrected) R2 statistic. The coefficient of determination determines the degree to which the estimated regression function explains the variability of y (Maddala, 2007).

4. Financial Differentiation of Rural Communes in Eastern Poland (Empirical Results)

An assessment of the identification of demographic factors influencing the spatial differentiation of the financial situation was carried out with the use of a synthetic measure in the system of 484 communes of eastern Poland (lubelskie, podkarpackie, podlaskie, świętokrzyskie, warmińsko-mazurskie voivodships). Eastern Poland is a compact area with the lowest level of economic development in Poland and one of the weakest in the European Union. The nature of the problems adversely affecting the socio-economic situation and the development prospects of this area to a large extent have a structural dimension, being a consequence of historical conditions. From the point of view of the development potential of these voivodships, the following are unfavorable conditions: low effectiveness of the structure of the economy and the labor market, constant outflow of its inhabitants to other regions or a low level of innovation (Program Operacyjny, Polska Wschodnia 2014–2020…).

Figure 1 shows the classification of rural communes in eastern Poland in terms of their financial situation and demographic potential (white are urban and urban-rural communes not included in the study, black is the best unit, and the lighter color is the weaker unit). The classification of municipalities was carried out on the basis of parentels, which were the threshold values for subsequent groups. The rural communes of eastern Poland are characterized by significant disproportions in terms of financial situation and demographic potential. Communes distinguished by a higher level of financial situation have a higher demographic potential index.

The synthetic measure qi of the financial situation ranged from 0.14 to 0.51 in 2018 and from 0.09 to 0.39 in 2009. In the case of the demographic potential measure, the synthetic measure ranged from 0.15 to 0.54 in in 2009 to 0.14 - 0.57 in 2018. An increase in the range measure from 0.30 to 0.37 in the case of the financial situation and from 0.38 to 0.42 - in the case of demographic potential, indicates an increase in the differentiation of individuals and a similar direction the impact of individuals on the processes taking place in their economy.

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Figure 1. *Quartile groups for measures of the synthetic financial situation and demographic potential of rural communes in eastern Poland in 2009 and 2018*
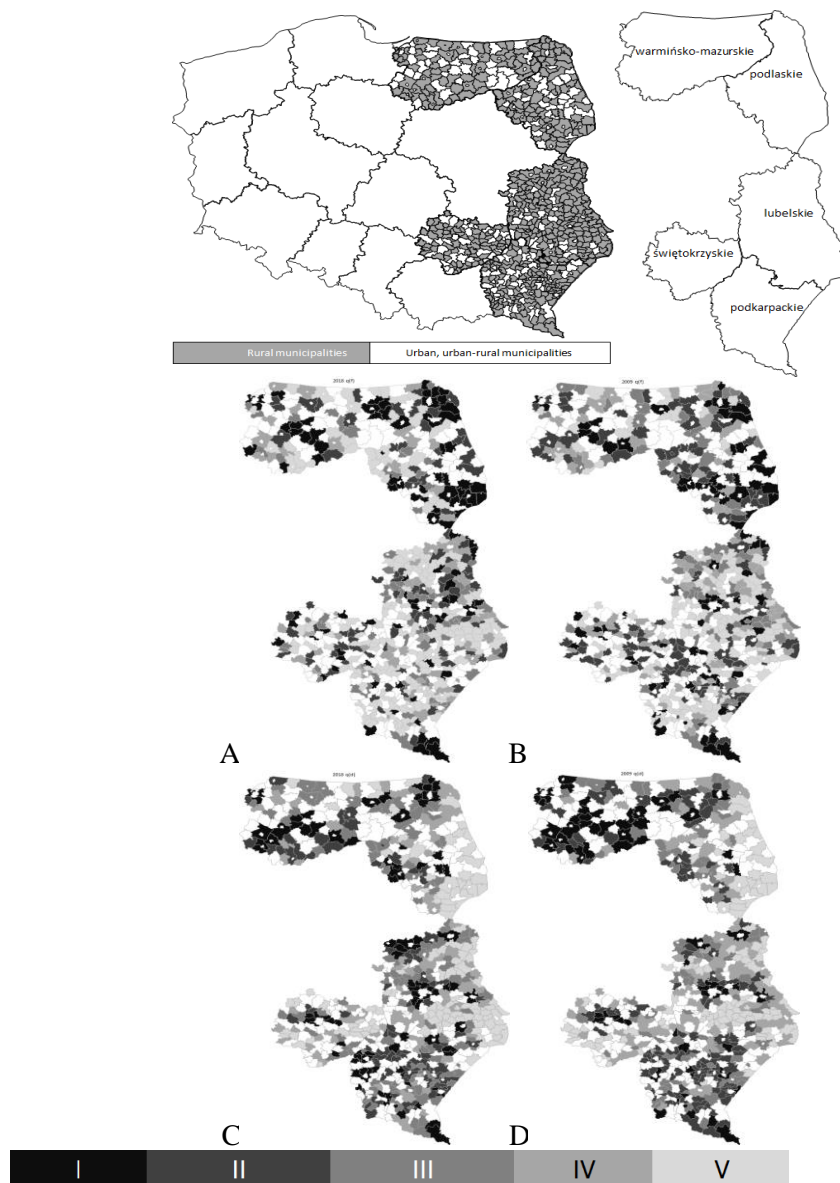
Note: A q financial situation 2018, B q financial situation 2009, C q demographic potential 2018, D q demographic potential 2009
Source: *Own study.*

When analyzing the internal conditions of municipalities divided into 5 typological groups (statistically similar to each other, according to the percentile values 2, 4, 6, 8), it should be noted that the group of municipalities with the best demographic potential in 2018 comprised

121 out of 484 municipalities, i.e. 25.0 % of rural communes in voivodships of eastern Poland, group II - 16.3%, group III - 25.6%, group IV - 15.49 and group V - 17.56%.

Regions located peripheral to the central center are characterized, among others, by the effect of capital leaching (siphoning capital from the periphery to the central center). According to Rosner's (2012) research, there is a close relationship between the processes of population (population, age and occupational structure, birth rate, migration balance, population density) and the level of socio-economic development. The age structure of the population shapes the situation on the labor market, and this indirectly influences the infrastructural potential and local finances. The use of the rent of location in relation to urban areas (local development centers, core and periphery theory) creates opportunities for their faster development. The decrease in the number of the unemployed in all groups, the increase in the number of the employed and natural persons running a business should be assessed positively. This may indicate that communes are departing from the typically agricultural character.

The communes of the first (best) group in relation to the communes of the fifth (weakest) group were characterized by a higher value of financial ratios, which allows for a higher freedom of disposal of financial resources. The analysis of the sources of income of rural communes in connection with their financial situation allows to conclude that communes in the best financial situation obtained higher values of the ratio of own income share in total income. The budgets of the weakest communes were the most fueled by income from transfers, which significantly weakens their independence. It seems that the main reason for the relatively low impact of financial conditions on the socio-economic development of communes is their strong dependence on transfer revenues transferred from the state budget and the stability of revenues obtained from the share of taxes constituting the state budget revenues (Table 3).

Table 3. Values of indicators describing the demographic and financial situation of rural communes in eastern Poland according to groups of synthetic measure

	Typological groups of the demography measure									
	2009					2018				
	I	II	III	IV	V	I	II	III	IV	V
q demographic potential	0.39	0.35	0.33	0.30	0.26	0.39	0.35	0.32	0.30	0.26
Number of communes	106	119	95	93	71	121	79	124	75	85
q financial situation	0.18	0.16	0.16	0.16	0.17	0.20	0.18	0.19	0.19	0.19
Determinants of the demographic and economic situation										
Population per km2	72	68	52	43	35	81	69	51	41	32
Birthrate	3.05	0.86	-0.56	-3.68	-8.07	1.32	0.02	-2.62	-4.48	-8.83
Balance of migration per 1,000 people	3.00	-1.19	-2.39	-2.81	-3.37	2.33	-2.34	-3.32	-4.48	-4.54
The unemployed registered in communes per 1,000 inhabitants	67	68	67	58	55	29	39	42	41	46
People working in communes per 1,000 inhabitants	109	71	63	56	65	124	81	72	66	62

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Entrepreneurship rate (Entities entered into the REGON register per 1000 population)	58	48	46	42	42	73	60	58	55	52
Natural persons running a business per 1000 population	47	39	37	32	31	59	48	45	42	38
Financial conditions										
Own income / total income (financial independence ratio)	0.33	0.26	0.24	0.23	0.26	0.33	0.26	0.26	0.26	0.28
Investment expenditures / total expenditures (investment attractiveness index)	0.21	0.19	0.20	0.18	0.20	0.22	0.20	0.21	0.20	0.19
Share in taxes constituting state budget revenues * / total revenues (fiscal wealth per capita)	0.04	0.03	0.03	0.03	0.04	0.08	0.07	0.08	0.09	0.11
Transfer revenues / total revenues (financial state interference rate)	0.62	0.70	0.72	0.74	0.70	0.60	0.67	0.67	0.66	0.65

Note: *Communes have a share in the personal income tax (PIT) and corporate tax (CIT).*
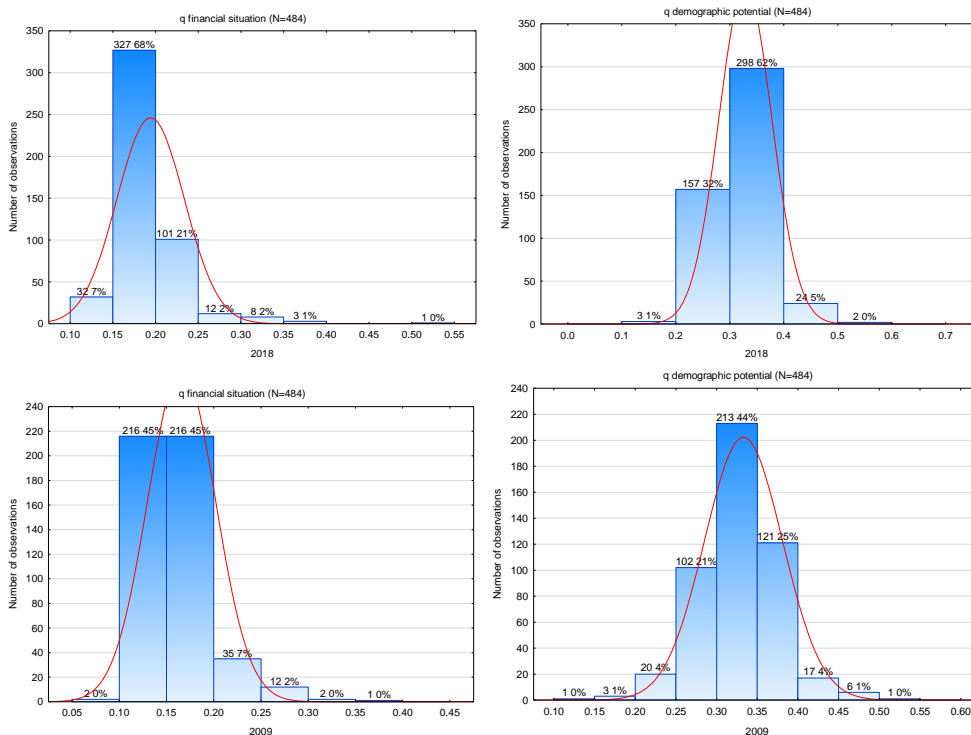**Source:** *Own study.*

Figure 2 shows the distribution model for the synthetic measure of financial situation and demographic potential. In the case of q financial situation, we observe a symmetrical distribution in 2018 and a right-hand distribution in 2009. In the case of q demographic potential, right-hand in 2018 and symmetrical in 2009. The right-hand skewness indicates that a greater number of communes have values of these variables lower than their average. This confirms the weakness of the studied region in the indicated area. The most numerous range in 2018 in the case of q financial situation was 0.15-0.20, which included 327 municipalities, i.e. 68%, and q demographic potential was the range of 0.30-0.40, which included 298 municipalities, i.e. 62%. There was a dominant in the indicated ranges.

The analysis of the range q of the financial situation and q of the demographic potential of rural communes in eastern Poland in 2009 and 2018 shows an increase in the differentiation from 0.30-0.37 for the financial situation and from 0.38-0.42 for demographics. The relative stability of the phenomenon is indicated by the coefficient of variation 0.21-0.20 for the financial situation and 0.14-0.15 for the demography, the positional coefficient of variation 0.12-0.10 for the financial situation and 0.09-0.09 for demographics, quarter deviation 0.02-0.02 for financial situation and 0.03-0.03 for demography, standard deviation 0.04-0.04 for financial situation and 0.05-0.05 for demography, and the range quartile 0.04-0.04 for financial situation and 0.06-0.06 for demographics. Moreover, it should be noted that q has a right-hand skew. This means that a larger number of communes have values of these variables lower than their average,

indicating the weakness of the analyzed region in the indicated area (Table 4).

Figure 2. *Synthetic measure of the financial situation of rural communes in eastern Poland in 2009 and 2018*

Source: *Own study based on the BDL CSO data.*

Table 4. *Statistical characteristics of the synthetic measure of the financial situation of rural communes in eastern Poland in 2009 and 2018*

	q financial situation		q demographics	
	2009	2018	2009	2018
min	0.09	0.14	0.15	0.14
max	0.39	0.51	0.54	0.57
gap	0.30	0.37	0.38	0.42
average	0.17	0.19	0.33	0.33
median	0.16	0.19	0.33	0.32
standard deviation	0.04	0.04	0.05	0.05
quarter deviation	0.02	0.02	0.03	0.03
coefficient of variation	0.21	0.20	0.14	0.15
positional co. volatility	0.12	0.10	0.09	0.09
gap	0.30	0.37	0.38	0.42
quartile range	0.04	0.04	0.06	0.06
skew (asymmetry)	1.85	2.64	0.19	0.36
kurtosis (measure of concentration)	6.08	12.56	1.53	2.05

Source: *Own study.*

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The economic potential of the commune is built, among others, by financial potential, professional activity of inhabitants, local labor market, entrepreneurship, infrastructure, and the condition of the natural environment. Adequate economic potential increases the standard of living, increases production, a better social situation, greater public safety. The endogenous potential of a commune, resulting from a combination of local conditions, determines its possibilities and directions of development with the support of exogenous variables.

The financial situation of rural communes was slightly correlated with the measure of demographic potential (2009 - yxy = 0.2048, 2018 - yxy = 0.0911). The financial situation is correlated with natural persons conducting business activity, as well as the unemployed and working in communes. The economy cannot develop without adequate human potential (Prus, Domagalska, 2010). Rural communes of eastern Poland are characterized by a low correlation between the financial situation and the natural increase (2009 rxy = -0.0095, 2018 rxy = -0.0816) and slightly higher with the net migration (2009 rxy = 0.2917, 2018 rxy = 0, 2636) and the number of people working in municipalities (2009 rxy = 0.3915, 2018 rxy = 0.3297). Migration is a factor causing significant changes in the level of population, spatial distribution and in various structures of the population (Okólski, 2005).

Among individual variables of the demographic potential shaping the financial condition of rural communes, the share of own income in total income had the greatest impact (2009 rxy = 0.316 rxy = 0.244). It is quite a frequently used indicator of the financial autonomy of local government units. In the case of the correlation of the financial situation with the level of tax revenues in total revenues (2009 rxy = -0.123 rxy = -0.166) and the share of transfers from the state budget in total revenues (2009 rxy = -0.312 rxy = -0.234) we have a negative value. Transfer income (subsidies and subsidies) is income transferred from the state budget and, to a large extent, in the Polish system of financing local government units, it is a source of supply for economically weaker units. Their amount weakens the financial independence of units and stiffens budget revenues (Table 5).

Table 5. *Correlation between measures of financial situation, development and socio-economic variables in rural communes of eastern Poland (Pearson's coefficient; 2009-2018).*

	TOPSIS fin
Physical people	0.3492
Foundations	0.2764
Balance	0.2202
The unemployed	0.1513
Working persons	0.3917

Note: Linear correlation coefficients for observations from sample 1-4840
Critical value (for two-sided 5% critical area) = 0.0282 for n = 4840
Source: *Own study.*

The importance of demographic factors for the fiscal situation of the analyzed rural

communes is much smaller. Their main problem is the scarcity of endogenous resources. The labor and endogenous capital resources in these communes are shrinking due to wash-out effects. It is important that this process does not destroy the absorption capacity necessary for the implementation of sustainable development processes. Gunnar Myrdal, in the theory of cumulative causality relating to the analysis of the interdependence of social, economic and institutional phenomena, proved that each element interacting with another element influences its behavior, and at the same time is modified by the reaction of that element (Stanny and Strzelczyk, 2018)

The regression analysis of q the financial situation and the variables of the demographic potential indicates that the presented regression model allows to explain 59.4% (0.594) of the model's variability, i.e. that it is explained by the variability of independent variables.It can be concluded that the model is fit enough. The fit of the model is measured with the use of indicators: multiple R2 (0.353) and corrected R2 (0.353). The adjusted coefficient of determination did not reach 60%. This may indicate the need to expand the scope of variables with economic elements so as to characterize the studied area in a multidimensional way. Further increasing the multidimensionality of the model would cause a slight increase in value, and the model could include statistically insignificant variables. The model could include statistically insignificant variables. This error is eliminated by the corrected R2. It shows the actual fit of the model, independent of the number of added variables that have no significant influence on the model. The F statistic is 263.66 (f (10.4829)) and is statistically significant (p <0.0000) (see Table 6).

Table 6. *Results of the regression analysis between the q financial situation and the variables of the demographic potential of rural communes in eastern Poland in 2009-2018*

	b*	standard error from b*	b	standard error from b	t(4834)	p
Free word			0.110206	0.002636	41.8033	0.000000
Natural persons conducting business activity (P)	0.253819	0.014532	0.000665	0.000038	17.4663	0.000000
Foundations, associations and social organizations (F)	0.145683	0.012461	0.004667	0.000399	11.6909	0.000000
People at the pharmacy open to the public (Pe)	-0.146116	0.012613	-0.000002	0.000000	-11.5849	0.000000
Natural increase (I)	-0.134092	0.013392	-0.001210	0.000121	-10.0131	0.000000
Balance of migration (B)	0.104105	0.013640	0.000718	0.000094	7.6323	0.000000

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The unemployed (U)	0.059831	0.012131	0.214728	0.043536	4.9322	0.000001
Working persons (WP)	0.297724	0.012239	0.000164	0.000007	24.3254	0.000000
People using the sewage system (S)	0.124945	0.014081	0.000210	0.000024	8.8734	0.000000
People using the waterworks system (W)	0.059552	0.012802	0.000105	0.000022	4.6517	0.000003
People using the gas system (Pg)	-0.134137	0.014379	-0.000199	0.000021	-9.3287	0.000000

Note: Observations 1-4840 used; Dependent variable q financial situation.
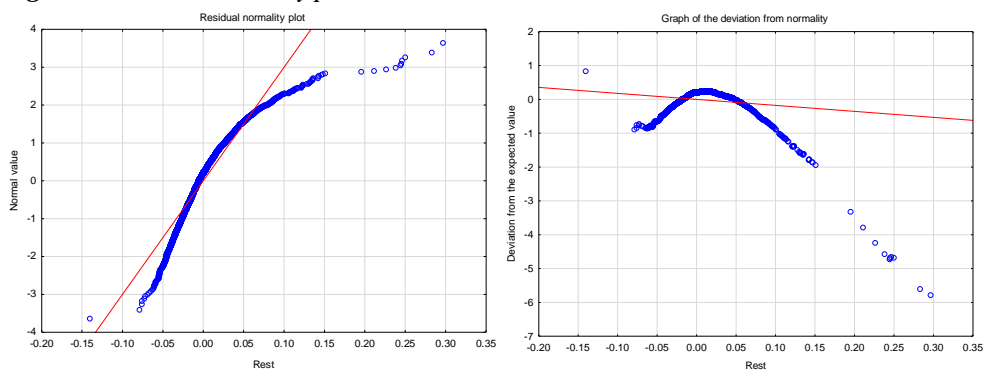*Source: Own study.*

The final form of the model is:

$$F(y) = 0.253819\,(P) + 0.145683\,(F) - 0.146116\,(Pe) - 0.134092\,(I) + 0.104105\,(B) + 0.059831\,(U) + 0.297724\,(WP) + 0.124945\,(S) + 0,059552\,(W) - 0.134137\,(Pg) + 0.03146$$

The resulting chart see Figure 3 allows a visual assessment of whether the residuals are normally distributed: if the residuals are not normally distributed, the points will deviate from a straight line. The residual normality plot may also reveal outliers. One may object to the observation because it is slightly distant from the line, but it seems that this separation does not significantly affect the normality of the residual values. Similar information as the probability normality plot is also provided by the residual histogram. Ideally the line should pass through the centers of the top edges of the bars. A slight deviation from normality is not dangerous, especially for numerous samples (N = 4840). The graph may also indicate the presence of outliers, which may be a continuation of the research being carried out.

Figure 3. *Residual normality plot*

Source: Own study based on BDL CSO data.

5. Conclusion

The distribution of the assessment of the financial situation and the demographic potential of communes in eastern Poland was spatially polarized. The results indicate that a better financial situation is associated with a better demographic potential. The synthetic qi measure of the financial situation ranged from 0.14 to 0.51 in 2018 and from 0.09 to 0.39 in 2009, and in the case of the demographic potential measure from 0.15 to 0.54 in 2009 and from 0.14 to 0.57 in 2018. An increase in the range measure from 0.30 to 0.37 in the case of the financial situation and from 0.38 to 0.42 - in the case of demographic potential, indicates an increase in the differentiation of units and a similar direction of influence of units on the processes taking place in their economy.

The range of challenges faced by local governments is related to the conduct of fiscal policy using the existing demographic potential, including by stimulating the local labor market and shaping the functional and spatial structure, taking into account the premises resulting from demographic forecasts. The age structure of the population shapes the situation on the labor market, and this indirectly influences the infrastructural potential and local finances.The economy cannot develop without adequate human potential. Rural communes of eastern Poland are characterized by a low measure of correlation of the financial situation with the natural increase and a slightly higher measure of correlation with the migration balance and the number of people working in communes. Migration is a factor causing significant changes in the level of population, spatial distribution and in various structures of the population.

Demographic conditions are one of the basic factors in the development of communes. The financial situation and development opportunities change in the face of a progressive decline in the fertility rate, aging of the population and increasing population mobility.

One of the tools that can be used to measure the relationship between the financial situation and demographic potential is the synthetic measure. Under the conditions of the dynamics of changes and their impact on economic relations in the local socio-economic and environmental space, it requires a lot of information, which should constitute a multidimensional space to support the decision-making process of local authorities.

The results of the research conducted allow local governments to compare the studied area with the situation of neighboring communes or communes with similar economic and social conditions. Conclusions drawn on this basis may allow local authorities to define potential directions for optimization of fiscal and demographic policies. The results indicate the directions of new research, which include: comparing the results of ordering on the basis of a larger number of tested objects or empirical data sets, conducting a spatial or dynamic analysis in a specific period of time in order to learn about the trends of changes and comparing the results of rankings based on other quality measures of the linear ordering methods.

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