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QUANTITATIVE ANALYSIS OF THE ECONOMIC POTENTIAL ON THE EXAMPLE OF THE UPPER SILESIAN METROPOLIS

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Purpose: The aim of the article is to show the modified method of calculating the economic potential on the example of territorial units of the Upper Silesian Metropolis.
Design/methodology/approach: Economic potential is a measure of a region's strength compared to other regions. In economics, potential is a substitute for socio-economic development. The methodology of calculating the modified economic potential of territorial units was discussed in the first part of the article, and an empirical example is presented in the second part.
Findings: As a result of the research, strong regions were identified and the self-potential of the regions and their surroundings were compared.
Research limitations/implications: The proposed modified method of potentials can be used for a comparative analysis of any territorial units. The metric that is used to measure the distance between territorial units is important.
Practical implications: On the basis of the presented method, any regions or countries can be compared in terms of socio-economic development.
Social implications: The method makes it possible to compare the socio-economic development of regions in terms of income and population.
Originality/value: The article compares selected communes of the Silesian Voivodeship in terms of income, population and socio-economic development. A modified measure of economic potential was used.

Keywords: economic potential, territorial unit potential, socio-economic development.

Category of the paper: Research paper.

1. Introduction

Potential is defined in economics as a resource of abilities, opportunities or performance that can be assigned to a given territorial unit or organization. In 1970, G. Dutton introduced the concept of income and population potential and their quotient, which became the equivalent of a measure of socio-economic development (Dutton, 1970). However, the potential of the

organization, enterprise and region, area - a territorial unit - is a multidimensional concept, as it depends on many different, often interdependent factors. The potential determines the capabilities of an individual on the basis of the abilities, competences and skills of a given organization, and measures the ability to use these resources and the resources of the environment.

According to the spatial model of the potential, the possibilities of a territorial unit (region, voivodeship, district or community) depend on the condition of the unit itself, but also on the unit's location in the space under consideration and on the adopted distance metric. It can be a geographic space where the distance between units is measured as the Euclidean distance between the geographic coordinates of the distinguished points, you can also consider road distance (shortest, fastest), consider the availability of connections between units. An interesting approach is also to consider a metric as an economic quantity. Among others, in the works of (Suchecki, 2010, 2012) there is a discussion on the use of the potential and potential quotient method in deliberations in the field of spatial econometrics (Paelinck and Klaassen, 1982; Rich, 1980; Sen and Smith, 1995; Mastalerz-Kodzis, 2018).

The aim of the work is to present an example of the empirical application of the spatial method of economic potential for territorial units of the Upper Silesia Metropolis (GZM – Metropolis of Upper Silesia and Zagłębie). The first part discusses the methodology of calculating the economic potential of territorial units, the second one presents an empirical example. The article ends with a summary.

2. Economic potential of regions

Sustainable economic development of the state and territorial units is the goal of the activities of state and local authorities. A proper diagnosis of the actual state, examination of the dependencies, relations between territorial units and their economic and social characteristics is the foundation for further activities aimed at improving the quality of life of the population and achieving the intended pace of economic growth (Biernacki, 2006; Stiglitz, 2012).

One of the measures of the development possibilities of territorial units is the economic potential. The analysis of the values of historical economic variables, including potential, changes in time and space, provides information on the direction and strength of changes in the economy for individual territorial units, and allows for taking actions to prevent negative trends. Numerous works in the field of regional research indicate the increased importance of location in economic research (Krugman, 1991; Giri, 2004; Arbia, 2006; Paelinck and Klaassen, 1983; Krugman, 1991; Pooler, 1987; Rich, 1980; Suchecki, 2012; Combes, Mayer, Thisse 2006; Geis, Mur, and Zoller, 2004).

The economic potential of territorial units is a multidimensional concept. Its size includes, among others, the number and structure of the population, the level of income and professional activity of inhabitants, the development of the local labour market. The economic potential largely determines the development of a territorial unit, implies economic changes, and stimulates investments. The economic potential is positively correlated with the measure of socio-economic development, the increase in potential increases the quality of life of the inhabitants and increases public safety.

The methodology of determining the potential of regions can be found, among others, in the works of: Dutton, 1970; Sen and Smith, 1995; Zeliaś, 1991; Chojnicki, 1966. An important element of the method of calculating this measure is the selection of an appropriate measure of the distance between territorial units (selection of the metric).

Potential models analyse the impact of all territorial units on a given unit. Then the potential can be interpreted as a force, intensity of the impact of all regions of the territorial division system on the selected region. A given region may have a small own potential, but it may be located in close proximity to strong regions, in a favourable territorial location, then its potential is increased.

The literature distinguishes between spatial models of income potential, population and location (Suchecki, 2012; Pooler, 1987). Population potential is a substitute for socio-economic phenomena, and income potential is treated as a measure of the availability of economic activity.

The 21st century is the time when the coal-based economy is being abandoned and replaced with ecological energy sources. For Poland, Silesia is a region abundant in coal deposits, therefore the upcoming transformation processes will be most noticeable in this region. Changing the structure of the industry is inevitable, the problem is to achieve it over time. Therefore, there is a need to diagnose the current state of the economy and create new economic zones that will activate professionally young people and people previously working in the mining and mining sector. Therefore, the measurement of the potential and strength of individual regions in the process of change is of particular importance. Therefore, in the empirical example in point 2.2, it was decided to calculate the potential for territorial units belonging to the GZE Metropolis.

3. Methodology of calculating the potential of regions

In physics, a potential is an auxiliary quantity that describes a physical field. The field of physical quantities is a set of functions characterizing points in space and other parameters (e.g. time). For a given system of physical units ($k, m = 1,..., n;$ n – any natural number),

for example, a partial potential P_{km} is used to analyse the interactions of units. For any two units, it is determined in accordance with the formula (1):

$$P_{km} = \alpha_0 \frac{M_k M_m}{d_{km}}. \tag{1}$$

The value of the partial potential is interpreted as the amount of energy between units *k* and *m* per unit mass, M_k, M_m is the mass of the units, d_{km} the distance between the units, and α_0 is a parameter.

On the basis of the definition of partial potential, the concept of the potential of a territorial unit is constructed. It is assumed that the territorial division system consists of n objects – spatial units $(n \in N)$. The potential of each individual is dependent on all other individuals, but to a different extent. The model of the potential of the *k*-th spatial unit in a given time unit (in a year, quarter, month) is written in the formula (2):

$$P_k = \alpha_0 \sum_{\substack{m=1 \\ m \neq k}}^{n} \frac{M_m^{\alpha_{1,m}} W_m^{\alpha_{2,m}}}{d_{km}^{\beta}} \tag{2}$$

where:

M_k - the mass of *k*-th unit,

W_k - the weight of the mass of *k*-th unit,

$\alpha_0, \alpha_{1,m}, \alpha_{2,m}$ - structural parameters of the model,

β - distance parameter, other symbols as above.

The components of the above formula may have an economic interpretation. For example, the mass of a unit may be production volume, GDP, population, employment, foreign trade turnover, investment volume. The weight of the mass of a given spatial unit may be the occupational structure of the population, age, gender, income, and the size of investments per capita. The weights can be taken arbitrarily or calculated on the basis of statistical data. The distance metric between units is, for example, temporal, physical, Euclidean, and economic. Model parameters are determined using the least squares method.

The explained variable V_k is interpreted as the total magnitude of the impact on the *k*-th spatial unit, and the total potential of the *k*-th unit is the sum of the partial potentials of all units of the system. The economic potential can be interpreted as the intensity of the impact of all regions of the system on a selected region. The potential is the sum of two components: own potential and the potential of the surrounding. The geographical location has a significant impact on the value of the potential of the surroundings. In economics, the following spatial models of potential can be mentioned: income, population, location (the region's accessibility to residents of other regions). The income potential is a function of the income generated in

a given region and in other regions, while the population potential is interpreted as the accessibility of a given region to the population of other regions.

The following designations are adopted:

PP_k - total potential of the population in the *k*-th region,

IP_k - total income potential in *k*-th region,

QP_k - quotient of potentials in the *k*-th region (economic potential),

GDP_k - GDP in the *k*-th region,

P_k - population in *k*-th region,

d_{km} - distance between regions *k* and *m*.

The total potential of the population and the total income potential are defined as the sum of their own and the environment's potentials (formulas (3) and (4)):

$$PP_k = P_k + \sum_{\substack{m=1 \\ m \neq k}}^{n} \frac{P_m}{d_{km}}, \tag{3}$$

$$IP_k = GDP_k + \sum_{\substack{m=1 \\ m \neq k}}^{n} \frac{GDP_m}{d_{km}}. \tag{4}$$

However, the quotient of the potential for the *k*-th region is given by the formula (5):

$$QP_k = \frac{IP_k}{PP_k}. \tag{5}$$

Potential is a measure of the spatial accessibility of a region, it determines the intensity of the impact between regions, taking into account economic values and distances between regions. In formulas (3) and (4), it is divided by the distance between the units, because the greater the distance, the smaller the influence on the analysed characteristics.

4. Analysis of the economic potential of municipalities of the Upper Silesia Metropolis (GZM)

GZM was established on July 1, 2017, the implementation of its tasks began on January 1, 2018. It is located in the Silesian Voivodeship, covers 41 communes, including 13 cities with district status and 13 communes with city status (Figure 1). The metropolis is inhabited by over 2 million people, but the population of the metropolis has been decreasing since 1989.

The analysis of demographic and economic characteristics over time for municipalities included in the Metropolis is interesting and important for economic reasons and sociological.

The functioning of the territorial units of the Metropolis largely depends on the development of industry in the region. One of the dominant industries in Silesia is mining. However, due to climate change and European Union directives, the structure of industry, and thus employment in the region, must change. This change will cause numerous social problems, changes in the labour market and changes in the income of the population.

Figure 1. Metropolis of GZM. Adapted from: http://infogzm.metropoliagzm.pl.

Based on the data obtained from the Central Statistical Office, the economic potential of territorial units included in the Metropolis GZM was determined. The data on the population and incomes of municipalities (as a substitute for GDP) for 2018 were used for empirical research. The Euclidean distance was the metric. On the basis of the data, the economic potential of the municipalities included in the Metropolis was calculated. The results are presented in Figure 2. The highest potential was recorded for the cities: Gliwice, Katowice, Dąbrowa Górnicza, Tychy and Chorzów. These cities are the most developed in terms of socio-economic.

Then, the values of QP_k/g_k for municipalities of the Metropolis were determined, where g_k is the quotient of I_k /P_k. The values are shown in Figure 3. Fourteen regions have a measure value of less than 1. This proves their strong position compared to other regions. It can be written that they are little dependent on other territorial units. The remaining 27 municipalities have a QP_k/g_k value greater than 1.

However, attention should be paid to the method of determining the measures and the metric used. In the process of determining the economic potential, for example for voivodships, the distances between voivodships are large, therefore they have a significant impact on the potential values. The smaller the territorial units, the smaller the distances between them, which implies a smaller influence of the value d_{km} on the value of the potential. From the point of view of the inhabitants, the accessibility of a region that is significantly distant is lower than that of a region closer to us (for example, taking into account the daily commuting to work or schools). The distance parameter for small areas is less important.

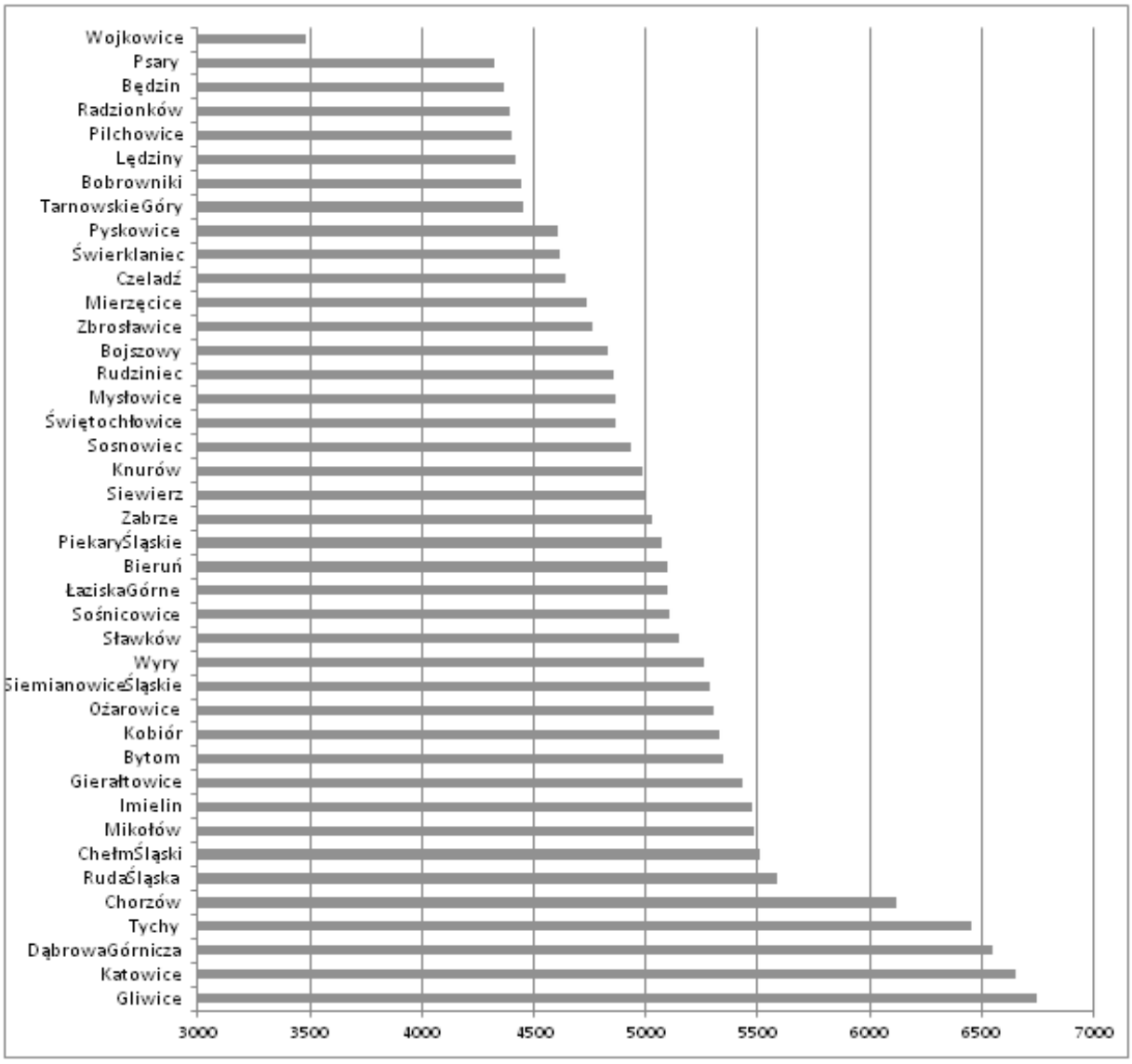

Figure 2. Economic potential QP_k of communes included in the Metropolis GZM.

The analysis of demographic and economic characteristics for the communes of the Metropolis GZM allows for the following conclusions:

- Population potential allows to identify communes with a large population in a given commune and in its immediate vicinity. The components of this potential are the own potential of the population (population of a given territorial unit) and the potential of the

surrounding population. The potential of the population may be useful in land development planning, designating special economic zones, and planning economic activities.

- The income potential indicates units that are strong in terms of GDP, income from a given source, or their substitute. Rich communes can plan new investments, modernize infrastructure and invest.
- The quotient of potentials determined as the quotient of income potential and population allows to answer the question to what extent a given territorial unit depends on the environment, it indicates strong regions, highly developed socially and economically, and less developed regions.

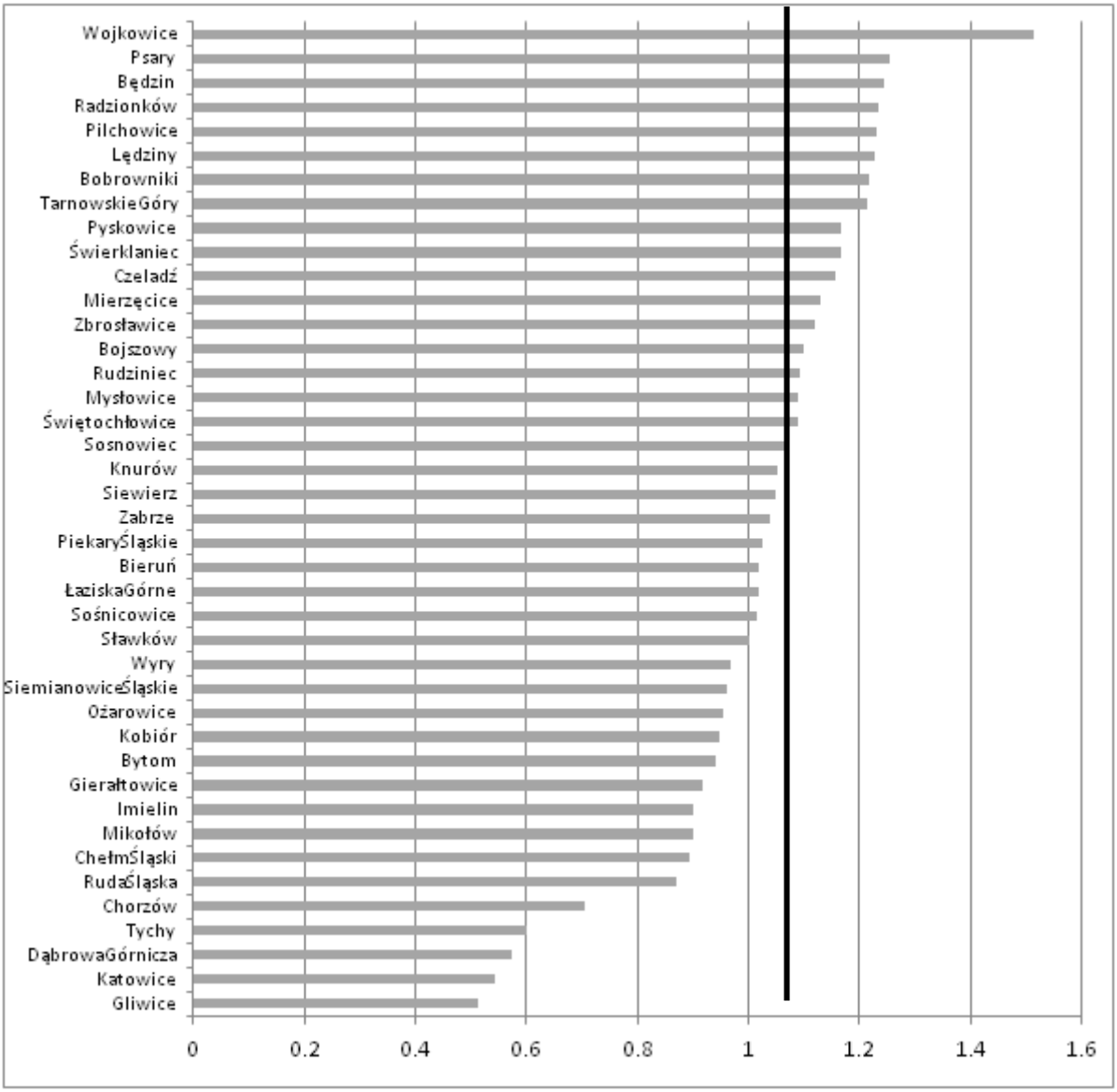

Figure 3. Values of the QP_k/g_{ik} measure for the territorial units included in the Metropolis GZM.

In the Silesian Voivodeship, a decreasing number of people has been observed for over 30 years. It is worth paying attention to the fact that cities with the greatest economic potential are also depopulating. However, there is a correlation between the value of the economic potential and the pace of population decline. Cities with high economic potential (Gliwice,

Tychy, Chorzów) are depopulating slowly. Due to the small distances between the regions, the population of the Metropolis settles in small towns or communes on the outskirts of large agglomerations without any problems with getting there.

Summary

In the article, on the basis of statistical data, the values of the economic potential for 41 communes included in the Metropolis GZM were determined. Strong communes, characterized by a high level of socio-economic development, and weak ones, largely dependent on the economic environment, were selected.

A question can be asked about the direction of changes in the economic and social spheres that will be subject to municipalities in the era of decreasing population of Silesia, including the Metropolis. The low rate of population growth, the movement of people from large agglomerations to small towns and communes certainly affects the economic potential of the regions.

Potential as a quantitative measure, can serve as a measure of socio-economic development, and can also be an auxiliary element in the decision-making process at the local management level. The quotient of potentials can therefore be a useful tool supporting economic decision-making and shaping the development strategies of cities and regions.

The method of potentials is used in regional analyses at the level of states, regions and even territorial units and communes. It influences efficient management in the economic sphere, it allows, for example, to effectively use the population's resources and the economic potential of regions. In this article, on the basis of the proposed method of the economic potential of the organization, an attempt was made to determine the possibility of the organization functioning in a specific economic environment. The use of any metric in the analysis process allows for great application possibilities of the proposed methodology, but also requires further empirical and simulation analyses. However, it seems that the proposed approach is interesting and has a wide field of application.

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