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The Significance of Factors Determining the Regional Development of Selected European Union Countries

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Abstract:

Purpose: *The choice of a specific weighting system for diagnostic variables can significantly influence the final research results in multivariate comparative analysis methods examining regional development. This article aims to investigate whether the commonly assumed premise of equal importance for the selected diagnostic variables is an appropriate approach in such research.*
Design/Methodology/Approach: *The determination of the significance of selected 11 variables describing regional development relied on a method using the entropy of diagnostic variables. The research encompassed 167 regions across 9 European Union countries.*
Findings: *Apart from the conceptually justified selection of variables characterizing regional development, determining the significance of individual indicators, i.e., assigning specific weights to them, is crucial in such studies. It is often suggested in literature that in the absence of clear indications regarding the differentiated importance and role of specific characteristics, an implicit assumption of equal weights for all selected diagnostic variables should be adopted. However, this approach introduces hidden weights and neglects the object's structure, data quality, etc.*
Practical Implications: *Accurately determining the weight values that describe the significance of individual variables in regional development can guide preferred areas for implementing specific investment projects from a regional development perspective.*
Originality/Value: *This article explores the potential of using entropy-based methods for weighting the significance of factors determining regional development. The issue of weighting diagnostic variables in regional development is only sparingly discussed in literature.*

Keywords: *Regional development, weighing diagnostic variables, determinants of regional development.*

JEL codes: *C38, O18, R11.*
Paper type: *Research article.*

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1. Introduction

The term "region" belongs to the commonly encountered, ambiguous concepts in social sciences. In regional studies literature, one can find numerous definitions of "region," some of which differ significantly from each other. This can largely be attributed to the fact that regions are of interest to many scientific disciplines, not only economics, regional economics, or local government finance but also economic geography, spatial planning, sociology, ethnography, among others (Flejterski, 2004, p. 13).

The term "region" is derived from the Latin word "regio, regionis," which, when translated directly, can mean "movement in a specific direction" or refer to space, more specifically, to the directions defining space, thus referring to a vicinity, a land, a district. The second meaning, referring to an area, gradually gained popularity and widespread acceptance, resulting in the appearance of the word "region" in many languages. Therefore, a region is currently perceived as a spatial subsystem of a zone (Korenik, 1999, p. 51).

In the 1970s, EUROSTAT (the Statistical Office of the European Union) initiated actions to standarize territorial units for regional statistics, including comparative analyses and assessment of regional development. Starting in 1988, the nomenclature of these units (The Nomenclature of Territorial Units for Statistics - NUTS) has been applied in the legislation of European Union countries. Despite the presumption of comparability between territorial units of the same NUTS level, each classification level still comprises regions that vary significantly in terms of area, population, and economic and administrative significance (Obrębalski, 1999).

Considering that the assumed average population of a region at the NUTS1 level should range from 3 to 7 million people, NUTS2 between 800,000 and 3 million, and NUTS3 between 150,000 and 800,000, in reality, 104 NUTS1 level regions are inhabited by 29,000 to 17.89 million people, 281 NUTS2 level regions - from 29,000 to 12.194 million people, and 1,348 NUTS3 level regions - from 433,000 to 6,477,000 people (Eurostat, 2018, pp. 6-13).

Nevertheless, for the European Union, a region primarily holds statistical significance, serving the allocation of aid funds to balance living standards in individual regions, and regional policy operates at the level of regions with an area of around 13,500 square kilometers and 2 million inhabitants (NUTS2 level) (Żelazny, 1998, p. 36).

The concept of regional development serves as an umbrella term encompassing a wide range of economic, social, and spatial phenomena (Strahl, 2006, p. 13). The term 'regional development' is a highly complex category and has not been unambiguously defined. Generally, it refers to a process of positive changes accompanied by quantitative and qualitative transformations.

Thus, regional development, as understood in this context, is largely an economic process marked by a region's economic growth, where quantitative changes in production should be paired with qualitative and structural changes (Kosiedowski, 2001). It can be established that regional development is a certain multivariate statistic that describes, to the extent of the constraints involved, in a comprehensive way the effect of positive quantitative and qualitative changes in the social, economic, environmental and/or institutional-political areas that have taken place in a given territorial area (Czyżycki, 2019).

The vast number and diversity of processes occurring within the regional territorial system, coupled with the complex nature of regional development, result in numerous factors influencing this development. These factors can be considered in a general (universal) sense, independent of the specific characteristics of a territorial unit, or in a specific (detailed) sense, pertinent to a particular space (Obrębalski, 2012, p. 218). It should be stressed that a universally recognized and unquestionable classification of development factors does not seem to exist in economic literature.

Due to the lack of a universal, timeless, and universally applicable system of appropriate indicators, as well as unambiguous principles for selecting diagnostic variables, the selection primarily depends on the ability to obtain comparable data and the need to meet substantive and formal requirement (Johann, 2005, pp. 54-55; Słaby, 1994, p. 39). The suitable selection of indicators should consider the spatial scope, as well as the temporal, substantive, and, importantly, the purpose of the assessment.

The most commonly indicated minimal requirements for such indicators are that they should be based on the SMART principle (Indicator Handbook. Operational Programme Human Capital 2007-2013, 2013, pp. 11-12):

- S – (Specific, simple) – detailed, related to specific problems, and straightforwardly constructed,
- M – (Measurable) – capable of measurement using appropriate tools,
- A – (Available/assessable/acceptable) – the necessary information for measuring the indicator is or will be available at an acceptable cost,
- R – (Realistic/relevant) – feasible or achievable with the available resources,
- T – (Timebound) – a specific deadline by which the target value of the indicator will be achieved, along with the frequency of measurement.

Along with a substantively justified selection of variables characterizing regional development, determining the importance of individual indicators, that is, assigning them specific weights, is also crucial in this type of research. In the literature, there are generally two fundamental ways of obtaining weights for individual diagnostic variables (Kao, 2010), direct and indirect. In the first case, weight values for individual variables are obtained prior to the stage of collecting data describing the

formation of these variables in the studied objects, often through interviews or based on surveys conducted among experts.

Hence, they are sometimes referred to as a priori weights. In the second case, weights are obtained directly from the analysis of previously collected data (a posteriori weights), which makes them conceptually more convincing. Unlike expert-assigned weights, which may remain constant in subsequent analyses of the same problem, a posteriori weights must be determined anew in each subsequent analysis (Sokołowski, 1985).

In the literature, it is often recommended that in the absence of clear indications regarding the differentiated significance and role of individual characteristics, one should tacitly assume equal weights for all selected diagnostic variables (Kukuła, 2000, p. 64). Indeed, this solution introduces hidden weights, disregarding the object's structure, data quality, etc., (Dziechciarz, 2006).

It also fails to account for potential changes in the 'importance' of individual indicators occurring with the development of regional data, which simultaneously assumes that their significance is independent of the stage of socio-economic development.

2. Data and Methods

Due to the adopted research objective, the significance of individual variables describing regional development will be examined only for those EU countries for which Eurostat has identified at least 9 units at the NUT2 level. This means that the study will include:

- 9 regions of Austria (Burgenland, Lower Austria, Vienna, Carinthia, Styria, Upper Austria, Salzburg, Tyrol, Vorarlberg);
- 11 regions of Belgium (Brussels-Capital Region, Province of Antwerp, Limburg, East Flanders, Flemish Brabant, West Flanders, Walloon Brabant, Hainaut, Liège, Luxembourg, Namur);
- 27 regions of France (Île-de-France, Centre-Val de Loire, Burgundy, Franche-Comté, Lower Normandy, Upper Normandy, Nord-Pas-de-Calais, Picardy, Alsace, Champagne-Ardenne, Lorraine, Pays de la Loire, Brittany, Aquitaine, Limousin, Poitou-Charentes, Languedoc-Roussillon, Midi-Pyrénées, Auvergne, Rhône-Alpes, Provence-Alpes-Côte d'Azur, Corsica, Guadeloupe, Martinique, French Guiana, Réunion, Mayotte);
- 13 regions of Greece (Central Greece Region, Epirus Region, Peloponnese Region, West Greece Region, Central Macedonia, Crete Region, Western Macedonia, South Aegean Region, East Macedonia and Thrace, Ionian Islands Region, Thessaly Region, North Aegean Region, Αττική);
- 19 regions of Spain (Ciudad Autónoma de Ceuta, Castile-La Mancha, Extremadura, Andalusia, Región de Murcia, Ciudad Autónoma de Melilla,

Castile and León, Land of Valencia, La Rioja, Aragon, Cantabria, Asturias, Balearic Islands, Galicia, Canarias, Catalonia, Comunidad de Madrid, Basque Autonomous Community, Comunidad Foral de Navarra);

- 12 regions of the Netherlands (Zeeland, Flevoland, Overijssel, North Brabant, Limburg, Gelderland, Utrecht, North Holland, South Holland, Drenthe, Groningen, Friesland);
- 38 regions of Germany (Detmold Government Region, Swabia, Upper Palatinate, Kassel Government Region, Stuttgart Government Region, Trier Government Region, Darmstadt Government Region, Karlsruhe Government Region, Lower Bavaria, Koblenz Government Region, Münster Government Region, Saarland, Schleswig-Holstein, Düsseldorf Government Region, Giessen Government Region, Lüneburg Government Region, Saxony-Anhalt, Upper Franconia, Arnsberg Government Region, Middle Franconia, Rheinhessen-Pfalz, Brunswick Government Region, Lower Franconia, Leipzig Government Region, Weser-Ems Government Region, Upper Bavaria, Freiburg Government Region, Cologne Government Region, Hamburg, Hanover Government Region, Tübingen Government Region, Berlin, Dresden Directorate District, Free Hanseatic City of Bremen, Thuringia, Chemnitz Government Region, Brandenburg, Mecklenburg-Western Pomerania);
- 17 regions of Poland (Podkarpackie Voivodeship, Mazowiecki regionalny, Greater Poland Voivodeship, Opole Voivodeship, Świętokrzyskie Voivodeship, Warmian-Masurian Voivodeship, Lubusz Voivodeship, Pomeranian Voivodeship, Kuyavian-Pomeranian Voivodeship, Lesser Poland Voivodeship, Łódź Voivodeship, Silesian Voivodeship, Lublin Voivodeship, West Pomeranian Voivodeship, Lower Silesian Voivodeship, Podlaskie Voivodeship, Warszawa – Capital City);
- 21 regions of Italy (Campania, Sicily, Apulia, Calabria, Molise, Basilicata, Abruzzo, Sardinia, Lazio, Marche, Veneto, Liguria, Umbria, Friuli-Venezia Giulia, Piedmont, Lombardy, Emilia-Romagna, Tuscany, Provincia Autonoma di Bolzano/Bozen, Trentino-South Tyrol, Valle d'Aosta/Vallée d'Aoste).

For all the aforementioned regions, data was collected describing the development of phenomena such as:

- Long-term unemployment – X_1;
- Share of long-term unemployed – X_2;
- GDP per capita in PPS of EU average – X_3;
- Unemployment rate – X_4;
- Employment rate – X_5;
- Population density – X_6;
- Life-long learning participation – X_7;
- Youth unemployment rate – X_8;
- NEET (young-unemployed-not-taking-part-in-education) – X_9;

- Old-age dependency ratio – X_{10};
- Gender gap in employment rate – X_{11}

The data, describing the development of the aforementioned variables in the previously indicated regions, were collected from the Eurostat website (https://ec.europa.eu/eurostat/en/) and the Employment Institute, IZ Bratislava (https://www.iz.sk/en/projects/eu-regions).

These described the level of a given phenomenon in 2021, and in the case of missing data, they were supplemented with data from 2020. The determination of the significance of individual variables in regional development was based on a method using variable entropy, which involves (Wang and Luo, 2010):

Normalizing variables according to the formula:
In the case of a stimulant:

$$z_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}}}$$

In the case of a destimulant:

$$z_{ij} = \frac{(x_{ij})^{-1}}{\sqrt{\sum_{i=1}^{m} (x_{ij})^{-1}}}$$

calculating the entropy value (Ej) and the degree of diversity (dj):

$$E_j = -\frac{1}{ln(m)} \cdot \sum_{i=1}^{m} z_{ij} \ln z_{ij}$$

$$d_j = 1 - E_j$$

determining weights:

$$w_j^4 = \frac{d_j}{\sum_{k=1}^{m} d_k}$$

The values obtained in this way satisfy two fundamental assumptions related to the weights of diagnostic variables, namely positivity $(w_j > 0)$ and summation to unity$(\sum_{j=1}^{m} w_j = 1)$.

3. Results

In the case of taking into account the assumptions of equal influence of individual diagnostic variables, which are very often adopted in studies on socio-economic development of regions, for studies based on 11 diagnostic variables, the weight value for each variable would be set at the level of 1/11 = 0.0909.

Based on the conducted research, it can be concluded that when considering all 167 analyzed regions, the variables that have considerably greater significance are those describing the population density in a given region (ω_6 = 0.4892) and the percentage of long-term unemployed individuals (ω_1 = 0.1336).

On the other hand, variables describing the differences between the employment levels of women and men (ω_{11} = 0.0039) as well as the percentage of the working-age population that is employed full-time compared to the total number of individuals in that age group who are in the labor market (ω_5 = 0.0049) have significantly less importance.

However, the significance of individual variables varies across different countries (Table 1). The percentage of long-term unemployed individuals is most significant in Italy (ω_1 = 0.3244), while it has very little importance in the case of regional development research in Spain (ω_1 = 0.0417), Greece (ω_1 = 0.0485), or Austria (ω_1 = 0.0548).

Population density has above-average significance (more than nine times greater than expected under the assumption of equal significance of all variables) in the study of regional development in countries such as Austria (ω_6 = 0.8677) and Spain (ω_6 = 0.8519), but it also has great importance in the case of Greece (ω_6 = 0.7518) and Germany (ω_6 = 0.7211). Population density has the smallest impact in Italy (ω_6 = 0.2355) and Poland (ω_6 = 0.3655).

In Poland, however, unlike in the other surveyed countries, the greatest significance in regional development lies in the engagement of residents in lifelong learning (ω_7 = 0.1506). Detailed information on the formation of weight values for individual variables in the analyzed European Union countries is presented in Table 1.

Table 1. *Evolution of weight values for individual diagnostic variables.*

weight	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11
EU*	0,1336	0,0300	0,0247	0,0787	0,0049	0,4892	0,0665	0,0946	0,0445	0,0294	0,0039
Austria	0,0548	0,0089	0,0067	0,0196	0,0005	0,8677	0,0083	0,0208	0,0087	0,0039	0,0001
Belgium	0,1604	0,0405	0,0285	0,0605	0,0022	0,6144	0,0202	0,0444	0,0188	0,0096	0,0004
France	0,1207	0,0426	0,0335	0,0427	0,0105	0,4306	0,0227	0,0463	0,0298	0,2152	0,0054
Greece	0,0485	0,0544	0,0160	0,0105	0,0014	0,7518	0,0506	0,0171	0,0415	0,0065	0,0019
Spain	0,0417	0,0075	0,0117	0,0235	0,0026	0,8519	0,0034	0,0179	0,0185	0,0194	0,0018
Netherlands	0,1053	0,0517	0,0548	0,0318	0,0006	0,5855	0,0086	0,0494	0,0702	0,0411	0,0009
Germany	0,0910	0,0263	0,0208	0,0343	0,0006	0,7211	0,0188	0,0388	0,0396	0,0084	0,0003

Poland	0,1542	0,0301	0,0810	0,0698	0,0017	0,3655	0,1506	0,1047	0,0377	0,0032	0,0013
Italy	0,3244	0,0584	0,0470	0,1114	0,0169	0,2355	0,0219	0,1193	0,0410	0,0072	0,0171

Note: **- Values determined solely based on the analyzed regions.*
Source: *Calculations and original research.*

Analyzing the data presented in Table 1, it can be clearly stated that different variables in various countries hold different significance. Additionally, based on previously conducted studies, it can also be assumed that the same variables in the same countries exhibit varying values across different periods (Klóska and Czyżycki, 2021), and the weight assigned to individual variables depends on the adopted method of determination (Czyżycki, 2018).

4. Conclusions

Based on conducted research, it seems justified to conclude that assuming equal weights for variables describing regional development in individual countries or throughout the European Union is a practical but conceptually unacceptable approach.

As demonstrated, the significance of individual diagnostic variables can vary significantly depending on the specific characteristics of the analyzed area. The determined weight values can be used to indicate preferred areas for implementing specific investment projects from the perspective of regional development.

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