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A STUDY ON THE DISTANCES BETWEEN POLAND AND SELECTED EUROPEAN COUNTRIES AND THE PROVINCES OF POLAND WITH RESPECT TO THE USE OF NEW TECHNOLOGIES BY ENTERPRISES

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Purpose: The aim of the analysis was to examine the dynamics of change in the synthetic variables describing the level of the phenomenon under consideration in selected European countries and Polish provinces.
Design/methodology/approach: The study examines the use of the Internet and information and communication technologies by enterprises in the Polish provinces and selected European countries. Data were drawn from Statistics Poland and Eurostat, taking into account the thematic area of the study and data availability. The study of distances led to the identification of the areas in the development and use of new technologies where Poland differed from other countries and the Śląskie province differed from other provinces. The analysis of the European countries covered three thematic areas in the years 2013-2020, and the analysis of provinces - two thematic areas in the years 2020-2022.
Findings: The study examines the use of the Internet and information and communication technologies by enterprises in the Polish provinces and selected European countries. Taxonomic analysis is an effective tool for assessing the influence of factors on selected characteristics of the development of the studied phenomenon.
Research limitations/implications: The inability to create a set of comparable statistical data over many years is the main limitation of the analysis.
Originality/value: The presented taxonomic analysis of the phenomenon under consideration can be used to compare different objects (countries, provinces, municipalities) or to carry out comparative analysis of other aspects of the issue, and the results of these studies will contribute to further research in this area. The results of the proposed research methodology can be used in economic and socio-economic policy analyses.
Keywords: taxonomic methods, Internet and ICT usage, COVID-19.
Category of the paper: Research paper.

1. Introduction

The ongoing digital revolution permeates all areas of our lives. Digital technology accompanies us every day (Drelichowski, 2002). We experience it in technological advancements, in particular through the Internet of Things or Big Data. Digital solutions assist us in our visits to public administration units, healthcare facilities, etc. – we are able to access their services remotely, submit applications and online forms. Increasingly, we take advantage of online shopping opportunities. We use mobile devices with internet access to attend to a variety of matters without leaving our homes, e.g. mobile banking applications enable us to make fast payments and transfers, etc.

Big data analytics tools allow automation of various processes, which results in cost reduction or production optimization. Digitalization is both an opportunity for development and a competitive weapon. Companies and organizations that implement modern solutions to enhance customer convenience can acquire a bigger number of customers or investors.

However, it should be remembered that the key to development is the ability to adapt to changes in business environments. This is the lesson learned from the Covid-19 pandemics as well as the war in Ukraine. Organizations can survive by investing in digital solutions, new tools, employee development, etc.

The aim of the analysis was to examine the dynamics of change in the synthetic variables describing the level of the phenomenon under consideration in selected European countries and Polish provinces. The study of distances led to the identification of the areas in the development and use of new technologies where Poland differed from other countries and the Śląskie province differed from other provinces.

2. The set of diagnostic characteristics of the problems under study

The study examines the use of the Internet and information and communication technologies by enterprises in the Polish provinces and selected European countries. Data were drawn from Statistics Poland and Eurostat. The dataset includes the scope of the study and the availability of data. The diagnostic variables adopted in the present study are measurable and best describe the development of the analysed phenomenon. Based on the calculated values of the coefficients of variation and the results of verifying correlation analysis conducted by means of an inverted correlation matrix, the final set of diagnostic characteristics which describes the phenomenon was obtained (Młodak, 2006; Chomątowski, Sokołowski, 1978; Pociecha et al., 1988; Panek, 2009; Zeliaś, 2004; Strahl, 1990; Malina, 2008).

Due to the lack of statistical data, it was necessary to reduce the thematic scope of the dataset. The analysis using selected data is a continuation of previous research (in the description of the data are used: S - stimulant) (Mika, 1995).

The Polish provinces (2020, 2021, 2022).

The first thematic area - variables related to access to the Internet by enterprises:

x_1 – Number of enterprises with broadband Internet access – [%] (S),

x_2 – Number of enterprises with access to the Internet via DSL or other – [%] (S),

x_3 – Number of enterprises, additional equipment in a mobile device to the Internet (e.g. notebooks, netbooks, tablets, smartphones) [%] (S),

x_4 – Number of employees of enterprises with remote access to business applications, documents, computer programs [%] (S),

x_5 – Number of employees in enterprises with remote access to business e-mail [%] (S).

The second thematic area - variables related to enterprises with Internet access buying cloud services:

y_1 – Number of Internet-enabled enterprises buying cloud services by type of email access – [%] (S),

y_2 – Number of enterprises with Internet access buying cloud services – office software (e.g. spreadsheet, word processor) – [%] (S),

y_3 – Number of enterprises with Internet access buying cloud services – financial and accounting software [%] (S),

y_4 – Number of enterprises with Internet access buying cloud services – enterprise database hosting [%] (S),

y_5 – Number of Internet-enabled enterprises buying cloud services – file storage[%] (S).

In describing the variables, the determination S – stimulant was introduced (Mika, 1995).

In 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020 the following set of variables was adopted for selected countries:

a) the first thematic area:
   z_1 – Number of enterprises having received orders online – [%] of enterprises (S),
   z_2 – E-banking and e-commerce [%] (S),
   z_3 – E-government activities of individuals via websites [%] (S).
b) the second thematic area:
   z_4 – Share of enterprises' turnover on e-commerce – [%] (S),
   z_5 – Percentage of the ICT sector on GDP [%] (S),
   z_6 – Digital single market – promoting e-commerce for individuals [%] (S),
   z_7 – High-tech exports [%] (S),
   z_8 – High-tech trade by high-tech group of products in million euro (S),
c) the third thematic area:
   z_9 – Population on 1 January (S),
   z_{10} – Number of individuals using the internet for selling goods or services [%] (S),
   z_{11} – Individuals using the internet for interacting with public authorities [%] (S).

3. Measuring distances between Poland and selected EU countries and the polish provinces with respect to the level of the phenomenon under study

The analysis of the level of ICT usage in enterprises was extended by examining distances between Poland and selected European countries. The differences between the values of variables representing the selected groups of measures and the value of the synthetic variable were determined. Next, the average rate of distance change was calculated according to formula (Zeliaś, 2004):

$$D_{qi} = \frac{d_{qi8} - d_{qi1}}{3} \tag{1}$$

where:

$$d_{qit} = z_{qit} - z_{qt} \tag{2}$$

i = 1, …, 17 (16 provinces), t = 1, …, 8 (t = 1, 2, 3), q = 1, 2, 3 (q = 1, 2).

When calculating the distances, the differences between the values were taken into account. A positive value means that, in a given year, in terms of the synthetic variable under consideration, Poland has a lower position than the country it is compared to (Zeliaś, 2004). A negative value indicates Poland's higher position than that of the other European country under examination.

Based on the values of the synthetic variable we can perform a more detailed analysis for selected European countries, and next – for Polish provinces (Zeliaś, 2004):

a) If in the years 2013 and 2020 (2020, 2021) the position of Poland (the Śląskie province) was lower than that of the country (province) it was compared with then: D > 0 means the distance increased while D < 0 shows a decrease in the distance between Poland (the Śląskie province) and the country (province) it was compared with **[**description **00]**.
b) If in the years 2013 and 2020 (2020, 2021) the position of Poland (the Śląskie province) was higher than that of the country (province) it was compared with then: D > 0 means the distance decreased while D < 0 indicates Poland (the Śląskie province) moved even further away from the country (province) it was compared with **[**description **11]**.
c) If in the year 2013 (2020) the position of Poland (the Śląskie province) was lower, but in the year 2020 (2021) Poland ranked higher than the country (province) it was compared with, it means that, in the time under study, Poland (the Śląskie province) had the same position as the country it was compared with and next - achieved a higher result **[**description **01]**.
d) A situation contrary to the one discussed in item c) indicates that in the period under study a country (a province) was on a par with Poland (the Śląskie province) and next, it ranked higher **[**description **10]**.

The value of 0 means that the value of the synthetic variable for Poland was lower than for the given country, for the value of 1 it means that it was higher (Zeliaś, 2004).

4. The empirical example

Once the variables are normalized, we synthesize each of the selected groups of measures and calculate a synthetic variable. The analysis covered 17 countries (Belgium, Bulgaria, Czechia, Germany, Estonia, France, Italy, Latvia, Lithuania, Hungary, Malta, Austria, Poland, Romania, Slovenia, Slovakia, Finland), the time frame was 8 years (2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020) and the number of variables was 11. In the second stage of the study, the analysis covered the Polish provinces (16 provinces), the time interval covered the years 2020, 2021, 2022. The number of variables was 10. Then, taking into account the value of the synthetic variable, the average rate of change of distances was calculated. The table presents the results for European countries.

Table 1.
Distance change values for Poland and European countries for three groups of meters

Country	D_1	Description	D_2	Description	D_3	Description
Belgium	-0.0060	00	0.00623	00	0.00372	00
Bulgaria	-0.0050	11	-0.00037	11	0.01658	11
Czechia	0.0016	00	-0.00252	00	0.01048	11
Germany	0.0163	00	0.01977	00	0.00516	00
Estonia	0.0034	00	0.00622	00	-0.00257	11
France	0.0209	00	0.01310	00	0.02898	00
Italy	-0.0007	11	-0.00693	11	0.00764	00
Latvia	-0.0010	11	-0.00213	00	-0.01239	11
Lithuania	-0.0042	11	-0.00174	00	-0.00896	11
Hungary	0.0047	00	-0.00525	10	-0.00819	10
Malta	0.0142	00	-0.01619	00	-0.01034	11
Austria	0.0142	00	-0.00510	00	0.00652	11
Romania	-0.0087	11	-0.01047	11	0.00082	11
Slovenia	0.0044	11	0.00123	00	0.04204	01
Slovakia	0.0191	01	0.01194	00	-0.01643	11
Finland	0.0138	00	0.01695	00	0.001384	00

Source: based on own research (https://ec.europa.eu/eurostat).

For D_1 we can say that the distance compared to Poland decreased only for Belgium and Slovenia (D_1 - presents the first thematic scope).

For D2 distance decreased for: Czechia, Latvia, Lithuania, Malta, Austria. For D_3, these are the following countries: Bulgaria, Czechia, Austria, Romania. For the other countries, the distance increased in the analyzed time period.

In the next step of the analysis, D values were determined for the Polish provinces.

Table 2.
Distance change values for the Polish provinces and the Śląskie province for two groups of meters

Province	D_1	Description	D_2	Description
Dolnośląskie	0.00352	11	-0.00542	11
Kujawsko-pomorskie	0.00646	11	-0.00165	11
Lubelskie	0.00776	11	-0.00192	11
Lubuskie	0.00623	11	-0.00138	11
Łódzkie	0.00285	11	0.000035	11
Małopolskie	0.00230	11	-0.00518	11
Mazowiecki	0.01780	00	-0.02101	11
Opolskie	0.00375	11	-0.0027	11
Podkarpackie	0.00652	11	-0.00058	11
Podlaskie	0.00420	11	-0.00259	11
Pomorskie	0.00259	11	-0.00336	11
Świętokrzyskie	0.00409	11	-0.00333	11
Warmińsko-mazurskie	0.00224	11	-0.00276	11
Wielkopolskie	-0.00541	11	-0.00643	11
Zachodniopomorskie	0.00352	11	0.000897	11

Source: based on own research (https://stat.gov.pl/)

For D_1 we see that the distance between the Śląskie province and the Mazowieckie province has increased. The distance also increased for the Wielkopolskie province. In other provinces the Śląskie province has a better position but the distance has decreased.

For D_2: the Łódzkie province and the Zachodniopomorskie province have reduced the distance to Śląskie province.

5. Conclusion

The aim of the analysis was to examine the dynamics of change in the synthetic variables describing the level of the phenomenon under consideration in selected European countries and Polish provinces. The study of distances led to the identification of the areas in the development and use of new technologies where Poland differed from other countries and the Śląskie province differed from other provinces. The analysis of the European countries covered three thematic areas in the years 2013-2020, and the analysis of provinces - two thematic areas in the years 2020-2022.

The results obtained in the first thematic area show a growing distance between Poland and the selected European countries (except for Belgium, Slovenia and Slovakia - the distance between Poland and these countries shortened).

As regards the second thematic area, the gap between Poland and Czechia, Latvia, Lithuania, Malta, Austria narrowed, while the distance between Poland and the other countries became bigger.

In the third thematic area we can observe a significantly increasing distance between Poland and all the other countries except Bulgaria, Czechia, Austria, Romania. Based on the results of the analysis the conclusion can be drawn that Poland remains far behind most selected countries when it comes to the use and development of new technologies.

The second stage of the analysis focused on Polish provinces. As far as the first thematic area is concerned, the results show that in the years 2020, 2021, 2022 the gap between the Śląskie province and the other provinces narrowed, but the Śląskie province ranked higher than the other provinces. The distance between the Mazowieckie province and the Wielkopolskie province grew. The second thematic area: the Łódzkie province and the Zachodniopomorskie province have reduced the distance to the Śląskie province.

During the covid-19 pandemic, the Śląskie province did not have the same level of Internet use as the Mazowieckie and Wielkopolskie provinces. To sum up, it can be said that digital transformation has a significant impact on our environment, businesses, public administration, society and national economy.

The process and effects of digitalisation are affecting our behaviour, consumer behaviour. Based on the experience of recent years, organisations, businesses, society and the economy need to react quickly to the changing environment and implement appropriate, effective solutions to survive.

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