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Regional Differentiation of Information Infrastructure in Poland in the Context of Building a Knowledge-Based Economy

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**Regional Differentiation of Information Infrastructure
in Poland in the Context of Building a Knowledge-
Based Economy**

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Regional Differentiation of Information Infrastructure in Poland in the Context of Building a Knowledge-Based Economy

JEL Classification: *O30; O33; R11*

Keywords: *information infrastructure; regional differentiation; knowledge-based economy*

Abstract

Research background: Information infrastructure creates the key infrastructure of the knowledge-based economy. The widespread use of information and communication technologies contributes not only to the increased efficiency of individual economic entities, but also to the possibilities of enhancing the entire economy. Information infrastructure is also a significant determinant in the development of territorial units, and therefore, it influences the regional dimension of building knowledge-based economy in Poland.

Purpose of the article: The purpose of the study was the evaluation of the regional differentiation of the level of information infrastructure in Poland, and changes which occurred in this respect between 2010 and 2015. The following research hypothesis was formulated: *Regional differentiation of the level of information infrastructure in Poland is decreasing, i.e. a regional convergence process is taking place in this respect.*

Methodology/methods: The study was performed at the regional NUTS II level. Taxonomic methods, including linear ordering based on a synthetic variable and a method of grouping linearly-ordered objects, were used.

Findings & Value added: The regional differentiation of the level of information infrastructure in Poland is at an average level, whereas the scale of this differentiation has slightly decreased. This may be confirmed by the value of the variation coefficient, which fell from the level of 17.6% in 2010 to the level of 14.4% in 2015. The regional convergence with respect to the level of information infrastructure in Poland was accompanied by the internal convergence and divergence of provinces. In consequence of such processes, the position of individual provinces with respect to others, has changed quite significant. Into the group of provinces with a very high ICT level were classified three provinces:

Mazowieckie, Dolnośląskie and Pomorskie. The group of provinces with very low ICT level includes: Lubelskie, Świętokrzyskie and Zachodniopomorskie.

Introduction

The modern economy is known as the knowledge-based economy (KBE). A strategic factor for its economic growth is knowledge, and the capacity to create, absorb and use it. One of the pillars of the knowledge-based economy is a modern and adequate information infrastructure. It facilitates effective communication, dissemination and processing of information and knowledge, implies the creation of new knowledge, and creates new possibilities for effective use of knowledge and information in the management process.

Information infrastructure is also a significant determinant in the development of territorial units, and therefore, it influences the regional dimension of building KBE. As noted by Miszczak (2012, p. 109), the development of information and communication technologies increases the amount and the quality of information and facilitates access to it. The growing volume of circulating information implies the generation of new knowledge which – being one of the factors of regional development – determines the shaping of the new structure of an economic region. Therefore, regional differences in the level of information infrastructure may translate to the aggravation of regional differences in the level of economic development, and may slow down the process of building the knowledge-based economy at the national level.

In light of the above, the purpose of the study was the evaluation of the regional differentiation of the level of information infrastructure in Poland, and changes which occurred in this respect between 2010 and 2015. The following research hypothesis was formulated: *Regional differentiation of the level of information infrastructure in Poland is decreasing, i.e. a regional convergence process is taking place in this respect.*

Information Infrastructure as a Pillar of Knowledge-Based Economy

The knowledge-based economy is a type of economy where knowledge is acquired, created, disseminated and used effectively by companies, organisations, natural persons and communities, contributing to the rapid development of the economy and the society (Dahlman & Andersson, 2000, p. 32). The key infrastructure of the knowledge-based economy is the information infrastructure, also defined as the information and communication technologies (ICT).

Information and communication technologies are the backbone of this kind of economy and, as such, are imperative for its development. They also provide significant support for the development of the other three pillars of knowledge (Al-Busaidi, 2014, p. 16). ICT are one of the key factors connecting technological progress and the globalization process in creating the knowledge-based economy (Kałkowska, 2016, p. 363). The ICT sector is a key pillar of the knowledge-based economy, the development of which has become a priority challenge for many countries, including Poland (Strożek & Jewczak, 2016, p. 208).

The information infrastructure refers to the accessibility, reliability and efficiency of computers, phones, television and radio sets and the various networks that link them (Chen & Dahlman, 2006, p. 7). It encompasses hardware, software, networks and media for the collection, storage, processing transmission and presentation of information in the form of voice, data, text and images (World Bank, 2003, p. 2). The information infrastructure consists of a set of modern devices, extended databases, varied and competing services and specialist institutions whose aim is to ensure the effective communication and efficient processing, storage and distribution of useful information for a number of entities (Madrak-Grochowska, 2013, pp. 361-362).

A dynamic information infrastructure facilitates the efficient communication, distribution and processing of information and knowledge (Al-Busaidi, 2014, p. 16). It enables citizens and companies to have easy and cheap access to material information from all over the world (Tocan, 2012, p. 207). It allows for the relatively inexpensive and efficient distribution of information; therefore, it contributes to a decrease in uncertainty and transaction costs (Gorji & Alipourian, 2011, p. 53). ICT are tools that have been generating several ways of living and working together (Kamińska, 2009, p. 166). ICT are one of the most important factors for development and economic growth in the globalised economy (Maryska et al., 2012, p. 1060). ICT contribute to development in two ways: as an enabler for the delivery of public and commercial services and a core technological competency for transforming all sectors of the economy; and as an industry, a new source of growth and keystone sector of the knowledge economy in its own right (Hanna, 2010, p. 183).

Research Methodology

In line with the *Knowledge Assessment Methodology*, to evaluate the level of information infrastructure, the following variables are used: number of telephones, computers, Internet users and television sets per 1,000 person, expenditure on ICT as % of the GDP or availability of

e-administration (Wasiak, 2008, pp. 83-84; Bashir, 2013, p. 32; Ujwary-Gil, 2013, p. 168). Nevertheless, numerous studies are performed on the basis of a modified set of variables as compared to the KAM (cf. Kukliński & Burzyński, 2004, pp. 2-41; Shapira et al., 2006, pp. 1522-1537; Strożek & Jewczak, 2016, pp. 208-217). When selecting the set of variables, authors try to choose variables that correspond best to the adopted definition, are adequate to the level of the performed analysis and are available for the adopted research period.

Being guided by the criteria above, the author selected variables with respect to substantive, formal and statistical aspects. The final set of variables on the basis of which a synthetic index of information infrastructure was built included the following variables:

- X_1 – percentage of households with PCs with Internet access;
- X_2 – percentage of households with mobile phones;
- X_3 – percentage of households with satellite or cable television devices;
- X_4 – percentage of companies¹ using computers;
- X_5 – percentage of companies¹ with Internet access;
- X_6 – percentage of companies¹ with their own websites;
- X_7 – percentage of companies¹ receiving orders via computer networks;
- X_8 – percentage of companies¹ filing orders via computer networks;
- X_9 – percentage of companies¹ using the Internet in contacts with public administration bodies.

Normalisation of variables was performed with the use of the zeroed unitarisation procedure. Due to the fact that all variables were assigned with the character of stimulators², the procedure was performed in line with the formula below (Panek & Zwierzchowski, 2013, p. 37):

$$z_{ij} = \frac{x_{ij} - \min_i \{x_{ij}\}}{\max_i \{x_{ij}\} - \min_i \{x_{ij}\}} \quad i = 1, 2, \dots, n; j = 1, 2, \dots, m, \quad (1)$$

where:

z_{ij} – normalised value of the j^{th} variable in the i^{th} object;

x_{ij} – value of the j^{th} variable in the i^{th} object;

$\min_i \{x_{ij}\}, \max_i \{x_{ij}\}$ – min and max values of the j^{th} variable in the set of

objects.

¹ Concerns non-financial sector companies.

² Verification of the adopted character of variables was performed *ex post* by checking the correlation of individual variables with the synthetic variable.

Normalised variables were subject to the synthetisation procedure in line with the aggregating formula (Panek & Zwierzchowski, 2013, p. 63):

$$s_i = \frac{1}{m} \sum_{j=1}^m z_{ij} \quad i = 1, 2, \dots, n; j = 1, 2, \dots, m, \quad (2)$$

where:

s_i – value of synthetic variable in the i^{th} object;

z_{ij} – normalised value of j^{th} variable in the i^{th} object;

m – number of variables.

The synthetic index of the information infrastructure (ICT index) adopted values within the range of [0, 1]. A higher value of the index implies a more favourable position of the province with respect to the examined characteristics.

Regional Differentiation of the Level of Information Infrastructure in Poland

Regional differentiation of the level of information infrastructure in Poland was evaluated on the basis of the values of the synthetic ICT index in provinces between 2010 and 2015, which are presented in Table 1.

Table 1. Synthetic index of the information infrastructure in provinces between 2010 and 2015.

Province	Value of the the synthetic ICT index						Dynamics of changes in 2010-2015
	2010	2011	2012	2013	2014	2015	
Dolnośląskie	0.559	0.564	0.605	0.552	0.670	0.757	1.35
Kujawsko-Pomorskie	0.582	0.592	0.598	0.506	0.558	0.655	1.13
Lubelskie	0.346	0.436	0.528	0.597	0.503	0.533	1.54
Lubuskie	0.533	0.537	0.514	0.560	0.550	0.698	1.31
Łódzkie	0.467	0.456	0.537	0.530	0.527	0.625	1.34
Małopolskie	0.504	0.491	0.469	0.528	0.534	0.571	1.13
Mazowieckie	0.631	0.678	0.703	0.712	0.741	0.842	1.34
Opolskie	0.515	0.462	0.576	0.587	0.604	0.632	1.23
Podkarpackie	0.447	0.418	0.429	0.470	0.577	0.648	1.45
Podlaskie	0.407	0.470	0.430	0.482	0.451	0.584	1.44
Pomorskie	0.656	0.647	0.617	0.657	0.711	0.803	1.22
Śląskie	0.584	0.599	0.682	0.664	0.640	0.713	1.22
Świętokrzyskie	0.307	0.200	0.347	0.360	0.404	0.488	1.59
Warmińsko-Mazurskie	0.397	0.384	0.380	0.442	0.503	0.552	1.39
Wielkopolskie	0.558	0.524	0.565	0.617	0.655	0.651	1.17
Zachodniopomorskie	0.535	0.526	0.490	0.487	0.481	0.530	0.99
Average for Poland	0.535	0.538	0.568	0.584	0.609	0.679	1.27
Variation coefficient	17.6%	20.6%	17.4%	15.1%	15.1%	14.4%	

Source: own calculations based on Bank Danych Lokalnych (2017).

Between 2010 and 2015, the level of information infrastructure in Poland clearly improved, which is confirmed by an increase in the average value of the synthetic ICT index for Poland by 27%. The dynamics of changes occurring in this respect in individual provinces was diversified. The highest growth was recorded in Świętokrzyskie Province – 1.59 and Lubelskie Province – 1.54; the lowest was in Kujawsko-Pomorskie Province and Małopolskie Province – 1.13 in each. A 1% drop in the level of information infrastructure in comparison to 2010 was recorded in only one province – Zachodniopomorskie Province.

Regional differentiation of the level of information infrastructure in Poland is at an average level, whereas the scale of this differentiation has slightly decreased. This may be confirmed by the value of the variation coefficient, which fell from the level of 17.6% in 2010 to 14.4% in 2015, as well as the fact that the relation between the maximum and the minimum values of the synthetic ICT index in provinces in individual years fell. In 2010, it amounted to 2.1; in 2015 it was at the level of 1.7.

The regional convergence with respect to the level of information infrastructure in Poland was accompanied by the internal convergence and divergence of provinces. In consequence of such processes, the position of individual provinces with respect to others, has changed quite significant. This is confirmed by the results of rankings prepared on the basis of values of the synthetic ICT index and the results of grouping of provinces which was performed with the use of the standard deviation method (table 2).

Table 2. Results of linear ordering and grouping of provinces according to the synthetic ICT index in 2010 and 2015

2010			2015		
Position in ranking	Province	Level of ICT	Position in ranking	Province	Level of ICT
1	Pomorskie	Very high $s_i \geq 0.602$	1	Mazowieckie	Very high $s_i \geq 0.744$
2	Mazowieckie		2	Pomorskie	
3	Śląskie		3	Dolnośląskie	
4	Kujawsko-Pomorskie	High $0.602 > s_i \geq 0.502$	4	Śląskie	High $0.744 > s_i \geq 0.643$
5	Dolnośląskie		5	Lubuskie	
6	Wielkopolskie		6	Kujawsko-Pomorskie	
7	Zachodniopomorskie		7	Wielkopolskie	
8	Lubuskie		8	Podkarpackie	
9	Opolskie		9	Opolskie	
10	Małopolskie	Low $0.502 > s_i$	10	Łódzkie	Low $0.643 > s_i \geq 0.542$
11	Łódzkie		11	Podlaskie	
12	Podkarpackie		12	Małopolskie	

13	Podlaskie	≥ 0.402	13	Warmińsko-Mazurskie	
14	Warmińsko-Mazurskie	Very low $s_t < 0.402$	14	Lubelskie	Very low $s_t < 0.542$
15	Lubelskie		15	Zachodniopomorskie	
16	Świętokrzyskie		16	Świętokrzyskie	

Source: author's own study on the basis of Table 1.

Mazowieckie Province has been the leader with respect to the level of information infrastructure. The advantage of this province is that it has the highest national percentage of households with PCs with Internet access, and non-financial sector companies receiving and filing orders via computer networks and having their own websites. Pomorskie Province also holds a high position in the ranking. The advantages of this province include the highest national percentage of non-financial sector companies using the Internet in contacts with public administration bodies, and the highest percentage of households equipped with satellite and cable television devices, as well as a high percentage of households with PCs with Internet access. In 2015, into the group of provinces with a very high ICT level was also classified Dolnośląskie Province. It is characterised by the highest national percentage of non-financial sector companies making use of computers and having Internet access.

Świętokrzyskie Province occupied the lowest position in the ranking in the entire analysed period. This province's weakness is that it has the lowest national percentage of households with PCs with Internet access, and non-financial sector companies receiving orders via computer networks. Lubelskie Province also holds a low position in the rankings along with Zachodniopomorskie Province since 2012, which dropped to 15th position in 2015 from 7th position in 2010. Such significant aggravation of the situation in the province was caused by the highest national decrease in the percentage of non-financial sector companies using computers and having Internet access; the result was the lowest position in the country in these two aspects. In consequence of changes, Zachodniopomorskie Province was classified in the group of provinces with very low ICT level in 2015.

Conclusions

The level of information infrastructure in Poland has improved significantly. The highest growth of the synthetic index of information infrastructure was recorded in Świętokrzyskie and Lubelskie Provinces, i.e. in provinces which were characterised by the lowest level of this index at the beginning of the examined period. The lowest growth was recorded in

Kujawsko-Pomorskie and Małopolskie Provinces. In one province, i.e. Zachodniopomorskie, a drop in the synthetic ICT index was recorded.

In consequence of the diverse dynamics of changes and a diverse level of information infrastructure at the beginning of the examined period, parallel internal convergence and divergence processes were observed in the group of provinces. As a result of such processes, the structure of the group of provinces with respect to the level of information infrastructure has become more homogeneous. This fact is confirmed by the value of the variation coefficient, which, from the level of 17.6% in 2010 fell to the level of 14.4% in 2015. The decreasing regional differentiation of the level of information infrastructure in Poland means that a slow convergence process took place in this respect. So the research hypothesis has been verified positively.

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