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Adam P. Balcerzak, Michał Bernard Pietrzak

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Assessment of effectiveness of forms of professional activisation in poviats in Poland in years 2008-2014

JEL Classification: *C38; J68*

Keywords: *registered unemployment; forms of professional activisation; cost and employment effectiveness; cluster analysis; k-means method*

Abstract

Research background: Active labour market policy and large related expenditures make it necessary to conduct analyses on the effectiveness of its instruments and to conduct evaluation studies. In case of the unemployment, this research refers to several aspects. These include in particular: identification of groups of persons threatened by the long-term unemployment, assessment of influence of introduced programmes on exit from unemployment and monitoring the disbursement of funds earmarked for these purposes.
Purpose of the article: The goal of the article was separation of homogeneous groups of poviats with respect to values of cost and employment effectiveness of basic forms of professional activation, realised by the poviat labour offices in the years 2008-2014.
Methods: The k-means method was used for clustering. Variables were standardised and the number of clusters was determined by means of the v-fold cross-validation.
Findings & Value added: In the analysed period it can be observed that the coefficients of cost (except for big decline in 2011) and employment effectiveness had the increasing trend. The analysis carried out did not allow to clearly define which areas of the country were characterized by a better use of funds for activisaation of

the unemployed. It can be observed that in the poviats of middle-east Poland effectiveness of forms of professional activisation generally belonged to worse groups, however the unemployment rate in these areas was not very high. On the other hand, in poviats of the north-west Poland the unemployment rate belonged to the highest and the funds for professional activisation were well used. Assessment of effectiveness of forms of professional activisation is justified because poviats receive appropriate funds and their activities usually influence the effective counteraction to unemployment.

Introduction

Effectiveness is a measure of efficiency of actions taken. It describes the relation of obtained effects to incurred expenses. It is understood as a measure of the extent to which the set goals are achieved. On the basis of economic policy, under the slogan of the effectiveness of the public sector functioning, there are all activities aimed at assessing the effectiveness of the use of state policy instruments. It is necessary to assess whether it is appropriate to continue using the instrument and to identify more effective solutions (Knapińska & Małecka-Ziembińska, 2016).

In the case of the labour market it is important to monitor the implemented programmes of support for the unemployed persons. From the social point of view it is important to employ as many looking for job unemployed persons as possible. On the contrary, in case of institutions financing the active programmes of support the assessment of disbursement of funds is essential. Therefore, when assessing the effectiveness of the implemented programmes, two coefficients are set: employment and cost effectiveness.

After Poland's accession to the European Union the scope of activities connected with the professional activisation of the unemployed persons, directed to the persons being in difficult situation on the labour market increased. Conducted researches indicate that these activities contribute to increase of probability and intensity of taking up jobs by the unemployed persons (Bieszk-Stolorz, 2017).

The goal of the article is clustering of poviats with respect to the effectiveness of the use of Labour Fund resources by poviat labour offices in years 2008-2014 on financing the basic forms of professional activisation with use of the k-means method.

Registered unemployment in Poland in years 2008-2014

The registered unemployment rate in Poland in years 2008-2014 was changing. In 2008 it was equal 9.5% and it rose to 13.4% during subsequent years (2012). It continued on this level in the year 2013 and fell to 11.4% in 2014. Similar changes can be observed in case of the number of registered unemployed persons (figure 1).

Numerous researches indicate that the unemployment in Poland is spatially very diversified (Murawska, 2016; Tatarczak & Boichuk, 2018; Woźniak-Jęchorek, 2015). It may result from the fact that the Polish labour market is highly disrupted by yearly fluctuations of other macroeconomic indicators **(**Hadas-Dyduch *et al*, 2016).

The amount of expenditures for the implementation of programmes for the promotion of employment in Poland in years 2008-2014 was nuanced. Figure 2 presents the amount of this expenditures in fixed prices from 2014. In the years 2008-2014 the expenditures rose quickly. This increase was justified by the economic recession that resulted in limited demand for work. In the year 2011 with respect to previous year these expenditures decreased abruptly (by about 64%). It was connected with the necessity of reducing public finance spending. Indeed, Poland was the subject to an excessive deficit procedure and, in line with the Ecofin Council recommendation (of July 7th 2009), was required to correct the general government deficit below 3% of GDP by 2012. Next, in years 2010-2014 the expenditures begun to grow again. Their amount were nuanced in particular voivodeships.

The research was conducted on the basis of statistical data referring to the cost and employment effectiveness. They are published in the elaborations of the Ministry of Family, Labour and Social Policy. The cost and employment effectiveness are calculated for basic forms of professional activisation. The catalogue of these forms is determined by the minister in charge of labour. During the period 2008-2014 this catalogue was changing. Because of the auxiliary character or insignificant share in incurred nationwide expenditures, in 2008-2014 some forms of support were not considered in the catalogue of basic forms of professional activisation.

The table 1 presents the structure of the unemployed persons participating in the basic forms of professional activisation. The largest number of persons participated in internships and trainings. The least number of people were activised by retrofitting or equipping workstations. In the table 1 the fields with missing data refer to the forms of professional activisation which in subsequent years stopped being counted as basic.

Research methodology

The employment effectiveness (the re-employment rate) is defined as the ratio of the number of unemployed persons who in a given year after completion or interruption of participation in a given form of activation, within 3 months were employed for at least 30 days, to the number of persons who completed participation in a given form of activation this year. It is the rate that allows to specify the chances of finding employment after completion of participation in the programme.

The cost effectiveness (the cost of re-employment) is the ratio of the amount of expenditures incurred in a given year for a given form of activation by the number of unemployed persons who, this year after the end of participation in a given form of activation, obtained employment within 3 months. By means of the cost effectiveness the cost of leading the unemployed person to employment.

The research covered poviats in years 2008-2014. There were two reasons of selection of such period. The first one resulted from change of methodology of calculation of employment effectiveness of the basic forms of professional activisation since 2015. Therefore it was not possible to compare this indicator with the previous years directly. Change of methodology consisted in different definition of completion of participation in activisation and accepting the different definition of employment.

The second cause of choice of the research period resulted from the data availability. The cost and employment effectiveness were considered as variables in the research. Since 2015 onwards, the effectiveness for the poviats has only been given in total.

The clustering was done by means of the *k*-means method. The stages of each clustering method are as follows:

- selection of objects and variables,
- choice of normalisation formulas,
- choice of the distance measure,
- choice of the classification method,
- choice of the number of classes,
- assessment of the classification results,
- interpretation and class profiling.

In the analysed case poviats were the cases and the variables – the cost and employment effectiveness of particular forms of professional activisation. All variables were standardised. Due to the existence of the outliers, they were eliminated by using the Tukey's fences approach (Adil & Irshad, 2015, p. 92). The Euclidean distance was used as a measure of distance.

The next step was determination of the number of clusters. In the research, the *v*-fold cross-validation was used with the assumption that if we have the certain number of clusters, further division will not occur if it does not decrease the clustering error by less than 3%.

The stages of the *k*-means method are as follows (Reddy & Jana, 2012, p. 396):

- The set of objects is initially divided into k clusters.
- For each cluster the centre of gravity is calculated.
- Assignment of objects to clusters with the closest centre of gravity is changed.
- For each cluster the new centre of gravity is calculated.
- The above stages are repeated until further reallocation of objects stops improving the general distances of the objects from the clusters' centres of gravity.

The quality of classification was assessed by calculation of distances between the clusters. The division was done in order to maximise the distance between them.

Results of clustering poviats

As a result of clustering, in the years 2008, 2009, 2012 and 2014 three clusters of poviats with respect to the cost and employment effectiveness were selected. In the year 2013 four clusters were selected and in 2010 and 2011 – 5.

In every year cluster 1 contained poviats with the best (the highest) values of the employment effectiveness and the best (the lowest) values of the cost effectiveness. The cluster with the highest number always had poviats with the worst values of these features.

In the years 2008-2011 poviats with the highest values of employment effectiveness, had them on a relatively stable level between 57.5% – 61% (table 2). At the same time, values of this feature amongst poviats with the most disadvantageous values of the employment effectiveness were even less diversified (between 43% and 45.44%). In this case the trend was declining. The years 2012-2014 were characterised by a clear upward trend of the mean employment effectiveness in both the first, the best cluster (from 65% to over 81%) and in the last, the worst one (from 58% to 72%). Since 2013 poviats with the worst values of the employment effectiveness had them on the level not worse than the best poviats in the years 2008-2011. Such trend cannot be observed in case of the cost effectiveness. On the

average, the most advantageous values of the cost effectiveness were in the year 2008 (in all clusters), and the most disadvantageous – in 2010. Over time the effectiveness of basic forms of professional activisation was increasing – it is visible in increasing values of then employment effectiveness that at the end of the analysed period have increased significantly since the beginning.

The relationship between the values of employment and cost effectiveness and the registered unemployment rate was analysed by means of the Spearman's rank correlation coefficient. It is expected that the relationship between the employment effectiveness and the unemployment rate should be negative (the higher the effectiveness, the lower unemployment), while the relationship between the cost effectiveness and the unemployment rate should be positive. The relationship between both types of effectiveness and the unemployment rate for the whole country was generally statistically significant but the correlation strength was small (table 3). For the first cluster in the years 2009 and 2010 the relationship was significant but weak for both types of effectiveness. In the years 2013 and 2014 it was significant only for the employment effectiveness. In case of classes with the most disadvantageous values of both types of effectiveness, in the year 2010 the correlation between them and the registered unemployment rate was the strongest and statistically significant. In the years 2008, 2012 and 2013 the correlations between the employment effectiveness and the registered unemployment rate were significant. To sum up, we can state that no type of the effectiveness was the determinant of the registered unemployment rate (table 3, figure 3, figure 4, figure 5). Even in case of significant relationship the correlation strength was so weak that we cannot say about the influence of applied forms of professional activisation on the change of the registered unemployment rate.

Conclusions

In the article the clustering of poviats into homogeneous clusters with respect to the effectiveness of basic forms of professional activisation in the years 2008-2014 was done. Conducted analysis did not allow to state unambiguously, which parts of Poland were characterised by better use of funds for activisation of the unemployed persons. Nevertheless it can be seen that in the poviats of the middle-east Poland the values of effectiveness of forms of professional activisation belonged to worse groups. In these poviats the unemployment rate, in turn, was not among the highest in Poland. In the north poviats of the Warmia and Mazury the registered un-

employment rate was high and the cost and employment effectiveness had disadvantageous values. Similar results were obtained for several poviats of the Świętokrzyskie voivodeship. In poviats of the north-west and west Poland the registered unemployment rate was among the highest and at the same time the funds for activation of the unemployed were well used. In some poviats of the Pomorskie and Wielkopolskie voivodeship with the low registered unemployment rate the effectiveness of the activisation programmes was high. From the point of view of the social policy the most undesirable situation is, when for the high unemployment rate the use of funds for activation of the unemployed persons is poor. In such case the modification of activities of the labour offices should be considered in order to better adjust their activities to the specificity of the areas concerned and the needs of the labour market. On the other hand, if the effectiveness of the measures is high and the unemployment rate remains high, it might be worth considering reaching more registered unemployed people with the programmes.

Despite the difficulties of the analysis on the poviat level, assessment of effectiveness of the forms of professional activisation on this level is fully justified. It is the poviat labour offices that receive appropriate funds and lead the activisation programmes and it is their actions that determine to a large extent the effective counteraction of unemployment.

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Annex

Table 1. The structure of the unemployed people beginning participation in basic forms of activisation in Poland in the years 2008–2014

Year	Basic forms of professional activisation							
	Trainings	Intervention works	Public works	Internships	Co-financing of business start-ups	Retrofitting or equipping workstations	Carrying out socially useful work	Preparation of adults for the profession in the workplace
2008	25.8%	7.1%	6.8%	26.0%	8.0%	4.3%	9.8%	12.2%
2009	24.6%	5.9%	7.9%	37.5%	9.3%	4.1%	9.6%	1.1%
2010	23.1%	5.5%	9.5%	38.0%	9.8%	5.5%	8.6%	–
2011	17.8%	9.4%	7.6%	36.6%	8.6%	3.5%	16.5%	–
2012	18.8%	7.4%	7.1%	41.3%	9.2%	5.2%	11.0%	–
2013	18.4%	7.4%	7.1%	42.1%	9.8%	5.1%	10.1%	–
2014	17.8%	7.0%	7.4%	49.7%	11.3%	6.8%	–	–

Source: own elaboration.

Table 2. Mean employment and cost effectiveness in particular clusters in the years 2008-2014

Year	Effectiveness	Cluster				
		1	2	3	4	5
2008	employment	61.09%	52.13%	45.44%	–	–
	cost	8,557.95 zł	11,075.91 zł	12,826.53 zł	–	–
2009	employment	57.46%	50.08%	44.44%	–	–
	cost	11,014.50 zł	13,385.78 zł	15,685.24 zł	–	–
2010	employment	59.45%	57.65%	53.60%	48.79%	43.90%
	cost	11,675.02 zł	12,734.02 zł	14,093.35 zł	15,778.54 zł	18,414.47 zł
2011	employment	60.46%	60.19%	56.74%	50.08%	43.09%
	cost	8,178.43 zł	8,710.19 zł	9,890.02 zł	11,448.04 zł	13,595.93 zł
2012	employment	65.05%	60.88%	58.34%	–	–
	cost	9,949.35 zł	12,052.14 zł	12,694.78 zł	–	–
2013	employment	67.68%	64.76%	64.96%	60.26%	–
	cost	9,967.50 zł	11,288.75 zł	11,804.52 zł	13,113.16 zł	–
2014	employment	81.57%	76.28%	72.01%	–	–
	cost	10,219.30 zł	11,611.62 zł	12,778.24 zł	–	–

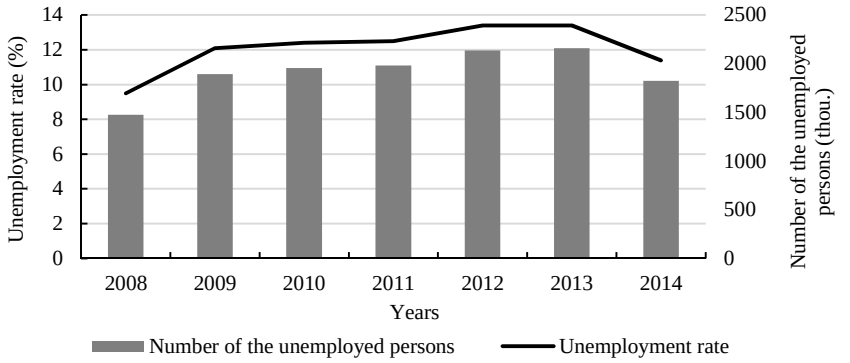
Source: own elaboration.

Table 3. Spearman's rank correlation coefficients between the cost and employment effectiveness and the registered unemployment rate in the years 2008-2014

Year	Effectiveness	Total	Cluster				
			1	2	3	4	5
2008	employment	**–0.1429**	–0.0346	–0.1378	**–0.3051**	–	–
	cost	**0.1648**	0.0920	**0.2066**	0.1501	–	–
2009	employment	–0.0259	**–0.2460**	–0.0707	0.0734	–	–
	cost	**0.1274**	**0.3364**	0.0978	0.0691	–	–
2010	employment	**–0.1336**	**–0.2863**	0.0439	–0.0422	–0.2125	**–0.3585**
	cost	**0.1715**	**0.2370**	0.0591	**0.2575**	0.1589	**0.3337**
2011	employment	**–0.1923**	0.0031	–0.1033	–0.1966	–0.2338	–0.0010
	cost	**0.1815**	–0.0120	**0.2061**	**0.3188**	**–0.3155**	0.0315
2012	employment	–0.0738	–0.0279	0.0238	**–0.2506**	–	–
	cost	0.0972	0.0762	0.1368	0.1842	–	–
2013	employment	**–0.2001**	**–0.3737**	–0.0847	0.0000	**–0.3660**	–
	cost	0.0563	0.0208	–0.0182	0.0844	0.0769	–
2014	employment	**–0.1585**	**–0.1880**	**–0.2059**	–0.0025	–	–
	cost	**0.1088**	–0.0332	**0.2929**	0.0385	–	–

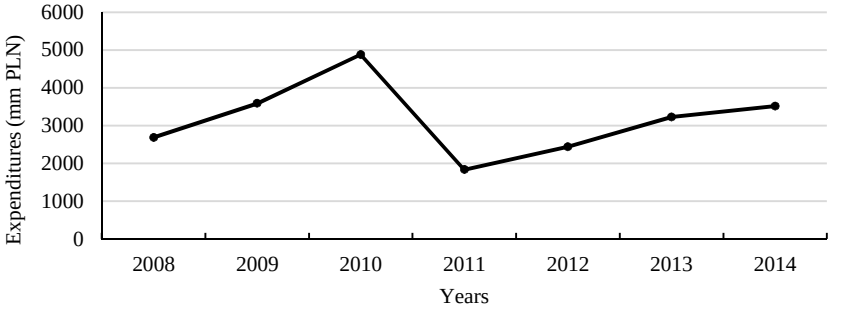
Source: own elaboration.

Figure 1. Registered unemployment rate and the number of registered unemployed persons in Poland in years 2008-2014



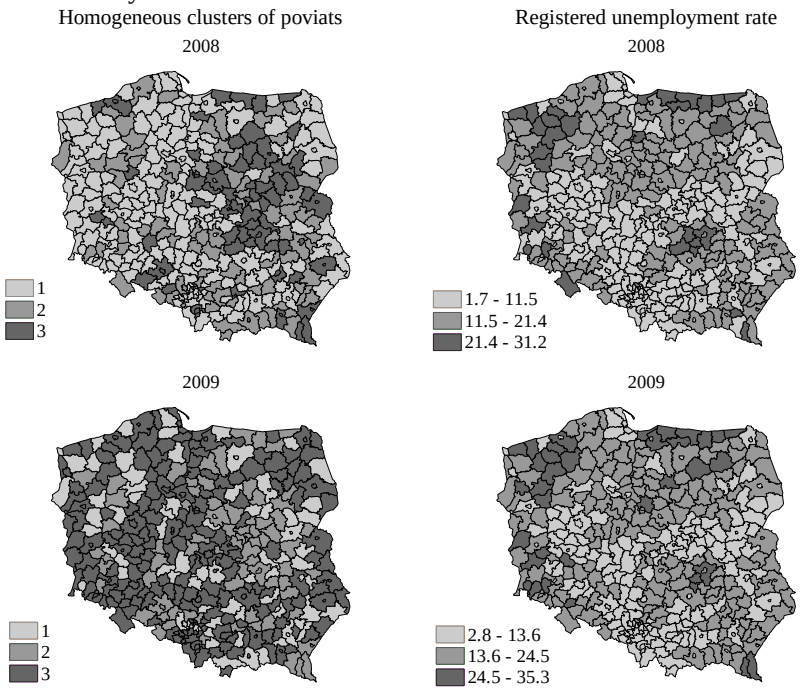
Source: own elaboration on the basis of the Local Data Base.

Figure 2. Expenditures for the implementation of programmes of professional activisation in Poland in years 2008–2014 (mm PLN, fixed prices from 2014)



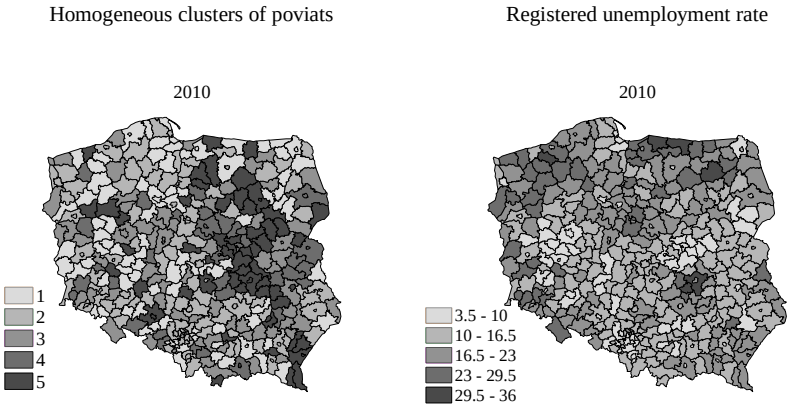
Source: own elaboration.

Figure 3. Homogeneous clusters of poviats with respect to the effectiveness of basic forms of professional activisation and the registered unemployment rate in poviats in the years 2008-2010



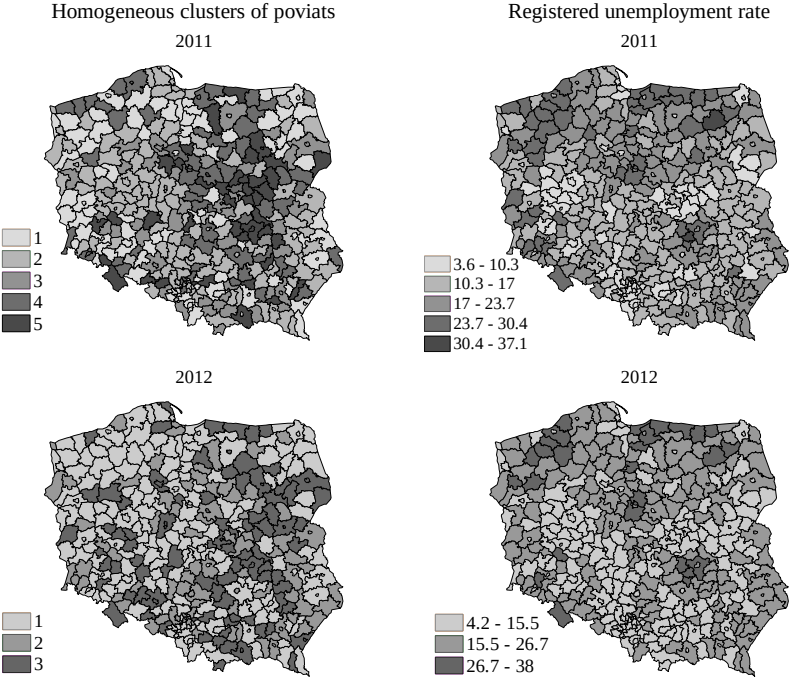
Source: own elaboration.

Figure 4. Continued



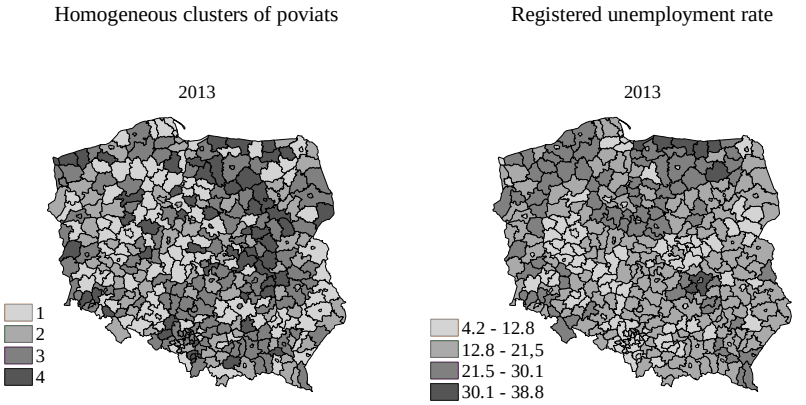
Source: own elaboration.

Figure 5. Homogeneous clusters of poviats with respect to the effectiveness of basic forms of professional activisation and the registered unemployment rate in poviats in the years 2011-2013



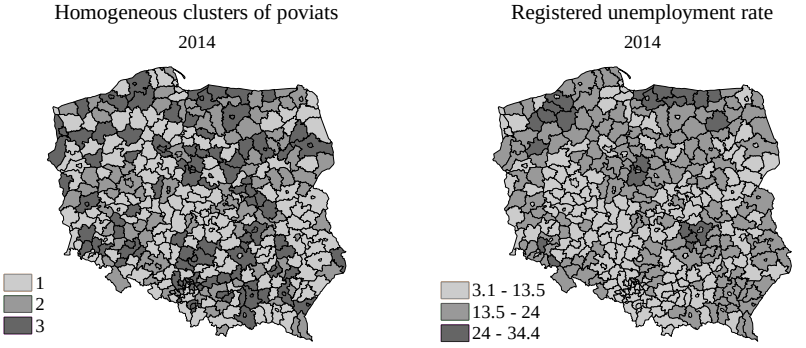
Source: own elaboration.

Figure 6. Continued



Source: own elaboration.

Figure 7. Homogeneous clusters of poviats with respect to the effectiveness of basic forms of professional activisation and the registered unemployment rate in poviats in 2014



Source: own elaboration.

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Investment – cash flow sensitivity under CEO overconfidence

JEL Classification: *D91; G31*

Keywords: *behavioral corporate finance; overconfidence; overinvestment; investment-cash flow sensitivity*

Abstract

Research background: Overconfidence is one of the biases and fallacies that affect a cognitive process. Indeed, overconfidence has some serious consequences even in corporate finance. Current literature, however, is not consistent as for the impact of overconfidence on investment and financing decisions – some research show overinvestment, while others underinvestment; some research show excessive debt usage, while others debt conservatism. We think that these discrepancies might be explained by investment - cash flow sensitivity.
Purpose of the article: The aim of this paper is to test investment - cash flow sensitivity under managerial overconfidence.
Methods: We test the investment cash flow sensitivity among panel data of Polish firms during 2010-2016. We collected the unique sample of 145 non-listed companies by surveying the CEOs on their overconfidence. We then divided the sample into two subsamples depending on the overconfidence. Subsequently, we compare cash flow and investment in the subsamples. To compare the subsamples we apply the nonparametric U Mann Whitney test.
Findings & Value added: The results support a number of recent findings reported in the literature. First, we find a positive and higher relation between the investment - cash flow sensitivity for companies managed by overconfident managers that is in line with recent research. However, we contribute to the existing literature in the following ways. We base our research on an original way of identifying and measuring overconfidence. Moreover, this is the first research referring to the relation between investment and cash flow in Polish companies managed by overconfident managers.

Introduction

Overconfidence is one of the biases and fallacies that affect cognitive processes. Overconfidence can have some serious consequences and researchers have offered overconfidence as an explanation for actions in all professions. Overconfidence has been studied since the 60ies of the XX century. Eventually, overconfidence was identified as a complex phenomenon (Moore & Healy, 2008).

Overconfidence also affects financial decisions and financial performance. Research on the relation between overconfidence and corporate finance reveals a strong relationship but the directions of this impact are not the same. Some research show overinvestment, while others indicate underinvestment; some research show excessive use of debt and others uncovers debt conservatism. The lack of consistency in research findings on the investment and financing decisions of overconfident managers gives a good rationale for further research. We think that the investment decisions of overconfident managers depend on access to funds (especially internal). Herein, access to the internal cash flow might be the explanation of investment decision and might explain under- and overinvestment. Furthermore, the relation between investment and financing decisions might shed a light on the pattern of financial decisions of overconfident managers. We hold that investment – cash flow relations might explain discrepancies in the association between investment and financing decisions - and overconfidence.

According to Modigliani and Miller (1958), in a perfect market, a firm's capital investment should be irrelevant to its internally generated cash flow in a perfect market. But in the 70-ies of the XX century studies have shown that real markets are imperfect, and thus the capital investment of a firm might be associated with internal cash flow. There is quite abundant literature on the close relation between internal cash flow and investment. For example, the best known research of Fazzari *et al.* (1988) and Kaplan and Zingales (1997) estimate investment–cash flow sensitivities of 0.20–0.70 for manufacturing firms from 1970–1984, statistically significant.

The aim of this paper is to test the investment – cash flow sensitivity under managerial overconfidence. We adopted investment-cash flow sensitivity to detect the relation between internal funds and investment decisions. We think that companies managed by overconfident managers show higher relation between cash flows and investment.

In this paper, we test the investment cash flow sensitivity within the panel data of Polish firms during 2010-2016. Using an original method of identifying of overconfidence we show the impact of CEOs' overconfi-

dence in the relationship between investment and internal cash flow. We collect the unique sample of 145 non-listed companies by surveying the CEOs on their overconfidence. We divide the sample into two subsamples depending on the overconfidence. We collect the financial data of surveyed companies covering the 2010-2016 period and the total number of observations is 1015. We compare cash flow and investment in the subsamples. To compare the subsamples we use nonparametric U Mann Whitney test (for independent subsamples). We also implemented regression analysis.

We contribute to the existing literature in the following ways. We base our research on original way of identifying and measuring overconfidence. And this is the first research referring to the relation between investment and cash flow in Polish companies managed by overconfident managers.

Research methodology

We are aware that there are a lot of measures of overconfidence. By far the most influential proxies for managerial overconfidence have been constructed by Malmendier and Tate (2005), whose proxies and dataset have been used in many other studies into overconfidence. These have been based on options (Longholder, Holder 67), shares (net buyer), and based on press. To identify and measure the overconfidence, we followed the methodology of Wrońska-Bukalska (2016) who assumed (after Moore and Healey, 2008) that overconfidence is a complex phenomenon consisting of overestimation, overplacement and overoptimism. She uses the survey to identify the overconfidence and developed an original method of overconfidence measuring. This methodology allows identifying managerial overconfidence and separating overconfident (OC) managers from non-overconfident (nonOC).

The sample comes from non-listed Polish companies. The data refer to the companies that were willing to take part in the survey on overconfidence. Research also covers the specific features of managers (overconfidence) and the financial data of 2010-2016 and include only those companies that meet the following requirements: established before 2010, in business for the whole 2010-2016 period, have the same president for the whole period of 2010-2016, have complete financial statement available, not operating as insurance and banking companies. We collected 145 surveys and were able to divide the sample (1015 observations) into two subsamples: non overconfident managers (nonOC – 78 companies and 546 observations) and overconfident managers (OC – 67 companies and

469 observations).

The descriptive statistics of the sample and subsamples are presented in Table 1. Investment is calculated as increase in fixed assets (I), while cash flow is based on operating cash flow (CF). TA represents the value of total assets, while SR represents the value of sales revenue.

The data in the Table 1 show that companies managed by overconfident managers have higher level of total assets, and they invest more and have higher operating cash flow but lower net profit. At the same time the sales revenue and employment do not differ. This means that cash flow, investment and total assets might be the result of managerial overconfidence. What is more, higher investment and cash flow calculated in relation to higher total assets for companies managed by overconfident managers might indicate that these companies have investment and cash flow ratio that is similar to companies managed by the non-overconfident (having lower investment, cash flow and total assets). Because calculating cash flow and investment in relation to total assets might distort our analysis, we decide to calculate all ratios in relation to sales revenue.

Results

Table 2 presents the descriptive statistics of investment and cash flow ratios.

Herein, it is evident that companies managed by overconfident managers have higher cash flow and investment ratios.

Table 3 presents the results of the univariate regression analysis that models the relation between variables.

For the full sample, overconfidence has statistically significant impact on the investment ratio; but in subsamples, the relation between cash flow and investment is strong and statistically significant. For both subsamples the relation is positive which means that investment is sensitive to cash flow. However, for the companies managed by overconfident managers the beta is higher. This reveals that investment - cash flow sensitivity is higher for companies managed by overconfident managers.

Conclusions

This study explores investment and financing decisions by way of the behavioral approach. We investigate the impact of one of the behavioral bias-

es – overconfidence – on the firms' investment policy. Adopting a modified investment – cash flow sensitivity model, we show evidence of the effect of overconfidence bias on investment - cash flow sensitivity.

Our work indicates positive and significant influence of overconfidence bias towards investment in the full sample. On classifying firms into two subsamples we find that managerial overconfidence increases investment - cash flow sensitivity.

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Annex

Table 1. Descriptive statistics of investment, cash flow, total assets and sales revenue level (in thousands PLN)

	Full sample			**Subsample of nonOC**			**Subsample of OC**			**U Mann Whitney**
	mean	**median**	**SD**	**mean**	**median**	**SD**	**mean**	**median**	**SD**	
CF	89	49	417	40	35	410	108	64	425	**-1,679 (0.098)**
I	29,996	49	657,374	13,197	49	316,918	49,496	50	904,260	**-1,933 (0.085)**
TA	8,147	3,237	15,733	6,347	3602	12,676	9,459	3,053	17,549	**-1,663 (0.093)**
SR	483,661	8,384	3,321,290	753,360	8,464	4,448,913	167,534	7,882	774,109	-1,264 (0.206)

Source: author's own calculations.

Table 2. Descriptive statistics for the sample and subsamples

	Full sample			**Subsample of nonOC**			**Subsample of OC**			**U Mann Whitney**
	mean	median	SD	mean	median	SD	mean	median	SD	
CF ratio	244.1	0.0	4,510.5	2.8	0.0	127.1	526.8	0.0	6,639.5	**-2,632 (0.008)**
I ratio	17.7	1.0	536.8	164.2	1.0	3,411.6	4,008.2	1.14	78,803.8	**-1,668 (0.099)**

Source: author's own calculations.

Table 3. Results of the regression analysis

Dependent variable	**I ratio (full sample)**	**I ratio (subsample of nonOC)**	**I ratio (subsample of OC)**
OC	**0.037 (0.041)**	x	x
CF ratio	0.000 (0.584)	**0.320 (0.000)**	**0.329 (0.000)**
R square	0.005	1.000	0.158
F statistics	2,175 (0.114)	989,797,180 (0.000)	75,253 (0.000)

Source: author's own calculations.

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Analysis of relationships between the unemployment rate and the unemployment duration in the Visegrad Group countries in years 2001-2017

JEL Classification: *C61; J64*

Keywords: *registered unemployment rate; unemployment duration; business cycle clock; Dynamic Time Warping; Visegrad Group countries*

Abstract

Research background: The registered unemployment rate and the unemployment duration are the most important indicators that describe the situation on the labour market. The high unemployment rate and long duration are devastating for the human capital on the labour market. Therefore, it is important to check if there is connection between these two indicators.
Purpose of the article: The goal of the article is the designation of relationship between the unemployment rate and the unemployment duration and the similarity of course of these indicators in the Visegrad Group countries.
Methods: The mutual course of the unemployment rate and the unemployment duration will be analysed by means of the business cycle clock methodology, while the similarity of the course of these two indications will be analysed by using the Pearson product-moment correlation coefficients and the Dynamic Time Warping (DTW) technique.
Findings & Value added: In Czechia, Poland and Slovakia the mutual course of the unemployment rate and the unemployment duration were to some extent similar – both the unemployment rate and the unemployment duration decreased until the outbreak of crisis in 2009, in subsequent years the unemployment rate started to

increase, while the growth of the unemployment duration was delayed by 2-3 years. After the year 2013 both indicators were decreasing. In Hungary, the course was quite different – the unemployment rate was increasing or steady until the year 2012 and next it started to decrease. The course of the unemployment duration did not follow the pattern of the remaining three countries. The added value is the application of the business clock cycle and the Dynamic Time Warping in analysis of relationships between the unemployment rate and the unemployment duration.

Introduction

In the analyses of the labour market there are many measures and indicators allowing for the assessment of the employment, wage and employment level, work conditions, labour costs or demand for work. The frequently used indicators are: activity rate, employment rate and unemployment rate. The unemployment rate is the basic indicator in the analysis of the unemployment. Apart from it, the mean unemployment duration is also analysed. However, due to the fact that the distribution of the unemployment duration is asymmetric, the median seems to be better measure of central tendency. During most economic cycles the strong correlation between the unemployment rate and the unemployment duration can be observed (Abraham & Shimmer, 2001, p. 1). When the economic situation deteriorates, the unemployment rate increases. It should imply the increase of the unemployment duration. On the contrary, the decrease of the unemployment rate should cause the decrease of the unemployment duration.

Reaction of the labour markets to changes of the economic conditions depend on many factors, of which the level of the economic development and the structure of economy seem to be the most important. Hence the differences in unemployment and employment rates between countries and their response to the crisis result (Chocholatá & Furková, 2018). Counteracting the effects of unemployment depends to a large extent on the effectiveness of the labour market policy pursued in a given country. Its character and influence on the economic situation in particular countries is nuanced (Rollnik-Sadowska & Dąbrowska, 2018). The labour market policy is implemented by the labour market institutions. Their tasks include, inter alia, assistance to people in a special situation on the labour market and at risk of long-term unemployment. Some of these activities, such as high unemployment benefits, may extend the unemployment duration (Bieszk-Stolorz & Markowicz 2015 Meyer, 1990; Mortensen, 1977). Markets in various countries do not always react on changes in the economy as presented in theoretical studies. In order to avoid these sources of diversity, the

subject of the analysis are the so-called the Visegrad Group countries: Poland, Czechia, Slovakia and Hungary. These countries can be treated as acting on the similar level of economic development and having similar employment structure (Zieliński, 2015). The Visegrad Group countries are currently considered as the example of successful transformation from the centrally planned economy into the market one and they are often indicated as the benchmark cases of the process of modernisation that increased their competitiveness in the globalised economy (Hadas-Dyduch *et al*, 2016).

The goal of the article is the designation of relationship between the unemployment rate and the unemployment duration and the similarity of course of these indicators in the Visegrad Group countries. The Eurostat data for years 2001-2017 was used in the research.

Unemployment rate and the unemployment duration in the Visegrad Group countries

Analysing the unemployment rate in years 2001-2017 it can be seen that for Poland, Czechia and Slovakia the period after the accession to the EU (since 2004) until the moment of the global financial crisis was the time of constant improvement of the situation on the labour markets that was characterised by the decrease of the unemployment rate (figure 1). In case of Hungary it noticeable that the unemployment rate was the lowest before 2004 and increased afterwards. It may be the result of the fact that the Hungarian labour market did not gain much after the accession to the EU. Slovakia had the worst situation after 2004 – it had the highest values of the unemployment rate. Accordingly to the results of the statistical data the longest unemployment duration and the highest unemployment indicators were in Slovakia. The social security system established in the Visegrad Group countries may be the cause that unemployment, especially the long-term one, is not the structural, but the system problem.

Indisputably the worst situation of Slovakia in years 2001-2007 was confirmed by the chart of the median unemployment duration (figure 2). It was much higher than the median calculated for the remaining countries and in the year 2007 it was equal almost 35 months. During following two years it decreased to the level of about 14.5 months and grew again up to 24.5 months in 2013. In case of Poland, Czechia and Hungary mean median unemployment durations were similar and equal 10.1, 10.9 and 10.7, respectively. Median values in years 2001-2017 were least nuanced in case of Hungary.

Research methodology

The research was conducted in two stages. In the first stage the mutual relation between the unemployment rate and median unemployment duration was analysed by means of the scatterplot charts that were analysed similarly as the business cycle clock (Abberger & Nierhaus, 2010). In the second stage it was analysed if there are lags between the changes of the unemployment rate and median unemployment duration. Consistency of course of time series of the unemployment rate and median unemployment duration was analysed by means of the Pearson product-moment correlation coefficient. The relationship between time series without lags was analysed and with lagged median unemployment duration with respect to the unemployment rate. The consistency was analysed with lags from 1 year until 5 years. The course of the time series in the more consistent, the higher the positive correlation between them is. Hence, the lag was estimated by the highest positive value of the correlation coefficient.

Knowing, what the lag of the unemployment duration with respect to the unemployment rate is, the similarity of analysed time series was analysed by means of the Dynamic Time Warping (DTW) method. It was created in the early seventies and originally was applied for the context speech recognition (Giorgino, 2009, p. 1). It is used for estimation of the optimal alignment of timeseries by the methods of the dynamic programming. If both compared series have the same variables (but measured for example for various objects) then these series can be compared directly. However, if both series are described by means of different variables, then they must be normalised. In the article, one of the quotient inversions was applied:

$$z_t = \frac{y_t}{\sqrt{\sum_{t=1}^{n} y_t^2}}, \tag{1}$$

where y_t – value of analysed variable in the period t, n – number of analysed periods.

By means of the DTW method we can draw the alignment plot that presents the similarity between the two analysed timeseries. In case of normalised variables, if the course of both series was identical, the alignment plot would be the straight line going from the lower-left to the upper-right corner. The more the alignment plot diverges from the minor diagonal, the more dissimilar the series are. In general, the higher Pearson product-moment correlation coefficient between the series is, the more similar to the minor diagonal the alignment is.

Results of the analysis

In the first stage the relationship between the unemployment rate and median unemployment duration was analysed. For this purpose the scatterplot charts showing four directions of changes.

The figures 3-6 present the scatterplot charts for all Visegrad Group countries. The scatterplot charts show that in years 2001-2007 the unemployment rates for Poland and Slovakia were very high and similar (20% in 2002 and 19.4% in 2001, respectively). In Poland the highest median unemployment duration was 14.6 equal months (2005) and in Slovakia – 34.6 months (2007). In Slovakia high changes in the unemployment rate generated high changes in the median unemployment duration. In Poland high changes of the unemployment rate did not cause as big changes of median. In Czechia changes of the median unemployment duration were similar as in Poland, but the unemployment rate was much lower and was characterised by the least variability. In Hungary the changes of the median unemployment durations were the lowest among all analysed countries and changes in the unemployment rate were higher than in Czechia, but much lower than in Poland and Slovakia. In 2017 the situation in all countries improved, but in Slovakia it was still much worse.

It can be seen than until the accession to the UE, the unemployment rate in Poland was very high. After 2004 it begun to decrease, while the median unemployment duration begun to decrease one year after. Both indicators had decreasing trend until 2008 – after this year the unemployment rate slightly increased, in 2009 also the median unemployment duration increased. Between the years 2009-2013 both indicators increased and since 2014 – both begun to decrease (figure 3).

In Czechia both indicators fluctuated, but until the year 2004 the changes were in the same direction. Since 2004, the unemployment rate was decreasing, but until 2006 the median unemployment duration was increasing. Until 2008, both indicators had decreasing trend. In 2009 the unemployment rate grew and the median grew one year after. Since 2010 the unemployment rate was decreasing, followed by the decrease in the median unemployment duration since 2015 (figure 4).

In Slovakia the unemployment rate was decreasing until the year 2008, while in the same period, until 2007 the median unemployment duration increased significantly. Since 2008 until 20143 the unemployment rate was increasing again and the median begun to increase with 1 year lag. Since 2014 both indicators were decreasing (figure 5).

In Hungary the mutual course of the unemployment rate and median unemployment duration was much more complicated than in the remaining

countries. It results from the fact that the median was changing in various directions and these changes were relatively very small. Only after 2010 the unemployment rate was characterised by a steady decrease, followed in 2013 by the decrease of median unemployment duration (figure 6).

In the next stage of the analysis, the lag of the median unemployment duration with respect to the unemployment rate was estimated. In this purpose the Pearson product-moment correlation coefficients were calculated (table 1).

In Poland the unemployment rate was the most strongly connected with the median unemployment duration. The strongest correlation was for 1 year lag. For Czechia, the strongest correlation was obtained for 2 years lag of the median unemployment duration, however the strength was much smaller than in case of Poland. The analysis for Hungary showed that the median unemployment duration was 1 year lagged with respect to the unemployment rate, but the correlation between these variables was smaller than for Czechia. In Slovakia the median unemployment duration was 3 years lagged with respect to the unemployment rate and the correlation strength between these variables was the weakest amongst the group. The main reason for this was the fact that in Slovakia until the year 2007, despite decreasing unemployment rate, the median unemployment duration increased significantly (from just over 15 months in 2001 up to almost 35 months in 2007).

In order to perform deeper analysis of similarity of the course of the unemployment rate to the course of the lagged median unemployment duration, the alignment plots for four analysed countries were made (figures 7-10).

As seen on the figure 7, the course of the alignment plot for Poland goes the closest to the minor diagonal, with minor deviations in the periods 2001-2005 (until the accession to the EU) and 2010-2015 (in the years following the financial crisis of 2007-2008). These periods were the years, in which the differences between the course of the unemployment rate and median unemployment duration were the biggest.

For Czechia, the alignment between the unemployment rate and the 2 years lagged median unemployment duration was much weaker than in case of Poland. There was one major discrepancy in the period 2008-2015, or since the beginning of the crisis until several years of its termination (figure 8).

In Slovakia the discrepancies between the unemployment rate and the 3 years lagged median unemployment duration were much deeper than for Poland and Czechia and they were long-lasting. It results from the fact, that Slovakia had (and still has) the highest unemployment duration and during

the first period (years 2001-2007) it rose dramatically. After the financial crisis the situation on the Slovak labour market much improved and at the same time the mutual changes of both analysed indicators became much better adjusted (figure 9).

In Hungary the correlation between the unemployment rate and the 1 year lagged median unemployment duration was higher than in Slovakia, but the alignment between both indicators differed the most from the minor diagonal in the alignment plot. Moreover, these discrepancies lasted virtually in the whole analysed period (figure 10). Probably it resulted from the fact that the median in the whole analysed period did not change much, as compared to other countries.

Conclusions

Conducted analysis confirmed the differentiation of the Visegrad Group countries with respect to the unemployment rate and the median unemployment duration. Considering these two indicators it should be stated that in years 2001-2017, covering the pre-accession period and the period of financial crisis (years 2007-2009), Polish economy coped the best with the unemployment. Despite differences in the unemployment rate and the median unemployment duration in Poland, Czechia and Slovakia the courses of curves joining the scatterplot points were similar, which indicates the similar reaction of the labour markets to the fact of accession to the EU and financial crisis. On the contrary, the situation in Hungary was quite different. Relatively high values of the analysed indicators are characteristic for Slovakia. The second analysed in the article problem was the lag of reaction of the unemployment duration with respect to the changes of the unemployment rate (it is assumed that the changes of the unemployment rate occur faster). The shortest lag (1 year) and the highest relationship between both indicators was observed for Poland. One-year lag was also in Hungary, but the relationship between both indicators was much smaller and their courses were much more different (what is confirmed by the analysis of the correlation coefficient and the similarity of time series by means of the DTW method). In Czechia the lag of the median unemployment duration with relation to the unemployment rate was about 2 years and the course of both curves was quite similar. In Slovakia the unemployment duration reacted to changes in the unemployment rate at the latest (after 3 years), however the correlation strength between them was the weakest, which also meant that the courses of both rows differed quite strongly between each other.

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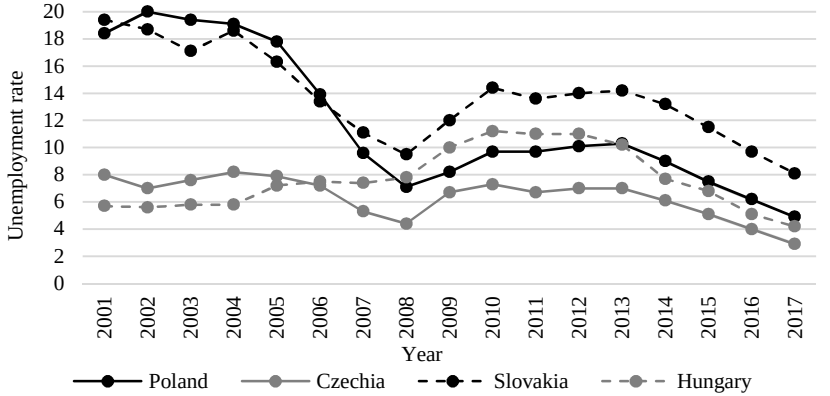
Annex

Table 1. Pearson product-moment correlation coefficients between the unemployment rate and lagged median unemployment duration

Lag of unemployment duration	Poland	Slovakia	Czechia	Hungary
No lag	0,8615	-0,2849	0,4341	0,5552
1 year lag	**0,9600**	0,1585	0,7659	**0,6716**
2 years lag	0,8931	0,4863	**0,7959**	0,4568
3 years lag	0,6862	**0,5623**	0,5171	0,1959
4 years lag	0,4244	0,5308	0,2039	-0,0912
5 years lag	0,1707	0,3398	0,0506	-0,2532

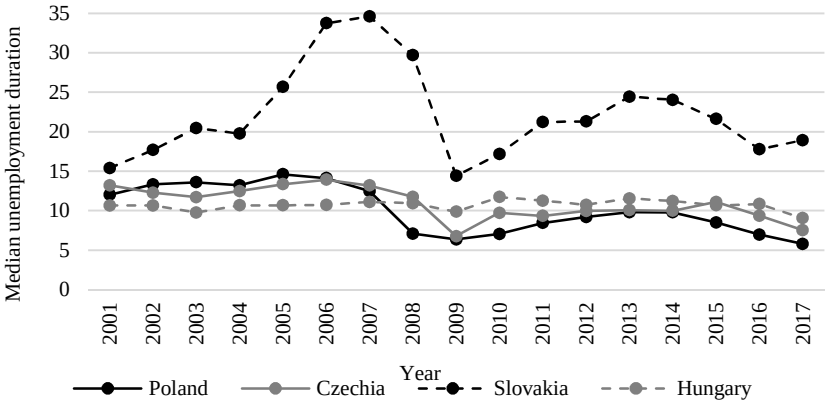
Source: own elaboration.

Figure 1. Unemployment rate in the Visegrad Group countries in years 2001-2017



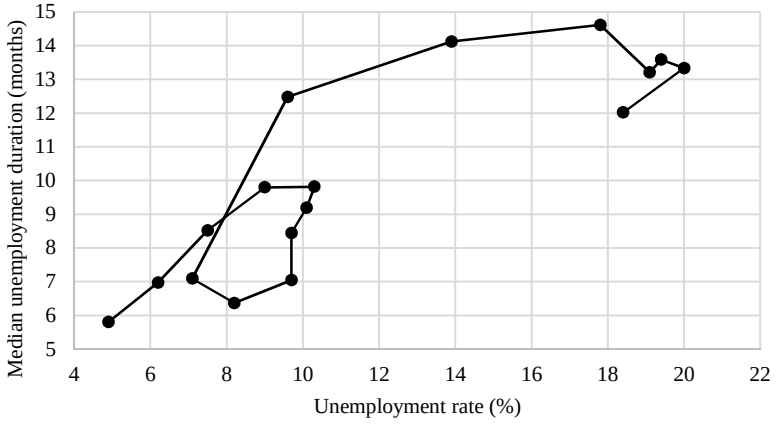
Source: own elaboration.

Figure 2. Median unemployment duration (months) in the Visegrad Group countries in years 2001-2017



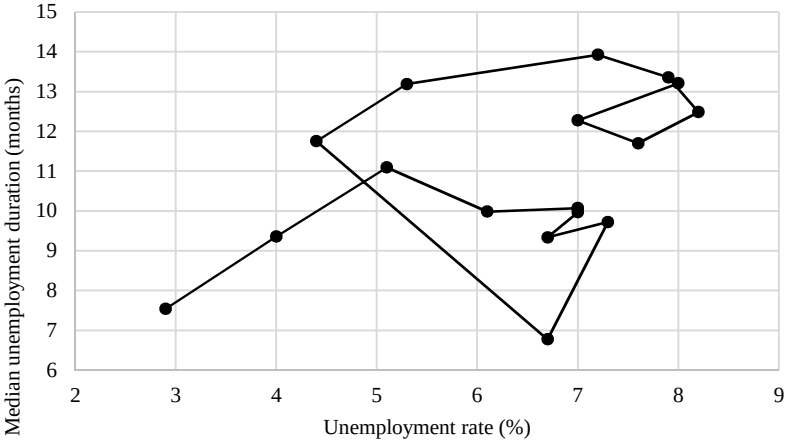
Source: own elaboration.

Figure 3. Relation between the unemployment rate and the median unemployment duration in Poland in years 2001-2017



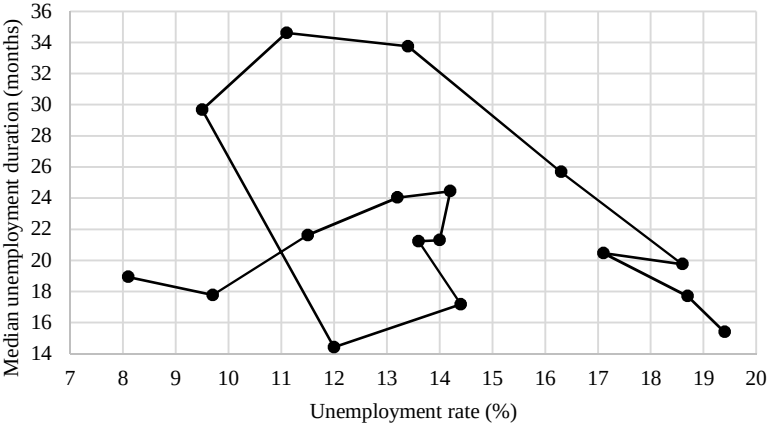
Source: own elaboration.

Figure 4. Relation between the unemployment rate and the median unemployment duration in Czechia in years 2001-2017



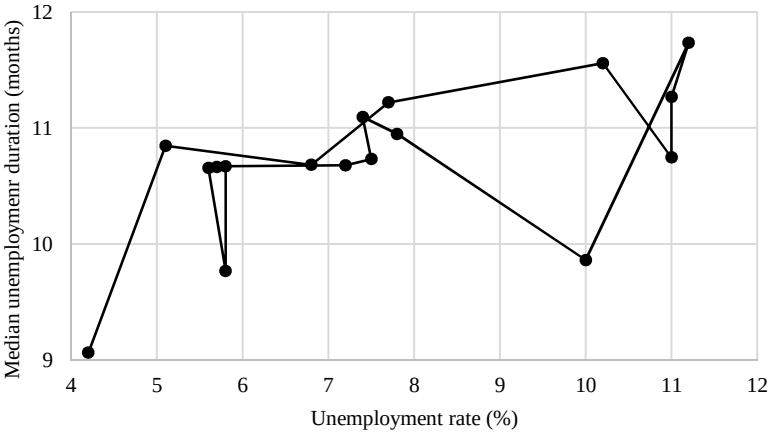
Source: own elaboration.

Figure 5. Relation between the unemployment rate and the median unemployment duration in Slovakia in years 2001-2017



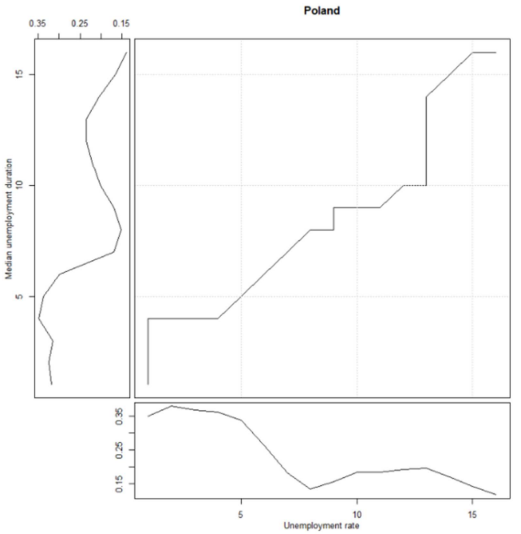
Source: own elaboration.

Figure 6. Relation between the unemployment rate and the median unemployment duration in Hungary in years 2001-2017



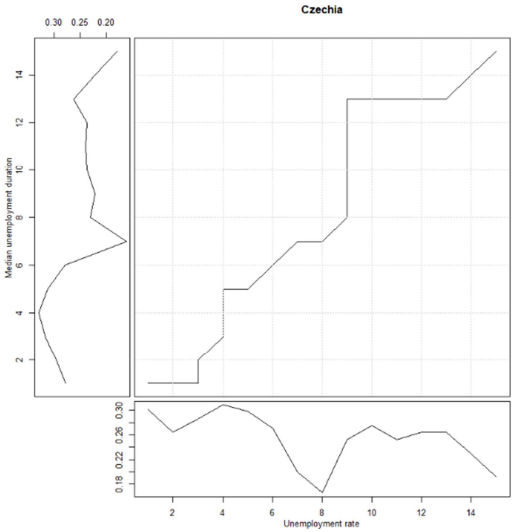
Source: own elaboration.

Figure 7. Alignment plots for the unemployment rate and lagged median unemployment duration for Poland



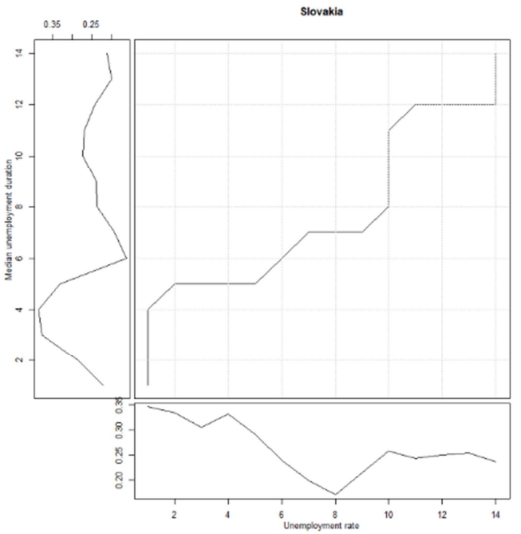
Source: own elaboration.

Figure 8. Alignment plots for the unemployment rate and lagged median unemployment duration for Czechia



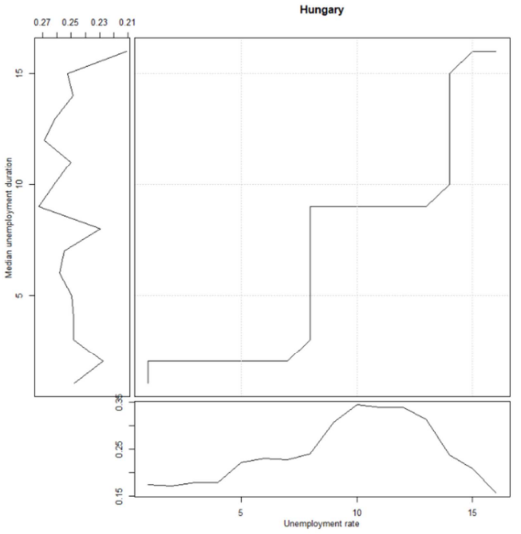
Source: own elaboration.

Figure 9. Alignment plots for the unemployment rate and lagged median unemployment duration for Slovakia



Source: own elaboration.

Figure 10. Alignment plots for the unemployment rate and lagged median unemployment duration for Hungary



Source: own elaboration.

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Real estate hierarchical clustering with spatial constraints in the process of mass valuation

JEL Classification: *C38; R30*

Keywords: *agglomerative clustering; entropy; property mass appraisal, market analysis*

Abstract

Research background: Real estate clustering is required stage of some property mass appraisal procedures. Such division can be made in many ways. Some of them are based on statistical approach. Regardless of the method of division, its result should be assessed with some quantitative criterion. The better clustering of real estate, the more accurate valuation results. One example of mass property valuation models is Szczecin Algorithm of Real Estate Mass Appraisal (SARE-MA). When using this algorithm, the area to be valued should be divided into so-called location attractiveness zones (LAZ).

Purpose of the article: The aim of the article is to present an application of hierarchical clustering with spatial constraints algorithm for the creation of elementary areas. This method requires the specification of spatial weight matrix to carry out the clustering process. Due to the fact that such a matrix can be specified in a number of ways, the impact of the proposed types of distance matrices on the clustering process will be determined. A modified measure of information entropy will be used to assess the clustering results. This modification allows taking into account specificity of real estate market.

Methods: The article utilises the algorithm of agglomerative clustering, which takes into account spatial constraints, which is particularly important in the context of real estate valuation. Two types of spatial weight matrices were used. Homogeneity of clusters will be determined with the means of information entropy. The lower the entropy the better clustering.

Findings & Value added: The main achievements of the study will be to assess whether the type of the distance matrix has a significant impact on the clustering of

properties under valuation and whether the agglomerative clustering provides LAZ with better parameters than reference division. As this reference division existing geodetic boundaries were utilised.

Introduction

There are two main approaches in real estate valuation: individual valuation and mass valuation. In an individual valuation, a valuer focuses on one or a small number of properties. In the case of mass valuation, the subject of valuation is a large number of properties of one type, which are appraised with an uniform approach resulting in consistent results.

In the field of mass valuation many models and algorithms can be distinguished. Acceptance of the adopted model should be based on the reliability of the results. One of the basic elements of many mass property valuation models is the division of the valued area into sub-areas. A sub-area is an territory in which a given number of appraisable properties has the same impact of location on their value. In the case of methods that are based on the valuation of a sample of real estate in a given zone, the concept of representative real estate shall be introduced. This representative real estate is selected by taking into account the characteristic features of a given type of real estate in a given zone. The aim is to obtain a situation in which representative properties reflect as much as possible the collection of properties from which they originate, in order to allow the extrapolation of the value of the representatives to the entire zone with highest accuracy.

Example of methods that can be used to create property zones are clustering methods (e.g. Hastie *et al.*, 2009). One of the available approaches is agglomeration clustering. This method makes it possible to group similar objects (in this case real estate) on the basis of many features describing them. From the real estate market point of view a particularly important element of this way of clustering is the possibility of introducing spatial constraints into the algorithm (e.g. Guo, 2008), which allow to take into account the adjacency of objects. These relationships take the form of spatial weights. These matrices can be created in many ways. One of the divisions of the spatial matrices can be found in the paper by Getis & Aldstadt (2004). This flexibility is one of the main objections to spatial analysis (LeSage & Pace, 2014). The issue of the impact of the applied matrix of spatial weights was discussed mainly within the studies related to the estimation of spatial regression models (i.e. Cellmer, 2013), but influence of the distance matrix on clustering results was also analysed (Mimmack *et al.*, 2000). The authors point out the fact that the results of the clustering

are sensitive to the distance matrix used in the process. The article will present the results of real estate clustering taking into account different spatial weights. It will be assessed whether the results of the clusterings are significantly different from one another.

Designation of valuation sub-areas (hereinafter referred to as Location Attractiveness Zones *LAZ*) is connected with the assessment of similarity of properties located within their boundaries. The article will present an approach in which the measurement of entropy (e.g. Truffet, 2018) will be used to determine the diversity of real estate in each *LAZ*. In publications related to spatial issues in their broadest sense, entropy explores, for example, land use changes (Bai & Wang, 2012) or ecosystem development (Ludovisi, 2014). In this study, entropy will be used for the evaluation of clustering of properties. A modification of the classic entropy measure, which will allow to better reflect the specificity of the real estate market, will be proposed.

Research methodology

There are a number of mass property valuation methods. One example of such methods is Szczecin's Algorithm of Real Estate Mass Appraisal (*SAREMA*) (see Hozer *et al.*, 2002). Important stage of the algorithm is the specification of *LAZ*. This algorithm will be used to determine the value of the properties, and the proposal to modify the entropy measure will be used to assess the homogeneity of the property in designated areas. As mentioned above, *SAREMA* requires the valued area to be divided into homogeneous sub-areas within which representative properties are drawn and individually assessed. This procedure of mass valuation of real estate, has already been used several times in practice, and experience from these applications shows that the appropriate representativeness of the location expressed in the algorithm ensures random choice of:

- one representative property from *LAZ*, when up to 10 properties are valuated,
- two representative properties, when 11 to 50 properties are valuated,
- three representative properties, when 51 to 100 properties are valuated,
- four representative properties, when 101 to 500 properties are valuated,
- five representative properties, when 501 to 1000 properties are valuated,
- six representative properties, when more than 1,000 properties are valuated.

The study will be carried out in the following way:

1. Using agglomeration clustering with spatial constraints real estate will be clustered into *LAZ*. Two types of spatial weight matrices were used as constraints. The first one is based on *k* nearest neighbours (*KNN*) and the second one on the distance band (*DB*). In both types of matrices several variants were used. For the *KNN* matrix, values 3, 5, 10, 20, 50 were taken as *k*. In the case of *DB* matrix it was 50m, 75m, 100m, 250m and 400 meters. Thus, 10 different matrices of spatial weights were obtained. For each of these matrices clustering was carried out with different number of clusters (*LAZ)*. In the study, the number of clusters ranged from 5 to 60.
2. For each clustering, on the basis of the size of each *LAZ*, the required number of representative properties and the average entropy ($\bar{H}_z$) were determined. The parameters of each clustering obtained in this way will be compared both with the reference division and with one another. As the reference clustering existing geodetic boundaries have been used.
3. The conclusions will be determined on the basis of whether agglomeration clusterings have different entropy depending on the adopted spatial weight matrix and whether the procedure used in study produces better results than the benchmark (geodetic boundaries).

The subject of mass valuation, for which the procedure of clustering to homogeneous *LAZ is* carried out, is a collection of 1630 plots of land located in Szczecin - the capital one of the 17 Polish Voivodeships - Zachodniopomorskie Voivodeship. It is important to point out that they did not constitute a single, coherent area. Properties were located randomly in the entire north part of the city. These plots of land are described by means of several attributes: area, utility access, surroundings, communication accessibility, and shape of the plot.

The clustering procedure was carried out on the basis of characteristics directly related to the location of the property: utility access, surroundings and communication accessibility. These features, being on the ordinal scale, were transformed into dummy variables.

In order to assess the homogeneity of the obtained *LAZ*, the entropy measure was used. However this classical measure was modified due to the different number of possible types of plots (classes of plots). Transformed information on variants of the three mentioned before plots' characteristics was used to assess entropy. The variants of these characteristics were coded in the form of natural numbers (worst state 0, intermediate state 1, best state 2 and in the case of communication accessibility, which was a feature of four states - 3) and they were combined into a three-digit codes. Each code value is a combination of variants of characteristics, which was understood

as a class. The entropy of the *LAZ* was calculated using the following measure:

$$H_z = \frac{\left(-\sum_{i=1}^{k} p_i \cdot log_k p_i\right) \cdot k}{L}, \quad (1)$$

where:
p_i - share of real estate belonging to the *i-th* class,
k - number of classes (combination of variants of market characteristics present in a given *LAZ*),
L - number of classes present in the analysed set.

Modification of the classical entropy measure consists in changing the assessment depending on the number of classes present in particular areas. For example, in the classic approach *LAZ* with two or ten classes and an even share of these classes will be characterised by total entropy. However, in the case of real estate market analysis, these two situations should be assessed differently. Two classes of plots' characteristics, when the specified area contains several dozen or more properties, should be described as highly homogeneous, even if the shares of both classes are 50%. The H_z measure will distinguish between the level of entropy depending both on the shares of classes and their number.

Results

The plots of land under study were qualified to the attractiveness zones of the location (*LAZ)* by means of agglomeration clustering with spatial constraints. Between 5 and 60 *LAZ* have been proposed. Each of the divisions was carried out taking into account 10 different spatial weights matrices. With the increase in the number of *LAZ*, their average entropy was decreasing. Such a result was to be expected, because with a larger number of subareas they contain less dissimilar plots. A more important observation is that, depending on the adopted spatial weight matrix, the average entropy for the same number of *LAZ* are different. This effect is similar for both types of utilised matrices (*KNN* and *DB*), as shown in Figures 1 and 2. Initially, with the increase of the number of *LAZ*, the decrease in average entropy is more rapid. After exceeding 20-30 *LAZ* this decrease is much slower. In the case of *KNN* matrix, the lowest mean entropy in 55 out of 56 cases was obtained for k = 50. In turn, the highest mean entropy was recorded for k = 3 and 5. In total, it was 50 cases per 56. In the case of *DB*

matrix, the lowest mean entropy was obtained in 50 out of 56 cases for r = 400. The highest mean entropy occurred at the shortest distance range of 50 meters. This was the case 28 times, so for the half of the clusterings.

The final stage of the study was to compare the results of the clustering of plots of land into *LAZ* with the reference division. Two criteria were taken into account: average entropy and the required number of representative plots. On the basis of the number of plots in each of *LAZ*, the required number of representatives was determined in accordance with the guidelines set out earlier. It was necessary to assess whether the agglomeration clustering allowed to obtain a clustering of land plots with a lower entropy than the reference division and whether it allowed to obtain a smaller number of representative plots. The latter criterion has a particular economic rationale. Each representative property must be valued individually, which involves the use of time and money. Figures 3 and 4 show the average entropy and the required number of representative plots in each clustering and for both types of spatial weights matrices. Tables 1 and 2 present selected results of clustering evaluation. In the case of *KNN* matrices, the number of clusterings for which the average entropy was lower than the average entropy of the reference division and the number of representatives was also lower than in the case of geodetic districts was very diversified. For k = 5 out of 56 divisions only 5 met both criteria. Whereas for k = 50 it was 26. This means that, at best, less than half of the clusterings turned out to be more favourable than the reference breakdown. The valued plots of land are located in the area of 39 geodetic districts. For each number of neighbours used in the study, the smallest number of *LAZ* whose average entropy was lower than the average entropy of geodetic districts was lower than 39 and ranged from 17 to 34. For such numbers of *LAZ*, the number of representative plots was also lower than the number of representatives for geodetic division and ranged from 50 to 77 depending on k, compared to 84 representatives established for the reference division. On the other hand, the results obtained for the matrix based on the distance band indicate that the differentiation of the number of clusterings meeting the criteria of entropy and the number of representative plots was much smaller. The lowest number of clusterings meeting both criteria is 22 (for r = 100 m) and the highest is 38 (for r = 50 m). Also the smallest number of *LAZ* with an average entropy below the reference one was less differentiated for the *DB* matrix and ranged from 14 to 16, i.e. much less than for the *KNN* matrix. Which means that with just 14 to 16 *LAZ* one can obtains average entropy equal to benchmark. As a result, this translated into a smaller (and less diversified, depending on r) number of required representative plots, whose number ranged from 41 to 48.

Conclusions

The article presents the results of the study, the aim of which was to determine what influence on the clustering has the applied spatial weights matrix. The effect of different matrices was assessed by changes in the average entropy of *LAZ* for a given clustering and by the required number of representative plots. The obtained results indicate that the decision on the applied matrix has a large impact on the level of entropy of location attractiveness zones and the number of plots to be valued (according to the *SAREMA* assumptions) in the individual approach. The results of agglomeration clustering were compared with entropy and a fixed number of representatives for the benchmark division. Depending on the number of *LAZ*, their average entropy was either lower or higher than the reference clustering. There were also significant differences in the number of clusterings that met the thresholds of a smaller number of representative plots than the reference division as well as a smaller than the reference average entropy. These conclusions were analogous for both types of the distance matrix. From both types of spatial weights matrices better results were obtained for the matrix based on the distance band. For the divisions carried out with the use of this type of matrix, lower than the reference average entropy and a smaller number of representative plots were more often obtained. The results for the different distance bands obtained with the *DB* matrix differed from one another significantly less than those for the *KNN* matrix. This means that clustering with spatial constraints in the form of a *DB* matrix is less sensitive to input parameters. The above results lead to the conclusion that the stage of selection of spatial weight matrix is an important element of the described mass valuation procedure. Before making a final choice, a preliminary assessment of the clusterings should to be carried out with various matrices in order to obtain more precise valuations.

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Annex

Table 1. Summary of selected results of plots of land clustering (*k* nearest neighbours spatial weights matrices)

Number of neighbours (*k*)	Number of clusterings meeting both thresholds	Minimum number of *LAZ* with entropy below the threshold	Required number of representative plots for first number of *LAZ* meeting entropy threshold
3	10	32	71
5	5	34	77
10	6	29	74
20	14	23	59
50	26	17	50

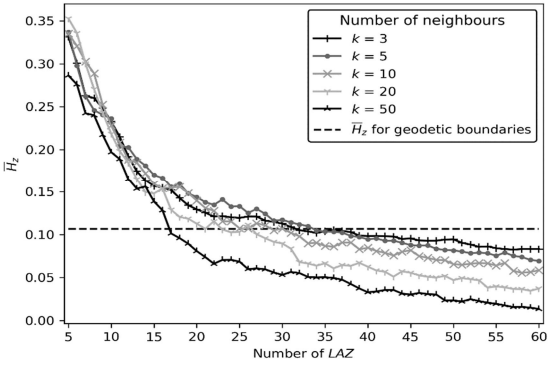
Source: own calculations.

Table 2. Summary of selected results of plots of land clustering (distance band spatial weights matrices)

Distance band (*r*)	Number of clusterings meeting both thresholds	Minimum number of *LAZ* with entropy below the threshold	Required number of representative plots for first number of *LAZ* meeting entropy threshold
50 m	38	16	46
75 m	37	14	41
100 m	22	15	47
250 m	32	16	48
400 m	34	14	44

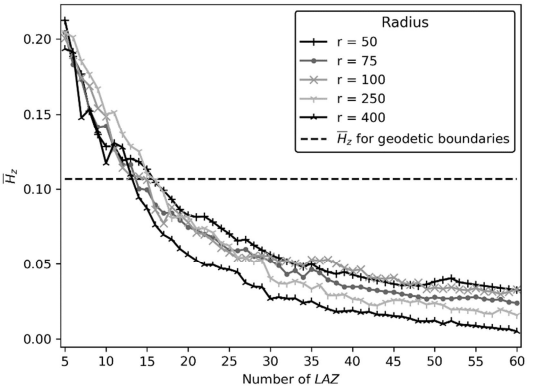
Source: own calculations.

Figure 1. Average *LAZs'* entropy for selected *k* nearest neighbours spatial weights matrices and different number of *LAZs*



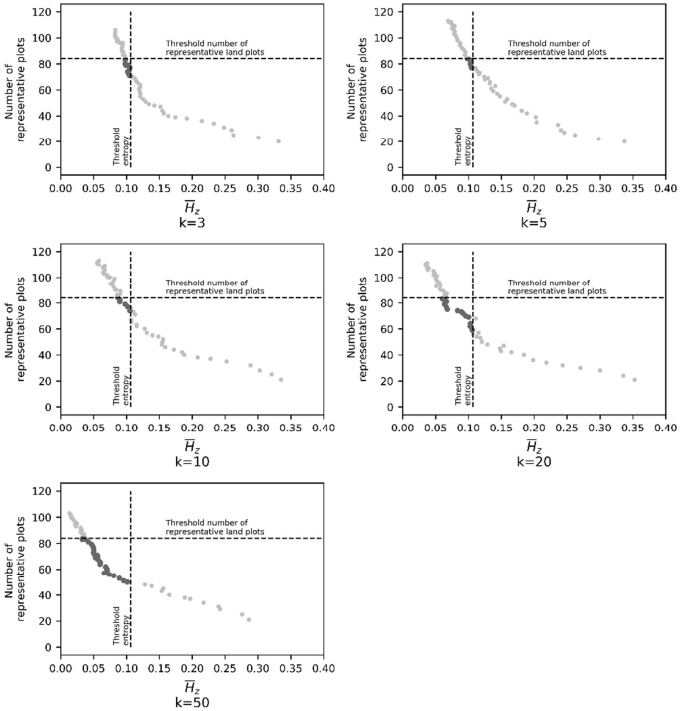
Source: own calculations.

Figure 2. Average *LAZs'* entropy for selected distance band spatial weights matrices and different number of *LAZs*.



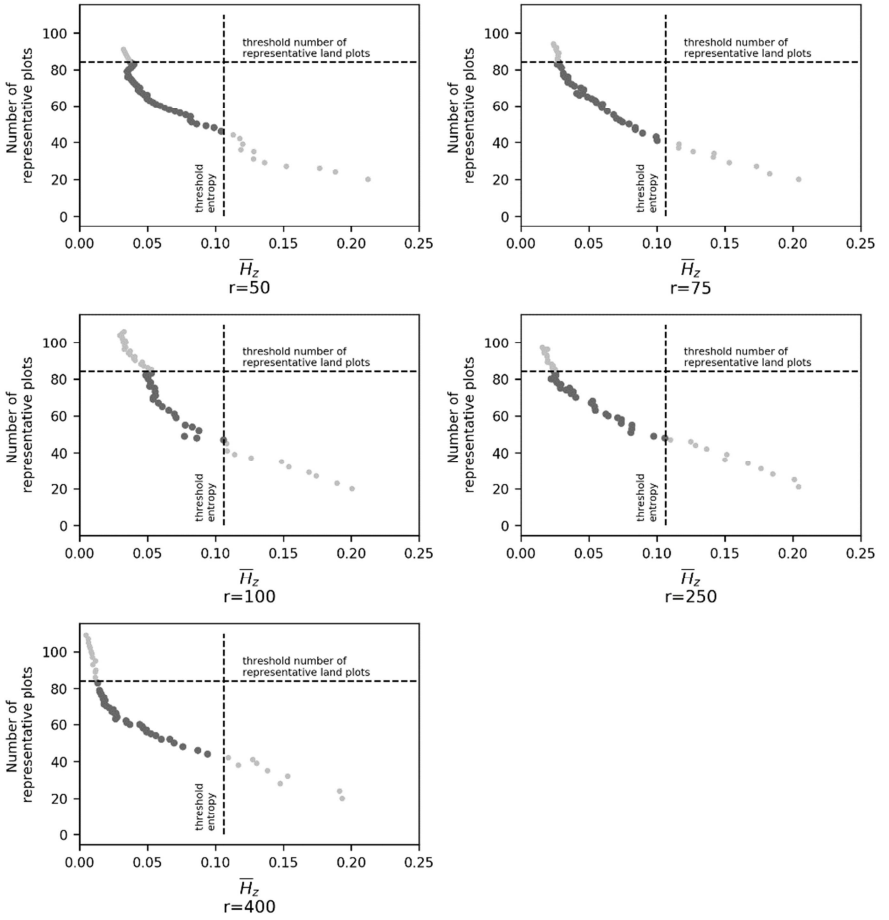
Source: own calculations.

Figure 3. Scatterplot of average *LAZs*' entropy and required number of representative plots (*k* nearest neighbours spatial weights matrices)



Source: own calculations.

Figure 4. Scatterplot of average *LAZs'* entropy and required number of representative plots (distance band spatial weights matrices)



Source: own calculations.

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Optimising Human Development Index with sensitivity analysis

JEL Classification: *C38, C10, O15*

Keywords: *Human Development Index, composite indicators, sensitivity analysis, rankings.*

Abstract

Research background: Composite indicators are commonly used not only to measure economic development, the standard of living, competitiveness, fairness, effectiveness, but they are also willingly implemented into many different fields. However, it seems that in most cases the variable weighting procedure is avoided or erroneous since in most cases so-called 'weights by belief' are applied. As researches show, it can be frequently observed that weights do not equal importance in composite indicators. As a result, biased rankings or grouping of objects are obtained.
Purpose of the article: The primary purpose of this article is to optimise and improve the Human Development Index which is the most commonly used composite indicator to rank countries in terms of their socio-economic development. The optimisation will be done by re-scaling the current weights so they will express the real impact of every single component taken into consideration during HDI's calculation process.
Methods: In order to achieve the purpose mentioned above, the sensitivity analysis tools (mainly the first order sensitivity index) were used to determine the appropriate weights in the Human Development Index. Based on the adjusted weights, a new ranking of countries was established and compiled with the initial ranking using among others Kendall tau correlation coefficient.
Findings & Value added: It has been shown that the Human Development Index is built incorrectly by putting equal weights for all its components. The weights proposed by the sensitivity analysis better reflect the actual contribution of individual factors to HDI variability. Re-scaled Human Development Index con-

structed based on proposed weights allow for better differentiation of countries due to their socio-economic development.

Introduction

Over the last fifty years, the accelerated growth in the interest of implementing composite indicators in researches in various fields can be observed. They are consequently applicated to approximate such complex phenomena as, for example, tourism destination competitiveness, sustainable development, oil vulnerability, the standard of living, informal work, innovation, quality of institutions, countries' competitiveness, wellbeing, agricultural sustainability, active citizenship, internal market dynamics, poverty, institutional quality, and many others. It is worth mentioning that Bandura in her work (Bandura, 2008, pp. 1-95) lists 178 indicators that aim to assess countries' performance in various areas of broadly understood socio-economic development. Some scientists harshly call this eager to measure everything at all cost as 'measure-mania' (Diefenbach, 2009, p. 900) and synthetic indices themselves as 'mashup indices' (Ravallion, 2010, pp. 1-32). In his work Ravallion (Ravallion, 2010, p. 1) defines mashup indices as those for which 'existing theory and practice provides little or no guidance for its design'.

According to Ravallion (Ravallion, 2010, pp. 3-5) one of the examples of 'mashup index' is a well-known Human Development Index created and yearly published by the United Nations Development Programme since 1990. However, it should be noted that the concept of HDI has evolved as a result of which some modification in HDI's calculations has been done in 2010 and 2014. To be more precise – since 2010 HDI is no longer the arithmetic mean of three determinants: life expectancy at birth, adult literacy rate and real GDP per capita in PPP ($). The change in methodology was the result of criticism directed towards HDI and concerning, among others: combining variables that represent flow, stock, input and output, and doubts directed at used normalisation and aggregation formulas (Zavaleta & Tomkinson (eds.), 2015, p. 31). Currently, the Human Development Index consists of four variables arranged into three dimensions (Figure 1):

- long and healthy life – life expectancy at birth (in years) (*LE*),
- knowledge – mean years of schooling (in years) (*MYS*) and expected years of schooling (in years) (*EYS*),
- a decent standard of living – Gross National Income per capita (PPP US$) (*GNI*).

The HDI aggregation formula was also changed from the arithmetic mean to the geometric mean of the three dimension indices (Zavaleta & Tomkinson (eds.), 2015, pp. 11-14):

$$HDI = \sqrt[3]{I_{health} \cdot I_{education} \cdot I_{income}}$$

where:
HDI – the value of the Human Development Index,
I_{health} – health dimension index,
$I_{education}$ – education dimension index,
I_{income} – income dimension index.
Individual dimension indices are calculated according to the formulas presented below:

$$I_{health} = \frac{LE - 20}{85 - 20};$$

$$I_{education} = \frac{\left(\frac{EYS}{18} + \frac{MYS}{15}\right)}{2};$$

$$I_{income} = \frac{\ln(GNI) - \ln(100)}{\ln(75000) - \ln(100)}.$$

The Human Development Index is probably the most prominent composite indicator ever used. However, being prominent it is not synonymous with being faultlessness and correctness. So, are the weights of individual variables truly reflecting the significance of each factor? Going further - does the Human Development Index in the above-presented form has a good discrimination ability? Additionally, does it precisely catch differences between countries due to their socio-economic development? This article will try to answer those questions. Sensitivity analysis was applied to investigate the correctness of HDI construction by (Aguna & Kovacevic, 2011, p. 1-65), which both are statisticians working for the United Nations Development Programme. They conclude that 'the HDI is a relatively robust index with the most sensitivity exhibited to the choice of weights for income and education component' (Aguna & Kovacevic, 2011, p. 40). However, they do not indicate what specific values of weights should be covered to reflect the real meaning of HDI's components.

Research methodology

In the vast majority of cases, the synthetic variable is created evading the stage of variable weighing. Thus basically is tantamount to giving different determinants the same weights, tacitly assuming that they are equally crucial for the analysed phenomenon. In some cases, weights are given subjectively by researchers or from experts' opinions. Much less common are weight set up at the basis of the principal component analysis, conjoint analysis or regression analysis. Some researchers (Pietrzak, 2016, pp. 69-86), when analysing spatial objects, decided to give weight based on spatial autocorrelation, but this does not solve the problem of weighing non-spatial objects. In the case of building synthetic variables for any of the objects, the approach promoted by the Competence Centre on Composite Indicators and Scoreboards (*COIN*) may be useful. The approach promoted by COIN's members is basing on the use of sensitivity analysis in the construction of synthetic meters is also supported by (Becker et al., 2016, pp. 1-33; Becker, Saisana, Paruolo, & Vandecasteele, 2017, pp. 12-22; Greco, Ishizaka, Tasiou, & Torrisi, 2019, pp. 61-94; Paruolo, Saisana, & Saltelli, 2013, pp. 609-634).

The approach proposed by the researchers mentioned above is based on the use of Pearson's correlation ratio – as a first-order sensitivity measure commonly applied in a global sensitivity analysis (Paruolo et al., 2013, p. 610). In that approach, a composite indicator is considered as an output variable, and its components are considered as input variables. A variance-based Pearson's correlation ratio will then express the strength of the dependence between the output and input variable (Becker et al., 2016, p. 3). Following the procedure presented in (Becker et al., 2017, pp. 13-15):

1. The composite indicator is understood as, not necessarily linear, function of determinants describing the analysed phenomenon:

$$y_j = f_i(x_{ji}) + \varepsilon_j,$$

where:
y_j – outpu variable,
x_{ji} – input variables,
ε_j – error term.

2. Pearson's correlation ratio is used to measure the influence of each input variable, assuming that all other input variables are fixed:

$$S_i = \frac{V_{x_i}\left(E_{x_{\sim i}}(y|x_i)\right)}{V(y)},$$

where:
$x_{\sim i}$ – the input variable vector containg all variables except the x_i,
$E_{x_{\sim i}}(y|x_i)$ – the main effect of x_i,

3. Estimation of main effects based on full-Bayesian Gaussian processes.
4. The estimated main effect of each input variable is decomposed to represent correlated and uncorrelated part:

$$S_i = S_i^c + S_i^u,$$

decomposition is also performed using Bayesian Gaussian processes.
5. Optimal weights were calculated as:

$$w_{opt} = argmin_w \sum_{i=1}^{d} \left(\tilde{S}_i^* - \tilde{S}_i(w)\right)^2,$$

where:
$\tilde{S}_i^*$ – target normalised correlation ratio,
$\tilde{S}_i$ – normalised correlation ratio.

6. Calculating Re-scaled Human Development Index as a weighted geometric mean,
7. Assessment of conformity of HDI and re-scaled HDI ranking using the Kendall-tau correlation coefficient.

Results

Based on data retrieved from the United Nations Development Programme concerning individual factors shaping HDI in 2018 it has been investigated whether each HDI's three pillars share equal importance or maybe its meaning resulting from the variance is entirely uneven. The procedure presented in the previous section was implemented to made all calculations. The data set include data concerning 189 countries.

As it was mentioned before the Human Development Index is currently calculated as a geometric mean of three sub-indices. The HDI's creators

assumed that all components are equivalent. Referring to the terminology contained in the previous chapter, HDI will be denoted as an output variable and health, education and income indices as input variables.

Taking into consideration the relations presented at Figure 2, one can observe that both output (HDI) and input variables have a negatively skewed distribution, which means that in case of all analysed variables more than 50% countries have values higher than the average value. Analysing the same figure it can be observed that the most robust liner relation between output variable (HDI) and input variables can be observed in case go GDI index, which is already a kind of premise that the indicated variable will have a potentially more significant impact on output variable. Table 2 is also wort to pay attention to. Analysing values from this table, it can be noted that in the case of each pair of variables there is a strong, statistically significant, positive correlation. Is should be emphasised that HDI has the strongest correlation with GNI, although the coefficient is only slightly higher than in the case of education index. Nevertheless, the most crucial stage of this analysis is to set up correctly first-order indices. Results included in Table 3 was obtained using 'tgp' R package, and they present estimated values of the correlated and uncorrelated main effect of each input variable onto an output variable. One should have in mind that, according to the intention of the creators, the impact of each variable should be even; when it is not. As it was expected to analyse the previous data the Income Index has the strongest influence on the HDI, while education one show the weakest impact. It is therefore clear that there is no justification for giving them equal weight.

The lack of equality was, therefore, the premise for trying to establish adequate weights using a simplex search method. The nelder-mead method was used as this one does not require the prior knowledge of trends in the analysed process. A comparison of original and optimised weights is included in Table 4. It is rather not surprising that as a result of the optimization procedure, the highest weight was obtained in the case of income index, while the lowest in the case of education index.

The change in weightning syste caused that the re-scaled Human Developmen Index has better discrimination features (compare Table 1 and Table 5) without changing significantly the country's orderings (see Table 6 and Figure 3). The Kendall's tau correlation coefficient, based on both rankings, reached the value of 0.969. Which proves the high compatibility of ordering.

Conclusions

This study uses the sensitivity analysis to check the stability of HDI results from 2018. Analysis conducted in this paper indicated that equal weights in HDI construction are not the optimal solution. It seems, therefore, that the Ravallion's statement that HDI is a 'mashup index' is not groundless. The article proposes adjusted weights that better illustrate the influence of each factor on the final counties' ranking due to their socio-economic development. Additionally, the re-scaled HDI has better discriminatory properties than its original version while maintaining statistically significant compatibility with the original ranks.

The main disadvantage of the presented method is its high degree of complexity and the necessity to recalculating weights each time. The recalculation is needed as the final set of weight is sensitive to the variance of variables. It seems, however, that this is a justified effort because it allows for the robust results and helps to avoid the most common defect in the use of synthetics measures, i.e. arbitrariness of weights.

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Annex

Table 1. Human Development Index – basic statistics

	Mean	Median	C.V.	Skewness
All countries	0.709	0.735	0.215	-0,379
EU countries	0.884	0.884	0.042	-0.267

Source: authors own study based on data from the United Nations Development Programme.

Table 2. Correlation between all variables used in the investigation

	I_{health}	$I_{education}$	I_{income}	HDI
I_{health}	1.000	0.825	0.815	0.902
$I_{education}$	0.825	1.000	0.838	0.945
I_{income}	0.815	0.838	1.000	0.957
HDI	0.902	0.945	0.957	1.000

Source: authors own study based on data from the United Nations Development Programme.

Table 3. Estimated values of main effects using linear dependence modelling

	S_i	S_i^C	S_i^U
I_{health}	0.388	0.274	0.114
$I_{education}$	0.208	0.130	0.078
I_{income}	0.537	0.172	0.365

Source: authors own study based on data from the United Nations Development Programme.

Table 4. Original and optimised weights

	I_{health}	$I_{education}$	I_{income}
Original	0.333	0.333	0.333
Optimised	0.323	0.292	0.384

Source: authors own study based on data from the United Nations Development Programme.

Table 5. Re-scaled Human Development Index – basic statistics

	Mean	Median	C.V.	Skewness
All countries	0.252	0.120	1.265	1.492
EU countries	0.682	0.642	0.364	0.262

Source: authors own study based on data from the United Nations Development Programme.

Table 6. The best and the worst 5 countries according to HDI and re-scaled HDI

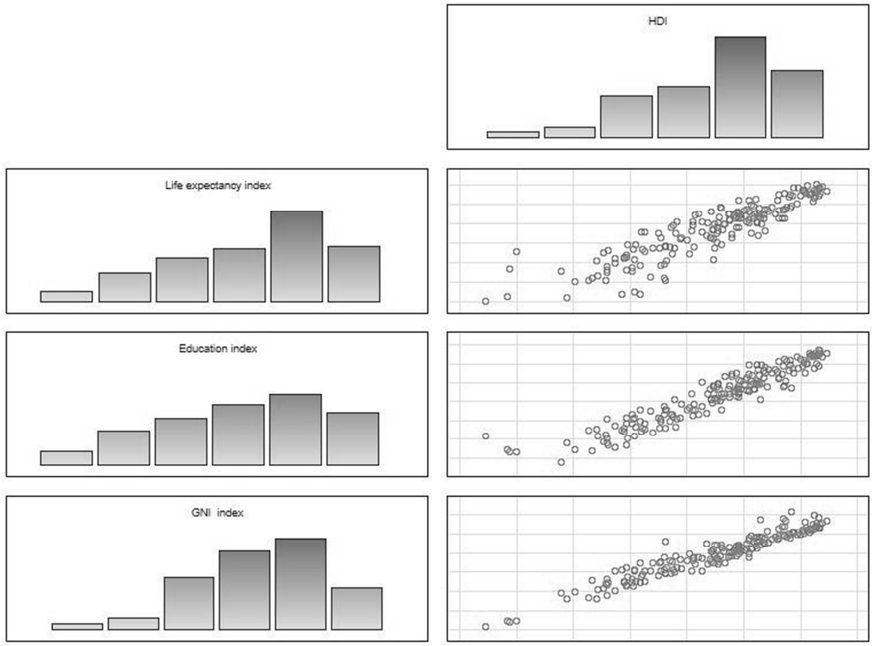
	Top 5	Bottom 5
HDI	Norway, Switzerland, Australia, Ireland, Germany	Burundi, Chad, South Sudan, Central African Republic, Niger
Re-scaled HDI	Norway, Switzerland, Australia, Germany, Ireland	Niger, Eritrea, Burkina Faso, Chad, Sierra Leone

Source: authors own study based on data from the United Nations Development Programme.

Figure 1. Indicators and dimensions of the Human Development Index

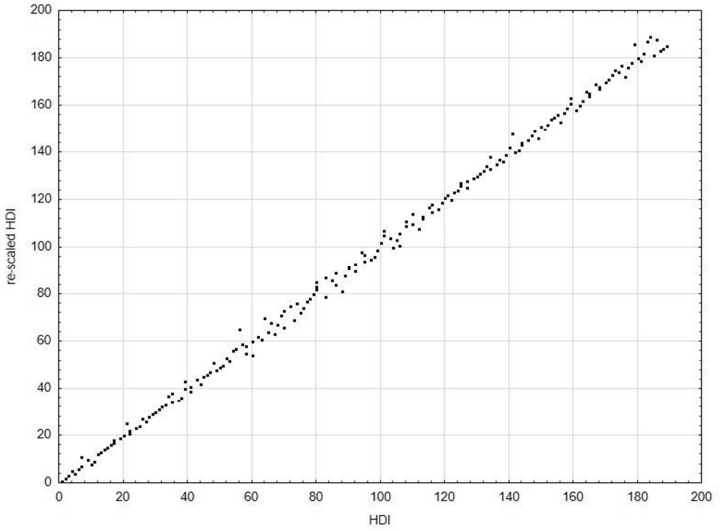
Source: Zavaleta & Tomkinson (eds.) (2015, p.5).

Figure 2. Scatterplots and histograms for variables used in the investigation



Source: author's own study.

Figure 3. The relation between HDI and re-scaled HDI ranks



Source: author's own study.

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The comparison of differences in income distributions for men and women in selected countries of the European Union

JEL Classification: *J31; D31*

Keywords: *gender pay gap, differences in distributions, decomposition methods*

Abstract

Research background: Recently there has been an increase in interest in the studies of income inequalities. The findings of empirical researches show that males earn higher wages than females. There is a need to study differences between men's and women's income distributions and to decompose them at various quantile points.
Purpose of the article: The aim of the paper is to compare personal income distributions in Poland and other selected countries of the European Union, taking into account gender differences.
Methods: First, we examined the income inequalities of men and women in each country using the Oaxaca-Blinder decomposition procedure. The unexplained part of the gender pay gap gave us information about the wage discrimination. Second, we extended the decomposition procedure to different quantile points along the income distribution. To describe differences between the incomes of men and women we constructed the so-called counterfactual distribution, which is a mixture of a conditional distribution of the dependent variable (income) and a distribution of the explanatory variables (individual people's characteristics). Then, we utilized the residual imputation approach (JMP-approach).
Findings & Value added: In the article data from EU-SILC were used. We found that there exists an important diversity in the size of the gender pay gap across members of the EU. In general, there are two types of countries in Europe: the countries, where the bulk of the observed income differences cannot be explained by observed characteristics, and the countries, where the explained and the unexplained effects are both positive, with even a bigger explained effect for the lower income ranges.

Introduction

Reducing the gender pay gap is one of the key priorities of gender policies. At EU level, the European Commission prioritized "reducing the gender pay, earnings and pension gaps and thus fighting poverty among women" as one of the key areas in the framework of the Strategic engagement for gender equality 2016-2019. The empirical studies show that males earn higher wages than females. There are considerable differences in earnings between EU countries, with the gender pay gap ranging from just over 5% in Romania, Italy and Luxembourg, to more than 25% in Estonia, followed by the Czech Republic and Germany (both almost 22%). In 2016, women's gross hourly earnings were on average 16.2 % below those of men in the EU-28 and 16.3% in the euro area (Eurostat, 2018).

The existence of a significant gap in earnings between males and females is a well-documented stylized fact of modern labour markets. The literature on the gender gap is huge. Numerous studies concentrate mainly on the decomposition of the average values for incomes. Some papers adopt a cross-country perspective. Using European Union Statistics on Income and Living Conditions (EU-SILC) data for 24 EU members, Hedija (2017, pp. 1804-1819) showed that the gender pay gap varies among the countries. In the study conducted by Boll and Lagemann (2018) the gap is analyzed based on the Structure of Earnings Survey (SES).

Sometimes, the analysis goes beyond the simple comparison of average values. Arulampalam *et al.* (2006, pp. 163-186) examined the gender wage gap in 11 European countries using the European Community Household Panel Survey (ECHPS). The gap widened toward the top of the wage distribution in most of countries and, in a few cases, it also widened at the bottom of the distribution. Nicodemo (2009) analyzed the gap in Mediterranean EU countries, using the EU-SILC and the ECHPS datasets. She found a positive wage gap, the greater part of which cannot be explained by observed characteristics. The gender gap was larger at the bottom and smaller at the top of the distribution in most countries. Also Christofides *et al.* (2013, pp. 86-102) used EU-SILC data and estimate the unexplained part of the gender pay gap for 26 European countries.

Despite many differences among the individual studies, they all conclude that the gender pay gap exhibits a remarkable heterogeneity across European countries. The gender pay gap is the result of many factors, including occupational segregation, bias against working mothers, and direct pay discrimination. A certain part of the wage differences between men and women remains unexplained. The results of these studies depend on the used data set, the number of explanatory variables and the applied method.

The purpose of this study is to compare personal income distributions in selected countries of the EU taking into account gender differences. We will examine the differences in the entire range of income values by the use of the residual imputation approach (JMP-approach) (see Juhn *et al.*, 1993, pp.410-442). In the article, data from EU-SILC will be used.

Research methodology

In recent times, a variety of techniques of income inequalities decomposition are becoming more popular. The standard method for pay gap decomposition is the procedure proposed by Oaxaca (1973, pp. 693-709) and Blinder (1973, pp. 436-455), which is widely used to study mean outcome differences between groups. This statistical method allows to take into account the individual characteristics of male and female employees.

Let Y_g denote the outcome variable in group g (e.g. the personal income in men's group, $g=M$, or in women's group, $g=W$) and X_g the vector of individual characteristics of the person in group g (such as education, age, work experience). The expected value of y conditionally on X is a linear function $y_g = X_g\beta_g + v_g, g = M,W$, where β_g are the returns to the characteristics. The Oaxaca-Blinder decomposition for the average income inequality between two groups at the aggregate level can be expressed as

$$\overline{Y}_M - \overline{Y}_W = \overline{X}_M\hat{\beta}_M - \overline{X}_W\hat{\beta}_W = \underbrace{\overline{X}_M(\hat{\beta}_M - \hat{\beta}_W)}_{\text{unexplained effect}} + \underbrace{(\overline{X}_M - \overline{X}_W)\hat{\beta}_W}_{\text{explained effect}}. \quad (1)$$

The first component, on the right side of the equation, called the unexplained effect is the result of differences in the estimated coefficients, and so in the "prices" of individual characteristics of group representatives. The unexplained portion of the gap is usually attributed to discrimination, but may also result from the influence of unobserved variables. The second term gives the effect of characteristics and is explained by group differences in the predictors (the so-called explained effect).

Several authors have developed extensions of the Oaxaca-Blinder method (see Fortin *et al.*, 2010). The proposed procedures go beyond the comparison of average values. Let $F_{Y_g}(y)$ be the distribution function for the dependent variable Y_g, which can be expressed as the conditional distribution $F_{Y_g|X_g}(y|X)$ of Y_g and the joint distribution $F_{X_g}(X)$ of all elements of X_g:

$$F_{Y_g}(y) = \int F_{Y_g|X_g}(y|X) \cdot F_{X_g}(X)\, dx, \qquad g = M, W. \tag{2}$$

Now, the mean decomposition analysis can be extended to the case of differences between the two distributions using the so-called counterfactual distribution:

$$F_{Y_W^C}(y) = \int F_{Y_W|X_W}(y|X) \cdot dF_{X_M}(X). \tag{3}$$

Such a mixture distribution is constructed by integrating the conditional income distribution for men with respect to the distribution of characteristics for women. Then the difference in the observed income distributions between men and women can be decomposed as follows:

$$F_{Y_M}(y) - F_{Y_W}(y) = \underbrace{[F_{Y_M}(y) - F_{Y_W^C}(y)]}_{\text{unexplained effect}} + \underbrace{[F_{Y_W^C}(y) - F_{Y_W}(y)]}_{\text{explained effect}}. \tag{4}$$

The counterfactual distribution can be constructed in various ways, e.g. using the residual imputation approach (Juhn *et al.*, 1993, pp. 410-442). In this method, one has to estimate the two equations: $y_{Wi} = X_{Wi}\beta_W + v_{Wi}$ and $y_{Mi} = X_{Mi}\beta_M + v_{Mi}, i = 1, \ldots, n$. Then, the income y_M form the group M is replaced by a counterfactual income y_W^C, where both the returns to observables and residuals are set to be as in group *W*.

The implementation of the procedure is two-step. In the first step, the residuals are replaced by counterfactual residuals under the assumption of the rank preservation: $y_{Wi}^{C,1} = X_{Mi}\beta_M + v_{Wi}^{C,1}, i = 1, \ldots, n,$ where $v_{Wi}^{C,1} = F^{-1}_{v_W|X}(\tau_{Mi}(X_{Mi}), X_{Mi})$ and $\tau_{Mi}(X_{Mi})$ is the conditional rank of v_{Mi} in the distribution of residuals for *M*. In the second step, the counterfactual returns to observables are imputed as $y_{Wi}^{C,2} = X_{Mi}\beta_W + v_{Wi}^{C,1}, i = 1, \ldots, n$.

In this study, after an assessment of the gender pay gap for selected EU countries, an attempt was made to group them using hierarchical clustering method. Hierarchical clustering is a widely used tool in data mining for grouping data into clusters that exposes similarities or dissimilarities in the data. One set of approaches to hierarchical clustering is known as agglomerative, whereby in each step of the clustering process an observation or cluster is merged into another cluster. In this work, the 1-nearest neighbors

algorithm for agglomerative clustering with Euclidean distance was applied.

Data basis

The empirical data used have been collected within the EU-SILC project in 2014 (research proposal 234/2016-EU-SILC). For the analysis, we chose 19 EU countries with the highest number of inhabitants (Germany, France, United Kingdom, Italy, Spain, Poland), the highest GDP per capita in 2015 (Luxembourg, Ireland, the Netherlands, Austria, Germany), the lowest GDP per capita in 2015 (Bulgaria, Romania, Croatia, Hungary, Poland, Greece), the highest gender pay gap according to Eurostat in 2016 (Estonia, Czech Republic, Germany, United Kingdom, Austria, Slovakia), the lowest gender pay gap according to Eurostat in 2016 (Romania, Italy, Luxembourg, Belgium, Poland). The selected sample consisted of 122,756 observations: 62,856 men and 59,900 women (see Table 1).

The annual gross employee incomes (in thousands of Euro) of men were compared with those obtained by women. The gross employee income corresponds mainly to wages and salaries paid for the time worked, remuneration for the time not worked, enhanced rates of pay for overtime, payments for fostering children, supplementary payments. In our analysis the logarithm of the annual income constitutes the outcome variable.

Each person was described by the following characteristics: *age* (in years), *educlevel* (education level: 1 – primary, . . ., 5 – tertiary), *married* (1 – married, 0 – unmarried), *yearswork* (number of years spent in paid work), *permanent* (1 – permanent job contract of unlimited duration, 0 – temporary contract), *parttime* (1 – person working part-time, 0 – person working full-time), *manager* (managerial position: 1 – supervisory, 0 – non-supervisory), *big* (number of persons working at the unit: 1 – more than 10, 0 – less than 11).

Results

Table 2 presents the results of the Oaxaca-Blinder decomposition of inequalities between men's and women's log incomes for 19 EU countries.

We have found that there is a positive difference between the mean values of log incomes for men and women for all 19 countries. The mean differential is the largest in Germany (0.625) and the smallest in Romania

(0.141). The country heterogeneity is not limited to the size of the gap, but also concerns its composition. The difference between the mean log income values was decomposed into two components: the unexplained part and the explained part. The unexplained effect is huge (and positive) for the states with the low raw differential and is small for the states with the high raw differential. It ranges from 21 % in Luxembourg to 125 % in Bulgaria. This part of the gender pay gap gives us information about the discrimination. The explained gap is negative in six countries (among others in Bulgaria, Poland, Hungary), which are countries with the lowest income discrepancies. The negative value of this component means that the difference of the average log incomes between men and women is reduced by the women's characteristics. In 13 countries, the explained part is positive, that is, it increases the overall gap, with a maximum explained gap in Luxembourg (79 %). Only in 8 countries, the explained part exceeds the unexplained part of the overall gap. However, the unexplained part is nowhere identified to be negative (compare Boll & Lagemann, 2018).

The detailed decomposition, which was also carried out, made it possible to isolate the factors explaining the inequality observed to a different extent. Because of lack of space in this paper, we present the results of the detailed decomposition only for 4 countries – Germany, the Czech Republic, Poland and Romania (see Table 3).

The strong effect of different education levels of men and women can be noticed, especially for Poland. The negative values of explained components mean that the differences of the average log incomes between men and women are reduced by the women's higher education levels. On the other hand, the values of *yearswork*, *parttime*, *manager* and *big* attributes possessed by men and women increase the income inequality in all countries. In all states women are discriminated against men because of their marital status and managerial position (if possessed) but not because of the education levels or years of work.

Since the Oaxaca-Blinder technique focuses only on average effects, next, we carried out the decomposition of inequalities along the distribution of log incomes for men and women using the JMP-approach. The total differences between the values of log incomes are computed and the results are shown in Figures 1-3. For each country, there are positive differences between the values of log incomes for men and women along the whole log income distribution. Then the calculated differences were decomposed into the sum of the unexplained and explained components (the results are also presented in Figures 1-3).

After assessing the gender pay gap for all 19 countries, an attempt was made to group them using hierarchical clustering method. The use of the 1-

nearest neighbors algorithm for agglomerative clustering with Euclidean distance allowed the grouping of countries into clusters. Four groups were identified:

- Group 1: the Czech Republic, Romania, Slovakia, Bulgaria, Hungary, Poland and Croatia,
- Group 2: France, the United Kingdom, the Netherlands, Austria, Luxembourg, Spain, Italy, Ireland, Belgium, Greece,
- Group 3: Estonia,
- Group 4: Germany.

Group 1 consists mainly of the former socialist states of eastern Europe. It is characterized by the U-shaped total gender pay gap (except Romania and Bulgaria) and the bigger unexplained effect than the explained one (see Figure 1). For most countries in this group, the total effect is low, but it widens at the bottom and at the top of the income distribution, suggesting sticky floor and glass ceiling effects (compare Arulampalam *et al.*, 2006, 163-186). We can see that the share of the unexplained part is very high and the effect of coefficients is positive and constant in the whole range of the income distribution. This is the result of differences in the "market prices" of individual characteristics of men and women, interpreted as the labor market discrimination. For 5 countries (Romania, Bulgaria, Hungary, Poland and Croatia), the explained differential (the effect of characteristics) is negative in the middle of the distribution, which means that the properties possessed by both people's groups decrease the inequalities. The effect of characteristics is often positive at the bottom and at the top of the income distribution.

Group 2, the largest group, consists mainly of the large, highly developed countries of western Europe. Similar to the results obtained by Nicodemo (2009), the total gender gap is larger at the bottom of the distribution and smaller at the top of the distribution in most countries (see Figure 2). The gender differences in characteristics are positive, which means that the different values of characteristics of men and women increase the income inequalities. Especially, the explained effect is bigger than the unexplained effect at the bottom of the log income distribution. For the higher income ranges, often the unexplained effect prevails. Both effects, the explained and the unexplained, are always positive, increasing the income discrepancies.

There is only one country in group 3. It is Estonia. This country is characterized by an increase of the income inequalities as we move toward the top of the income distribution (Figure 3 (a)). We observe the glass ceiling effects. Also the share of the unexplained effect is very high. We can ob-

serve the negative explained effect at the bottom of the distribution, which means a decrease of the income inequalities for the poorer.

The last group, group 4, is made up of Germany. In this case, the large total gap and the large explained effect have a decreasing shape and are rapidly falling as we move toward the top of the income distribution (Figure 3 (b)). The unexplained part is positive and at a moderate level, presenting the existing effect of discrimination on the labor market.

Conclusions

The goal of this paper was to compare personal income distributions in selected countries of the EU taking into account gender differences. Using data from the 2014 EU-SILC, the gender pay gap was examined for a set of 19 European countries.

We started with the decomposition of the average values for log incomes by using the Oaxaca-Blinder method. As has been documented in the previous research, we also found that there is a positive difference between the mean income values for men and women. The mean log income differential was the largest in Germany and the smallest in Romania. The unexplained effect, which gives us information about the discrimination, was huge for the states with the low raw differential and was small for the states with the high raw differential. The explained gap was negative in the countries with the lowest income discrepancies (e.g. in Bulgaria, Poland, Hungary). The negative value of this component means that the difference of the average log incomes between men and women is reduced by the women's characteristics.

Then, we examined the differences in the entire range of income values by the use of the JMP-residual imputation approach. We extended the decomposition procedure to different quantile points along the income distribution. After assessing the raw gap, the explained and the unexplained gap for all 19 countries, we grouped them using the agglomerative clustering method.

Group 1 consisted mainly of the former socialist states of eastern Europe. The results obtained for that group indicated the low U-shaped total effect. The unexplained component dominates in the whole range of the income distribution. The gender pay gap is poorly explained by gender differences in observable characteristics of people. For several countries the explained differential was negative in the middle of the distribution, which means that female characteristics are superior to the male ones.

In group 2 of highly developed countries of western Europe the total gender gap was larger at the bottom of the log income distribution and smaller at the top. For the lower income ranges, the explained effect was often bigger than the unexplained. Both effects, the explained and the unexplained, were positive, increasing the income discrepancies.

Group 3 (only Estonia) was characterized by an increase of the income inequalities at the top of the income distribution. For group 4 (Germany), we noted the large total gap and the large explained effect rapidly falling as we move toward the top of the distribution.

Summarizing, there exists an important diversity in the size of the gender pay gap across members of the EU. Excluding the two extreme cases of Estonia and Germany, there are two types of countries in Europe: the countries, where the bulk of the observed income differences cannot be explained by observed characteristics, and the countries, where the explained and the unexplained effects are both positive, with even a bigger explained effect for the lower income ranges. Of course, the results obtained depend on the selection of explanatory variables to the estimated models. Nevertheless, it is justified to say that there are roughly two types of EU Member States: those with higher and those with lower level of gender discrimination on the labor market. Considering that the gender discrimination may lead to loss in productivity and wealth, inequalities induced in this way pose a serious challenge for the society.

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Annex

Table 1. Sample size and average annual income (in Euro) in selected countries

Country	*n*	*n* men	*n* women	Average Y_M	Average Y_W
LU	3932	2110	1822	56353.29	43849.64
NL	4912	2433	2479	49364.79	30024.32
IE	3759	1773	1986	44876.80	31165.20
AT	4798	2547	2251	44253.14	28841.96
BE	4677	2334	2343	43554.01	32171.61
DE	10128	4999	5129	42368.01	24741.80
UK	8179	3965	4214	39785.26	25168.27
FR	9251	4589	4662	33494.49	24012.36
IT	12715	6741	5974	30007.71	22655.93
ES	8493	4378	4115	25225.28	18640.89
EL	3687	2059	1628	17658.02	13934.03
EE	5506	2663	2843	13064.08	8899.18
CZ	6501	3443	3058	12413.62	8865.36
HR	3601	1983	1618	10350.23	8871.80
SK	5755	2847	2908	10292.61	7980.63
PL	9908	5180	4728	9619.24	7947.84
HU	8054	4061	3993	7565.97	6208.86
BG	4058	2018	2040	4646.59	3747.83
RO	4842	2733	2109	4306.87	3768.30
Total	122756	62856	59900		

Source: own elaboration.

Table 2. The results of the aggregate Oaxaca-Blinder decomposition of gender pay gap in selected countries

Country	Raw differential	Unexplained effect	Explained effect	% unexplained	% explained
DE	0.625	0.186	0.439	29.8%	70.2%
NL	0.520	0.167	0.354	32.1%	67.9%
AT	0.485	0.109	0.376	22.5%	77.5%
UK	0.479	0.250	0.230	52.1%	47.9%
FR	0.376	0.198	0.179	52.5%	47.5%
ES	0.361	0.149	0.212	41.3%	58.7%
IE	0.353	0.144	0.209	40.8%	59.2%
CZ	0.343	0.248	0.095	72.3%	27.7%
BE	0.329	0.135	0.195	40.9%	59.1%
EE	0.328	0.372	-0.044	113.4%	-13.4%
LU	0.296	0.062	0.235	20.9%	79.1%
IT	0.287	0.133	0.155	46.2%	53.8%
SK	0.265	0.247	0.019	92.9%	7.1%
EL	0.206	0.106	0.099	51.7%	48.3%
PL	0.183	0.209	-0.026	114.2%	-14.2%
BG	0.178	0.221	-0.044	124.9%	-24.9%
HU	0.176	0.200	-0.024	113.6%	-13.6%
HR	0.167	0.175	-0.008	104.8%	-4.8%
RO	0.141	0.155	-0.013	109.2%	-9.2%

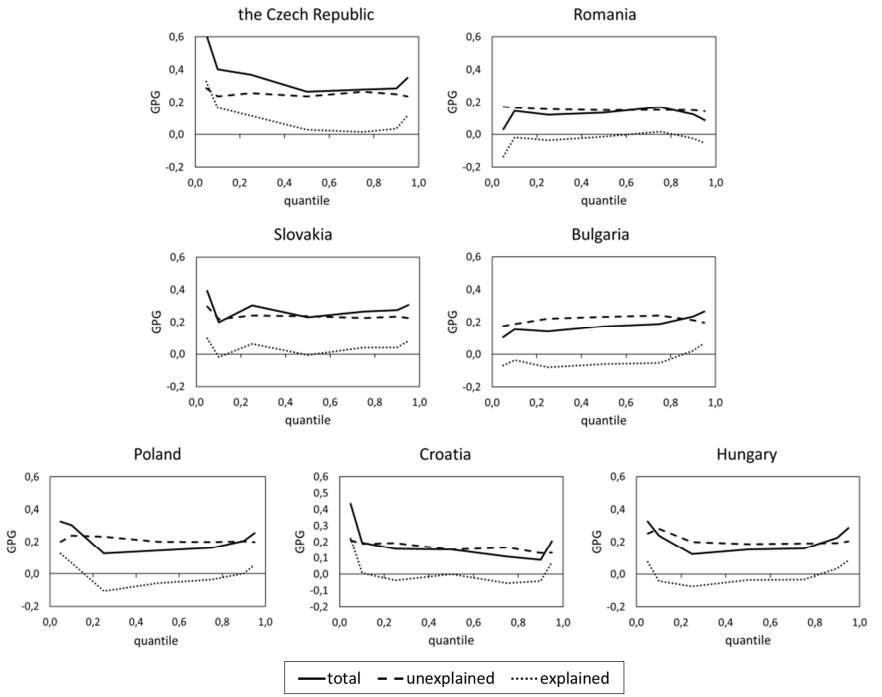
Source: own elaboration using the Stata.

Table 3. The results of the detailed Oaxaca-Blinder decomposition

	Detailed decomposition							
	Unexplained effect				Explained effect			
Variable	DE	CZ	PL	RO	DE	CZ	PL	RO
Age	0.667	0.192	-0.175	0.081	0.006	0.003	0.000	0.000
educlevel	-0.098	-0.107	-0.091	-0.088	0.028	-0.003	-0.087	-0.038
married	0.174	0.101	0.091	0.061	-0.004	0.001	0.001	0.000
yearswork	-0.546	-0.261	-0.050	-0.089	0.045	0.017	0.021	0.012
permanent	0.141	-0.072	-0.048	-0.082	0.012	0.014	-0.004	-0.001
parttime	0.003	0.000	-0.005	0.000	0.270	0.024	0.032	0.001
manager	0.013	0.003	0.015	0.001	0.030	0.030	0.007	0.004
big	-0.099	-0.008	-0.005	0.013	0.053	0.009	0.004	0.008
cons	-0.069	0.399	0.478	0.254	0.000	0.000	0.000	0.000
Total	0.186	0.248	0.209	0.155	0.439	0.095	-0.026	-0.013

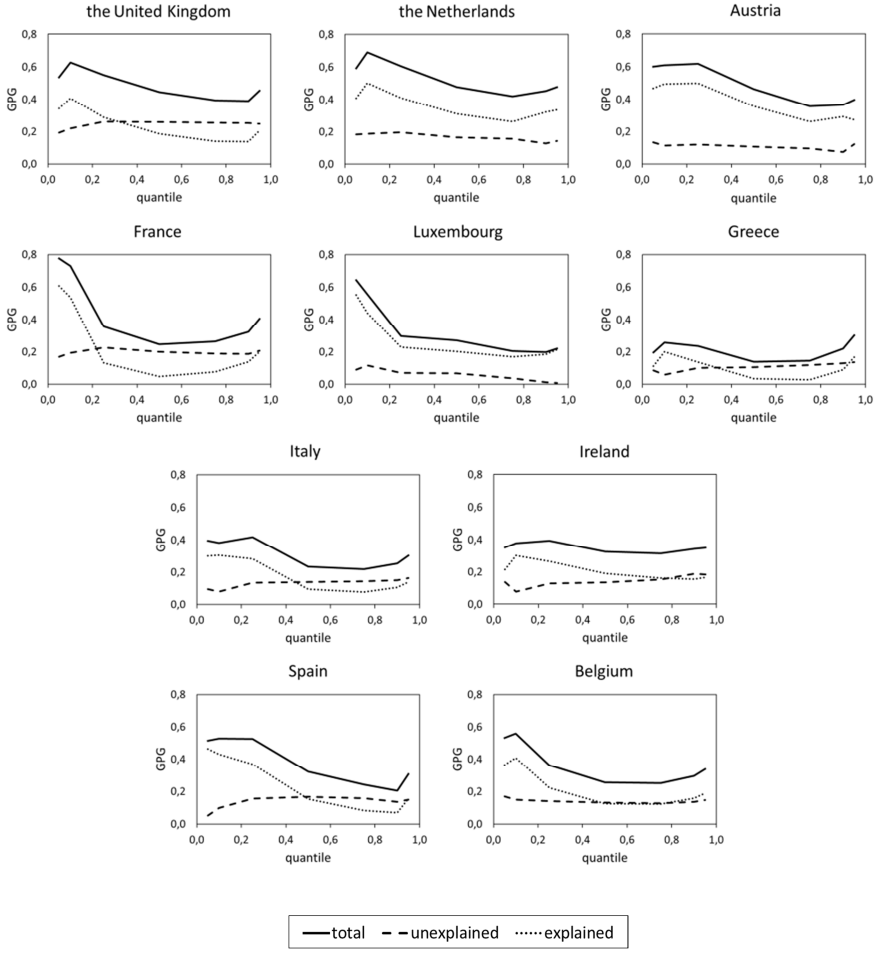
Source: own elaboration using the Stata.

Figure 1. The differences between the log income distributions for men and women vs. quantile rank in group 1



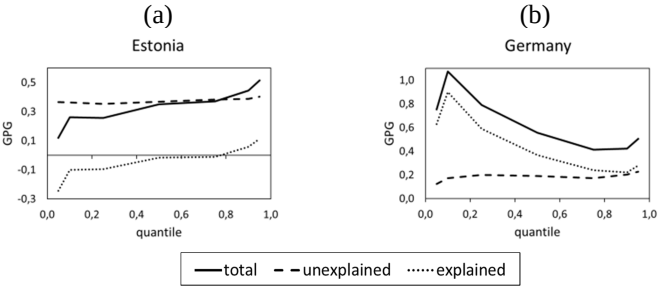
Source: own elaboration.

Figure 2. The differences between the log income distributions for men and women vs. quantile rank in group 2



Source: own elaboration.

Figure 3. The differences between the log income distributions for men and women vs. quantile rank in group 3 (a) and group 4 (b)



Source: own elaboration,

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Quality of life in Poland and Belarus – cross-regional analysis of selected indicators

JEL Classification: *C38; I31; R13*

Keywords: *quality of life; living standards; Polish regions; Belarusian regions; rank method*

Abstract

Research background: Quality of life is not a new economic category. Currently, most of the developed economies, in addition to macroeconomic indicators, also analyze indicators related to the general well-being and the quality of life of the population. The authors stress, however, that it is still difficult to agree on a definition of this category as well as the measurement method, because of the unobservable and multidimensional nature of the phenomenon. There are many proposals for measuring quality of life, but there are significant differences between methodologies and results. Despite this diversity, some similarities can be identified, among them similarities in the selection of observable variables (indicators) defining the quality of life.
Purpose of the paper: The purpose of the paper is to analyze the regional disparities in the values of selected quality of life indicators in the Polish and Belarusian regions and order the Polish and Belarusian regions in terms of the quality of life.
Methods: The basic measures of descriptive statistics were used in the research: maximum and minimum values, mean, standard deviation, coefficient of variation. In addition, based on the rank method (the linear ordering method non-based on the

pattern), the values of the synthetic measure were determined on the basis of which the regions were ordered.
Findings & Value added: The statistical analyzes made it possible to distinguish the indicators that most contribute to the disparities in the quality of life of the inhabitants of Polish and Belarusian regions. In turn, the use of the rank method allowed to order the regions in terms of quality of life. The obtained results are a starting point for further research on quality of life with the application of multidimensional statistical analysis methods.

Introduction

Quality of life (QoL) is not a new economic category. Currently, most of the developed economies, in addition to macroeconomic indicators, also analyze indicators related to the general well-being and the QoL. In addition, once more often, QoL is included in growth and economic development models (see Kilimova, 2016; Krutilla & Reuveny, 2002; Zinam, 1989).

Strategic documents applicable in Poland directly or indirectly refer to the category QoL. Improving the QoL of the Polish citizens is the main strategic goal of the long-term national development strategy (Ministry of Administration and Digitization, 2013, pp. 42). The strategy provides for increased expenditure in the following areas: education, health, infrastructure, research and development, and culture. Also the medium-term national development strategy (Ministry of Regional Development, 2012, pp. 20) concerned with improving QoL. Its main aim is to strengthen and exploit economic, social and institutional potentials to ensure faster, sustainable growth of the economy, and to improve the quality of life of the population.

As for Belarus, the urgency of the task of enhancing people's life quality is confirmed by the national strategy for sustainable socio-economic development (Ministry of Economy of the Republic of Belarus, 2015). The strategy highlights the following aspects of QoL: accessibility of high-quality education and health services, ensuring high quality housing, wide access to cultural goods, high standards of personal and environmental security.

The purpose of the paper is to analyze the regional disparities in the values of selected indicators of QoL in the Polish and Belarusian regions and order the Polish and Belarusian regions in terms of the QoL.

Even though the phrase ‘quality of life’ has functioned in the theory of economics and in economic practice for many years, the debate on its precise definition is still ongoing. The term 'quality of life' is used interchangeably with the following phrases: well-being, living conditions, level of living, living standards, way of life, or lifestyle. The differences or simi-

larities between these expressions have not been clearly identified, which often leads to theoretical and practical contradictions.

In the present paper, QoL is defined as a complex socio-economic category, reflecting the level of development of the material, spiritual and social needs of a population, the degree of their satisfaction and the current conditions of their development.

Research methodology

The lack of a single, widely accepted definition of QoL results in the fact that there is no unambiguous method of measuring this category. International organisations, e.g. the European Union, the United Nation, the World Bank, the OECD, as well as individual countries, including Poland and Belarus have been involved in developing criteria for assessing the standard and quality of people's lives. Scientists and practitioners make attempts at constructing synthetic measures of QoL (see Dudek & Szczesny, 2017; Nowak, 2018; Wniarczyk-Razniak & Razniak, 2011). The most widely known ones include: the Human Development Index, the Physical Quality of Life Index, Gross National Happiness, the Happy Planet Index, The Economist Intelligence Unit's Quality-of-Life Index, the Gallup-Healthways Global Well-being Index, and the Legatum Prosperity Index.

Table 1 presents the set of diagnostic variables used in the study. The set is a result of a compromise between knowledge and experience in measuring QoL and the accessibility of comparable data for the two groups of regions which are investigated by the authors. The variables were classified according to five categories: quality of population, living conditions, social sphere, environment, and cultural sphere. The statistical data were obtained from the official databases of statistical offices in Poland and Belarus. Year 2016 was selected as the period of interest, due to the availability of statistical data.

The indicators were subjected to statistical analysis, in particular basic descriptive statistics were calculated: mini- and maximal values, mean, standard deviation, coefficient of variation. In addition, using the rank method, rankings of Polish and Belarusian regions in terms of the QoL were created. The rank method is the linear ordering method non-based on the pattern. The following algorithm was used:

Stage 1. Stimulation of diagnostic variables, i. e. replacement of a destimulant with stimulants, by means of the following formula:

$$x_{ij}^{S} = -x_{ij}^{D}, \tag{1}$$

where x_{ij} is the value of the *j*-th diagnostic variable in the *i*-th region, $i = 1,\ldots n$, $j = 1,\ldots m$.

Stage 2. Normalisation of the values of diagnostic variables, by means of the following formula:

$$z_{ij} = \frac{x_{ij} - \bar{x}_j}{s(x_j)}, \tag{2}$$

where z_{ij} is the standardized value of the *j*-th diagnostic variable in the *i*-th region, and $\bar{x}_j$, $s(x_j)$ are the mean and standard deviation of the *j*-th diagnostic variable.

Stage 3. Ranking of regions due to the normalized values of each diagnostic variable. In the situation when the standardized value of the diagnostic variable was present in more than one region, the regions were assigned the same rank, being the arithmetic mean of the rank assigned to them.
Stage 4. Calculation of the value of the synthetic measure for each region, by means of the following formula:

$$s_i = \frac{1}{m}\sum_{j=1}^{m} z_{ij} \tag{3}$$

Stage 5. Ordering of the studied regions.

Rresults

Tables 2 and 3 present the values of basic descriptive statistics calculated for diagnostic variables of the category ‘quality of population’.

Both Polish and Belarusian regions showed the strongest differences in terms of values of net migration rate and birth rate per 1000 population. Net migration rate reached the highest values in Mazowieckie Voivodeship (Poland), and in the City of Minsk (Belarus), in turn the lowest values – in Warmińsko-Mazurskie Voivodeship and Grodno Region. The highest birth rate per 1000 population was in Pomorskie Voivodeship and in the City of Minsk, the lowest – in Łódzkie Voivodeship and Vitebsk Region.

The lowest variability concerned the variable 'Life expectancy'. The variables: 'Pre-working age population per 1000 persons of working age', 'Post-working age population per 1000 persons of working age', 'Number of deaths per 1000 population' , and 'Number of marriages per 1000 population' were characterized by low variability.

The values of descriptive statistics calculated for diagnostic variables related to the category 'living conditions' are shown in Tables 4 and 5. Regions were the most diversified in terms of retail sales of goods per person, and the least – in terms of average usable floor area of residential premises per person.

Mazowieckie Voivodeship was the leader among Polish voivodships. The region achieved the highest values for five out of six diagnostic variables. In the case of the Belarusian regions, the city of Minsk took the first position four times.

Tables 6 and 7 provide the values of descriptive statistics calculated for diagnostic variables from the category 'social sphere'. Polish regions were the most diversified in terms of the value of the variable 'Unemployment rate', while the Belarusian regions in terms of the value of the variable 'Number of doctors per 10000 population'.

The last two categories of QoL: 'environment' and 'cultural sphere" were characterized by diagnostic variables with high variation (see Tables 8 and 9). In the 'environment' category, the least favorable situation concerned the Śląskie Voivodeship. The regions included in the so-called 'green lungs of Poland', that is: Warmińsko-Mazurskie and Podlaskie reached the lowest values of destimulants in this category.

Diagnostic variables were stimulated and normalized in accordance with formulas (1) and (2). Then, the regions were ranked due to the standardized values of diagnostic variables. Ranks were used to calculate the value of a synthetic measure as the arithmetic mean of individual ranks, according to the formula (3). Tables 8 and 9 provide the results of the ordering of the Polish and Belarusian regions in terms of QoL conducted by rank method.

The highest level of QoL in 2016 was marked by the Mazowieckie Voivodeship. In the capital of the region – Warsaw, a large part of the country's economic, scientific and cultural potential is concentrated. Twelve of the twenty-six diagnostic variables reached the highest values for this region. On the other hand, the Warmińsko-Mazurskie Voivodeship was on the last position.

The City of Minsk clearly stood out from the rest of Belarusian regions. The main potential of the active population in terms of ability to work and reproduce is concentrated in the capital. In addition, revenues and, as a consequence, consumption of various types of services is much higher. For

the City of Minsk, eighteen of the twenty six diagnostic variables reached the highest values for this region. The last position was taken by Vitebsk Region.

Conclusions

The paper presents the results of statistical analyzes of regional disparities in the values of selected indicators of QoL in Polish and Belarusian regions. The study encompasses sixteen Polish voivodeships and seven Belarusian regions. Due to the differences between the two countries in terms of, e.g. the level of economic development, political systems, cultural backgrounds, and because of the fact that the present paper is a pilot study, the two groups were analysed separately.

The best QoL is offered by metropolitan regions. In Poland, these include Mazowieckie Voivodeship with the City of Warsaw, Małopolskie Voivodehip with the City of Cracow, Pomorskie Voivodeship with the City of Gdańsk. In Belarus, the City of Minsk was found to have the best QoL. Low QoL is characteristic of less developed, peripheral regions: Warmińsko-Mazurskie, Świętokrzyskie, Mogilev Region and Vitebsk Region.

Indicators classified to the specified categories of QoL show different levels of differentiation: from extremely high (X1, X2, X23), through moderate (e.g. X14, X16, X19) to very low (e. g. X3).

Monitoring the QoL in regions, analysing interregional variations, and seeking factors that could contribute to reducing socio-economic inequalities thus seem crucial. This is acknowledged by state authorities, institutions which gather and analyse data, as well as economic researchers. Evaluating QoL at the regional level is a particularly significant task in the context of socio-economic analyses.

The conducted research is a pilot project. Further investigations are to develop synthetic measures of QoL by means of selected methods of multivariate statistical analysis.

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Annex

Table 1. Diagnostic variables of QoL

Symbol	Diagnostic variable	Type of variable*
	QUALITY OF POPULATION	
X1	Net migration rate	S
X2	Birth rate per 1000 population	S
X3	Life expectancy	S
X4	Infant mortality rate	D
X5	Pre-working age population per 1000 persons of working age	S
X6	Post-working age population per 1000 persons of working age	D
X7	Percentage of population with tertiary education employed in economy (Polish regions) Percentage of population with tertiary education employed in organisations (Belarusian regions)	S
X8	Number of deaths per 1000 population	D
X9	Number of marriages per 1000 population	S
X10	Number of divorces per 1000 population	S
	LIVING CONDITIONS	
X11	Average monthly salary	S
X12	Average usable floor area of residential premises per person	S
X13	Number of passenger cars per 1000 population	S
X14	GDP per capita	S
X15	Retail sale of goods per person	S
X16	Percentage of households below poverty line	D
	SOCIAL SPHERE	
X17	Unemployment rate	D
X18	Employment rate	S
X19	Number of doctors per 10000 population	S
X20	Number of nurses and midwives per 10000 population	S
X21	Number of persons injured in accidents at work per 1000 employed	D
X22	Number of offences per 1000 population	D
	ENVIRONMENT	
X23	Emission of particulate pollutants by plants of significant nuisance to air quality	D
X24	Industrial and municipal waste water requiring treatment discharged into waters or into the ground	D
	CULTURAL SPHERE	
X25	Audience in theatres and music institutions per 1000 population	S
X26	Number of museum admissions per 10000 population	S

* S – stimulant, D – destiumalnt

Source: own elaboration

Table 2. Descriptive statistics of diagnostic variables in the category 'quality of population' – Polish regions

Symbol	Min	Max	Mean	Coefficient of variation (%)
X1 (S)	-2.07 Warmińsko-Mazurskie	2.41 Mazowieckie	-0.38	326.78
X2 (S)	-2.98 Łódzkie	2.04 Pomorskie	-0.40	355.61
X3 (S)	76.58 Łódzkie	79.26 Podkarpackie	77.95	0.91
X4 (D)	3.27 Mazowieckie	5.86 Lubuskie	4.18	16.60
X5 (S)	25.21 Opolskie	31.59 Pomorskie	28.66	5.82
X6 (D)	29.20 Warmińsko-Mazurskie	37.00 Łódzkie	32.48	6.36
X7 (S)	26.70 Łódzkie	42.91 Mazowieckie	32.15	11.48
X8 (D)	8.98 Podkarpackie	12.14 Łódzkie	10.09	7.85
X9 (S)	4.65 Warmińsko-Mazurskie	5.36 Pomorskie	5.01	4.57
X10 (S)	1.20 Podkarpackie	1.90 Warmińsko-Mazurskie, Lubuskie	1.62	12.20

Source: own calculation based on the database of Central Statistical Office (CSO).

Table 3. Descriptive statistics of diagnostic variables in the category 'quality of population' – Belarusian regions

Symbol	Min	Max	Mean	Coefficient of variation (%)
X1 (S)	-1.75 Grodno Rregion	4.96 City of Minsk	0.37	793.15
X2 (S)	-3.52 Vitebsk Region	2.65 City of Minsk	-0.47	381.11
X3 (S)	73.1 Minsk Region	76.5 City of Minsk	74.00	1.50
X4 (D)	2.8 Vitebsk Region, Gomel Region	3.8 Minsk Region	3.14	10.46
X5 (S)	267 City of Minsk	344 Brest Region	310.43	8.15
X6 (D)	369 City of Minsk	486 Vitebsk Region	450.29	7.90
X7 (S)	21.9 Minsk Region	40.7 City of Minsk	26.09	23.07
X8 (D)	8.7 City of Minsk	14.6 Vitebsk Region	12.93	14.15
X9 (S)	6.3 Vitebsk Region, Gomel Region	7.7 City of Minsk	6.69	6.61
X10 (S)	3.0 Grodno Region, Brest Region	3.8 City of Minsk	3.40	8.02

Source: own calculation based on database of the National Statistical Committee of the Republic of Belarus (NSCRB).

Table 4. Descriptive statistics of diagnostic variables in the category 'living conditions' – Polish regions

Symbol	Min	Max	Mean	Coefficient of variation (%)
X11 (S)	3619.16 Warmińsko-Mazurskie	5240.86 Mazowieckie	3993.79	9.94
X12 (S)	24.2 Warmińsko-Mazurskie	29.9 Mazowieckie	27.11	5.58
X13 (S)	485.19 Podlaskie	626.59 Wielkopolskie	555.82	7.30
X14 (S)	33371 Lubelskie	77359 Mazowieckie	43765.31	24.81
X15 (S)	8597 Opolskie	40383 Mazowieckie	16295.69	56.77
X16 (D)	8.5 Mazowieckie	21.3 Podkarpackie	13.32	31.34

Source: own calculation based on the database of CSO.

Table 5. Descriptive statistics of diagnostic variables in the category 'living conditions' – Belarusian regions

Symbol	Min	Max	Mean	Coefficient of variation (%)
X11 (S)	241.2 Gomel Region	445.0 City of Minsk	285.51	23.49
X12 (S)	22.5 City of Minsk	29.7 Minsk Region	27.14	8.24
X13 (S)	267 Gomel Region	352 Grodno Region	310.14	8.74
X14 (S)	6295.1 Vitebsk Region	12960.0 City of Minsk	8001.43	28.18
X15 (S)	3251.7 Mogilev Region	11285.4 City of Minsk	5274.77	48.13
X16 (D)	1.4 City of Minsk	8.1 Brest Region	5.81	39.07

Source: own calculation based on the database of NSCRB.

Table 6. Descriptive statistics of diagnostic variables in the category 'social sphere' – Polish regions

Symbol	Min	Max	Mean	Coefficient of variation (%)
X17 (D)	4.90 Wielkopolskie	14.20 Warmińsko-Mazurskie	9.09	26.36
X18 (S)	49.00 Warmińsko-Mazurskie	56.60 Mazowieckie	52.19	3.98
X19 (S)	35.97 Wielkopolskie	71.32 Mazowieckie	52.59	18.87
X20 (S)	50.32 Wielkopolskie	76.45 Śląskie	66.95	11.71
X21 (D)	4.84 Mazowieckie	9.17 Warmińsko-Mazurskie	7.38	16.50
X22 (D)	11.02 Podkarpackie	25.73 Dolnośląskie	18.87	19.21

Source: own calculation based on the database of CSO.

Table 7. Descriptive statistics of diagnostic variables in the category 'social sphere' – Belarusian regions

Symbol	Min	Max	Mean	Coefficient of variation (%)
X17 (D)	0.5 City of Minsk	1.0 Vitebsk Region, Gomel Region	0.84	19.91
X18 (S)	63.1 Gomel Region	71.5 City of Minsk	66.31	4.28
X19 (S)	32.8 Minsk Region	58.7 City of Minsk	42.76	20.07
X20 (S)	120.6 Minsk Region	137.2 Grodno Region	132.69	3.97
X21 (D)	0.30 City of Minsk	0.52 Grodno Region	0.44	16.49
X22 (D)	826 Brest Region	1203 Minsk Region	974.57	11.68

Source: own calculation based on the database of NSCRB.

Table 8. Descriptive statistics of diagnostic variables in the 'environment' and 'cultural sphere' categories – Polish regions

Symbol	Min	Max	Mean	Coefficient of variation (%)
X23 (D)	0.03 Warmińsko-mazurskie	0.74 Śląskie	0.14	112.47
X24 (D)	2.00 Podlaskie	30.10 Śląskie	7.60	89.22
X25 (S)	100 Podkarpackie	716 Dolnośląskie	332.50	54.76
X26 (S)	2412 Opolskie	29363 Małopolskie	7674.49	90.86

Source: own calculation based on the database of CSO.

Table 9. Descriptive statistics of diagnostic variables in the 'environment' and 'cultural sphere' categories – Belarusian regions

Symbol	Min	Max	Mean	Coefficient of variation (%)
X23 (D)	1.45 Mogilev Region	60.33 City of Minsk	10.38	196.52
X24 (D)	0.09 City of Minsk	0.22 Minsk Region	0.14	29.26
X25 (S)	413.8 Minsk Region	3976.7 City of Minsk	1135.89	106.48
X26 (S)	434 Mogilev Region	827 City of Minsk	655.14	20.12

Source: own calculation based on the database of NSCRB.

Table 10. The ordering of Polish regions in terms of QoL in 2016

Region	Synthetic measure	Rank
Mazowieckie	3,85	1
Małopolskie	5,35	2
Pomorskie	5,75	3
Wielkopolskie	7,60	4
Podlaskie	7,96	5
Dolnośląskie	7,98	6
Podkarpackie	8,19	7
Lubelskie	8,71	8
Łódzkie	9,06	9
Lubuskie	9,12	10
Śląskie	9,52	11
Kujawsko-pomorskie	9,71	12
Zachodniopomorskie	10,10	13
Opolskie	10,44	14
Świętokrzyskie	11,04	15
Warmińsko-mazurskie	11,63	16

Source: own calculation.

Table 11. The ordering of Belarusian regions in terms of QoL in 2016

Region	Synthetic measure	Rank
City of Minsk	2,40	1
Grodno Region	3,33	2
Brest Region	3,73	3
Minsk Region	4,38	4
Gomel Region	4,40	5
Mogilev Region	4,83	6
Vitebsk Region	4,92	7

Source: own calculation.

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Digital skills and labor market challenges in the era of the fourth industrial revolution: multiple criteria analysis for European countries

JEL Classification: *J21; J24; E24*

Keywords: *digital skills; digital competencies; labor market; industrial relations; industry 4.0; European countries*

Abstract

Research background: In the era of a digital revolution business environment is transformed, and adapting to these changes is essential for every economy. The Internet, the progressive digitalization, the new industrial relations and dynamic interactions among different stakeholders are raising new challenges. Our study compares the labor market demands on digital competencies with digital skills level of the individuals and employees in European Countries. Recognizing the gap between market requirements and digital competences supply as well as identifying the position of Poland against other countries in the EU gives rise to the discussion about the future of education policy and digital competence development.
Purpose of the article: This paper aims twofold: (1) to provide an overview of the new trends in developing digital competencies concerning the labor market challenges as well as (2) to compare and evaluate digital skills level and labor market challenges in European countries in this regard.

Methods: The empirical part of the paper presents a comparative analysis of digital skills in European countries based on public statistics of Eurostat. The secondary data set used covers multi-criterion information describing the research problem. The data analysis is conducted by using the TOPSIS method.
Findings & Value added: The originality of this study lies in the comprehensive overview of the level of digital competences of individuals against the level of labor market digitalization and companies demand on digital skills. Also, the added value comes from the use of multiple criteria decision analysis methodology, in particular, TOPSIS method, to the problem of measuring the level of digital competence concerning the companies needs and labor market requirements.

Introduction

Digital technologies have deeply remodeled ways of doing business over the past few years. Less than a decade ago mobile devices, social networks, cloud computing or analytical capabilities of companies were "in its infancy," and hardly anyone expected how deep they would affect business processes or social relations, including the labor market (Kergroach, 2017). Since 2011, the term Industry 4.0 has started to be widely used, after launching of the German project in the manufacturing sector. Initially, the term appeared at the Hanover Trade Fair as the name for the common initiative of the representatives of business, policy, and science promoting the idea of strengthening the competitiveness of the German industry. In the literature, there are numerous definitions (Müller, Buliga & Voigt, 2018). According to Lasi *et al*. (2014) "*Industry 4.0 describes the increasing digitization and automation of the manufacturing environment, as well as the creation of digital value chains to enable communication between products, their environment, and business partners*".

The development of technology affects changes in the socio-economic context and defines a new model of industry based on system integration and networking, especially by the integration of people and digitally controlled machines into the Internet and information technologies. Such ubiquitous flow of information resulting from the 4.0 industrial revolution requires new competencies necessary on the labor market, and thus poses challenges for the education system in the information society.

The aim of this paper is on the one hand to provide an overview of the new trends in developing digital competencies concerning the labor market challenges, and on the other hand to compare and evaluate digital skills level and labor market challenges in European countries. To achieve the

primary goal of the study, we conduct comparative analysis of digital skills in 28 European countries based on public statistics of Eurostat. For the data analysis, the TOPSIS method is applied. The remaining sections of this paper are structured as follows. In section 2, we provide the theoretical background on digital competence supply and demand in perspective of the fourth industrial revolution. Section 3 introduces the research methods and methodological procedures for the data analysis. The results and discussion are presented in Section 4, followed by the conclusions.

Digital competence supply and demand in perspective of the fourth industrial revolution - literature review

In connection with the advancing digital revolution, digital competences play an increasingly important role in both society and business. The concept of digital competences is defined differently in the literature. Ferrari (2012, pp. 3-4) defines digital competence as "*the set of knowledge, skills, attitudes (thus including abilities, strategies, values and awareness) that are required when using ICT and digital media to perform tasks; solve problems; communicate; manage information; collaborate; create and share content; and build knowledge effectively, efficiently, appropriately, critically, creatively, autonomously, flexibly, ethically, reflectively for work, leisure, participation, learning, socialising, consuming, and empowerment.*"

The shaping of digital skills is the subject of many documents developed by the European Union, which analyze the progress of the Member States in the field of digital competitiveness by applying the complex index DESI (The Digital Economy and Society Index) (European Union, 2018).

Analyzing the impact of the fourth industrial revolution on the labor market, various studies on current trends and challenges exist. For example, research conducted by the Boston Consulting Group (BCG) points to the positive effect of the "Industry 4.0" concept on the labor market. BCG forecasts employment growth by 6% by 2030, which will be based primarily on the growing demand for a highly qualified workforce in the machine and automotive industry (Boston Consulting Group, 2015). According to other forecasts, employment will be reduced. This prediction is explained by the fact that after achieving the expected productivity at the current level of orders, smart factories will need fewer employees (Schlund, Hämmerle & Strölin, 2014). The study also shows that with the development of tech-

nology, employees with low skills will retrain to tasks that are not susceptible to computerization, i.e., those that require creative and social competencies. These employees will be forced to acquire creative skills (Frey & Osborne, 2017). The combination of skills needed in modern societies is becoming more complex and will evolve as work environments with increased technology development, requiring future generations of employees to develop digital skills and lifelong learning opportunities at an early age.

Data and research methodology

The problem of digital competencies and their measurement concerning the supply and demand side is a kind of compound issue. In order to analyze the specifics of labor markets in EU countries according to technological development and digital competence needs of companies and the digital skills level of individuals, we established three categories to be measured:

1. ***Labor market 4.0*** - described by a set of indicators characterizing the market specificity in each UE country, primarily in terms of the presence of the modern technologies sector and the availability of IT specialists.
2. ***Society 4.0*** – showed by the level of digital skills and the use of IT tools in the daily life of individuals, as well as their striving to developing such skills.
3. ***Companies 4.0*** - a research category assessed by features that demonstrate the importance and the use of IT tools in the day-to-day operation of the companies what influences the demand for digital skills.

The data used in analysis were collected from the public statistic of Eurostat. The list of the variables used in the study include table 1.

The TOPSIS algorithm is one of the most easy-applied method for solving complex problems. It belongs to Multi-Criteria Decision Aid (MCDA) or Multi-Criteria Decision Making (MCDM) methods, which offers a various range of useful tools enabling to evaluate, assess and rank alternatives across diverse area (Yoon & Hwang, 1995). Comparisons between European countries with the use of TOPSIS method have been presented by Dinçer (2011), Masca (2017). Some of the paper relate to the digital economy Ardielli & Halásková (2015), Balcerzak & Pietrzak (2017).

TOPSIS was initially developed by Hwang and Yoon (1980) and is defined as "*an approach to identify an alternative which is closest to the ideal*

solution and farthest to the negative ideal solution in a multi-dimensional computing space" (Qin et al., 2008, p. 2166).

The methodological procedure starts with forming the initial matrix of all alternatives (countries in our case) in terms of each criterion (variables), and its normalization. In opposite to, e.g., cluster analysis methods, TOPSIS does not require attributes to be independent (Chen & Hwang, 1992). Then the normalized decision matrix has to be weighted. Next, one needs to determine positive and negative ideal solutions for each attribute and calculate the separation measure according to n-dimensional Euclidean distance. Finally, the aggregate index, combining all starting attributes, for each alternative is being calculated. After that, the value of the total measure the ranking of countries is delivered (Yoon & Hwang, 1981, pp.130-132).
The value of aggregate index is in the range between 0-1. The higher score reflects a higher level of the studied phenomenon. Rank shows the position of each UE countries in term of three analyzed issues. In order to divide countries into similar groups due to the aggregate index level, we use the simple algorithm, splitting objects into four classes, as follows:

$$\bar{c} + S_c < C_i \leq c_{max} \quad \text{I class}$$

$$\bar{c} < C_i \leq \bar{c} + S_c \quad \text{II class}$$

$$\bar{c} - S_c < C_i \leq \bar{c} \quad \text{III class}$$

$$c_{min} \leq C_i \leq \bar{c} - S_c \quad \text{IV class}$$

where $\bar{c}$ is a mean of aggregate index and S_c is its standard derivation.

Research findings and discussion

The first rank for a Labor market 4.0 performance relates to supply and demand side of the market due to the presence of technologically advanced companies and IT specialists and includes companies' experience in filling vacancies for IT specialists during the recruiting process. This category differs from the next others, not measuring the level of digitization of society and enterprises exclusively.

The highest score reached Western European countries: Ireland, Finland, Spain, Sweden, and the United Kingdom. Next to this group is Esto-

nia opening the II class countries. Our research shows that Estonia gained a high level in all three categories measured and the highest score concerning other post-communist countries. In fact, Estonia has made tremendous progress in the field of digitization and in 2018 it was recognized by the "Wired" magazine as the most digitally advanced society in the world. In turn, the worst labor market situation is noted in the Czech Republic and Latvia.

The second rank concerning a Society 4.0 shows digital skills level of individuals. The best scores of synthetic measure are observed in Finland, Luxembourg, Sweden, and Denmark. These outcomes confirm the results of DESI (2017). The worst level of digital skills represents individuals from Cyprus, Romania, Croatia, Italy, and Bulgaria. Poland is also below the average of the UE. These results are in line with DESI as well.

The last category taken into consideration refers to Companies 4.0. The results obtained by the countries in this category are highly correlated with the previous outcomes - Society 4.0. The highest level of use IT tools in business operation is in Finland, Denmark and unexpectedly in Slovenia. Among countries with the lowest score of companies' digitalization are Greece, Hungary, Poland, Romania and Bulgaria. In overall, Poland gains poor outcomes in terms of both digitalization of the enterprises and society. Similar place in the ranking have such countries like Romania, Latvia, and Greece.

Conclusions

The challenges of the modern era of globalization together with the fourth industrial revolution create many opportunities and threats. Automation of production, the digital revolution, robotization, machine learning, and further technological progress have a significant impact on the labor market and the demand for digital competences, and above all digital skills.

The aim of the paper was to provide an overview of the new trends in developing digital competencies concerning the labor market challenges and to analyze digital skills level and labor market challenges in European countries. The results showed that the combination of skills needed in modern societies is becoming more complex and will evolve as work environments with increased technology development, requiring future employees to develop digital skills and lifelong learning opportunities. Based on the public statistics of Eurostat of 28 European countries a comparative analy-

sis of digital skills was conducted. The data used in the study referred to Labor market 4.0, Society 4.0 as well as to Companies 4.0.

The results showed a varied level of digitization of countries in these three categories. Our findings are consistent with various recent streams of other empirical studies that have demonstrated relevant differences in actual digital skills among the population, depending on economic, educational, geographical, and demographical disparities (Gui, 2007; Van Deursen & Van Dijk, 2008). Future studies can be targeted towards the research question on how companies and society can support digital competences development.

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Annex

Table 1. List of the variable used in the research

Labor market 4.0
• Employment rates[4]
• Science, mathematics and computing, engineering, manufacturing and construction profile of education[4]
• Employed ICT specialists[9]
• High-technology sectors[5]
• Enterprises that employ ICT specialists[6]
• Enterprise had hard-to-fill vacancies for jobs requiring ICT specialist skills specialists[6]
• Enterprise had no hard-to-fill vacancies for jobs requiring ICT specialist skills specialists[6]
Society 4.0
• Never use of computer[7]
• Frequency of computer use: daily[8]
• Frequency of computer use: at least once a week (but not every day)[7]
• Frequency of internet access: once a week (including every day)[7]
• Used internet storage space to save documents, pictures, music, video or other files[7]
• Individuals who have low overall digital skills[7]
• Individuals who have above basic overall digital skills[7]
• Individuals carried out free training provided by public programs or organizations to improve skills relating to the use of computers, software or applications[2, 7]
• Individuals carried out training paid or provided by the employer to improve skills relating to the use of computers, software or applications[2, 7]
Companies 4.0
• Enterprises with a website[6]
• Enterprises sending invoices, suitable for automated processing[6]
• Enterprises using any social media[6]
• Buy cloud computing services used over the internet[6]
• Enterprises analyzing big data from any data source[6]
• ICT functions are mainly performed by own employees[6]
• The support for web solutions is mainly performed by external suppliers[6]
• Enterprise provided training to their personnel to develop/upgrade their ICT skills[6]

[1] 2016 for Italy, [2] lack of data for the United Kingdom – approximated on a base of European Union mean value, [3] 2016 for UK, [4] percentage of total population from 15 to 64 years, [5] percentage of total population, [6] percentage of all enterprises without financial sector - 10 persons employed or more, [7] percentage of all individuals, [8] percentage of individuals aged 25 to 64 who are employees, self-employed or family workers, [9] percentage of total employment

Source: own elaboration based on the data from Eurostat.

Table 2. Multicriteria ranking results using TOPSIS

Country	Labour market TOPSIS	Rank	Class	Country	Society TOPSIS	Rank	Class	Country	Company TOPSIS	Rank	Class
Ireland	0,64	1	I	Finland	0,83	1	I	Finland	0,88	1	I
Finland	0,59	2	I	Luxembourg	0,63	2	I	Denmark	0,66	2	I
Spain	0,55	3	I	Sweden	0,61	3	I	Sweden	0,55	3	I
Sweden	0,53	4	I	Denmark	0,56	4	I	Slovenia	0,54	4	I
United Kingdom	0,53	5	I	Netherlands	0,53	5	II	Netherlands	0,53	5	II
Estonia	0,49	6	II	Spain	0,49	6	II	Belgium	0,50	6	II
Denmark	0,46	7	II	Germany	0,48	7	II	Ireland	0,50	7	II
Belgium	0,45	8	II	Austria	0,48	8	II	Malta	0,48	8	II
Bulgaria	0,45	9	II	United Kingdom	0,47	9	II	United Kingdom	0,44	9	II
Portugal	0,44	10	II	Malta	0,46	10	II	Luxembourg	0,40	10	II
Slovenia	0,43	11	III	Estonia	0,42	11	II	Estonia	0,39	11	II
Lithuania	0,42	12	III	Belgium	0,40	12	II	Germany	0,38	12	II
Poland	0,41	13	III	Portugal	0,40	13	II	Spain	0,37	13	III
Hungary	0,40	14	III	Slovenia	0,39	14	III	Italy	0,35	14	III
Netherlands	0,39	15	III	Hungary	0,37	15	III	Lithuania	0,35	15	III
France	0,39	16	III	Slovakia	0,37	16	III	Austria	0,34	16	III
Slovakia	0,38	17	III	Ireland	0,37	17	III	Croatia	0,33	17	III
Germany	0,38	18	III	France	0,36	18	III	Portugal	0,33	18	III

Table 2. Multicriteria ranking results using TOPSIS

Country	Labour market TOPSIS	Rank	Class	Country	Society TOPSIS	Rank	Class	Country	Company TOPSIS	Rank	Class
Austria	0,38	19	III	Lithuania	0,32	19	III	France	0,32	19	III
Cyprus	0,38	20	III	Czech Republic	0,31	20	III	Czech Republic	0,32	20	III
Luxembourg	0,37	21	III	Latvia	0,29	21	III	Cyprus	0,31	21	III
Croatia	0,37	22	III	Poland	0,28	22	III	Slovakia	0,25	22	III
Romania	0,37	23	III	Greece	0,24	23	III	Latvia	0,23	23	III
Malta	0,37	24	III	Cyprus	0,23	24	IV	Greece	0,22	24	IV
Italy	0,37	25	III	Romania	0,21	25	IV	Hungary	0,19	25	IV
Greece	0,36	26	III	Croatia	0,18	26	IV	Poland	0,18	26	IV
Czech Republic	0,35	27	IV	Italy	0,17	27	IV	Romania	0,17	27	IV
Latvia	0,34	28	IV	Bulgaria	0,12	28	IV	Bulgaria	0,10	28	IV

Source: own estimation and elaboration.

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Ranking of EU countries according to quality of mirror data on intra-Community trade in goods – changes over time

JEL Classification: *F14; C10; C82*

Keywords: *official statistics data quality, mirror data, intra-Community trade, EU*

Abstract

Research background: Intrastat system was introduced in Poland after the country's accession to the European Union. As a system of official EU statistics, it contains data collected by member states aggregated by Eurostat on Union's level in the form of COMEXT database. Country-level data are based on declarations made by businesses dispatching or acquiring goods from other EU member states. Since the same transaction is declared twice: as an intra-Community supply of goods (ICS) in one country and at the same time as an intra-Community acquisition (ICA) in another country by the partner the database contains mirror data. Analysis of mirror data lets us assess quality of public statistics data on international trade.
Purpose of the article: The aim of the article is to prepare an EU member states ranking according to quality of data on intra-Community trade in goods collected by Intrastat. Foreign trade stimulates economic development on one hand and is the development's reflection on the other. Thus it is very important that official statistics in this area be of good quality. Analysis of mirror data from partner states in intra-Community trade in goods allows us to claim that not every member state provides data of satisfactory quality level.
Methods: In the article we used authors' own methodology of assessing quality of mirror data. This includes data asymmetry indices, both proposed by Eurostat and

authors' own proposals. We have also examined the changes in the above mentioned rankings over time.
Findings & Value added: The result of the survey is a ranking of EU member states according to quality of data on intra-Community trade in goods. The rankings are presented over the period of 2014-2017, during which there were 28 member states of the EU. Changes in distinct countries' positions were shown as a result of changes in overall quality of statistical data collected in these countries. The research methodology can be used in the process of monitoring data quality of the Intrastat system.

Introduction

Foreign trade stimulates economic development on one hand and is the development's reflection on the other. Thus it is very important that official statistics in this area be of good quality.
These data are used to assess the economic situation of a given state and in the process of creating strategies both at the country level and for the entire European Union. This is why Eurostat, together with the national statistical offices, attaches great importance to monitoring and improving the quality of intra-Community trade data.

The Intrastat system was introduced in 1991 by Council Regulation No 3330/91 (7 November 1991) on the statistics relating to the trading of goods between Member States and has been applicable since 1993. Since then, international trade in goods statistics are based on two data systems: for intra-EU and for extra-EU trade statistics. Extra-EU trade data, which relate to the trading of goods with non-member countries, continue to be collected by customs administrations, whereas most of the intra-EU trade data are directly collected from traders within the Intrastat system (Eurostat, 2017b).

Intrastat system was introduced in Poland after the country's accession to the European Union. As a system of official EU statistics, it contains data collected by member states aggregated by Eurostat on Union's level in the form of COMEXT database. Country-level data are based on statistical declarations made by businesses dispatching or acquiring goods from other EU member states. Since the same transaction is declared twice: as an intra-Community supply of goods (ICS) in one country and at the same time as an intra-Community acquisition (ICA) in another country by the partner the database contains mirror data. Analysis of mirror data lets us assess quality of public statistics data on international trade.

The topic of mirror data quality is the subject of numerous publications of national statistical offices or Eurostat. It is however rarely raised as the

subject of scientific research. Foreign trade turnover is an important parameter and is used in various analyses, diagnoses and economic forecasts. It is therefore crucial for a researcher to be able to estimate the true value of foreign trade within and outside the EU. The scientific literature more often presents the results of research concerning foreign trade itself, its size and dependence on various factors, and the quality of data is usually neglected.

For example, the goal of article by Brodzicki *et al*. (2015) was to investigate the determinants of the intensity of Polish exports to its trade partners (country level). The analysis was carried out for 234 trade partners of Poland in the period 1999-2013 with the use of panel gravity modelling. The impact of standard determinants of gravity including partners size and distance on the dependent variable (level of exports) is highly statistically significant and in accordance with general expectations. The impact of size similarity has not been proven. Adjacency has a robust and positive impact (EU membership).

The problem of discrepancies in mirror data has long been noted by researchers, and literature can be divided into theoretical works, especially concerning the modelling of an unknown, true structure and size of trade between countries, and application works concerning foreign trade research on specific countries or trade within groups of countries. Parniczky (1980) indicates that such research was carried out at least since the 1920s, and Tsigas *et al*. (1992) date it back to the 1880s. However, all these authors acknowledge that a consensus among economists and statisticians on the need to investigate the mismatch between mirror data has been present since the 1960s. In his work (Parniczky 1980), the author primarily points out that matrices of data on exports and imports are not equally useful, as it might seem. Although most practitioners have favoured the use of export information, he argues that the use of a modified import matrix is a better solution. Consequently, according to such a philosophy, in the study of discrepancies between mirror data, it is the importing side that should be given more credit.

The paper (Tsigas *et al*., 1992) and other works by creators and users of the GTAP model (Purdue University) and (Ten Cate 2014) are examples of theoretical articles. The article by Tsigas *et al*. (after Parniczky) points out the causes of discrepancies: the time of registration of transactions, different levels of interest of customs and public statistics, classification errors, transport and insurance costs, inclusion of transit. Another reasons are errors in determining the country of origin or shipment, changes in exchange rates during the reporting period or intentional actions, listed e.g. in the list of reasons for the occurrence of discrepancies in the paper by Hamanaka (2012), which is an example of application work. The authors of the next

application study, Ferrantino & Wang (2008) use the measure of asymmetry, which is a slightly modified version of the measure being the basis of the aggregate index presented later in this paper (although they incorrectly describe the formula). These authors then use asymmetry measurement in (Ferrantino *et al*., 2011), among others, to detect evading customs declarations.

Since intra-EU trade statistics are based on statistical declarations of businesses, social and emotional factors in human activity should also be borne in mind (Baran & Markowicz, 2018b). These issues are considered within behavioural economics, initiated by Simon's concept of limited rationality (1972).

Behavioral effects make the data less reliable and more difficult to use, which is an important reason for searching for appropriate methods of data quality assessment.

The aim of the article is to prepare an EU member states ranking according to quality of data on intra-Community trade in goods collected by Intrastat. Analysis of mirror data from partner states in intra-Community trade in goods allows us to claim that not every member state provides data of satisfactory quality level. It should be stressed that the quality of data collected in a given country affects the quality of data in the trading partner countries. Therefore, improving this quality in all EU countries is a priority for Eurostat.

In the article the authors' methodology of assessing quality of mirror data was used. This includes calculating data asymmetry indices, both proposed by Eurostat and authors' own proposals. We have also examined the changes in the above mentioned rankings over time.

The result of the survey is a ranking of EU member states according to quality of data on intra-Community trade in goods. The rankings are presented over the period of 2014-2017, during which there were 28 member states of the EU. Changes in distinct countries' positions were shown as a result of changes in overall quality of statistical data collected in these countries. The research methodology can be used in the process of monitoring data quality of the Intrastat system.

Research methodology

The study used data on intra-Community supplies of goods from EU member states and its mirror data on intra-Community acquisitions. Mirror data (Baran & Markowicz, 2018a) for two countries A and B should be understood as follows: it is the amount of goods declared by a country A based

business as dispatched from country A to country B, and acquisition of goods declared in country B as originated from country A (or goods acquired by country A based business from country B, declared in country A and goods declared as supplied from country B to country A, declared in country B).

Data from 2014-2017 were obtained from Eurostat's Comext database. The database is updated on an ongoing basis once the data have been collected by the national statistical offices. The analysed data were downloaded on 18 November 2018.

Examination of the quality of data concerning trade in goods between EU countries is possible thanks to the method of collecting these data. The information is derived from declarations made by entities engaged in intra-Community supplies of goods (ICS) or intra-Community acquisitions of goods (ICA). Data are transmitted from individual member states to Eurostat. They constitute the Comext database, which then contains mirror data on transactions between all pairs of countries.

Data quality testing is based on an analysis of the differences between mirror data or asymmetries. Eurostat (2017a, 2017b) proposes to use the following asymmetry index:

$$ {}_{O}W_{E}^{AU} = \frac{E_{AU} - I_{UA}}{K} \tag{1}$$

where:
E_{AU} – declared value of dispatches (supply) from country *A* to all other EU member states combined,
I_{UA} – declared total value of acquisitions by all other EU member states delivered from country *A* (mirror data),

$$K = \frac{E_{AB} + I_{BA}}{2} \text{ or } K = I_{BA} \text{ or } K = E_{AB}.$$

We call this index ‘general’. What we propose instead is an approach using absolute differences between exports and mirror imports. Such an approach allows for the cumulation of all discrepancies and avoids the balancing of positive and negative differences. All discrepancies are thus taken into account. The authors’ indicator is called the ‘aggregated’ data asymmetry index (mirror data quality index) and is written as:

$$ {}_{Z}W_{E}^{AU} = \frac{\sum_{i=1}^{n} \left| E_{AB_i} - I_{B_i A} \right|}{K} \tag{2}$$

where:
E_{AB_i} – declared value of dispatches (supply) from country *A* to country B_i,
I_{B_iA} – declared value of acquisitions by country B_i delivered from country *A* (mirror data),

$$K = \sum_{i=1}^{n} \frac{E_{AB_i} + I_{B_iA}}{2}.$$

The aggregate index takes values from the range from 0 to 2. The higher its value, the lower the quality of the analysed data.

The survey was conducted for 28 EU countries in 2014-2017. The last country to join the EU was Croatia. It has been a member since July 2013, so 2014 is the first year with complete intra-Community trade data for the whole group of 28 member states. For each country, an aggregated data discrepancy index (2) was calculated for the years 2014 to 2017. Countries were then ranked according to the value of the index in each year. This resulted in joint rankings of EU member states according to the quality of ICS mirror data in 2014-2017. Such a compilation shows how the quality of each country's data has changed in relation to other countries.

Results

The positions of the EU member states in the rankings by quality of intra-Community trade data for the period 2014-2017 are shown in Fig. 1. These positions change more or less over the period considered. First of all, attention should be paid to two countries: Cyprus and Malta. They invariably ranked in the last two positions in the ranking, which indicates the lowest quality of data on trade with other EU countries. Germany, Austria, Romania and France are among the top ranked countries. Another group of countries includes: Bulgaria, Belgium, the Netherlands, Spain, Great Britain, Italy, Hungary, Sweden, the Czech Republic, Poland and Slovakia. These countries changed their ranking positions in the years under analysis, and the above list reflects the ordering from 2017 (positions from 5 to 15). The most significant changes in rankings from 2014 to 2017 can be observed for Finland, who lost 10 positions (ranked 8th in 2014 and 18th in 2017) and Estonia (who gained 7 positions over this four-year period). This means that quality of data as compared to other Member States has risen for one and fallen for the other of those two neighbouring countries.

The positions occupied by many individual countries changed in the analysed years. This is due to a similar level of data quality indicators (Fig.

2). The values of indicators for most countries were similar and in 2017 ranged from 0.055 (Germany) to 0.160 (Portugal). Slightly higher values of the indicator (approx. 0.2) were reached by Latvia and Croatia in 2014, and by Luxembourg and Croatia in 2017. On the other hand, outliers are observed in the case of Malta (an increase from 0.380 to 0.520) and Cyprus (a decrease from 1.041 to 0.578). Unfortunately, except for the latter there was no spectacular decrease of the index (or increase of data quality) among EU countries.

It should be added that the value of the difference in mirror data (declared ICS of the analysed country and declared ICA of its trade partners) usually depends on the value of the ICS of the country. Therefore, the discrepancy of data alone cannot be identified with the level of quality. Larger ICS may result in a higher data discrepancy, but the difference in mirror data may still be a small part of the ICS value. These considerations are illustrated in Fig. 3-4. It turns out that in 2017 there was a strong positive correlation between the difference between the mirror data and the ICS value for the EU-28 countries. On the other hand, there is no correlation between the data quality indicators and the value of the ICS. This confirms the usefulness of using indicators in analysing the quality of intra-Community trade data.

Conclusions

The authors have created a ranking of EU countries according to data quality for both ICS and ICA for 2017 in an earlier work. However, these two rankings don't perfectly fit each other. It appears we have, somewhat unintentionally, tested the stability of our ranking over a period of constant reconciliation and updates of database. Fig 5 presents ranking of EU member states according to ICS in 2017 for provisional data downloaded in April, 2018 (on the left) compared to the ranking for the same period, but created with latest possible data available at the time of writing (database snapshot was from November, 2018). The overall sum of updated or changed figures exceeds EUR 24.3 billion which accounts for over a 0.75% of overall intra-Community trade in goods for the period. And it causes unexpected changes within the ranking positions of several countries (Bulgaria gains seven positions while Sweden loses 5, and Poland or Latvia lose 4 positions in the ranking). Same holds true for ICA reported in Comext database. All this leads to a conclusion that a researcher cannot use provisional data on trade without serious consequences like changing a huge part of the ranking as database improves. On the other hand, it might be interesting to observe

how the data converge from a raw and incomplete state to their final and correct form. We could also examine whether the quality of data really grows in the process and asymmetries in mirror data vanish.

Unfortunately, comparing database figures stored at various points in time is not an easy task, since Eurostat does not disseminate versions of their database prior to updates. The only way to follow the whole process of reconciliation and convergence of the intra-Community trade database to its final form would be to download the whole of the Comext data affected after every update (nominally the updates are performed once a month) in a bulk, store it locally, and compare with previous snapshots on a regular basis. We plan performing such a task for individual years of 2017-2020 period in order to find a stable, global schema of such convergence if it only exists.

In conclusion, research on intra-Community trade raises specific problems. First of all, they concern the quality and reliability of the data. As indicated in the article, statistical data are burdened with various types of errors, which are the cause of discrepancies that are easy to identify. Due to the importance of the data in economic analysis, the quality of the data is constantly monitored by national statistical offices and the Eurostat, the statistical services are working every day in order to improve data on trade.

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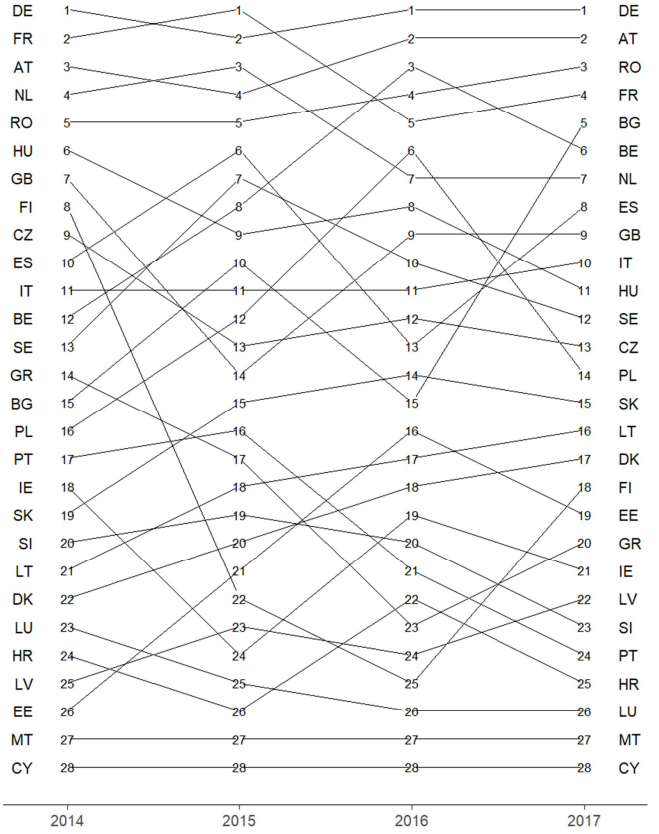
Annex

Table 1. Correlations between ICS and absolute asymmetries vs. correlations between ICS and index of mirror data quality over the period of 2014-2017

Year	Correlation between ICS and	
	absolute difference between ICA and ICS	aggregated index of data quality
2014	0,9680	-0,2886
2015	0,9662	-0,3193
2016	0,9598	-0,3295
2017	0,9684	-0,3742

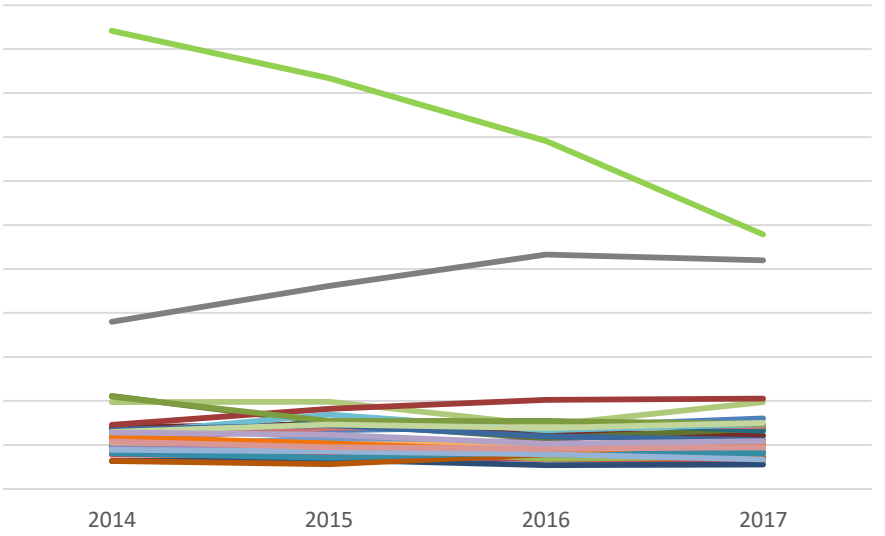
Source: own calculations.

Figure 1. Changing positions of EU member states in ranking according to ICS mirror data quality over the period of 2014-2017



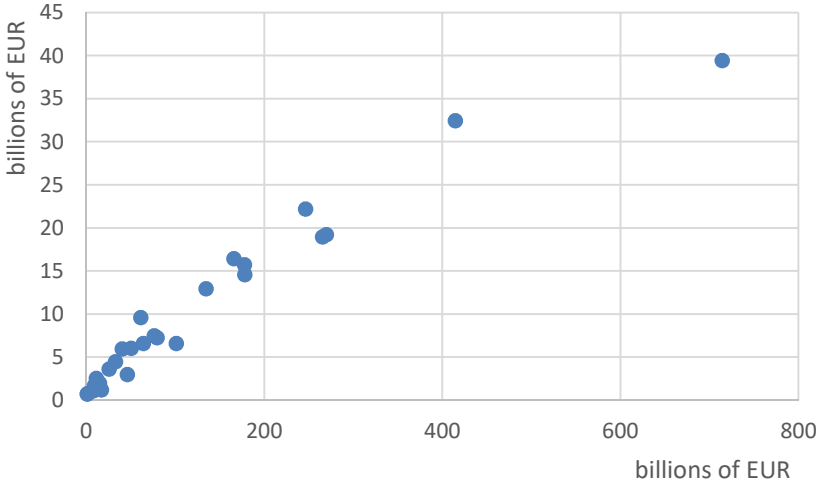
Source: own calculations.

Figure 2. Values of ICS mirror data quality index for EU countries over the period of 2014-2017



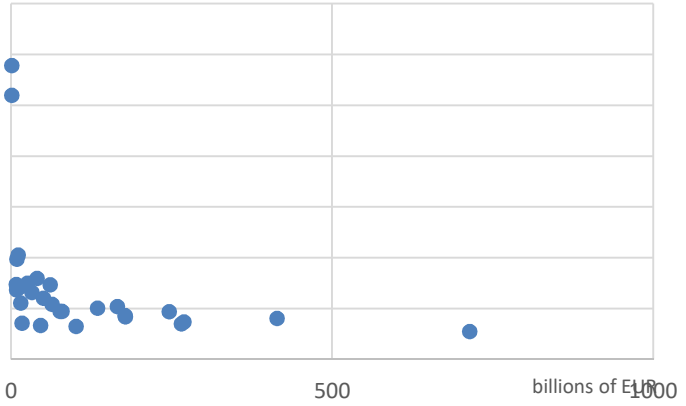
Source: own calculations.

Figure 3. Differences between EU countries' mirror data combined vs. ICS in 2017 (in EUR)



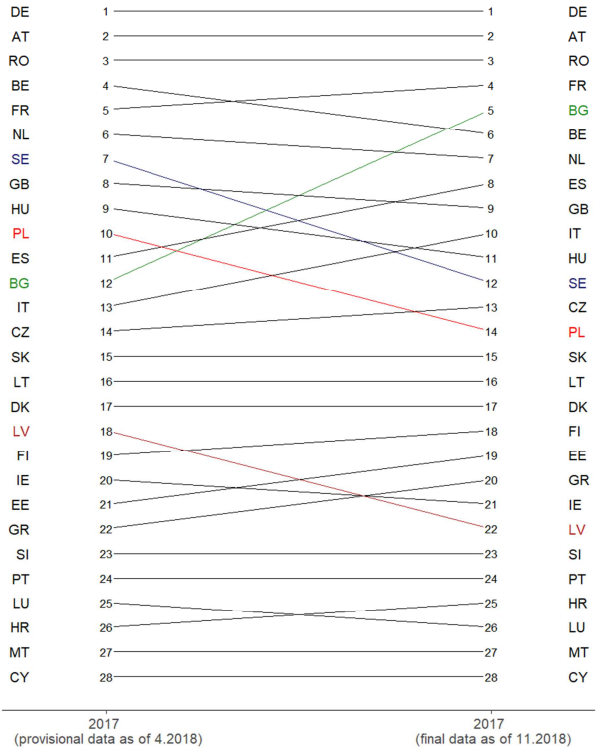
Source: own calculations.

Figure 4. Mirror data quality index vs. ICS in EU countries in 2017 (in EUR)



Source: own calculations.

Figure 5. Comparison of rankings of EU countries according to mirror data quality in 2017 calculated with data downloaded in April 2018 and in November 2018



Source: own calculations.

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Price transmission between sale and consumer milk price in the Slovak Republic

JEL Classification: *Q02; Q11; C51*

Keywords: *price transmission; milk; agri-food chain; sale price; consumer price*

Abstract

Research background: Milk is a general agricultural commodity and plays very important role in the nutrition of the population. Milk is distributed through stages of milk supply chain before it reaches the final consumer. All stages have significant impact on its price. Therefore, relations in the milk supply chain affects all subjects operated at the market.
Purpose of the article: Article is focused on the market of cow's milk in Slovakia in period January 2000 - December 2017. Main research aim is to evaluate price transmission between the sale and consumer milk price in the supply chain.

Methods: Using the Augmented Dickey-Fuller test and the cointegration test is verified the stationarity and cointegration of the time series of sale and consumer milk prices. The Error Correction Model (ECM) is applied to estimate the price transmission effect.
Findings & Value added: In period 2000 to 2017 was the average milk sales price in Slovakia 43.25 EUR/100kg and consumer price was 73.46 EUR/100kg. The "price scissors" between milk sale price and consumer price increased mostly during the first years of analysed period, contrariwise by the end of period had been decreasing. The difference between consumer and sale milk price was not constant during estimated period. The time series of sale and consumer milk prices are non-stationary and cointegrated. Based on statistical results we can state that change in the consumer milk price of examined month was affected by a change in the sale price of the examined month and also with one month before. Change of sale milk price during examined month had 13% impact on consumer milk price change which occurred in the same month. Change in the consumer price of milk by 17% in estimated month was transferred from change of milk sale price, which occurred one month before.

Introduction

Although milk plays very important role in the nutrition of the population, we are observing its constantly declining consumption in Slovakia. Milk is distributed through many subjects of milk supply chain before it reaches the final consumer. All articles have a significant impact on its price. Every change in the price of milk is transferred differently to the consumer. Therefore, it is needed to follow the price changes that occur along the supply chain of milk.

The Slovak milk market is affected by government interventions. The abolition of milk quotas negatively affected Slovak farmers, since currently their producer milk prices are higher than prices in other EU countries. Because of these fact Slovak dairy products will be replaced out of the market by cheaper imported products. Russia's attempts of reaching self-sufficiency meant restrictions on imports of milk from the whole EU. This has formed surpluses of milk on the EU market that have pressed milk prices down. The significant increase in butter prices is also linked with the Russian ban, but mainly with the market integration of America that has caused this increase (see Newton, 2016, pp. 57-71).

The gradual changes in the CAP in the EU have led to a greater focus on the dairy industry. As a result, the volatility of milk prices has increased significantly. Bergmann *et al.* (2016, pp. 1-23) proved that both volatility and prices are evidently transmitted between the world butter market and

the EU butter market. Shocks in the butter market are transmitted to palm oil volatility. Price changes of crude oil affect world butter prices and also global volatility in the butter market. Tadesse *et al.* (2014, pp. 117-128) also confirmed the interconnectedness of the food, energy and financial markets. Volatility of food prices is explainable due to changes in the financial and energy markets. As a result of crude oil price volatility, there is a stronger volatility of food prices and the more massive the financial speculations, the more extreme the price spike.

Weldesenbet (2013, pp. 512-524) studied producer, wholesale and retail prices on the Slovak liquid milk market. Using causality test he clarified that for the 1993-2010 horizon, producer milk prices cause changes in wholesale and retail prices. Bidirectional causality was verified between wholesale and retail prices of milk. The Slovak liquid milk market is characterized by asymmetric price transmission in both short and long term. The same results confirming the asymmetric (incomplete) price transmission in the milk market were also drawn by Serra & Goodwin (2003, pp. 1889-1899) on the Spanish market and by Szajner (2017, pp. 3-23) on the market in Poland.

Asymmetric price transmission is more frequent in practice than symmetric. It is also proved by a study of 282 products, including 120 agricultural and food products. The study proved, that the asymmetric price transmission occurs almost always, while symmetric is exceptional (see Meyer & Cramon-Taubadel, 2004, pp. 28-31).

Research methodology

The database of the applied research consists of time series of monthly price data, specifically:

- monthly sale price of milk in EUR/100kg and
- monthly consumer price of milk in EUR/100kg.

The data are obtained from the Agricultural Paying Agency of Slovakia and the Statistical Office of the Slovak Republic and are processed in the Gretl program.

The Error Correction Model (ECM) was applied. Model variables (price time series) have to be:

- non-stationary and at the same time integrated of order 1, I(1) and
- cointegrated.

First step is testing the stationarity of variables. The Augmented Dickey-Fuller test (ADF), called a unit root test, is used to test stationarity and to examine the presence of a unit root in a time series respectively to exam-

ine the order of time series integration. If there is a unit root in price time series, the time series are non-stationary. Each model variable is tested by the ADF test separately.

Model hypotheses for testing the stationarity of the ADF test:

H0: $\delta = 1$ time series has a unit root (i.e. non-stationary).

H1: $\delta < 1$ time series does not have a unit root (i.e. stationary).

The ADF test requires to specify the number of delays, the Akaike information criterion will be used for this purpose. The acceptance or rejection of the null hypothesis depends on the F test statistic, which is calculated for the model and compared to its table value.

The cointegration test is used to verify whether the two time series are cointegrated, i.e., whether they move together in time or not. If the variables are cointegrated, there exists a linear combination of these variables, that is stationary. Thus, this test is used to detect stationarity of linear combination of two examined variables. The linear combination of variables represents residuals from their regression (cointegration regression) which are tested by ADF test.

Cointegration test is applied to determine the relations between variables. When the short-term relationship between model variables is revealed, the long-term relationship is also examined. The long-term relationship allows to identify long-term balance of the observed price pairs. Cointegration shows the long-term balance, while there might be no short-term correlation between variables.

The pair of prices subjected to the cointegration test has the following form:

$$P_1 = \alpha + \beta P_2 + \varepsilon$$

$$\varepsilon = P_1 - \alpha - \beta P_2$$

Where: P1 - price time series of one level of food supply chain; P2 - price time series of another level of food supply chain

If the model variables are stationary and cointegrated, there is a long-term equilibrium relationship between them, it is possible to quantify all the necessary parameters which determine this relationship. The quantification is done by estimating the Error Correction Model (ECM). A great advantage of the ECM model is the combination of the short-term (first dif-

ference) and the long-term relationship (correction member) between the variables into one equation.

The ECM of price pair in the milk food vertical can be defined as follows:

$$\Delta p_t^{CPM} = \gamma + \theta\left(p_{t-1}^{CPM} - \beta p_{t-1}^{SPM}\right) + \delta \Delta p_t^{SPM} + \rho \Delta p_{t-1}^{CPM} + \varepsilon_t$$

Where: p_t^{CPM} - consumer price of milk in logarithmic form; p_t^{SPM}- sale price of milk in logarithmic form; p_{t-1}^{CPM} , p_{t-1}^{SPM} - lagged prices; Δ - first difference, $\Delta p = p_t - p_{t-1}$; γ , β , δ , θ , ρ - parameters estimated by model; ε_t - error term.

The equation coefficients can be interpreted as follows:

- β – when entering the logarithms of prices into model, this member is interpreted as the long-term elasticity of the consumer milk price in relation to the sale milk price. It is a cointegration coefficient that determines how many percent of change in price is transmitted over a long period from a certain higher level of food vertical to its lower level.
- θ – the error correction coefficient determines the deviation rate at which the deflected value of the consumer milk price returns to the long-term equilibrium relationship with the sale milk price.
- δ – the coefficient of short-term change gives the elasticity of the lower segment in the vertical (consumer) in relation to the price of the higher segment (processor) in the vertical in the short term. It represents the percentage adjustment of consumer milk prices after one percent (1%) of price shock in sale milk price.
- ρ – autoregression coefficient indicates how a change of the consumer milk price influences consumer milk prices in the next time periods.

Results

Milk has been known as an important part of our daily diet, across all nations, rich in proteins, but also in fat and sugars. Breast milk contains significantly bigger amount of these substances than the cow's milk. Milk contains vitamins D and K which are essential for bones, as well as iodine, vitamins A, B12, selenium, magnesium, potassium and many others. Milk can be obtained from various animal sources – not only from cows, but also from sheep and goats or lambs or even camels. Of course, the most consumed is the cow's milk, which is used for the production of butter, yoghurts, cheese and other dairy products.

Table 1 displays the overview of prices in December during the period 2000-2017 at the sale and consumer level. There are calculated differences between sale price and consumer price called as price scissors. These gaps expanded particularly in the early years of the examined period and on the contrary they were diminished at the end of the examined period. The difference between the sale and the consumer price of milk is certainly not constant over time (see Figure 1). The average year-on-year decline in the sale price of milk, calculated from the December data, is 0.35%, while consumer prices increased every year by 0.7% on average.

Calculated descriptive statistics of the price time series are displayed in Table 2. The average value of sale price of milk was 43.25 EUR per 100 kg in the period 2000-2017, while the average consumer price was higher – consumers paid on average 73.46 EUR per 100 kg of milk. The standard deviation is not too high, which means that individual price data are not too far from the average of our sample. Table 2 also shows values of kurtosis and skewness of price time series. The total number of observation of each variable is 216.

Before the application of ECM model, we displayed the development of time series graphically in order to support a presumption of the possible cointegration relationship of the considered prices, respectively to reject this presumption due to the different price trends development of time series is graphically displayed. Figure 2 graphically illustrates the logarithms of monthly price time series in analysed years. The development of prices is not similar and there are observed small differences in development. Based on this is neither possible to reject the potential cointegration relationship. Therefore, the ECM procedure is applied and interpret the conclusions.

Test of stationarity

In order to implement the ECM model of the sale and consumer price of milk, two conditions must be satisfied. According to the first condition the variable should be non-stationary and integrated of order 1. The assumption of non-stationarity is tested separately for each variable by the following ADF test. Similarly, the ADF test is also applied to the first price differences in order to see if they are integrated of order 1 – thus to find out whether just one difference is enough to make the model variables stationary.

Hypotheses formulated for the ADF test

Null hypothesis H0: $\delta = 1$ price time series has a unit root – it is non-stationary.

Alternative hypothesis H1: $\delta < 1$ price time series does not have a unit root – it is stationary.

Taking into account the ADF test values calculated for the sale and consumer price in a model with constant (see Table 3), null hypothesis assuming the presence of the unit root is accepted. Both prices are therefore non-stationary time series, i.e. they represent generated process of random walks. However, for their first differences, the alternative hypothesis assuming the absence of the unit root, which indicates stationarity, is accepted. The time series of the sale and consumer prices of milk are therefore non-stationary, and integrated of order 1 I(1), which means that the first condition is fulfilled.

Cointegration test

The cointegration test verifies whether price time series move together over time and copy their development, i.e. whether they are cointegrated. It is the basis for the second condition for variables entering the ECM model. Stationarity of cointegration regression residuals is tested using simple method of OLS.

$$l\_CPM = 3.3 + 0.27\ l\_SPM$$

where: l_CPM - consumer price of milk in logarithmic form; l_SPM - sale price of milk in logarithmic form.

The created regression model explains 22% of variation in the consumer price of milk through changes in the sale price of milk. Despite this, the model is highly relevant and appears to be suitable for the given dependence. Given the price logarithms, it can be argued that due to 1% increase in sale price of milk, the consumer price of milk increases by 0.27 %. The consumer price moves slower than the sale price of milk.

P-values of the cointegration regression in a model with constant (see Table 4) confirm the alternative hypothesis of the ADF test and reject the null hypothesis of the presence of the unit root. Therefore, the residuals are stationary, which means that the model variables (time series of the sales

and consumer prices) are cointegrated and have the same development over time.

ECM model

Since the time series of sale and consumer milk prices are non-stationary and cointegrated, the ECM model is created in the following form, which shows the short- and long-term relationship between prices:

$$\Delta l\_CPM_t = 0.13\Delta l\_SPM_t + 0.17\Delta l\_SPM_{t-1} - 0.04EC_{t-1}$$

The change in the consumer price of milk that occurred in the monitored month was affected by a change in the sale price in the previous month (t-1) and in the monitored month (t). The change in the sale price of milk with a delay of more than one month (t-2, t-3, ...) has no significant impact on the change in the consumer price of milk and is not passed on it. The change in sale price of milk in the monitored month had a 13% share of the change in the consumer price of milk that occurred in the same month. 17% of the change in the consumer price of milk in the monitored month was attributable to a change in the sale price of milk, which occurred with 1 month delay (t-1). At the same time, the error correction coefficient determining the rate at which the deflected value of the consumer price of milk returns to its original long-term equilibrium with the sale price of milk demonstrates that the consumer price of milk is adjusted each month by 4% in order to maintain a long-term equilibrium with the sale price of milk.

Conclusions

Milk is the general agricultural commodity and food of the population. Relations in the milk supply chain affects all subjects operated at the market.

The average value of sale price of milk was 43.25 EUR per 100 kg in the period 2000-2017, while the average consumer price was 73.46 EUR per 100 kg of milk. The difference between the sale and the consumer price of milk, called “price scissors” is certainly not constant over time. During the first years, difference increased mostly, contrariwise by the end of analysed period had been decreasing.

Based on the ADF test of stationarity we confirm that sale and consumer milk prices are non-stationary time series. Using the cointegration test we prove that residuals from co-regression are stationary, which means that the

time series of the sales and consumer milk prices are cointegrated and have the same development over time. Cointegration regression shows, that consumer price moves slower than the sale price of milk. A 1% increase in sale prices of milk causes a rise in the consumer price of milk by 0.27%. We have verified that there is a short-term and long-term relationship between the consumer and sale prices of milk in Slovakia. The change in sale price of milk in the monitored month had a 13% share of the change in the consumer price of milk in the same month and the change in the sale price of milk with a 1-month delay had a 17% share. Consumer price of milk is adjusted each month by 4% in order to maintain a long-term equilibrium with the sale price of milk

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Annex

Table 1. Sale and consumer price of milk (EUR/100kg) December 2000-2017

	Sale price	Consumer price	Price scissors
2000	50.22	67.81	17.59
2001	51.92	71.53	19.62
2002	48.80	73.62	24.83
2003	49.33	76.92	27.59
2004	44.00	81.11	37.11
2005	41.91	75.12	33.20
2006	43.63	73.86	30.23
2007	52.36	83.88	31.52
2008	44.09	74.69	30.60
2009	36.26	63.60	27.34
2010	37.59	70.10	32.51
2011	41.78	75.20	33.42
2012	42.36	75.10	32.74
2013	48.79	81.70	32.91
2014	40.90	79.80	38.90
2015	35.55	74.70	39.15
2016	40.52	68.00	27.48
2017	42.36	72.40	30.04

Source: Agricultural Paying Agency, Statistical office of the Slovak Republic (2018).

Table 2. Descriptive statistics of sale and consumer milk prices (EUR/100kg) January 2000 - December 2017

	Sale price	*Consumer price*
Mean	43.25	73.46
Standard Error	0.39	0.38
Median	43.56	73.78
Mode	51.22	67.20
Standard Deviation	5.71	5.51
Sample Variance	32.62	30.39
Kurtosis	-0.31	-0.29
Skewness	-0.30	-0.33
Range	28.12	26.17

Source: own processing.

Table 3. Results of ADF test for sale and consumer price of milk

Logarithmic of variable	Type of model	Lag	P-value of variable	Lag	P-value of first difference	Alfa
sale price	with constant	8	0.0656	6	1.37E-13	0.05
	with constant and trend	8	0.0383	6	4.81E-13	0.05
consumer price	with constant	2	0.0777	4	4.17E-08	0.05
	with constant and trend	2	0.2366	4	4.01E-07	0.05

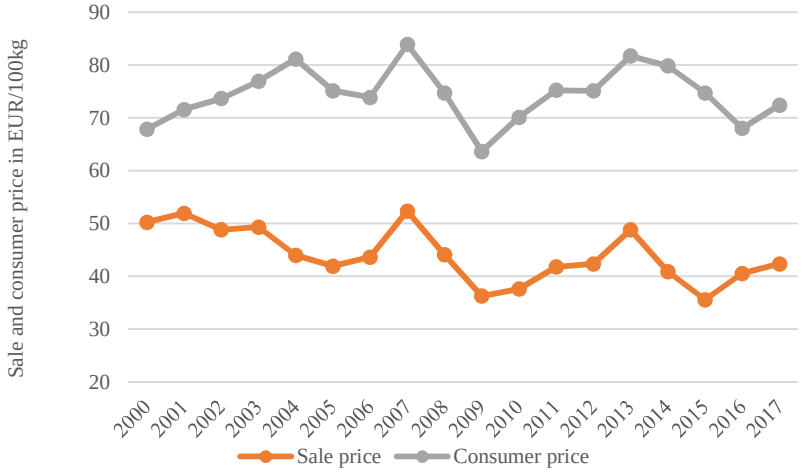
Source: own calculations.

Table 4. Results of ADF test for residuals

Variable	Type of model	Lag	P-value of variable	alfa
residuals	with constant	12	0.0076	0.05
	with constant and trend	12	0.0352	0.05

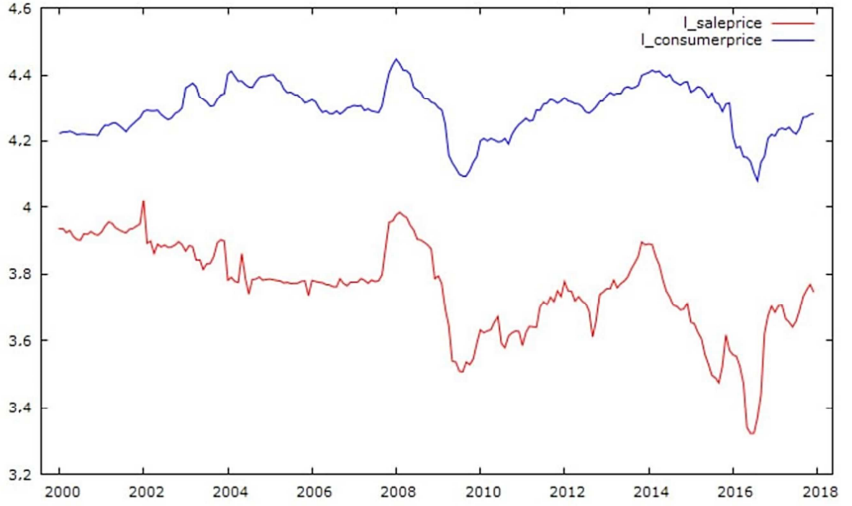
Source: own calculations.

Figure 1. Sale and consumer price of milk (EUR/100kg) December 2000-2017



Source: own processing.

Figure 2. Logarithmic of time seiries of sale and consumer milk price January 2000 - December 2017



Source: own processing in Gretl.

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Application of multivariate comparative analysis for the evaluation of special economic zones in Poland

JEL Classification: *R11; R58*

Keywords: *entrepreneurial region, multivariate comparative analysis, regional development, special economic zones*

Abstract

Research background: The considerations defined in the article concern the issues of the functioning of special economic zones (SEZ) in Poland, recognized through the prism of the most important indicators concerning the economic activity of the zones, and also showing the potential of these zones – by recognizing their advantages or their distance from other zones, from the point of view of criteria of functioning of privileged zones together forming a group.
Purpose of the article: The aim of this article is to present one of the methods of multidimensional comparative analysis, to recognize the diversification of functioning of fourteen SEZ in Poland, in a time-space system.
Methods: The test method used in the examination, was the analysis of secondary data, so-called desk-research. In this case, the main source of numerical data were reports including operational and financial results, concerning the effects of functioning of SEZ. In order to assert the comparability of results from particular years, the examination procedure covered the years 2009-2017. A model of development determination method was used.
Findings & Value added: Based on the performed examination, a positioning of described privileged zones in each examination period was performed. Then, further research has been done, in order to designate the factors favoring and limiting the activities favoring the creation of entrepreneurship of economic entities functioning in Polish economic zones.

Introduction

The change in political situation after the year 1989 caused substantial changes in the polish law system which resulted in changes in the functioning of the economy. These changes induced serious consequences for the whole country and lockal environments. During the last twenty years there has been an important change of the polish economy model. SEZ deserve an attention in this area. In 1994 - 14 SEZ were established in the least-developed regions in Poland. They are an example of the dynamic development of private business entities and the restructuring of public enterprises (Ambroziak & Hartwell, 2018, p.1322). Since the creation of SEZ in Poland, their rapid development has taken place (Hajduga *et al*., 2018, pp. 84-85). As a result, the zone has become an important tool for stimulating the country's economic development. In these zones good conditions for functioning of enterprises and investment placement were created (Ambroziak, 2016, p. 248). SEZ are the popular kind of help to enterprises all over the world because they are assigned a general goal related to generating economic benefits and accelerating the economic development of the regions (see: Rustidja *et al*., 2017, pp. 138-139). SEZ are conception of regional development and enterprises and institutions working with them.

The considerations defined in the article concern the issues of the functioning of SEZ in Poland, recognized through the prism of the most important indicators concerning the economic activity of the zones, and also showing the potential of these zones – by recognizing their advantages or their distance from other zones, from the point of view of criteria of functioning of privileged zones together forming a group. For this purpose, the multidimensional comparative analysis method was used: the development pattern method.

Research methodology

The most popular tool which is used to group and data classificate in economic research is numerical taxonomy (Suchecki, 2010). The taxonomy is the field of multidimensional analysis that deals with the principles and rules of the classification of multi-feature objects (Heffner, Gibas, 2007). In the calculation one of the numerical taxonomy methid was used, the Hellwing's method of development pattern. The introduction to the proper analysis in the methods of multivariate comparative analysis is the selection of a set of possible to use variables describing the subject of the study, the so-called potential variables. In connection with the above, a choice of

eight traits was made. These traits were given the numbers from 1 to 8. All of the traits are stimulants (the higher a value is the more beneficial a position is, that is SEZ), which means that an increase in the value of the explanatory variable leads to an increase in the value of the explained variable (see Table 1). These variables are present in all of the spheres studied and they characterise by high spatial diversity. These indicators characterise the demographic, social, economic and infrastructural potential of of the privileged zones studied. A vector is examined: $X = [x_1\ x_2\ x_3\ x_4\ x_5\ x_6\ x_7\ x_8]$, where: X – a representative of a single object, $x_1x_2x_3x_4x_5x_6x_7x_8$ – values of the examined features.

A process of determining the development pattern consisted of three stages. In the first stage the abstract observation was made, the so-called taxonomic character development pattern z_{oj} representing the best (maximum) values for each variable. Standardized variables were used to determine the so-called development pattern z_0, which was a vector with coordinates $z_{01}\ z_{02}$ ... z_{0j} ... z_{om}. In the second stage the similarity of the observations to the abstract, best observation was checked by calculating the euclidean distance of each from the development pattern. Based on standardized variables for each spheres the distance of individual zones from the development pattern was determined. A collected data led to calculate the mutual distances d_{ij} (i,j=1,…,14) between fourteen SEZ due to the eight characteristics studied. For assurance the equal impact of every of the traits (variables) z_1, z_2, z_3, z_4, z_5, z_6, z_7, z_8 on the value of the distance was standardized for each feature. The more the object is similar to the pattern, i.e. less distant from it, the higher the level of the complex phenomenon for this object. The third- the last stage- was setting for each taxonomic object the measure of development normalized within the range [0,1]. The synthetic variable proposed for this method by Hellwig is:

$$m_i = 1 - \frac{d_{i0}}{d0}$$

where:
m_i – measure of development for i- of that object,
d_0 – is the Euclidean distance of the object from the reference object.

Assignation of a taxonomic measure of development allowed to hierarchization of examined multi-feature objects as well as their grouping. Such constructed measure helped to assess the level of entrepreneurship development in the set of SEZ subjects. The data analized came from

raports Information on the implementation of the Act on SEZ published on the website of the Ministry of Enterprise and Technology.

The first analized variable was a number of valid permissions for business activity in SEZ. The number of business permits issued in all zones amounted to 349 in 2017 and increased as compared to 2016 as much as 34.6%. The total number of permits issued from the beginning of the zones until the end of 2017 amounted to 4 036.

The second analyzed variable necessary to estimate the economy activity SEZ is size and diversity of investments made by entrepreneurs who run their own businesses on SEZ area. From the appointment of the first SEZ till the end of 2017 investors who led activities on the basis of valid permits incurred investment outlays worth more than 106.6 mln zlotych, which in comparison to 2016 decreased by almost 5.7 mln (ie by 5%).

The next very important determinant is the level of employment achieved in the areas of the zones. When establishing the SEZ, it was assumed that 160,000 new jobs will be created in the zones. The predicted number was achieved in 2007. Buffering of structural unemployment by creating new jobs was the basis for establishing the following zones: Kamienna Góra, Kostrzyn-Słubice, Łódź, Mielec, Słupsk, Starachowice, Suwałki, Tczew, Wałbrzych, Warmia i Mazury and Żarnowiec.

Nextly, the analysys was subjected to achived effectcs calculated on the total expanse of zones in hectares. The effectiveness of activities of zone managers has an impact on development of the investment area that the zone has (Pastusiak, 2011, p. 204). SEZ and its activity range 181 cities and 305 boroughs. The number of boroughs where privileged areas are established systematically grows. Their total area is over 22 thousand hectares. According to a law a joint area of functioning can't exceed 25 thousand hectares.

Another analyzed variable were costs of infrastructure building in million zlotych. According to the article 8, the law of SEZ the tasks of the manager include conducting activities aimed at developing business activity in the zone. The main activities of managers are building infrastructure and promoting zones. The entire costs of infrastructure building on privileged area from the beginning of zone's existence till the end of 2017 were more than 4,6 billion zlotych.

Same as in case of costs of infrastructure building, the costs of zones promotion are the priority tasks assigned to zone management companies. The biggest costs on this goal were allowed zones: Kostrzyńsko- Słubicka, Łódzka and Katowicka. Inclusively, in 2017, management companies spent 7,07 million zlotych on zones promotion. From the beginning of zones

functioning, the biggest costs were spent by Kostrzyńsko- Słubicka zone-15, 28 million zlotych in total.

The next very important SEZ result criterion is the financial result of companies managing zones in a given year in thousand zlotych. Companies managing SEZ are business entities that base their activities on the provisions of the Code of Commercial Companies, the law of income tax on legal body and the act on the freedom of economic activity. The main income's source for management companies are incomes from sales of land, fees for the administration and management of the zone, paid by entrepreneurs operating within the zone.

Attracting a large number of investors is reflected in the financial results of the zone management companies. 2016 and 2017 were the years in which all SEZ management companies achieved a positive financial result. The highest profit was achieved by Kostrzyńsko-Słubicka SEZ S.A. (22.9 million zlotych), then a management company of Tarnobrzeg zone, ie Agencja Rozwoju Przemysłu in Warsaw S.A. Branch in Tarnobrzeg (18.2 million zlotych), as well as Katowice SEZ S.A. (17.6 million zlotych).

The last analyzes variable was the size of tax exemptions for companies managing zones in a given year in million zlotych. The main incentive which wncourages to investment placement within the zones are different kinds of tax preferences due to every domestic and foreign entrepreneur and which are public. The size of given aid in shape of an income tax exemption is limited by the amount of costs eligible for aid and the maximum intensity of regional public aid calculated for a given area. It depends on the size of the company (for an average the size of an aid is 10% more, for a small and micro entrepreneurs the aid raises to 20%). However, it doesn't apply to micro, small and medium-sized companies operating in the transport sector.

Results

In the further part of a given research for fourteen SEZ a calculation of distance values of each tested zone from the determined pattern of development and ordering of objects in the order from the best to the worst in the analyzed years was made.

In 2009 an undisputed leader was Katowicka SEZ. From eight of examined traits, five are exemplary values, i.e. the most advantageous ones. Analyzing three remaining traits (total area of the zone, financial result and tax exemptions of companies managing zones) for every analyzed areas the results reached above average. After Katowicka SEZ there is Wałbrzyska

zone because of the total zone area corresponding to the pattern of development.

Year 2010 brought the change of a SEZ's leader. From the second position in 2009 to the first possition raised Wałbrzyska zone and reached the value of expenditures for the construction of infrastructure, corresponding to the pattern of development. In Wałbrzyska zone in 2010 18 valid permits were issued for running a business (in Katowice zone half less). In comparison to 2009 management companies achieved the highest financial result in terms of value (16 776 thousand zlotych). It's high possition is affected by very high tax exemption rate, similar to the development pattern. In 2010, Katowice SEZ occupied the second position, despite achieving in five studied characteristics the value corresponding to the development model.

Year 2011 brought a change on the leader. Katowicka SEZ again took the first position and achieved the values of the developmental pattern for the five variables examined. In 2011 the most workplaces were created - 5068 and investments costs increased by 1285 million zlotych. The second position went to Wałbrzyska SEZ. The fall of this zone on a lower position was caused by the lower financial result of the zone management companies compared to 2010 (by 1413,29 thousand zlotych) and tax exemptions by 2.33 million zlotych. Łódź SEZ collapsed from fourth to third position.

2012 was a successful period for Wałbrzyska SEZ which intercepted the first position and three of examined traits reached the standard values. On the second position fell Katowicka SEZ, four examined traits assumed the standard values, but the least expenditures for infrastructure construction were incurred (10 million zlotych) and the lowest tax exemption rate among the best zones (Wałbrzyska, Łódzka, Tarnobrzeg) was obtained, compared to 2011. The third position, same as in 2011 went for Łódzka SEZ.

The year 2013 consolidates the advantage of Wałbrzych zone over Katowice zone which still had a leading position. On the third position was Łódzka zone, Mielecka zone promoted on fourth position. In 2013 the total area of the zone increased only on 14,14 hectare in Łódzka zone but in zones: Wałbrzyska, Katowicka and Tarnobrzeska remained on the level from 2012.

In 2014 an undisputed leader was Katowicka SEZ. From the second position in 2013 it advanced into the first position. From eight of examined traits, six are the best or most favorable values. After Katowicka SEZ on the secon position Łódzka zone promoted, the third position was occupied by Tarnobrzeska zone. Wałbrzyska zone decreased on the fourth position. A

significal increase (of 72%) of amount of entrepreneurs granted business permits proves that. As in the previous years, the most permits were held by entrepreneurs in the following zones: Katowice, then Wałbrzyska, Mielecka, Łódzka and Tarnobrzeska.

In 2015 on a leader position was still Katowicka zone, on a second position advanced- from the fourth position in 2014 - Wałbrzyska zone. While Łódzka zone dropped from the second to third position. Katowice SEZ generated the highest profit - 172.2 million zlotych, and SEZ in Łódź took third position, earning a profit of 5.2 million zlotych.

In 2016 the Katowice SEZ remained the leader for the third time. From eight of examined traits, three are the best or most favorable values. The second position went again to Wałbrzyska SEZ reaching as many as four are the best or most favorable values. From the fourth in 2015, the Tarnobrzeg zone was promoted to the third place.

In 2017, the Katowice SEZ remain the leaders, which for the fourth consecutive year ranks first, followed by the third year in Wałbrzyska SEZ, and the third place was promoted by the Kostrzyńsko- Słubicka SEZ. The last place belongs to the Starachowice Zone - 13th place and the Kamiennogórska Zone - the last place. All the features studied have reached the reference values, i.e. the most favorable in the zones occupying the first three places.

Conclusions

Methods of multivariate comparative analysis which lead to consult many aspects of development at the same time can be a helpful tool for the local government authorities assessing the accuracy of decisions taken in the past and the effectiveness of the region's management instruments used in the past. An important advantage of a development pattern method is that it can be used directly to evaluate several or more than a dozen statistical units. The same patterns and normative factors are introduced. Distances are counted from the same point, and then they are reduced to the same scale. A reference object changes dynamically together with a change of values of individual variables in given years, which should be read as the value of the meter. It allows the inclusionof changes in the field of macro and microeconomic factors and their impact on companies' situation in individual years of analysis. The conclusion od the presented considerations is that the economy is a pillar of the economy development. A regional development is a process of possitive changes embracives

quantitative, qualitative and structural growth. The economic and social aspects of this process are important.

The regional development means systematic activities of the local community, authorities and other entities operating in a given region, aimed at creating favorable conditions for local entrepreneurship. A goal which a regional development aims that is competition and an innovative economy is the most reasonable one. A concept of a local development is concentrated on stimulating entrepreneurship, which has a positive impact on regional development. The creation of new business entities in the areas of SEZ brings demand for investment goods, and the creation of new jobs - for consumer goods. It is then very important if entrepreneurs and local authorities create a climate which aids the entrepreneurship because it bias the regional development and the interaction between entrepreneurs and local authorities is a feedback and bi-directional. As it appears from researches, SEZ accomplishes a role of an entrepreneurial region. But it should be remembered that the lack of certainty concerning the future of SEZs in Poland can stop the inflow of new investments, thus reducing the positive impacts of SEZ.

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Annex

Table 1. Variables describing the subject of the study

Variable	Characteristics of variables
x^1	A number of valid permits to conduct business activity in SEZ (cumulatively).
x^2	Incurred investment outlays in PLN million (cumulative).
x^3	Created jobs in special economic zones (total).
x^4	Total area of the zone (in hectares).
x^5	Expenditures for infrastructure construction in milion zlotych(cumulative).
x^6	Financial result of companies managing zones in a given year in thousands of PLN.
x^7	Expenditures of management companies for the promotion of zones in million złotych (cumulative).
x^8	Tax exemptions for companies managing zones in a given year in million złotych.

Source: own elaboration.

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European central banks' transparency and effectiveness. Are they similar?

JEL Classification: *E52; E58*

Keywords: *central bank transparency; forward-looking communication; coefficients of similarity*

Abstract

Research background: The previous studies on monetary policy transparency suggest that the dependence of the degree of transparency and monetary policy effectiveness exists. In this examination we tackle this issue for the most recent sample with the application of novel transparency measure which is designed to cover forward-looking policy approach.
Purpose of the article: We aim at evaluating forward-looking transparency of the European central banks and juxtapose it with their effectiveness in achieving monetary policy goals: price stability and output stabilization. We also search for the patters of similarity in our sample.
Methods: We apply a novel, index-based transparency measure to assess central banks' transparency. We also estimate inflation gap and the output gap. The methods used are based on data and statistical analysis. The comparison of the behaviour of individual central banks is carried out for the variables measuring transparency and inflation and output gaps. The similarity of the performance of individual central banks is assessed with the use of measures of the distance between objects, including our own measure.

Findings & Value added: Our results suggest the existence of different degree of similarity in the sample, but some common tendencies can be found as well. For example, central banks with comparable transparency degree are found more similar. Novelty of the examination is related to our methodology: transparency and similarity measures applied and the most recent time span covered.

Introduction

We aim at evaluating forward-looking transparency of the European central banks (CBs) and juxtaposing it with their effectiveness in achieving monetary policy goals: price stability and output stabilization. The study covers two developed economies: Sweden and the UK and four Central and Eastern European (CEE) countries: the Czech Republic, Hungary, Poland, and Romania. The sample covers late nineties – mid-2018. The starting point of the sample differs across the countries as they launched forward-looking communication at different moments.

Our research methodology covers a novel index-based assessment of the degree of central bank transparency. Our index extends and updates transparency measure elaborated at the beginning of 21st century. It focuses on forward-looking context of communication. Secondly, we examine the achievement of monetary policy goals: inflation and output gap stabilization. Thirdly, we compare the performance of the central banks by assessing similarities between them.

Literature review

Monetary policy transparency is commonly defined as an extent of information revealed by the central bank to the public (Geraats, 2002, p. F533). This is the simplest approach, however, it offers the opportunity to operationalize easily qualitative concept of transparency. Once we aim at evaluating a forward-looking transparency of six CBs and discuss their effectiveness having in mind their transparency, we need to proxy the degree of transparency. The index of transparency which is well recognized by monetary policy researchers was presented by Eijffinger and Geraats (2006). This index was compiled at the beginning of the ongoing century. It is out-of-date: the majority of IT central banks has already reached a maximum score. Moreover, the central banks' transparency has evolved: central banks put an effort to clearly communicate their intentions. The notable increase

in openness of macroeconomic prospects and the recent advance of forward policy guidance are a fact nowadays (Geraats, 2014b, p. 22). Post-crisis discussion on transparency and communication analyses mostly forward guidance (FG).

A literature review study by Blinder, Ehrmann, Fratzscher, De Haan, & Jansen (2008, p. 940) concluded that communication has the ability to help achieve central banks' macroeconomic objectives. More recent studies reconfirm this conclusion on theoretical or empirical basis (Siklos, 2011, Dincer & Eichengreen, 2014, Geraats, 2014a, 2014b). The majority of studies suggests that the dependence of central bank transparency and macro variables exists. This is why we expect to find such a relationship for our sample as well. We also need to mention that previous research of theoretical and empirical nature remains cautious while interpreting the dependence in terms of causality.

Research methodology

The sample covers: Sweden - Sveriges Riksbank (SR) (1997Q4-2018Q2), the UK - Bank of England (BoE) (1998Q1-2018Q2), the Czech Republic - Czech National Bank (CNB) (2001Q2-2018Q2), Hungary - National Bank of Hungary (NBH) (2001Q3-2018Q2), Poland - National Bank of Poland (NBP) (2004Q3-2018Q2), Romania - National Bank of Romania (NBR) (2005Q3-2018Q2). Starting points differ as the CBs launched more future-oriented communication at different moments. We apply a research procedure that incorporates:

(1) An approximation of central banks forward-looking transparency by means of a novel index.
(2) Calculation of the inflation gaps and the output gaps.
(3) Cross-country similarity analysis of the transparency and central banks' goals realization.

Appendix 1 provides a rules of points attribution for our forward-looking transparency (FRT) index. It covers only publication of the information that is related to economic outlook. The index proxies the degree of forward-looking transparency as it incorporates the way how the forecast is communicated, assesses orientation for the future of CBs post-decisions announcements and includes the most recent tool of forward-looking communication – forward guidance. FRT index is calculated for each central bank separately. Due to the frequency of forecast publication we used a

quarterly frequency of data. The values of the index vary from 0 to 10.

The second step of the research procedure covers examination of the inflation gap and the output gap. To derive inflation gap defined as the deviation of inflation from targeted level, we confront inflation figures published by national statistical offices with central bank's inflation target. Output gap is calculated as deviation of smoothed GDP from the trend value (in percentage terms). Trend was estimated by Hodrick-Prescott filter. GDP at constant prices, seasonally adjusted, is derived from Eurostat database, then smoothed by 5-period moving average.

Finally, we provide measures of similarity. Three variables are used in our examination: FRT index value, inflation gap, and output gap. The former one is measured on a ratio scale, whereas the latter two ones are expressed on an interval scale. In such a case, to normalize the variables and calculate distances it is necessary to exclude the methods which are proper only in the case of a ratio scale.

From a variety of measures of similarity described by Walesiak (2016), we choose two methods of normalizing the variables (standardization and normalization to the [-1;1] range) and one method of calculating the distances between the objects. The adopted methods are not the first-best option to estimate the similarity as the calculated distances are not constrained and range between 0 and infinity. In such a case while 0 means no distance (full similarity), it is much more difficult to conclude in terms of dissimilarity (whether the highest distance means full dissimilarity or not). That is why we propose an alternative measure, developed by us, which in our opinion is better to macroeconomic purposes. It is more robust to outliers. Moreover, after a given critical distance, full dissimilarity is assigned regardless of the distance between the objects.

Let x_1 be the FRT index, x_2 - the output gap, and x_3 - the inflation gap. Let $n1_m$ and $n2_m$ be the normalized values of the variable x_m (m = 1, 2, 3). We use two commonly used methods of normalizing the values: standardization ($n1$) and normalization to the [-1;1] range ($n2$). In such a case:

$$n1_{mit} = \frac{x_{mit} - \overline{x_{mt}}}{\text{st. dev.}\,(x_{mt})}; \quad n2_{mit} = \frac{x_{mit} - \overline{x_{mt}}}{\max_i |x_{mit} - \overline{x_{mt}}|}$$

where *i* indicates the country (*i* = 1,…,6), *t* is time (*t* = 2005Q3, …, 2017Q4)[1], a bar over a variable means an average value, and st.dev. is the standard deviation. On the basis of the normalized variables, the distances (*d*1 and *d*2) between countries *k* and *l* in the period *t* are calculated according to the Euclidean algorithm given by the following formula:

$$dx_{klt} = \sqrt{\sum_{m=1}^{3}(nx_{mlt} - nx_{mkt})^2}$$

where *x* = 1,2 indicates the method of normalization. The distances *d*1 and *d*2 range from 0 to infinity, although the normalized variable *n*2 is between -1 and +1.

Distances are transformed into similarity coefficients according to the following authors' algorithm. We evaluate similarity coefficients ranging from 0 to 100 where the value of 100 indicates full similarity (no distance) while the value of 0 refers to full dissimilarity (large distance). To transform distances into similarity coefficients, we assume that the highest distance between any two countries in a given quarter is linked with full dissimilarity and the value 0 is given. A zero-distance is linked with full similarity and the value 100 is assigned. The similarity coefficients for the other distances are calculated proportionally. In the other words, similarity coefficients *cs*1 and *cs*2 for any pair of countries *k* and *l*, calculated on the basis of the distances *d*1 and *d*2, are obtained according to the following formula:

$$csx_{klt} = \left(1 - \frac{dx_{klt}}{\max\limits_{ij, i \neq j}\{dx_{ijt}\}}\right) \times 100$$

where *i*,*j* = 1,…,6 indicate the country.

Similarity coefficients *cs*1 and *cs*2 have a few disadvantages. First of all, they are highly influenced by outliers. Secondly, in any compared group the most distant country is interpreted as completely dissimilar (the coefficient is zero), although from the economic point of view it need not be so.

We have developed our own formula of the similarity coefficient, denoted as *cs*3. The scale is the same: from 0 (no similarity) to 100 (full simi-

[1] To achieve comparable results, similarity coefficients are calculated for the shorter period for which all the time series are available for all the countries.

larity). The value of 100 is assigned if a given variable is the same in the two compared countries. The value of 0 is ascribed if a given variable in one country exceeds by three standard deviations or more the value of the same variable in another country, regardless of the direction (standard deviation is calculated for a given variable for a given quarter inside the whole group of the analysed countries). If the difference between the two countries is less than 3 standard deviations, the coefficient is calculated proportionally. In the other words, for each variable *m* (*m* = 1,…,3), we have:

$$cs3_{mklt} = \begin{cases} \left(1 - \frac{|x_{mkt} - x_{mlt}|}{3 \times \text{st. dev.}(x_{mt})}\right) \times 100 & if\ |x_{mkt} - x_{mlt}| < 3 \times \text{st. dev.}(x_{mt}) \\ 0 & \text{otherwise} \end{cases}$$

The aggregated similarity coefficient *cs*3 to measure central banks' performance is the arithmetic average of the coefficients calculated for the individual variables.

Results

We observe an increase of forward-looking transparency in our sample (Figure 1). Over-time evolution towards greater openness was expected and is in line with central bank practice.

Index value evolution is related to the general tendency towards more explicit intention signalling. It is also partially linked to the recent crisis arrival and consequences for monetary policy conduct: communication aimed directly at shaping expectations gained a new role in central bank's toolkit. Steps backward in the degree of transparency are also observed in our sample. In some cases they result from natural decision of the policy maker to reveal less or less frequently. In some other cases forward guidance was abandoned (the Czech Republic, Poland, the UK).

Due to the limited length of the paper we do not discuss the evolution of inflation gap and output gap in our sample. The most important part of the examination refers to cross-country analysis of similarities.

Table 2 shows the whole period average values of the similarity coefficients calculated according to three methods. The ranking of the most similar countries is comparable for both the *cs*1 and *cs*2 coefficients as well as the *cs*3 coefficient. However, their values differ. Our formula (*cs*3) gives

higher levels of similarity because it is free from some weaknesses of the remaining coefficients, discussed above.

It turns out that, on the average basis, the performance of the CEE central banks is relatively similar to that of the Western European central banks. The CNB was closest to the SR (1st rank) and the BoE (2nd rank). This outcome is confirmed by all the three similarity coefficients.

The fluctuations of the similarity coefficients in the 2005Q3-2017Q4 period occured. It turns out that the degree of similarity of the countries highly fluctuates. This outcome is economically justified. Changes in inflation and output gaps are driven by many factors, not only by the central banks' actions. The target of monetary policy aiming at minimizing inflation and output gaps is supported or outweighed by country-specific fluctuations of the other macroeconomic variables. Hence, the similarity of the central banks' performance of any pair of countries reveals large changes throughout our research horizon.

These results can be interpreted as the convergence in central banks' behaviour between the new and old EU member states. The catching-up process between the Central-Eastern and Western Europe has been confirmed in the economic literature in many areas, including narrowing income gap, synchronizing business cycles, equalizing price levels, unifying institutional environment (Próchniak & Witkowski, 2016). These results indicate another area of convergence – namely, the convergence in central banks' performance.

On the average basis, the degree of transparency of the central banks and their efficiency in terms of inflation gap and output gap minimization in the four new EU member states were quite akin to Sweden and the UK, that is the two Western European countries. These outcomes suggest that convergence between Central-Eastern and Western Europe was much broader and took place even in the behaviour and efficiency of the central banks' performance.

Moreover, our ranging of similarities resembles the ranking of central bank's forward-looking transparency: the CNB and SR are the most transparent entities in our sample and they converge more, on average, than remaining central banks.

The results are not much stable over time. High fluctuations in the similarity coefficients are due to the fact that the involved variables depend on many factors and it is quite difficult to find a lot of regularities between the countries. However, our method indicates that some common characteristics in central banks' performance can be found. The adopted method al-

lows us to quantify the similarities, which improves the justification of the findings.

Conclusions

In this paper we aimed at investigating CBs' transparency and their dependence with monetary policy goals' achievement. Our sample covered six economies. Firstly, we presented our index of forward-looking transparency. Secondly, we calculated inflation and output gaps. The most relevant part of the examination covered similarity analysis, that included the application of our own measure overcoming drawbacks of standard similarity coefficients. The results suggest that transparency matters for goals achievement as some clustering of economies with similar degree of transparency was captured. We are also entitled to conclude on convergence of the economies that we analyse.

The contribution of our examination consists in the application of updated transparency index and a novel similarity measure. Except methodological innovations, we delivered the results for the most recent sample. We see the room for further research as the question on the dependence of transparency and CBs' goals achievement is not fully answered either in this study or in literature. The simplest extension of this examination could provide the results for subsamples or other IT central banks. The application of model-based assessments of causality could be the next towards more conclusive results. However, the data set that we have at our disposal and complexity of economic relationships both imply a very cautious interpretation of the results even in the cases of causality examination.

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Annex

Table 1. Forward-looking transparency index coverage

Question:	**Points attribution:**
Do the CB explain how it forecasts macroeconomic variables?	1: for revealing forecasting principles including model 0.5: for general description of forecasting tools 0: description not published
How often is the CB's forecasts revealed?	1: at least quarterly 0.5: biannual publication or 2 publication per year 0: less frequent publication
How is the forecasted central path for inflation published?	2: numerically for the entire monetary policy horizon 1: fixed-event publication only (usually at the end of subsequent years) 0: not published
Does the CB reveal the forecast of a real sphere variable?	1: published analogously to the way how the central path of inflation is revealed 0.5: when a real sphere variable is rather an inflation driver 0: no information regarding future development of the real sphere is revealed.
Is the policy path revealed?	2: numerically expressed (including a fan chart) policy path for the entire monetary policy horizon 1: only the description of the nearest rates movement 0: the path is not presented
Are the CB's announcements forward-looking?	1: yes, the description of forward-looking factors prevails 0.5: there is an explicit reference to forecasts but it does not dominate post-decision announcement 0: in case of no reference to economic outlook
Is a forward guidance used as communication tool?	2: a fixed-date or conditional forward guidance 1: qualitative FG or Delphic FG 0: no FG announcements

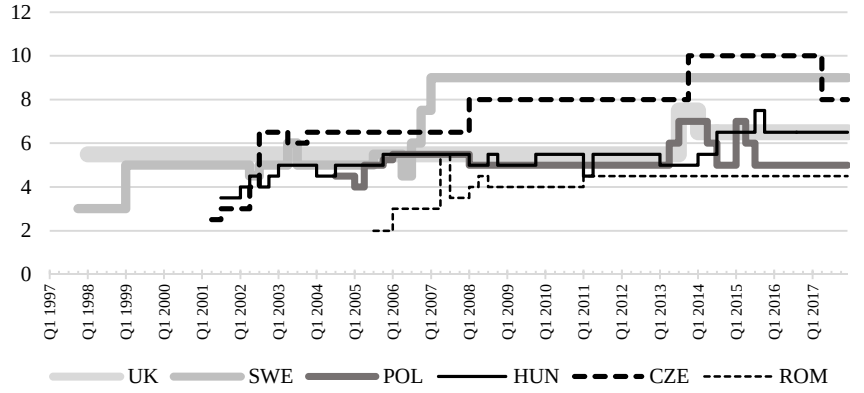
Note: CB- central bank.
Source: own elaboration.

Table 2. Average coefficients of similarity for each pair of countries, 2005Q3-2017Q4

	CZ	HU	PL	RO	SE	UK
Coefficient of similarity *cs*1						
CZ	100.0	37.6	35.6	19.6	64.1	46.0
HU	37.6	100.0	48.4	35.2	35.5	55.4
PL	35.6	48.4	100.0	38.0	33.6	49.2
RO	19.6	35.2	38.0	100.0	8.9	39.4
SE	64.1	35.5	33.6	8.9	100.0	44.3
UK	46.0	55.4	49.2	39.4	44.3	100.0
Coefficient of similarity *cs*2						
CZ	100.0	37.3	34.0	20.0	64.9	45.8
HU	37.3	100.0	46.9	35.7	34.6	55.1
PL	34.0	46.9	100.0	39.9	31.4	48.6
RO	20.0	35.7	39.9	100.0	8.8	39.8
SE	64.9	34.6	31.4	8.8	100.0	43.6
UK	45.8	55.1	48.6	39.8	43.6	100.0
Coefficient of similarity *cs*3						
CZ	100.0	53.9	53.0	40.9	74.4	62.1
HU	53.9	100.0	66.6	53.4	53.0	74.0
PL	53.0	66.6	100.0	58.8	53.1	66.0
RO	40.9	53.4	58.8	100.0	31.2	55.3
SE	74.4	53.0	53.1	31.2	100.0	60.3
UK	62.1	74.0	66.0	55.3	60.3	100.0

Note: For each country given in a row, the grey cell indicates the highest coefficient of similarity. If the difference between the highest coefficient and the 2nd one is less than 3 percentage points, two cells are marked in grey.
Source: own calculations.

Figure 1. Forward-looking transparency indices in the six EU countries



Source: own calculations.

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Opportunities and threats of socio-economic development: application of composite index to the EU NUTS 2 regions

JEL Classification: *C38; C43; C82; O18; R10; R11*

Keywords: *composite index; entropy weight; European Union; NUTS-2 region; spatial inequalities*

Abstract

Research background: The 2007-2008 economic and financial crisis struck in turn several interconnected economies across the world, revealing the underlying problems of the global economy. The subsequent economic crisis strongly affected European states, revealing the structural weaknesses of the common policy framework. The uneven geographical development pattern, an inherent characteristic of socio-economic development, has prevented the achievement of convergence objectives in the European integration framework.
Purpose of the article: Thus, the current economic crisis has exacerbated the preexisting disparities and conflicts between the European North and South and contributed to the development of different crisis symptoms. Both the depth and duration of the crisis differ among the countries. The purpose of this study is to introduce evaluation of socio-economic development convergence and divergence trends, challenges and prospects among the EU countries in the context cohesion.

Methods: The aim of this study is to propose original methodology for assessing development of regions based on the construction of own composite index calculated from selected indicators in the EU Cohesion reports. The main is to assess socio-economic dimension of cohesion and spatial inequalities in NUTS 2 regions of the EU Member States during the reference period 2000-2017.
Findings & Value added: Findings contain features of typology premises of the EU28 and point to a large diversity in inequality patterns, as authors observe both increases and decreases in spatial inequalities at the EU level. Recent changes in inequalities have been associated with the impacts of economic and financial crises. Additionally the development challenges are discussed for improvement of the socio-economic well-being of the EU and to avoid or minimize disparities.

Introduction

Current economic fundamentals are threatened by shifting of production activities to places with better conditions. Activities and economic processes are affected by the regionalization of public policy because of shifting of decision-making and coordination of activities at regional level. Interest has grown in the regional foundations of economies, and with developing new forms of regionally based policy interventions to help improve the competitiveness of every region and hence the national economy as a whole (Gardiner, Martin and Tyler, 2004; Bristow, 2005). Economic development has been viewed as an important process which asserts an enhancement of both qualitative and quantitative features in territories contributing to higher levels of prosperity (Briguglio et al., 2009; Meyer, 2016). Measurement of progress which societies have made in their developmental efforts, has proven to be difficult but also very popular, especially in the regional dimension (Soares et al., 2003). Disparities are a major obstacle to the balanced and harmonious development of the regions, but also of the territory as a whole. Support to the coherent, sustainable and balanced development of the countries and regions, together with an increasing competitiveness of the European Union (EU) are two main complement development objectives.

In this sense, the paper provides a definition of concepts of regional disparities with special attention to the EU cohesion context, and background of relevant methods for disparities evaluation. The main purpose of the paper is to propose an original methodology for assessing the development of regions based on the own construction of Composite Weighted Aggregate Index of Regional Disparities (CWAID) in the EU countries at the level of NUTS 2, i.e. basic regions for the application of regional policies,

in the reference period 2000-2017. The initial presumption is stated, that in the EU NUTS 2 regions with the lowest level of disparities and highest derived level of development potential, the agglomeration of capital cities are located what has positive effect on regions in less developed countries.

Theoretical background

There exist a lot of definitions of terms of disparity in theoretical literature, but two basic reasons why we examine the disparities between countries and regions. The first reason is we understand disparities as something negative which disqualifies the country or the region in a comparison with others. The second less frequent reason up to now is examining differences as uniqueness, the capability to differ specifically and efficiently from others and to have some comparative or competitive advantages which may be efficiently used and so they increase the development potential of the country or region.

In the EU, the existence of disparities and their elimination is, therefore, one of the main aspects of the EU Cohesion Policy. The EU Cohesion Policy is evoked by the existence of disparities between countries, regions and social groups and its main goal is to reduce these disparities. In the EU, the level of disparities can be regarded as a measure of the level of cohesion and the lower rate of disparities, the higher the level of cohesion territory achieves and vice versa. Cohesion can be expressed by such level of differences between countries, regions or groups that are politically and socially tolerable (Molle, 2007). The definition of the term cohesion is thus based on the theory of disparities and based on the typology of disparities, three dimensions of cohesion can be recognized. Economic cohesion evaluates economic convergence and can be expressed by disparities reducing development levels of countries and regions by economic indicators. Social cohesion tends to achieve objectives in employment and unemployment, education level, social exclusion of different groups and in demographic trends. Territorial cohesion aims to promote the harmonious and sustainable development of all regions, based on their local characteristics and resources.

Research methodology

Relatively independent and in recent years frequently used approach to the measurement and evaluation of disparities is the construction of comprehensively integrated indicators and composite indices. Composite indicators (CIs) which compare territorial performance are increasingly recognised as a useful tool in policy analysis and public communication and very common for benchmarking the mutual and relative progress of territories in a variety of policy domains. However, CIs can send misleading policy messages if they are poorly constructed or misinterpreted. In fact, CIs must be seen as a means of initiating discussion and stimulating public interest (Melecký, 2017; Melecký and Staníčková, 2015; Staníčková, 2017). CIs are much like mathematical or computational models. The definition type of CI used in this paper is adopted by the European Commission. It is based on sub-indicators having no common meaningful unit of measurement and no obvious way of weighting of these sub-indicators (Saisana and Tarantola, 2002, p. 5).

The procedure of CWAID is based on a combination of selected multivariate mathematical and statistical methods that lead to unique of model includes three sub-indices of economic, social and territorial disparities that can summarise complex and multi-dimensional view of regional disparities and are easier to interpret than a battery of many separate indicators. CWAID consists of the calculation of Index of economic disparities (IED), Index of social disparities (ISD) and Index of territorial disparities (ITD). The multi-step procedure is recommended e.g. by Nardo, et al. (2005) or OECD (2008). Synthetic indices of economic, social and territorial disparities are from a statistical point of view designed as modified weighted squared Euclidean distance. Calculation of CWAID is based on weighted linear aggregation defined by formula (1):

$$CWAID_{r,t} = IED_{r,t} zew_{i_E} + ISD_{r,t} zew_{i_S} + ITD_{r,t} zew_{i_T} \quad (1)$$

$$s.t.$$

$$\sum_{i=1}^{d} zew_i = 1 \quad \forall i = 1,...,d \quad (1a)$$

Where $CWAID_{r,t}$ presents composite weighted aggregate index of disparities for and *r-th* region in time *t*; $IED_{r,t}$ presents index of economic disparities for *r-th* region in time *t*; $ISD_{r,t}$ presents index of social disparities for *r-th* region in time *t*; $ITD_{r,t}$ presents index of territorial disparities

for *r-th* region in time *t*; zew_{i_E} is normalized entropy weight for economic dimension of disparities; zew_{i_S} is normalized entropy weight for social dimension of disparities; zew_{i_T} is normalized entropy weight for territorial dimension of disparities; *r* presents region; *r* = {AT11, … , UKN0}, $n_r = 273$; *I* is dimension of disparities, *i* = {*E* = economic, *S* = social, *T* = territorial}; *t* is time, *t* = {2000, …, 2017}.

Results and discussion

With respect to the area of interest of the EU Cohesion Policy, in the paper, the empirical analysis is territorially applied on the EU regions at level NUTS 2 which are the main territory for the application of regional policies, and the different regions across the EU countries are comparable at this NUTS level. The selection of adequate indicators of economic, social and territorial disparities observed at level of NUTS 2 regions has been identified within the Reports on Economic, Social and Territorial Cohesion (i.e. the EU Cohesion Reports) that evaluate the trends of disparities and cohesion in the EU Member States and their NUTS 2 regions (see European Commission, 2007, 2010, 2014, 2017). The initial data matrix is created by the values of 24 indicators for 273 NUTS 2 regions of the EU. The reference period 2000-2017 is determined by the selection of all indicators and their data availability for the EU28 NUTS 2 regions in Eurostat database. Indicators, initial units, criterion of optimization and source are shown in Table 1. The calculations have been made in MS Excel 2016 and IBM SPSS Statistics 25.

The synthetic indices of economic, social and territorial disparities can be used for calculation of the difference to the criteria value (in this case the value 0) which represents in the fact the level of the examined disparities. It can be said that smaller value of the calculated difference, marks the lower rate of disparities and therefore the higher level of cohesion, as stated in Table 2.

Results of the weighted synthetic index of disparities have also confirmed the initial presumption of the paper. The lower value of CWAID then higher ranking of the region and lower level of disparities. Scores of CWAID for the whole reference period, sign out that the rate of regional disparities in NUTS 2 regions with agglomeration of capital cities is rather smaller than in rest of NUTS 2 regions. CWAID curve closer to value 0 presents NUTS 2 regions higher cohesion and lower level of disparities,

and conversely, a higher value of CWAID and curve has more distant from the centre, NUTS 2 regions present lower cohesion and a higher level of disparities. There are obvious differences between traditionally developed and known less developed NUTS 2 regions what means that results of CWAID are conclusive and relevant at this regional level. For all evaluated regions in the reference period, scores of CWAID are marked by traffic light method and highlighted through conditional formatting feature, which makes it easy to spot the differences in the scores of the index. As marked in Table 2, regions with the highest and higher values of CWAID mean a lower level of cohesion – the higher value, the darker shadow of grey colour. Regions with the lowest and lower values of CWAID mean a higher level of cohesion – the lower value, the lighter shadow of grey colour.

Conclusions

Issues of disparities are complicated and to manage them requires to apply multidimensional and multidisciplinary approach, integrating view and plural investigating methodology. In this paper, measurement and evaluation of regional disparities in economic, social and territorial dimension have been performed through the construction of CI, namely CWAID, calculated from standardized values of disparities by modified square Euclidean distance and Exploratory Factor analysis. The main advantage of used approach consists in inability to summarize the different units of the measure under the one synthetic characteristic (index), which is the dimensionless figure. The empirical analysis showed that, for the most part, there was a consensus in the trends of the EU NUTS 2 regions in terms of attainment level of disparities and development potential, depending on the level of existing disparities and the initial hypothesis of the paper can be confirmed. In spite of narrowing rate of economic, social and territorial disparities and convergence process in the level of cohesion, the significant regional disparities between countries still remain, especially in comparison the “old” and “new” member states. This baseline research points many future additional lines of inquiry, e.g. drop the outliers; use panel data methods that would allow us to use information about connections among observations and indicators; divide the reference period concerning the economic cycle, etc.

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Annex

Table 1. Selected Indicators of Regional Disparities for the EU NUTS 2 Regions

Dimension	Indicator	Abbreviation	Criterion
Economic disparities	GDP per capita	GDPpc	Maximum
	Disposable income of households	DI	Maximum
	Labour productivity per person employed	LP	Maximum
	Total intramural R&D expenditure	GERD	Maximum
	Gross fixed capital formation	GFCF	Maximum
	Human Resources in Science and Technology	HRST	Maximum
	Patent applications to the European Patent Office	EPO	Maximum
	Employment in technology and knowledge-intensive sectors	ETKI	Maximum
Social disparities	Employment rate from 15 to 64 years	ER15to64	Maximum
	Employment rate of woman from 15 to 64 years	ERw15to64	Maximum
	Employment rate of older workers from 55 to 64 years	ER55to64	Maximum
	Unemployment rate from 15 to 64 years	UR15to64	Minimum
	Unemployment rate of youth from 15 to 24 years	URy15to24	Minimum
	Long-term unemployment from 15 to 64 years	LtUR	Minimum
	Population aged 25-34 with tertiary education attainment	PATE	Maximum
	Annual average population change	AAP	Maximum
Territorial disparities	Number of passenger flights	PF	Maximum
	Density of railway	DR	Maximum
	Density of motorway	DM	Maximum
	Life expectancy by age	LEx	Maximum
	Number of tourist accommodation establishments	TAE	Maximum
	Arrivals at tourist accommodation establishments	ATAE	Maximum
	Victims of road accidents	VRA	Minimum
	Infant mortality rate	IMR	Minimum

Source: European Commission, 2007, 2010, 2014, 2017; Eurostat, 2019; own elaboration, 2019.

Table 2. Results of CWAID: the EU NUTS 2 regions (in alphabetical order)

NUTS 2	CWAID	NUTS 2	CWAID	NUTS 2	CWAID	NUTS 2	CWAID	NUTS 2	CWAID	NUTS 2	CWAID	NUTS 2	CWAID	NUTS 2	CWAID
AT11	0,907	DE13	0,596	DK01	0,335	FR30	1,075	HU23	2,038	NL31	0,124	SE11	0,169	UKJ2	0,323
AT12	0,750	DE14	0,597	DK02	0,635	FR41	1,119	HU31	2,163	NL32	0,261	SE12	0,515	UKJ3	0,426
AT13	0,750	DE21	0,515	DK03	0,680	FR42	0,832	HU32	2,157	NL33	0,349	SE21	0,613	UKJ4	0,553
AT21	0,851	DE22	0,872	DK04	0,556	FR43	1,069	HU33	2,057	NL34	0,560	SE22	0,436	UKK1	0,390
AT22	0,880	DE23	0,816	DK05	0,703	FR51	1,049	IE01	1,223	NL41	0,387	SE23	0,445	UKK2	0,523
AT31	0,789	DE24	0,800	EE00	1,528	FR52	1,034	IE02	1,051	NL42	0,459	SE31	0,693	UKK3	0,844
AT32	0,715	DE25	0,651	ES11	1,323	FR53	1,127	ITC1	1,263	PL11	1,814	SE32	0,666	UKK4	0,654
AT33	0,711	DE26	0,689	ES12	1,320	FR61	1,049	ITC2	1,244	PL12	1,542	SE33	0,625	UKL1	0,906
AT34	0,693	DE27	0,747	ES13	1,300	FR62	0,967	ITC3	1,231	PL21	1,709	SI01	1,343	UKL2	0,612
BE10	0,635	DE30	0,698	ES21	0,997	FR63	1,115	ITC4	1,196	PL22	1,742	SI02	1,065	UKM2	0,689
BE21	0,565	DE41	0,698	ES22	1,108	FR71	0,892	ITD1	1,036	PL31	1,877	SK01	1,184	UKM3	0,842
BE22	0,598	DE42	0,698	ES23	1,255	FR72	1,223	ITD2	1,061	PL32	1,848	SK02	1,836	UKM5	0,648
BE23	0,560	DE50	0,654	ES24	1,217	FR81	1,172	ITD3	1,280	PL33	1,953	SK03	1,992	UKM6	0,875
BE24	0,635	DE60	0,425	ES30	0,848	FR82	1,093	ITD4	1,203	PL34	1,876	SK04	2,056	UKN0	1,050
BE25	0,638	DE71	0,429	ES41	1,348	FR83	1,245	ITD5	1,159	PL41	1,824	UKC1	0,897		
BE31	0,635	DE72	0,682	ES42	1,408	FR91	1,726	ITE1	1,283	PL42	1,859	UKC2	0,826		
BE32	1,175	DE73	0,747	ES43	1,515	FR92	1,679	ITE2	1,273	PL43	1,803	UKD1	0,798		
BE33	0,990	DE80	1,025	ES51	1,218	FR93	1,757	ITE3	1,375	PL51	1,789	UKD2	0,680		
BE34	1,081	DE91	0,724	ES52	1,357	FR94	1,789	ITE4	1,398	PL52	1,713	UKD3	0,674		
BE35	0,990	DE92	0,682	ES53	1,342	GR11	2,148	ITF1	1,497	PL61	1,931	UKD4	0,671		
BG31	2,604	DE93	0,817	ES61	1,559	GR12	1,962	ITF2	1,715	PL62	1,870	UKD5	0,951		
BG32	2,340	DE94	0,826	ES62	1,416	GR13	2,141	ITF3	1,967	PL63	1,726	UKE1	0,883		
BG33	2,268	DEA1	0,635	ES63	1,615	GR14	2,041	ITF4	1,879	PT11	1,530	UKE2	0,608		
BG34	2,411	DEA2	0,511	ES64	1,566	GR21	1,953	ITF5	1,790	PT15	1,465	UKE3	0,823		
BG41	1,915	DEA3	0,724	ES70	1,492	GR22	1,846	ITF6	1,974	PT16	1,475	UKE4	0,750		
BG42	2,248	DEA4	0,727	FI13	0,839	GR23	2,005	ITG1	1,966	PT17	1,195	UKF1	0,599		
CY00	1,198	DEA5	0,757	FI18	0,515	GR24	2,102	ITG2	1,659	PT18	1,469	UKF2	0,449		
CZ01	1,105	DEB1	0,715	FI19	0,734	GR25	2,083	LT00	1,932	PT20	1,669	UKF3	0,640		
CZ02	1,105	DEB2	0,771	FI1A	0,839	GR30	1,471	LU00	0,434	PT30	1,675	UKG1	0,528		
CZ03	1,383	DEB3	0,664	FI20	0,530	GR41	1,916	LV00	1,941	RO11	2,208	UKG2	0,673		
CZ04	1,685	DEC0	0,820	FR10	0,535	GR42	1,842	MT00	1,218	RO12	2,280	UKG3	0,774		
CZ05	1,402	DED1	0,898	FR21	1,251	GR43	1,861	NL11	0,466	RO21	2,377	UKH1	0,558		
CZ06	1,415	DED2	0,796	FR22	1,152	HR03	2,068	NL12	0,553	RO22	2,451	UKH2	0,383		
CZ07	1,551	DED3	0,791	FR23	1,172	HR04	2,095	NL13	0,530	RO31	2,331	UKH3	0,383		
CZ08	1,555	DEE0	0,948	FR24	1,047	HU10	1,638	NL21	0,457	RO32	1,696	UKI1	0,383		
DE11	0,504	DEF0	0,778	FR25	1,179	HU21	1,871	NL22	0,398	RO41	2,283	UKI2	0,383		
DE12	0,514	DEG0	0,760	FR26	1,170	HU22	1,789	NL23	0,261	RO42	2,304	UKJ1	0,227		

Source: own calculation and elaboration, 2019.

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Tourist development between security and terrorism

JEL Classification: *F000; C21*

Keywords: *terrorism; revenues from international tourism; managing uncertainty*

Abstract

Research background: In the context of complex global relations, the movement of people, especially those related to tourism, raises new issues concerning the safety and security. The tourism industry has a priority for the economic development of many countries in the world and is a large source of export earnings and, at the same time, an important factor in the balance of payments of a significant part of the national economies in the world. The growing importance of the tourism industry, however, puts tourist destinations worldwide at the forefront of new challenges, one of which is terrorism. In this environment, new relationships are emerging and development strategies are being affected, but the financial outcomes of tourism are also largely affected.
Purpose of the article: Respecting the new realities, the study explores the link between the risk of terrorism and the income from international tourism. Its main purpose is to investigate the impact of terrorism on the financial revenues from tourism in the European countries and the United States. The research is determined by the perception that the financial flows from the international tourism are the quantitative manifestation of the hidden effects of the terrorism.

Methods: The research method includes a regression cross-section analysis and Granger Causality test. The survey is panel and includes 36 countries from Europe tourism region and the United States from Americas' tourism region (according UNWTO).
Findings & Value added: In conclusion, the effects of terrorism on the studied regions have been summarized, commenting on the prerequisites provoking such events.

Introduction

The effects of terrorism on tourism have shown tremendous power in the 21st century. The age in which we live instead of fanfares started with a colossal terrorist act, which was carried out on September 11, 2001 in New York. It was followed by acts of terrorism in Moscow (2002), Madrid (2004), London (2005), Paris (2015, 2016), Nice (2016), Berlin (2016), Brussels (2017, 2018), Istanbul (2016, 2017, 2018), etc. – all of them leading tourist cities, which is indicative for the linking trends between tourism and terrorism.

The development of terrorism assumes the characteristic of a phenomenon that seeks a strong public response that is being achieved as a consequence of the strategic tactical goals of terrorist attacks. Nowadays the terrorist ideology is realized through terrorist acts that target the world's leading tourist destinations (see Faulkner, 2001, pp. 135-147; Ritchie, 2004, pp. 669-683; Baker, 2014, pp. 58-67; Ahmad, Chai-Aun & Chee-Wooi, 2014, pp. 302-304; Stankova, 2011, pp. 65-77 and many others). Thus, the terrorism becomes a risk that affects the decisions of tourists about their choice of a tourist destination. The distinctive connection between the terrorism and the tourism is becoming a fundamental problem for the development of tourism, especially in the financial and economic aspect. Continuing in the same rationale of reasoning, one of the most important effects of the terrorism logically stands out, namely its ability to redirect the tourist preferences from one destination to another. In addition, the terrorism has a creative character, which means that the terrorist attacks induce certain reforms that make the tourist destinations much safer and more profitable. These two effects of terrorism remain hidden from the general public, which is set in the initial effect of terrorism. Consequently, the issue of the impact of terrorism on the international tourism revenues for European countries and the United States appears to be logical and therefore meaningful as an object of research in the context of the study and the outlined range of terrorist goals.

The subject of the study is determined by the perception that the financial flows from the international tourism are the quantitative manifestation of the hidden effects of the terrorism. And this is namely the ability of the international tourism to redirect the tourist preferences from one destination to another and its creative power, which leads to increased competitiveness of the tourist destinations. Therefore, the dynamics of the international tourism flows, which is determined by the terrorism, is a quantitative indicator of the risk of terrorism. Changing the tourism preferences, which determine the magnitude of the financial flows that are the basis for better competitiveness.

Research methodology

The research is aimed at the impact of the terrorism on tourism, and its focus is the effect of terrorism on the revenues from the international tourism in Europe and the United States.

The methodology used is a regression cross section analysis and Granger Causality tests (Granger, 1969, pp. pp. 425-435). Panel tests for single root testing (Panel unit root test: Summary), are also applied.

A stationary process is a Gaus distribution with independent random variables that have a normal distribution.

$$\mathrm{E}(\boldsymbol{Y_t}) = \boldsymbol{\mu} = \boldsymbol{cost} \tag{1}$$

The stationarity of the dynamic lines is expressed with the following equation:

$$\Delta \mathbf{y_t} = \boldsymbol{\alpha}\boldsymbol{\gamma_{t-1}} + \mathbf{x_t'} + \boldsymbol{\varepsilon_t} \tag{2}$$

The null hypothesis says that there is unit root,

$$\mathbf{H_0} : \mathbf{a} = \mathbf{0} \tag{3}$$

$$\mathbf{H_1} : \mathbf{a} < \mathbf{0} \tag{4}$$

The alternative hypothesis states that there is not unit root.

The regression model used is described by the following mathematical equation.

$$\boldsymbol{\gamma} = \boldsymbol{\alpha_1}\mathbf{x_{j1}} + \boldsymbol{\beta_2}\,\mathbf{x_{j2+}}\boldsymbol{\varepsilon_i} \tag{5}$$

The Granger Causality tests is expressed by the following two regression equations:

$$\gamma_t = \alpha_0 + \alpha_1\gamma_{t-1} + \cdots + \alpha_1\gamma_{t-1} + \beta_1 x_{t-1} + \cdots + \beta_1 x_{t-1} + \varepsilon_t$$
$$x_t = \alpha_0 + \alpha_1 x_{t-1} + \cdots + \alpha_1 x_{t-1} + \beta_1\gamma_{t-1} + \cdots + \beta_1 x\gamma_{t-1} + u_t \quad (6)$$

All countries geographically positioned in Europe, along with Russia and Turkey and the United States have been considered.

The study is panel-based and has a time limit covering the period 2012-2017 for two variables: the Global Terrorism Index (GTI) 2012-2017 and the International tourism receipts (ITR).

The databases used are from the Institute for Economics and Peace, 2012-2017 and the World Bank, covering 35 countries and 223 observations.

Results

The study assumes that the risk of terrorism creates both uncertainty in a given geographic region and, at the same time, in another area leads to favorable conditions for the development of tourism. It is this dialectical effect that is the core of the empirical analysis, achieved by examining the dependence between the terrorism and the tourism and how this dependence is manifested in Europe and the United States.

The starting point from which the theoretical logic of the problem can be developed, is the main characteristic of terrorism, namely the creation of uncertainty that influences the preferences of the tourists and has the ability to change them. Consequently, the regulation of the insecurity generated by the terrorism leads to the manifestation of the destructive-creative effect of terrorism. Continuing in the same rationale of reasoning, this means that if we look at the tourism as an aggregate system consisting of different geographic regions, then the allocation of the uncertainty created by the terrorism is characterized by a dynamism that induces the movement and the widening of the uncertainty between the different geographic regions, respectively, between the different tourist destinations. This logically follows the conclusion that the control and the effects of this uncertainty generated by terrorism, determine the direction and the magnitude of the movement of the tourists and respectively of the revenues from tourism. Hence, the usefulness of the dependence between the terrorism and the tourism de-

pends on their simultaneous but not synchronous[1] growth. The simultaneous but not synchronous growth of terrorism and tourism, inherently, means that there is a difference in the rate of increase between the tourism and the terrorism revenues over the time. A mechanism, however, determined by an exogenous variable which, for a geographic region, possesses the property of diversification and another of an adversely affecting factor. Such an exogenous variable is the geopolitics, which is realized as a military-political control. Applying the military-political control, in both internal and external policy, a direct and indirect regulation is achieved on the allocation and the magnitude and the speed of the dynamics of the insecurity created by terrorism.[2]

Mathematical justification of the theoretical concept is conceived in the following mathematical abstraction:

$$U= ITR- MPC\ GTI \tag{7}$$

Where: U- is the utility, ITR- revenues from international tourism, GTI – global index of terrorism, MPC- geopolitical influence seen as military-political control

From such a equation follows that the output for the European countries is a consequence of the simultaneous increase in the risk of terrorism and tourism revenues, but the increase may be simultaneous, but not synchronous, i. e. the revenue growth is always faster than the increase in the risk of terrorism.

Mathematically, this is explained as:

$$ITR=1 \tag{8}$$

$$GTI<1 \tag{9}$$

From where it follows, that:

$$ITR> GTI \tag{10}$$

To be realized, the mathematical expressions depend on the degree of the military-political control. Therefore, if the military-political control is increasing in a given geographic region, it has the function of diversification and reduces the rate of the risk to another geographic region, accelerat-

[1] By non-synchronously is meant the rate of increase
[2] By non-synchronously is meant the rate of increase

ing the uncertainty in the controlled geographic region. This allows the revenue to be increased at a faster rate than the risk, resulting in a common utility or a beneficial effect on the tourism in Europe and the United States at the cost of a negative impact on tourism in the Middle East, explained mathematically by the monotone function:

$$ITR > GTI \longrightarrow f(MPC) \tag{11}$$

It follows that the rate of growth of the international tourism revenue and the uncertainty generated by the magnitude of the risk of terrorism, are a function of exogenous external and internal political factors, as well as military strategic actions that give rise to control.

In order to prove empirically that concept, we must empirically record the existing dependence between the revenues from the international tourism and the terrorism (tab.1).

The interaction between them is characterized as a moderate force dependence, which confirms the theoretically justified link. The dependence between the terrorism and the tourism is an important starting point for analyzing the impulse effects that are transmitted between the terrorism and the tourism. Their dependence is bidirectional and linear, which characterizes the dynamics of the trends of the two variables as a direct proportional transformation over the time (fig.1). Consequently, we have a simultaneous change of the two variables considered, but the correlation analysis can not determine the rate of the change of the two variables.

At this stage of the study, the empirical argument that can be inferred, is that the increase in the risk of terrorism and the incomes from international tourism in the European countries, Russia and the United States, is simultaneously and mutually inducible. This empirical characterization is explained by the geographical allocation of the risk of terrorism, respectively of the arising uncertainty. In other words, the geopolitical, the geoeconomic and the geographic link between European countries and the United States, on the one hand, and on the other - the Middle East, leads to a simultaneous increase in the risk of terrorism and incomes from tourism in Europe and the United States. And in the Middle East we have an excessive increase in the risk but not in the revenue.

It is obvious that terrorism has a strong impact on the international tourism cash flows, empirically from the finding that the increase in the risk of terrorism by a unit, leads to an increase of the revenues from international tourism by 9.03, i.e. - a significantly higher increase. From here it can be concluded, that the rate of the increase of the revenues from the international tourist flow, is greater than the rate at which the risk rises. Therefore,

the international tourism revenue from the European countries and the United States, is characterized by a considerably increasing size. This effect of terrorism shows the hidden effects of the rising risk of insecurity. On one hand, the uncertainty generates an outflow of tourists from the tourist destinations in the Middle East. On the other hand, the risk of terrorism, which has been growing in Europe, induces the political decisions in the European countries that lead to increased security measures and more sophisticated security methods, which, in turn, collide with more efficient and attractive tourist offers that also include the price management. This interaction between a governmental policy solution, larger and more sophisticated security and rational management measures, lead to more competitive tourist destinations. The effect is to increase the cash receipts, as a result of the greater security that attracts the international flows.

The positive influence of the terrorism on the cash receipts in the countries under consideration, reveals its dialectical multidimensional geographic influence, which has a creative destructive power. The terrorism, creating insecurity, does not necessarily have negative effects on the tourism cash flows. On the contrary, it even creates favorable conditions for their increase. It can therefore be concluded, that the terrorism impacts differently on the different tourist destinations, which is a result of its creative creative power, that has geographic, political and economic manifestations (see Ahlfeldt, Franke & Maennig, 2015, pp. 3-21 and Teoman, 2017, pp. 132-142).

The impact between terrorism and tourism is a two-way one. Therefore, what is of interest, this is the impact of the international tourism revenue on the dynamics of the preference for terrorist attacks (fig. 2). It is logical that larger cash flow leads to more tourists. And the terrorism prefers locations that are densely populated and comfortable for terrorist attacks. Because the densely populated tourist destinations have characteristics that determine the effectiveness of the terrorist attacks. That is why it is important to determine the impact of the increasing financial revenues on terrorism.

Increasing the revenues from the international tourism leads to an increase in the risk of terrorism by a coefficient of 1.99. Comparing this coefficient with the growth rate of tourism revenues as a result of the increasing risk of terrorism, it becomes clear that the terrorism induces growth in the tourism revenue by a coefficient of 9.03. This comparison proves that the rate of the tourism revenue is higher than the rate of increase in the risk of tourism.

Thus, empirical arguments are presented in support of the theoretical and mathematical logic outlined above. The theoretical explanation is limited to the following. The uncertainty in the Middle East is a factor contrib-

uting to the development of the tourism in Europe and the United States. The conclusions made so far, allow to suggest the argument that terrorism is rather stimulating to the European tourism. The stimulating force of the terrorism appears to be the direction of the tourism flows to Europe and the United States, which leads to an increase in the revenues from the international tourism. However, the increase in the revenue from tourism does not lead to a shift in the risk movements to the same force as the increase in the tourist flows.

The increasing of the revenue from tourism also leads to an increase in the risk of terrorism, but the consequences are not negative. Rather, it may be argued that this process leads to a usefulness for Europe and the United States, which is times greater than the increase in risk. This utility is being determined by the military actions that have been developing in the Middle East and are under the political and economic control of the United States, Russia, Turkey and Europe. It is these actions that are an exogenous variable that induces the diversification of the risk of terrorism for Europe and the US and an optimization of utility. The diversification is a consequence of NATO's control on the events in the Arab world in political and military terms.

From the analysis made so far, it is clear that the following inequality is in effect:

$$ITR > GTI \tag{12}$$

which means that the empirical analysis gives econometric arguments that we have a simultaneous increase of the two variables, but the rate of their growth is different, which is determined by geopolitical, economic and military factors.

Here it has also been confirmed that the positive effect of terrorism on tourism in Europe and the United States is a consequence of the unfavorable conditions in the Middle East. The causal relationship between the dependence of tourism and terrorism for the observed period and the countries under consideration and on equal terms, is clearly established (tabl.2).

To prove the main thesis, namely, that the terrorism has a dialectical-creative nature, empirical arguments have to be found, that the reason, determining the relationship between terrorism and tourism, is precisely the risk of increasing uncertainty as a result of terrorism. An empirical argument is been presented, that the impulses of the dynamics are transmitted as a root cause of the terrorism to the cash receipts from the international tourism. Then the evidenced thesis is set. It is the result from the Granger Causality Tests that gives such arguments that the cause for the dependence and

the process provoked by this relationship between terrorism and tourism, is from terrorism to tourism, which confirms the set thesis. Theoretically, the empirical results correspond to the theoretical logic, which is derived from the notion that terrorism has taken its peak over in the Middle East, even thare was created a state on a terrorist basis under the name of The Islamic state.

Conclusions

The established dependence between terrorism and tourism illustrates the creative-destructive effect of terrorism. An argument for the existence of such an effect is that the root cause for the established cause-and-effect relationship between the two variables is the effect of the terrorism and the investigation – the dynamics of the magnitude of the revenues from international tourism.

The results obtained from the empirical analysis provide an argument in favor of the realized utility for the countries under consideration, which is a consequence of the dependence between the risk of terrorism and the revenues from international tourism.

Considering the terrorism as a factor and causative variable, it has been established that its increase by a unit leads to a much higher increase in the tourism revenue, which realizes a coefficient of 9.03. The increased financial revenues from international tourism, on one hand, increasing by one unit, lead to a proportional increase in the risk of terrorism to 1.98. Consequently, the final result is that the increase in the tourism revenue is several times greater than the increase in the risk of terrorism. This result is due to geopolitical factors that lead to diversification that limits the risk at the expense of a significant increase in revenue. This diversification mechanism is possible because the tourist regions are a system of geographic approximations that allow the distribution of the insecurity, which is subjected to a politically military control.

The geographic link between Europe and the Middle East is the reason for the increasing terrorism in countries such as Iraq and Syria to redirect the tourist flows to the European countries. NATO's political and military intervention in the Middle East is the reason for the terrorism to be directed to Europe and the US, but on the other hand, the political and the military control applied, leads to the regulation of the risk of terrorism. The consequence of the described complex geopolitical processes is precisely the positive influence of terrorism on the increase of tourism revenues in Europe, Russia and the USA.

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Annex

Table 1. Correlation Matrix between GTI and ITR

	GTI	ITR
GTI	1	0.42361248
ITR	0.423612480	1

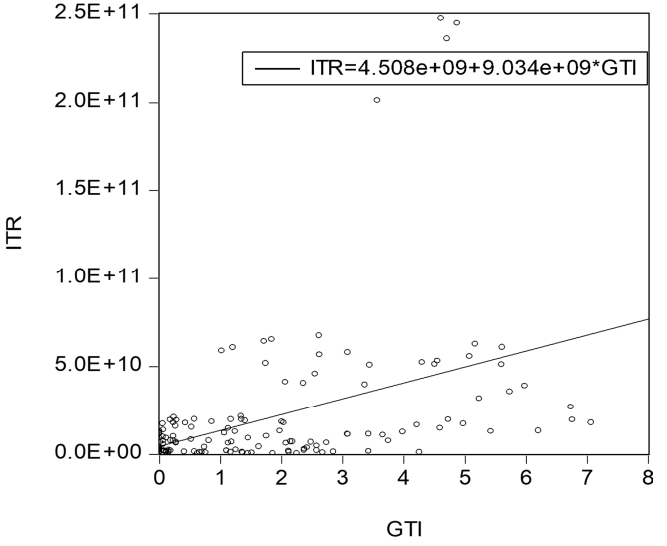
Source: own calculations based on World Bank data, Global Terrorism Index-Measuring and Understanding the Impact of Terrorism; the Institute for Economics and Peace (IEP), 2012-2017.

Table 2. Granger Causality tests results

Pairwise Granger Causality Tests			
Null Hypothesis:	Obs	F-Statistic	Prob.
ITR does not Granger Cause GTI	37	0.57457	0.5686
GTI does not Granger Cause ITR		6.97329	0.0031

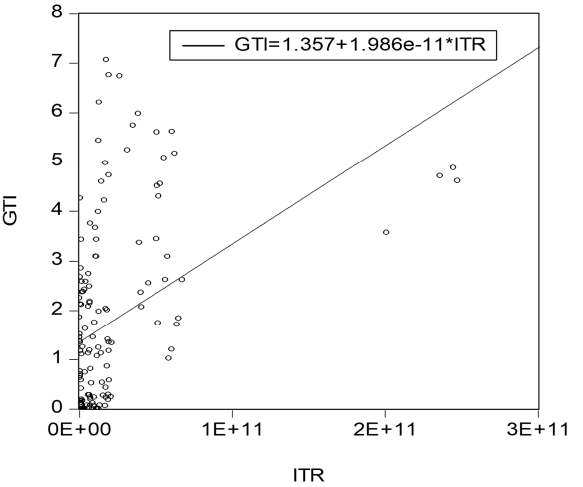
Source: own calculations based on World Bank data, Global Terrorism Index-Measuring and Understanding the Impact of Terrorism; the Institute for Economics and Peace (IEP), 2012-2017.

Figure 1. The impact of terrorism on the tourism



Source: own calculations based on World Bank data, Global Terrorism Index-Measuring and Understanding the Impact of Terrorism; the Institute for Economics and Peace (IEP), 2012-2017.

Figure 2. The impact of the international tourism revenue on the terrorism



Source: own calculations based on World Bank data, Global Terrorism Index-Measuring and Understanding the Impact of Terrorism; the Institute for Economics and Peace (IEP), 2012-2017.

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Innovative cooperation in industry and business support organizations in Poland in 2013-2017 - system perspective

JEL Classification: *O31; O32; L60*

Keywords: *Business support organizations, cooperation, innovation, technology park, incubator*

Abstract

Research background: Innovative economy and the business environment are important factors in the socio-economic development of the country. In a knowledge-based society, economic processes (especially innovation activity) require a specific stimulus. This stimulus can be provided by business support organization, which have been present in the Polish economy since the 1990s.
Purpose of the article: The main goal of the article is to assess the system impact of business support organizations on cooperation in the area of new solutions (product and process innovations) in industry in Poland.
Methods: The research method which was used in the analysis was logit modelling. Cooperation in the area of new solutions with the supplier, recipient and competitor was established as a dependent variable and business support organizations as independent variable. The analysis using logistic regression was based on comparison two groups of enterprises: those that were service recipients of support organizations and those that did not belong to this group. In this way, it was possible to determine if the use of BSO services increased the chances for innovative cooperation in industry. The survey was conducted in 2013-2017 among 6284 industrial enterprises.
Findings & Value added: The survey showed that business support organizations significantly and systematically influence the establishment of innovative coopera-

tion. Recipients of support organizations twice more often cooperated with suppliers and recipients than entities that did not. Stimulation of cooperation with competitors by BSO was weaker than it was in the case of suppliers and recipients.

Introduction

Innovative economy and business environment are important factors in the socio-economic development of the country (Churski & Dominiak, 2012, pp. 54-77). In a knowledge-based society, economic processes require a specific stimulus that is a synergic system of business entrepreneurship, scientific innovation and dynamic creativity, creating an innovation ecosystem, although the formulation itself all the time raises interpretative doubts (Oh *et al.*, 2016, pp.1-6.). The combination of these elements can be stimulated through appropriate institutional equipment and an innovative environment.

Business support organizations function among the institutional equipment structures. The currently developed national and regional development strategies outline the structure of the support structures of innovative economy based largely on the intervention of state authorities in the process of knowledge transfer. In Poland, the following are distinguished (Matusiak, 2011, p. 182):

- innovation centres – technology parks, technological incubators, academic business incubators, technology transfer offices;
- financing institutions – business angel networks, local or regional loan funds, credit guarantee funds;
- business centres – training and consulting centres.

Innovation centres focus on promoting and supporting innovative activity among enterprises. Their activity is closely related to the innovative activity (Mizgajska & Wściubiak, 2018, pp. 26-37). Enterprises located in technological parks are characterized by better innovative performance, and companies from less technologically developed regions benefit more in this context (Albahari *et al*., 2018, pp. 253-279). Functions of parks are supplemented by the operation of incubators on their premises. They play an important role in the development of start-ups, because the entities operating in technological incubators have better results than those outside them (Reyani *et al.*, 2018, pp. 569-573).

Technology transfer offices intermediate in the transfer of technologies from the sphere of science to business and between enterprises themselves. It is easier for the centres to stimulate the process of mediation and cooperation between the enterprises themselves, because problems related to the

trust of scientists arise on the science-business line (Sideri & Panagopoulos, 2018, pp. 953-965).

Financing of innovation activity takes place thanks to private support (business angels networks) or public support (loan and guarantee funds). Investments of business angels fill the gap related to the imperfections of the financial market in relation to the high risk of innovative projects and the difficulties associated with their evaluation (Scheela *et al.*, 2018, pp. 96-106). Loan and guarantee funds are an institutional form of public support for entrepreneurship and innovation. They offer loans and guarantees to entrepreneurs on more favourable terms than banks. At the same time, fund recipients are enterprises with lower growth potential than the network of business angels (Grimsby, 2018, pp. 1344-1365).

The training and consulting centres aim to support entrepreneurship, but not only that related to innovation. They increase the economic potential of the region in which they operate and improve the quality of life of its inhabitants.

When looking for and reviewing the studies in field of business support organizations, many publications can be found, but there is a lack of research on the systematic impact of such institutions on cooperation in the field of new solutions in macroeconomic terms, not only in relation to the Polish economy, but also the world. This problem is not only about confirming the thesis that business environment institutions have a positive impact on establishing innovative cooperation. A particularly interesting phenomenon is the precise definition of the directions and scale of such impact. This became the primary premise for conducting research in this area. In this context, the research hypothesis is that business support organizations significantly, strongly and systematically accelerate cooperation in the area of new solutions in terms of sectors in industrial enterprises in Poland. The main research goal is to assess the systemic importance of business support organizations in stimulating innovative cooperation in Polish industrial enterprises.

Research methodology

In the analysis of the impact of business support organizations on cooperation in the area of new solutions, BSOs, which are most common in Poland, were adopted as independent variables. These are technology parks, technology incubators, academic business incubators, technology transfer offices, business angel networks, local or regional loan funds, credit guarantee funds and training and consulting centres. The dependent variables were

formed, however, by the innovative sectoral cooperation, i.e. with the supplier, recipient and competitor.

The variables adopted for the study were dichotomous, i.e. if the company cooperated innovatively, it received the value of 1, if not, the value of 0. In the case of zero-one variables, the analysis may use logistic regression. It is a mathematical model that we can use to describe the influence of several variables X_1, X_2, …, X_k on the dichotomous variable Y.

In logit modelling, the interpretation subjects to the so-called odds ratio that allows the comparison of two observation classes. It indicates the relationship that a given event will be included in the first group of elements (e.g. in enterprises using technology transfer offices) in relation to the fact that it will also be in the second group (e.g. in the group of entities that did not use the services of centres). They are written using the formula (Stanisz, 2007, s. 222):

$$OddsRatio = \frac{p_1}{1-p_1}\frac{1-p_2}{p_2} = \frac{p_1(1-p_2)}{p_2(1-p_1)}.$$

The values of the odds ratio are interpreted as follows:
- *OddsRatio*> 1 – in the first group an incident is more likely to occur,
- *OddsRatio*< 1 – in the first group an incident is less likely to occur,
- *OddsRatio* = 1 – in both observation classes, the event is just as likely.

The study of the impact of business support organizations on the innovative activity was attended by 6284 enterprises whose business profile corresponds to section C of the Polish Classification of Activities: Industrial processing. The study was conducted in 2013-2017 and covered the whole Poland with respect to regional proportions.

In the surveyed group of enterprises (Table 1), more than 44% were micro enterprises that employed 9 people or less. Small entities with employment from 10 to 49 persons accounted for nearly 35% of the research sample, and medium enterprises (from 50 to 249 employees) over 16%. The share of large enterprises in the sample amounted to less than 5%.

From among all business support organizations, training and consulting centres were the most popular (Table 2). Over 30% of the surveyed entities used their services. The recipients of loan and guarantee funds were approximately 20% of enterprises. Less entities benefited from the services of innovation centres. 7% of surveyed enterprises benefited from the offer of technology parks, less than 4% of the technology transfer offices, slightly over 2% of technology incubators, and 1.6% of the academic business incubators and business angel networks.

Results

All business support organizations that were taken into account in the analysis increased the chances of establishing cooperation in the area of new solutions with the suppliers (Table 3). It is worth emphasizing in this case that the estimated odds ratio are characterized by a high level of statistical significance (p-value=0,01), which shows that 99% of the research sample is part of the estimated model. Most often, cooperation was established with suppliers in enterprises that used the services of training and consulting centres, business angel networks and credit guarantee funds. They were more than doubled in relation to enterprises that were not interested in these institutions. Almost two-fold increase in opportunities was noted in the case of innovation centres – technology parks, technology incubators, academic business incubators and technology transfer offices. The smallest, but still positive impact was seen in loan funds. The chances of implementing novelties among their recipients increased by 40%. The constant at the level of 0.25 informs that the chances of cooperation in entities that did not use the services of support institutions are 75% lower than in companies that used the BSOs services.

The impact of business support organizations on establishing innovative cooperation with customers is lower than in the case of suppliers (Table 3). It is visible in two aspects. First, the conditions of statistical significance were not met by one institution, namely the local or regional loan funds. This means that among their recipients, no regularities related to more frequent or less frequent cooperation with the recipient were noticed. Secondly, the odds ratio estimated for the "recipient" model were lower than for suppliers. More than two-fold increase in the chances of establishing cooperation was noted only among the recipients of technological incubators. Other innovation centres increased them from 60% to 70%. In this range, there were also chances among enterprises that used the services of the business angels network (70%) and training and consulting centres (66%). Credit guarantee funds contributed to the increase of chances for establishing innovative cooperation with the recipient by 40%. It is also important that entrepreneurs who did not use the services of business support organizations over 80% less frequently cooperated in terms of innovation with the recipient.

The rarest impact, although still strong and important, came from business environment institutions on establishing cooperation in the area of new solutions with a competitor (Table 3). In the case of this model, the highest value of the odds ratio was noted – namely the technology transfer offices more than tripled the chances of implementing new solutions in coopera-

tion with a competitor. In the case of technology incubators, the chances increased almost twice, and technological parks – 1.6 times. At the same time, there was no relationship between cooperation and the use of academic business incubators and business angel networks. Credit guarantee funds contributed to an increase in opportunities by 46%, and training and consulting centres by 29%. In the case of credit guarantee funds, the value of odds ratio was below one (it was equal to 0.68). This means that entities that used their services, 32% less often established cooperation with a competitor than companies that did not use the services of funds. Also, 96% less often cooperated in an innovative way with a organizations.

Summing up, based on the collected primary data and calculations carried out, it should be stated that business support organizations in Poland have a systemic, strong and positive impact on establishing cooperation in the area of new solutions regardless of the type of organization under consideration. The only exceptions are loan funds (lack of connection in the case of cooperation with the recipient and negative interaction in the case of cooperation with a competitor) and academic business incubators and business angels networks (no connection for establishing cooperation with a competitor).

Conclusions

In the light of the analyses conducted, it can be assumed that the research hypothesis at the beginning of the article was confirmed – business support organizations in a significant and systemic manner contributed to establishing cooperation in the industry in the area of new solutions. Greater influence in this area was characteristic of the innovation centres than financing institutions and business centres. This concerned not only the impact, but also the direction (reducing the chances of cooperation with a competitor among the recipients of loan funds). This is not surprising, as cooperation in the area of new solutions concerns entities that seek support among institutions specializing in providing pro-innovative services, which include innovation centres. While financing institutions and training centres support entrepreneurship, which is connected not only with innovation, but also with the professional activation of people from socially excluded groups.

It was easier for business support organizations to initiate cooperation along the supply chain than with a competitor. This result is not surprising because cooperation with a competitor is one of the highest forms of cooperation in the area of new solutions. It requires a clear definition of the areas in which competing entities will use the results of an innovative project.

In addition, entrepreneurs are more likely to interact with the supplier or the recipient even because of "everyday" business contacts.

The conducted study clearly indicated the large number of innovation centres in the process of stimulating innovative cooperation. In the case of technology parks and technology incubators, as well as academic business incubators, the geographic concentration of enterprises may influence the establishment of cooperation. At the same time, the question about building a network remains open – do these business support organizations generate the building of innovation cooperation within themselves (among companies-occupants), in regional arrangements, or maybe outside the region/country. The activity of technology transfer offices is considered mainly in the context of the commercialization of knowledge produced in universities. However, the conducted study showed that the centres also contributed to sectoral cooperation and that of all support institutions, they stimulated the cooperation with the competitor the most.

Financing institutions were characterized by the least impact on cooperation among the analysed BSOs. In the case of the business angels netowork, this can be explained by the fact that a small number of enterprises used their services, which did not allow to justify their systemic impact on establishing cooperation with a competitor. A large number of entities used the services of loan and guarantee funds (20% of the research sample), however their impact on the cooperation was small or none (loan funds) or significantly smaller than other institutions (guarantee funds). This means that supporting innovation is not their main area of activity. Considering this fact and the small number of entities that have used the capital of business angels, it can be hypothesised that there is a bottleneck in the Polish national innovation system related to financing cooperation in the area of new solutions.

The study was of a diagnostic nature. It was indicated how BSOs influence the establishment of innovative cooperation, however, the reasons for this state are not clearly defined. Therefore, the research topic covering the determinants of mechanisms for the spread of knowledge between enterprises with the participation of business support organizations would be interesting. The aspects analysing the spatial extent of the initiated cooperation would also be interesting. It would show whether there are strong centres generating new products and technologies in Polish regions, or maybe enterprises must enter into agreements on a macro scale to seek partners for innovative projects.

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Annex

Table 1. Structure of the studied companies in terms of the of size classes and level of technical advancement

Size classes	Quantity of companies	Percentage
Micro	2779	44.2%
Small	2172	34.6%
Medium-sized	1041	16.6%
Large	292	4.6%
Sum	6284	100%

Source: author's own research based on survey.

Table 2. Cooperation of the studied company with Business Support Organizations in 2012-2014

Business Support Organizations	Quantity of companies	Percentage
Technology Parks	440	7.0%
Technology Incubators	144	2.3%
Academic Business Incubators	102	1.6%
Technology Transfer Offices	239	3.8%
Business Angels Networks	103	1.6%
Local and Regional Loan Funds	1320	21.1%
Credit Guarantee Funds	1158	18.5%
Training and Consulting Centres	1914	30.6%

Source: author's own research based on survey.

Table 3. Ilorazy szans w wieloczynnikowej regresji logitowej obrazujące związki między instytucjami otoczenia biznesu a podejmowaniem współpracy w przedsiębiorstwach przemysłowych w Polsce w latach 2013-2017

Business Support Organizations	Cooperation with		
	supplier	recipient	competitor
Technology Parks	1.94 (*)	1.61 (*)	1.58 (**)
Technology Incubators	1.88 (*)	2.35(*)	1.96 (**)
Academic Business Incubators	1.86 (*)	1.59 (*)	1.72
Technology Transfer Offices	1.95 (*)	1.70 (*)	3.11 (*)
Business Angels Networks	2.17 (*)	1.70 (*)	1.08
Local and Regional Loan Funds	1.41 (*)	1.12	0.68 (**)
Credit Guarantee Funds	2.13 (*)	1.40 (*)	1.46 (**)
Training and Consulting Centres	2.18 (*)	1.66 (*)	1.29 (***)
constants	0.25 (*)	0.18 (*)	0.04 (*)
chi-square	647.36	227.95	78.463
p-value	0.000	0.000	0.000

* - statistical significance 0.01
** - statistical significance 0.05
*** - statistical significance 0.1

Source: author's own research based on survey.

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Degree of monopoly and market power vs. price flexibility in Polish economy - empirical analysis based on COICOP classification

JEL Classification: *D42; D43; L11*

Keywords: *degree of monopoly; market power; price rigidity; COICOP; Polish economy*

Abstract

Research background: The issue of price flexibility is crucial in economy both in the aspect of company theory and its macroeconomic consequences. In a number of publications, the sources of variable price flexibility are linked to the market power of enterprises as well as the market structure that developed in a given branch. It is difficult to indicate empirical studies that would state clearly whether price flexibility depends on the degree of monopoly or the market power of enterprises. This paper concerns that particular field of study.
Purpose of the article: The purpose of the paper is to present the statistical dependence of the degree of monopoly and market power vs. price flexibility in economy.
Methods: The analysis has been conducted using aggregated data concerning Polish economy in the period from 2001 to 2013, based on COICOP. The degree of monopoly indicator was the average number of companies in a given branch, following the classical models of market structures; the market power indicator was the average net revenue from sales of products per enterprise representing a given branch; the measure of price flexibility was the probability of price variation estimated using the Calvo pricing model. It is therefore a frequency-based approach to price flexibility. Statistical dependence was analysed using the Spearman's rank and Kendall's tau correlation coefficient and simple regression models.
Findings & Value added: The outcomes indicate that there is no statistically significant relation between the degree of monopoly and price flexibility and also between the market power and price flexibility. Thus, the findings of the analysis

support the studies which reject the assumption that higher degree of monopoly or higher market power of an enterprise is followed by less flexible prices.

Introduction

The goal of this study is an empirical analysis of the relation between the degree of monopoly, market power and price flexibility in Poland. This study is an attempt to fill the gap in the literature on the relation of the degree of monopoly, market power and flexibility of prices in Poland. The study has been conducted using the data from the period of 2001 to 2013. Degree of monopoly, market power and price flexibility indexes have been estimated. The degree of monopoly index represented the average number of enterprises per branch, with the assumption that lower number of enterprises is followed by a larger degree of monopoly. Market power index was the average net sales revenue per an enterprise in a given branch – higher index values indicate larger market power. Finally, price flexibility has been estimated using the Calvo price setting model that indicates the price variation probability – higher values indicate more flexible prices. The dependence between the degree of monopoly, market power and price flexibility has been analysed using the Spearman's rank correlation coefficient and simple regression models.

The first part of the paper presents the review of publications concerning price flexibility in the economy and its relation with the degree of monopoly. Next, the data used for determining the degree of monopoly and market power indexes as well as Calvo price setting probability coefficients are presented. The following parts contain the results of the said indexes as well as the analysis of the dependence of the degree of monopoly, market power and price flexibility. The paper ends with a conclusion and an appendix, containing the details not included in the main part of the study.

Literature review

The studies of the relation of price flexibility and the degree of monopoly or market power of enterprises have a long tradition. However, individual categories have been defined in various ways. Price flexibility has been analysed as a response of price to variable demand, as well as the scale or frequency of price variations. Different measures of degree of monopoly and market power have also been used. The studies were based on various types of data - aggregated, unit or survey data. This review is a synthetic

discussion on the most important studies concerning this issue, in which analysed categories are understood differently.

S. Aaranovitch and M. Sawyer (Aaranovitch and Sawyer, 1981) indicated that price response during the economic recovery period (demand increase), or economic regression (demand decrease), depended on the market structure – in sectors with larger concentration prices were more rigid than in more competitive sectors. The study of J. Jones and L. Laudadio (1990), conducted using aggregated data concerning Canadian industrial enterprises from 1971 to 1982, confirmed the assumed price rigidity in monopolised sectors, but only to a limited extent. Price rigidity in monopolised sectors did not maintain throughout the entire period of high inflation, only in its initial period. Prices in monopolised sectors started to reflect inflation and changed in the same way as those in competitive sectors.

A separate group of price behaviour analysis tasks is the analysis of the frequency of changes, conducted both on aggregated prices and on micro-data. It is assumed that is price changes occur too often, which means that they are flexible, then the monetary policy has no effect on the real values in the economy. However, if price changes are relatively rare, then money is not neutral and the monetary policy determines the real values.

In the already classical studies of price changes frequency, M. Bils and P. Klenow (Bils and Klenow, 2004) claimed that prices in the USA are more flexible than it has been determined in other analyses. To analyse the relation between the price changes frequency (dependent variable) and the degree of concentration, Bils and Klenow used the following dependent variables: contribution of four largest enterprises in branch revenue, margin and diversion ration of a given product. The estimated model indicates larger price changes frequency in more competitive sectors, measured by the concentration coefficient and the margin and product substitution (Ibidem, pp. 957-959). In the second model, Bils and Klenow considered the degree of product processing. That variable seems to have a significant effect on the price variability frequency. In that model, variables: contribution of four largest enterprises in branch revenue and margin, became less significant in terms of price change frequency[1]. The authors indicate that competitiveness of the branch, at least measured by the variables used, is a weak predictor of price change frequency.

[1] The second model proved better adjustment to the data – R^2 63%, as compared to 36% in model 1.

Research methodology

Three types of data have been used in the research: 1) data concerning the number of companies according to the PKD classification[2] (annual data of the period from 2001 to 2013); 2) data concerning net revenue on sales of products, grouped according to the PKD classification (annual data of the period from 2001 to 2013); 3) price indexes of consumer goods and services announced on the basis of the Classification of Individual Consumption according to Purpose, adapted to the needs Harmonized Indices of Consumer Prices[3] (COICOP/HICP) (Central Statistical Office 2014) (monthly data of the period from December 2001 to April 2013).

Based on the data mentioned in item 1, the indexes of degree of monopoly[4] have been estimated. Their purpose is to determine the relative degree of monopoly in individual branches. In this study it has been assumed that the degree of monopoly is measured as the average number of enterprises in a given branch – the lower is the number of companies, the less competitive is a given structure. To estimate the degree of monopoly (competitiveness) of a given sector, the Average Numbers of Companies Index (ANoCI)[5] has been used. ANoCI has been estimated based on the following formula[6]:

$$ANoCI_i = \frac{\sum_{j=1}^{n} n_{jt}}{\sum_{j=1}^{n} N_{jt}} / \frac{\sum_{j=1}^{n} n_{jt}}{\sum_{j=1}^{n} N_{jt}}$$

where:
$ANoCI_i$ – average numbers of companies index in sector i, based on COICOP
n_{jt} – number of companies having PKD code j in the year t;
N_{jt} – number of PKD codes representing sector i, based on COICOP in the year t;
i – COICOP code;
j – PKD code;
t – year (t=2001,…,2013)

[2] Data derived from the National Official Business Register REGON. Collected data concern approx. 40 thousand enterprises.

[3] Data derived from the CEIC database.

[4] The paper that presents methodology and results of degree of monopoly and market power is in review (Umiński, in review).

[5] In particular it refers to an average number of companies under the same PKD code. One COICOP code usually covers several PKD codes. It is the effect of matching of both classifications.

[6] This index has been transformed into a fixed base index by determining the ratio of the average number of companies in a given COICOP sector (code) in the whole analysed period and the average number of companies in all COICOP sectors (code) in the whole analysed period.

Market Power Index (MPI) has been determined using additional data concerning net revenue from sales of products achieved by companies grouped according to the PKD classification (item 2). Market power of enterprises, that can be used, e.g. in the price-setting process, does not have to be determined only by the market structure. In other words, if a given branch is relatively small, then even an oligopolistic market structure may not give the companies representing that branch a significant market power and the possibility to shape their prices. Thus the market power index MPI is the average revenue per company in a given branch – the lower is the number of companies representing the branch and the higher is the revenue achieved by all companies in that branch, the higher are the values of the MPI index[7]. MPIs for individual COICOP sectors have been estimated with the use of the following formula:

$$MPI_i = \frac{\sum_{j=1}^{n} \frac{r_{jt}}{n_{jt}}}{\sum_{j=1}^{n} N_{jt}} \Big/ \frac{\overline{\sum_{j=1}^{n} \frac{r_{jt}}{n_{jt}}}}{\sum_{j=1}^{n} N_{it}}$$

where:
n_{jt}– number of companies having PKD code j in the year t;
N_{it}– number of PKD codes representing sector i, based on COICOP in the year t;
r_{jt}– net revenue from sales of products of PKD code j in the year t;
i – COICOP code;
j – PKD code;
t – year (t=2001,…,2013)

Unfortunately, part of the data concerning net revenue from sales had not been disclosed, due to the possibility of identifying the entity concerned. According to the statistical confidentiality principle, individual data or data in which aggregation comprises less than three entities, or in which the proportion of an individual entity exceeds 3/4 in a particular aggregation, cannot be made available[8]. As a result, MPIs estimation has been limited, considering only those years in which net sales revenues of all companies were public. If for a given branch there were no years in which all net

[7] The obtained average net revenues from sales of products have been transformed into a fixed base index by dividing individual values by the average revenue in all COICOP sectors (codes) and in all years encompassed by the analysis.

[8] Act of 29 June 1995 concerning official statistics, Journal of Laws of 1995 No. 88, item 439.

revenue values were public, the analysis was limited to those years in which confidentiality was relatively lowest[9].
ANoCI and MPI indexes are presented in figure 1.

In this analysis, price indexes of consumer goods and services announced by the Central Statistical Office have been used[10]. The publications of the Central Statistical Office are based on the Classification of Individual Consumption by Purpose adapted to the needs of Harmonised Indices of Consumer Prices (COICOP/HICP) (Central Statistical Office, 2014).

The price setting model formulated by Guillermo Calvo (Calvo 1983) assumes that revision of prices in individual enterprises is not a continuous process, and that these processes between enterprises are not synchronised. Consequently, a business entity must respond in its price-setting process to the occurrence of a random signal that triggers the price-setting decision. It is assumed that the probability of occurrence of that signal in the following periods is not related to the period in which it occurred in the past and is specific for every company. The Calvo price setting model also assumes that individual companies determine the prices of their products with consideration of the expected average price and the market situation. A given price is changed only when respective company receives a signal that indicates the necessity of that change (Ibidem 1983, p. 383-384).

According to the Calvo price setting model, price in time t is the function of a discounted sequence of price-setting decisions made in the preceding periods:

$$p_t = \delta \sum_{j=0}^{\infty} (1-\delta)^j v_{t-1}$$

where:
p_t – price in time t;
δ – probability of receiving a price change signal from the market;
v_t– price-setting decisions in period t.

[9] The highest coefficient for which data have been used to estimate MPIs for companies whose data have been made confidential in relation to all companies in the branch, was 3.3%. Considering the fact that in group 08.1 Postal Services there were no years in which complete data were available, and the minimum rate of enterprises with undisclosed revenue due to statistical confidentiality, in relation to all companies in the branch was 23.8%. That group has been excluded from MPI estimation.

[10] It actually concerns the CEIC database, not the publications on the website of the Central Statistical Office.

This equation can be presented in form of a difference equation (Wallusch, 2007):

$$p_t = \delta v_t + (1 - \delta) p_{t-1}$$

Then the unobserved variable *v* is considered a residual of the autoregressive AR(1) model:

$$p_t = \alpha p_{t-1} + \eta_t$$

where:

$$\alpha \equiv 1 - \delta$$

$$\eta_t \equiv \delta v_t$$

It is also assumed that price-setting decisions v_t are a white noise process, which allows to assume that the product of δv_t has a normal distribution with zero average and finite variance.

Having parameter α estimated, it is possible to determine the price change probability in the following month:

$$\delta = 1 - \alpha$$

With the assumption that price may change any time, not only with monthly intervals, it is possible to determine the so-called immediate price change possibility:

$$-ln(1 - \alpha)$$

the average time between price changes in months is (Wallusch, 2007, p. 147):

$$T = \frac{-1}{ln(1 - \delta)}$$

Trend has been removed from the used time series of prices by means of the Hodrick-Prescott filter with standard smoothing parameter for monthly

series[11]. Seasonality has been removed using the Census X-12 method.

The price change probability for the aggregated index of consumer prices from December 2001 to April 2013 is 5.71%, which gives 17.02 months between price changes[12].

Results

The analysis of correlation using both Spearman's rank and Kendall's Tau coefficients (Table 1) indicates the lack of any statistically significant dependence between the Calvo price change probability, degree of monopoly index ANoC and the market power index MPI. It implies that the the market structure and the market power of enterprises in a given branch have no effect on price flexibility in these branches.

Conclusions formulated on the basis of the analysis of correlation coefficients have been confirmed by the regressive analysis[13]. In all cases – whether in the divisions, groups or classes[14] – the regression analysis confirmed the lack of any statistically significant dependence between the degree of monopoly (ANoC) and price flexibility (Calvo) and also between the market power index (MPI) and price flexibility (Calvo). In each case, the dependent variable – ANoC or MPI – was statistically insignificant.

Conclusions

The analysis performed indicates that there is no statistically important dependence between the degree of monopoly, market power and price flexibility. Despite the fact that high differentiation of price change probability occurred in individual branches, it could not be explained using the assumed degree of monopoly and market power indexes.

The dependence between the degree of monopoly, market power and price flexibility has been analysed many times. The obtained results suggested that such dependence occurs frequently, but its strength is rather insignificant. The surveys indicated a bit stronger dependence. Consequent-

[11] It is necessary due to high autoregressive parameter values occurring when trend is nor removed from the time series. In such case, price change probability is underrated.

[12] J. Wallusch obtained a similar result for CPI in the period from January 1994 to June 2006, amounting to 6.6% (15 months between price changes) (Wallusch, 2007, p. 150).

[13] All presented models had correct specification.

[14] In case of sub-classes, the number of available observations was not sufficient to conduct the regression analysis.

ly, other factors may better explain the differentiation in price flexibility, or in this case, price change frequency, than the degree of monopoly and market power. It is also confirmed by the research presented in this paper, which suggests that in Poland, selected variables of degree of monopoly and market power cannot explain price change frequency at all.

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Annex

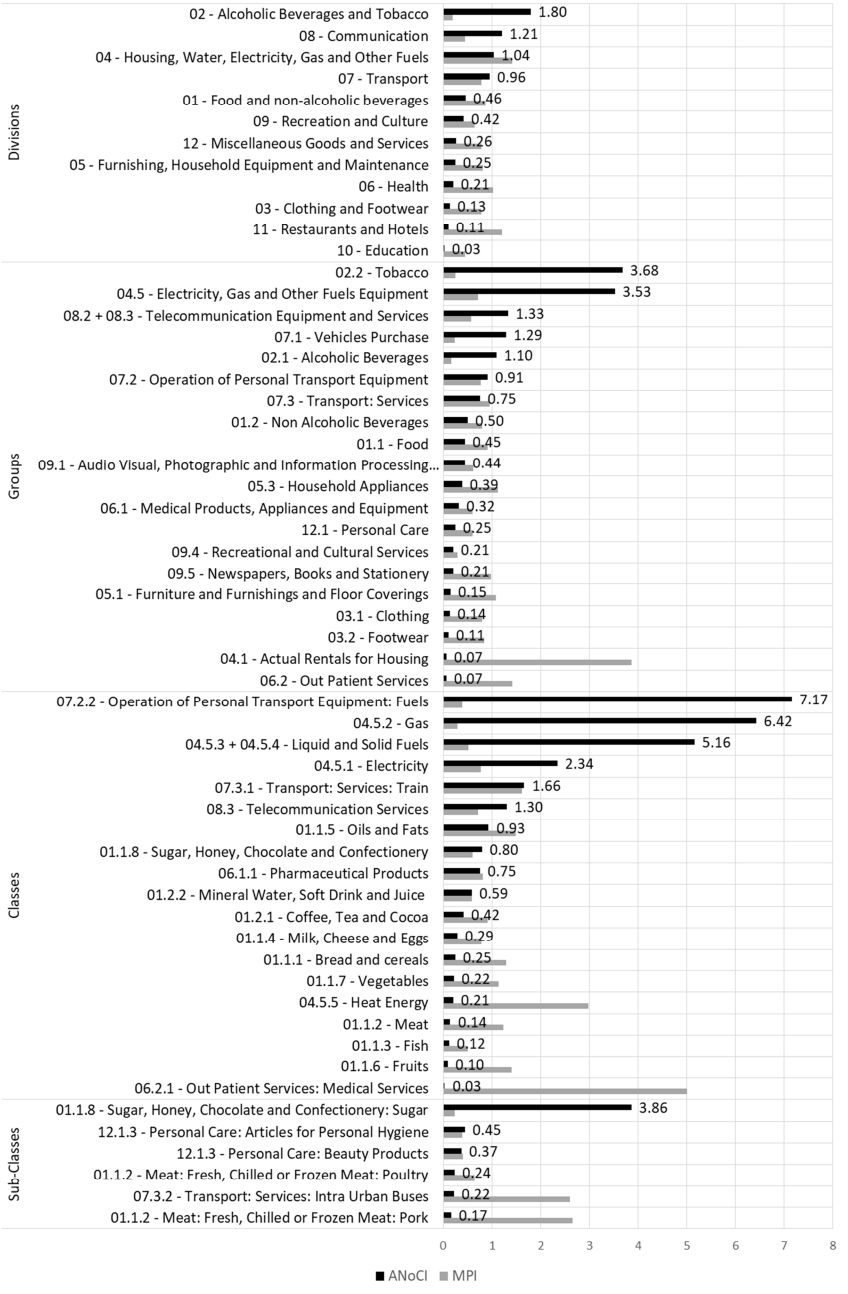
Table 1. Results of calculation of the Spearman's rank correlation and Kendall's Tau coefficients between Calvo price change probability and the degree of monopoly and the market power indexes

	number of observations	Spearman's rank correlation coefficient/ Kendall's Tau	coefficient value	p-value
ANoCI - degree of monopoly index	divisions - 12	Spearman	-0.32	0.29
		Kendall	-0.27	0.19
	groups - 20	Spearman	-0.34	0.14
		Kendall	-0.22	0.16
	classes - 19	Spearman	0.07	0.77
		Kendall	0.08	0.67
	sub-classes - 6	Spearman	-0.54	0.22
		Kendall	-0.47	0.13
MPI - market power index	divisions - 12	Spearman	-0.08	0.78
		Kendall	-0.09	0.63
	groups - 20	Spearman	0.26	0.27
		Kendall	0.20	0.23
	classes - 19	Spearman	0.27	0.25
		Kendall	0.16	0.36
	sub-classes - 6	Spearman	0.54	0.22
		Kendall	0.47	0.26

Table 2. Results of regression analysis between Calvo price change probability and the degree of monopoly and the market power indexes

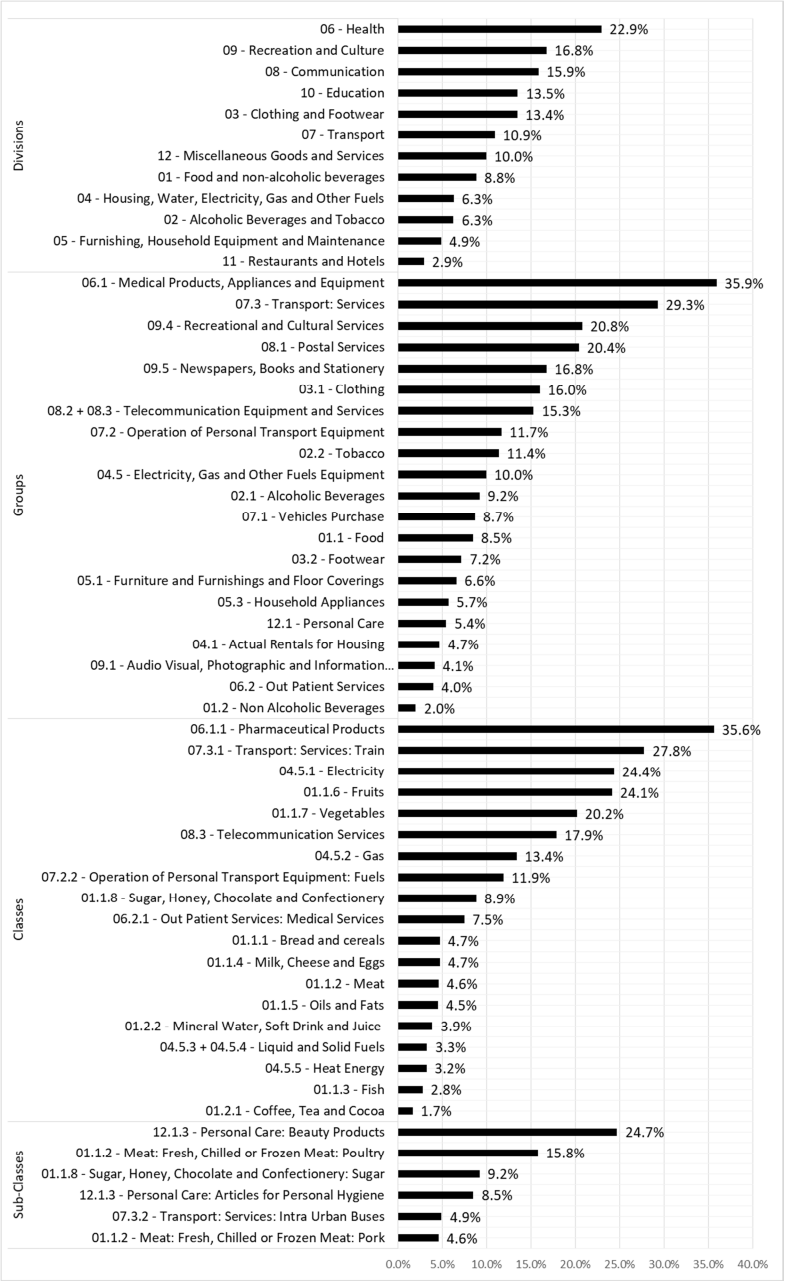
	sample size	Model	P-value	Determination factor R-square
ANoCI - degree of monopoly index	divisions - 12	Calvo = 0.06 + 0.21 ANoC - 0.15 $ANoC^2$	0.35 0.26	0.18
	groups - 20	ln_Calvo = -2.50 - 0.34 ln_ANoC	0.11	0.13
	classes - 19	Calvo = 0.10 + 0.04 ANoC - 0.01 $ANoC^2$	0.67 0.58	0.03
	sub-classes - 6	insufficient observation	---	---
MPI - market power index	divisions - 12	Calvo = 0.12 - 0.02 MPI	0.57	0.03
	groups - 20	ln_Calvo = -2.27 + 0.13 ln_MPI	0.36	0.05
	classes - 19	ln_Calvo = -2.43 + 0.15 ln_MPI	0.32	0.06
	sub-classes - 6	insufficient observation	---	---

Figure 1. Degree of monopoly and market power in selected sectors of the Polish economy based on COICOP classification



Source: individual study.

Figure 2. Price change probability according to Calvo method in divisions, groups, classes and subclasses of the Polish economy



Source: individual study.

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The member cities of the Polish National Cittaslow Network – a common idea, different development potential

JEL Classification: *O18; R11*

Keywords: *idea Cittaslow; Polish National Cittaslow Network; ranking of cities*

Abstract

Research background: Currently, 28 cities belong to the Polish National Cittaslow Network, including 20 from the Warmińsko-Mazurskie Province. The network is dynamically growing and is the second largest Cittaslow network in the world. Cities co-operate within the network, promote and spread the idea of a good life. At the same time, they take care of preserving the unique character of each of them. Cities are joined by a common idea adopted to improve the quality of residents' life. However, each city has a different history, tradition, natural and cultural values, and also has a different development potential.
Purpose of the article: The purpose of the study was to assess the development potential of member cities of the Polish National Cittaslow Network.
Methods: The method of linear ordering based on a synthetic index was used to assess the development potential of cities. The synthetic index of development potential of cities was determined using non-model methods.
Findings & Value added: The highest development potential is characterized by Rzgów, a city located in the Łódzkie Province, being part of the Łódź agglomeration. In the second place in the ranking is Lubawa, a city located in the Warmińsko-Mazurskie Province. The cities with the lowest development potential are Rejowiec Fabryczny, located in the Lubelskie Province and Kalety, located in the Śląskie Province. Most of the cities of the Polish National Cittaslow Network are cities in which the value of the synthetic index of development potential is below the average for all cities. These cities hope that membership in the network will become a factor that positively accumulates their development.

Introduction

The Polish National Cittaslow Network was founded on April 2007. It is currently the second largest Cittaslow network in the world, and continues to develop very dynamically. There are 28 member cities, of which 20 lie in the Warmińsko-Mazurskie Province. The supporting member of the network is the Marshal's Office of the Wamińsko-Mazurskie Province.

The purpose of the Polish National Cittaslow Network is to promote and spread the idea of good life, which is an alternative to urban rush and progressing globalisation. Actions undertaken by member cities concentrate on the improvement of the quality of residents' life, care for history, nature, tradition and hospitality. The cities belonging to the network share the same idea adopted in order to improve quality of life of their inhabitants. However, each of these cities has different natural and cultural assets, different history and tradition as well as a different development potential.

In connection with the above, the purpose of the study was to assess the development potential of member cities of the Polish National Cittaslow Network.

The method of linear ordering based on a synthetic index was used to assess the development potential of cities. The synthetic index of development potential of cities was determined using the non-model methods. Values of the variables were obtained from the Local Data Bank. The analysis covered data from the year 2017.

Polish National Cittaslow Network – creation and development

The Cittaslow movement was born in Italy in 1999, and its aim was to extend the concept of *slow food* to other areas of human life, and consequently to offer local communities a new concept of life – "good life". The Cittaslow movement is based on the philosophy of slowness, which opposes the excessive acceleration of the pace of life in the era of globalization (Roma *et al.*, 2012, p. 28).

Idea Cittaslow is an alternative approach to urban development that focuses on local resources, economic and cultural strengths, and the unique historical context of a town. Slow cities are places where citizens and local leaders pay attention to local history and utilize the distinct local context to develop in better and more sustainable ways (Mayer & Knox, 2006, pp. 321-322). Cittaslow is an alternative vision of development, aimed towards preserving the precious local values (Grzelak-Kostulska *et al.*, 2011, p.

191). Cittaslow is a movement that highlights local differences in times of homogeneity (Baldemir *et al.*, 2013, p. 75).

The creation of the Cittaslow network was initiated by the authorities of 4 Italian cities: Bra, Greve in Chianti, Orvieto and Positano. The Cittaslow network may include small and medium-sized cities with a population fewer than 50,000 inhabitants. A candidate city must meet a minimum 50% of the 72 criteria in the certification process. These criteria are grouped into 7 areas: energy and environmental policy; infrastructure policies; quality of urban life policies; agricultural, turistic and artisan policies; policies for hospitality, awareness and training; social cohesion; partnership.

The international Cittaslow network currently consisted of 252 cities from around the world. The network is dominated by European cities – there are about 190. In second place in terms of the number of cities in the network there is Asia – about 50 cities. The European leader in terms of the number of cities in the Cittaslow network is Italy – 84 cities. In second place is Poland – 28 cities, the third place is occupied by Germany – 19 cities (*Cittaslow List*, 2018, pp. 1-10).

The Polish National Cittaslow Network was established on 13 April 2007. The founders of the network were four cities from the Warmińsko-Mazurskie Province: Biskupiec, Bisztynek, Lidzbark Warmiński and Reszel. The Marshal's Office of the Warmińsko-Mazurskie Province became the supporting member of the network. The goal of the Polish National Cittaslow Network is to promote and spread the idea of good life of city residents by implementing in cities certain solutions which belong to the scope of environmental and infrastructural policy, urban space, hospitality, social cohesion and partnership.

The Polish National Cittaslow Network currently encompasses 28 cities, of which 20 lie in the Warmińsko-Mazurskie Province. (Fig 1). Most of the cities which belong to the Polish National Cittaslow Network are small, with a population of up to 20,000, and only 3 cities, such as Bartoszyce, Działdowo and Prudnik, are medium-size ones, having over 20,000 inhabitants. The average size of a member city is 9,300 residents.

The development of cities belonging to the Cittaslow network is based on the theory of endogenous development. The most important endogenous assets of Polish slow cities include: attractive geographical location, natural environment values, rich historical and cultural heritage, local tradtitions and products, and the strong sense of social identity. Cities try to use these advantages. Therefore, the cities concentrate mostly on activities aimed at environmental protection, improving the living conditions of residents, promoting the tourist attractiveness of the city and raising the pro-ecological awareness of residents. As noted by Hatipoglu (2015, p. 33),

slow cities strive to maintain small-town distinctiveness by protecting the local heritage, slowing the pace of time and increasing livability, while supporting the principles of sustainable development. As noted by Rysz & Mazurek (2015, p. 41), slow cities lead a daily life differently than before, in a slower, less rapid way, not focused on productivity.

In summary, the development of the Polish slow cities is based on their local, endogenous potential. Importantly, each of the cities of the network has a different, unique development potential, and thus has different development opportunities.

Research methodology

The method of linear ordering based on a synthetic index was used to assess the development potential of cities belonging to the Polish National Cittaslow Network. The selection of variables was made on the basis of substantive, formal and statistical criteria. There were attempts to choose such variables that best describe the development potential of cities and are available and complete. Variability of variables and their correlation with other variables were also taken into account.

In the final set of variables on the basis of which the synthetic index of development potential of cities was built, the following variables were found (both stimulants – S, and destimulants – D):

- X_1 – number of population at the non-working age per 100 of working-age persons – D,
- X_2 – number of privately owned business enterprises per 1,000 residents – S,
- X_3 –share of enterprises in section C (industrial processing) in the total number of business entities – S,
- X_4 – share of enterprises in section G (wholesale and retail trade, car repair) in the total number of business entities – S,
- X_5 – share of enterprises in sections I and R (hospitality and catering, culture, entertainment and recreation) in the total number of business entities – S,
- X_6 – number of working persons per 1,000 residents – S,
- X_7 – population growth per 1,000 residents – S,
- X_8 – balance of internal migrations for permanent residence per 1,000 residents – S,
- X_9 – school enrollment rate for post-primary school students – S,

- X_{10} – number of residents per 1 health centre – D,
- X_{11} – number of residents per 1 pharmacy – D,
- X_{12} – number of flats per 1,000 residents – S,
- X_{13} – average useful floorspace per 1 person – S,
- X_{14} – share of the population in households with access to waterworks and sewers – S.

The synthetic index of the development potential of cities was calculated after the variables had been stimulated and normalised. The stimulation of the variables considered to act as destimulants was performed according to the formula (Panek & Zwierzchowski, 2013, p. 34):

$$\boldsymbol{x_{ij}^{S} = \max_i\{x_{ij}^{D}\} - x_{ij}^{D}} \qquad \boldsymbol{i = 1, 2, \dots, n;\ j = 1, 2, \dots, m,} \tag{1}$$

where:
x_{ij}^{S} – value of j-th variable in i-th object after stimulation,
$\max_i\{x_{ij}^{D}\}$ – maximum value of j-th destimulant variable in the set of objects,
x_{ij}^{D} – value of j-th destimulant variable in i-th object.

After stimulation, the variables were normalised. Normalisation was accomplished by applying the zeroed unitarisation procedure, according to the formula (Panek & Zwierzchowski, 2013, p. 37):

$$\boldsymbol{z_{ij} = \frac{x_{ij} - \min\limits_i\{x_{ij}\}}{\max\limits_i\{x_{ij}\} - \min\limits_i\{x_{ij}\}}} \qquad \boldsymbol{i = 1, 2, \dots, n; j = 1, 2, \dots, m,} \tag{2}$$

where:
z_{ij} – normalised value of j-th variable in i-th object,
x_{ij} – value of j-th variable in i-th object,
$\min\limits_i\{x_{ij}\}$, $\max\limits_i\{x_{ij}\}$ – min and max values of j-th variable in the set of objects.

Normalised variables were submitted to the procedure of synthetisation. The synthetic index of the socio-economic potential of cities was determined using non-model methods, according to the following formula (Panek & Zwierzchowski, 2013, p. 63):

$$s_i = \frac{1}{m}\sum_{j=1}^{m} z_{ij} \qquad i = 1, 2, \dots, n, \tag{3}$$

where:
s_i – value of a synthetic index in i^{-th} object,
z_{ij} – normalised value of j^{-th} variable in i^{-th} object,
m – number of variables.

The synthetic index of the development potential of the cities gained values within the interval of [0; 1]. Based on the values of this index, the cities which belong to the Polish National Cittaslow Network were ordered linearly.

Results

Values of the synthetic index of development potential of the cities belonging to the Polish National Cittaslow Network are presented in Table 1.

The highest development potential was determined for Rzgów, a city located in the Łódzkie Province, being part of the Łódź agglomeration. The distinguishing asset of this city among all the 28 networked cities is the highest level of entrepreneurship. There are 212 privately owned business enterprises per 1,000 inhabitants of Rzgów, while the average for all cities of the network is 93. Rzgów is characterised by the highest number of working persons per 1,000 city inhabitants (745 versus the average of 246) and the highest percentage of companies from sections C and G in the total number of economic entities (their total share was 58%).

The second place in ranking was scored by Lubawa (cf. Konecka-Szydłowska, 2017, pp. 61-73), a city in the Warmińsko-Mazurskie Province. This city has a very high number of working persons per 1,000 population (539 versus the average of 246), a high positive population growth rate per 1,000 population (3.9 versus the average -1.4) and a high positive internal migration balance for permanent residence per 1,000 population (5.8 versus the average -2.4). The third place in ranking was assigned to Murowana Goślina, a city in Wielkopolskie Province, lying with the agglomeration of Poznań. An asset of this city is its high level of entrepreneurship (there are 144 private business enterprises per 1,000 population). Murowana Goślina is also distinguished by the lowest demographic load, among all cities of network, measured by the number of non-working age population per 100 working-age persons (49 versus the average 61).

The lowest development potential was determined for Rejowiec Fabryczny, a city situated in the Lubelskie Province. The weakness of this city is its lowest entrepreneurship level among all 28 member cities. There are only 52 private sector companies per 1,000 population, which is four-fold

fewer than in Rzgów. Rejowiec Fabryczny is also characterised by a very small number of working persons per 1,000 residents (108 versus the average of 246). Other cities with low development potential are Kalety in the Śląskie Province and Górowo Iławeckie in the Warmińsko-Mazurskie Province. Significantly, in 18 member cities of the Polish National Cittaslow Network the value of the synthetic index of the socio-economic potential is below the average for all cities.

The differentiation in the development potential of the cities belonging to the Polish National Cittaslow Network is at a medium level. This is confirmed by the value of the coefficient of variation, which equals 17.4%, and by the gap between the max and min value of the synthetic index which equalled 2.5.

Conclusions

As results from the research, the differentiation in the development potential of the member cities of the network is at the medium level. This is confirmed by the value of the coefficient of variation, which equalled 17.4%, and by the relation between the maximum and minimum value of the synthetic index of the development potential of these cities, which equalled 2.5. The highest level of development potential is characterized by Rzgów, a city which lies in the Łódź agglomeration. The lowest level of development potential is characterized by Rejowiec Fabryczny. Significantly, only in 10 member cities of the Polish National Cittaslow Network the value of the synthetic index of the development potential is above the average for all cities. Tese cities are: Rzgów, Lubawa, Murowana Goślina, Nowy Dwór Gdański, Biskupiec, Nidzica, Działdowo, Pasym, Lidzbark and Lidzbark Warmiński.

Despite this diversity, the cities share the common idea, the common development model adopted to improve the quality of life in a small city. Cities cooperate with each other as part of the network, and hope that this cooperation will bring them many benefits. The functioning of cities in accordance with the idea of Cittaslow, does not mean their slowdown. It means their development by improving the quality of residents' life, increasing the attractiveness of the city for tourists, joint promotional campaigns and easier sourcing of capital.

The adoption of the "slow city" development model is therefore an opportunity to improve the attractiveness and competitiveness of small cities. It also creates real opportunities to improve their level of economic development.

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Annex

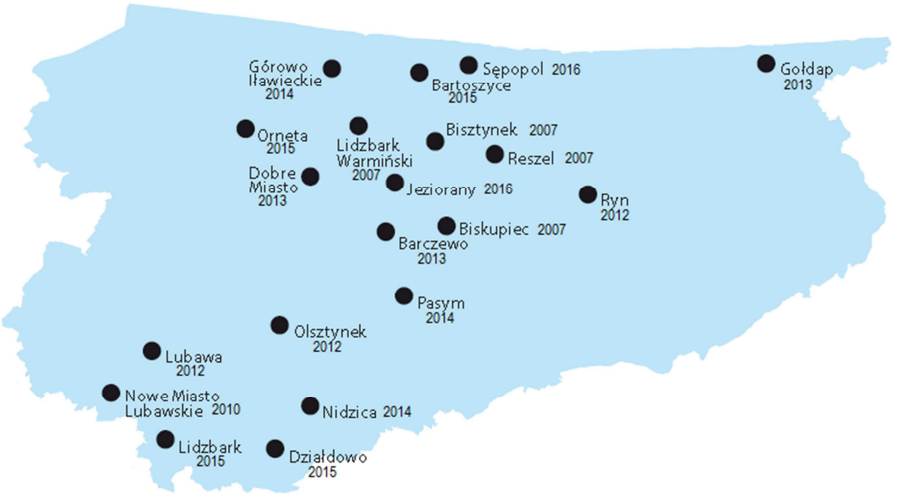
Table 1. Results of linear ordering of member cities of the Polish National Cittaslow Network

Position in the ranking	City	Synthetic index of the development potential
1	Rzgów	0.718
2	Lubawa	0.482
3	Murowana Goślina	0.473
4	Nowy Dwór Gdański	0.468
5	Biskupiec	0.456
6	Nidzica	0.426
7	Działdowo	0.423
8	Pasym	0.423
9	Lidzbark	0.411
10	Lidzbark Warmiński	0.411
11	Olsztynek	0.403
12	Barczewo	0.402
13	Głubczyce	0.402
14	Sianów	0.401
15	Bisztynek	0.401
16	Ryn	0.401
17	Bartoszyce	0.393
18	Dobre Miasto	0.389
19	Jeziorany	0.389
20	Orneta	0.386
21	Prudnik	0.376
22	Reszel	0.374
23	Nowe Miasto Lubawskie	0.370
24	Gołdap	0.363
25	Sępopol	0.363
26	Górowo Iławeckie	0.360
27	Kalety	0.337
28	Rejowiec Fabryczny	0.292
Arithmetic mean		**0.410**
Coefficient of variation		**17.4%**

Source: own calculations based on Local Data Bank (2019).

Figure 1. The member cities of the Polish National Cittaslow Network (1a – in the Warmińsko-Mazurskie Province, 1b – in other Provinces)

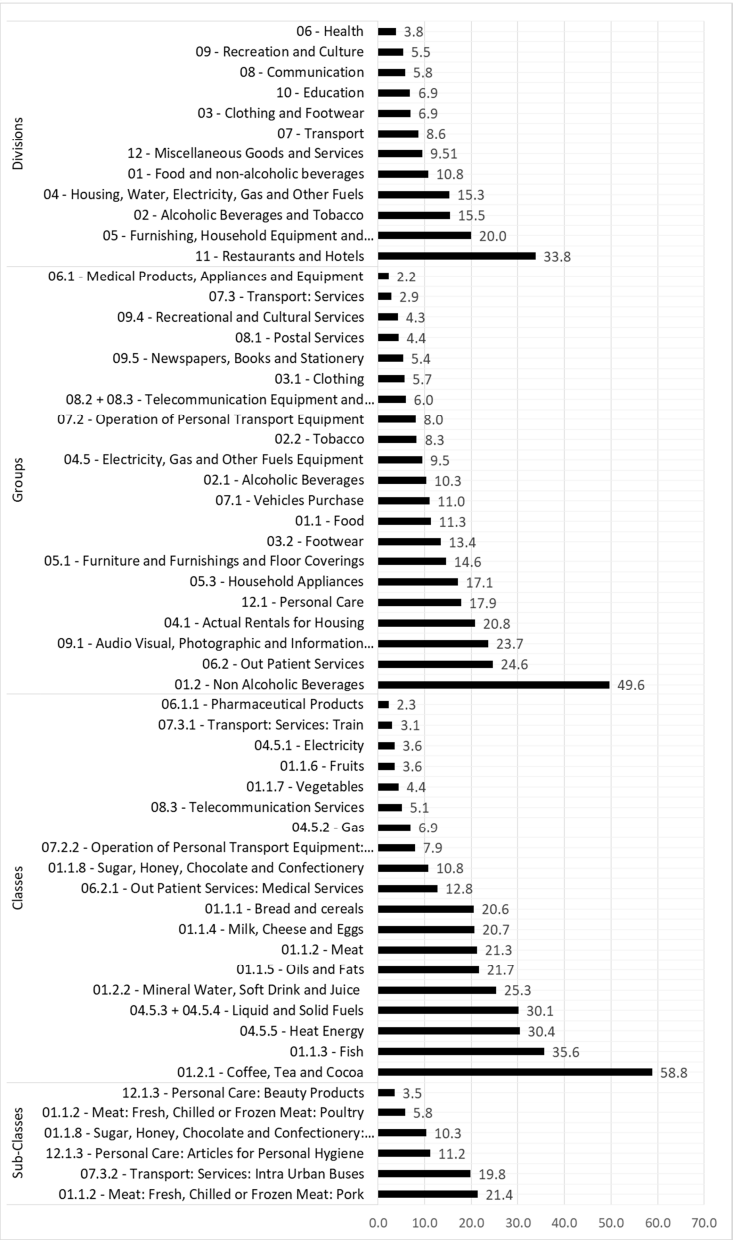
1a



1b

Source: own study.

Figure 3. Average time between price changes (in months) in divisions, groups, classes and subclasses



Source: individual study.

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