CONTEMPORARY ISSUES IN ECONOMY

11

# PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON APPLIED ECONOMICS

## QUANTITATIVE METHODS

**EDITED BY**
ADAM P. BALCERZAK
MICHAŁ B. PIETRZAK

The project implemented with Narodowy Bank Polski
under the economic education programme


NARODOWY BANK POLSKI

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# Contemporary Issues in Economy

# 11

**Proceedings of the International Conference on Applied Economics: Quantitative Methods**

**edited by**
**Adam P. Balcerzak, Michał Bernard Pietrzak**

**2021**

**Poland**

**Cover Design**
Ilona Pietryka

**The book is indexed in:**
**Economic Publishing Platform;**
**RePEc EconPapers Books and Chapters; Google Scholar**



Website: http://www.contemporary-issues.pl/proceedings

DOI: 10.24136/eep.proc.2021.4 (eBook)

ISBN 978-83-65605-44-3

ISSN 2544-2384 (Online)

Publisher
Instytut Badań Gospodarczych // Institute of Economic Research
e-mail: biuro@badania-gospodarcze.pl
www.badania-gospodarcze.pl // www.economic-research.pl

ul. Ks. Roberta Bilitewskiego, nr 5, lok. 19
10-693 Olsztyn
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**Proceedings of the 11th International Conference on Applied Economics Contemporary Issues in Economy: Quantitative Methods**

**Olsztyn: Instytut Badań Gospodarczych // Institute of Economic Research**

**2021**

**DOI: 10.24136/eep.proc.2021.2 (eBook)**
**ISBN 978-83-65605-44-3; ISSN 2544-2384 (Online)**

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# The importance of intellectual capital in building the competitiveness of banks – an example of Polish listed banks

**JEL Classification:** *G21; O34; J24; M21*

**Keywords:** *intellectual capital; competitiveness; bank*

## Abstract

**Research background:** The considerations presented in the article concern the concept of a bank's intellectual capital (IC), which has been discussed for a very long time in the source literature, mainly in relation to its components, but also the principles and methods of measurement effectiveness, mainly due to the difficult-to-measure nature of these components. The concept of division of the bank's intellectual capital into three subsystems was herein presented: organizational capital (KORG), innovative capital (KINN) and institutional capital (KINS). The role of intellectual capital in building the competitiveness of banks, which is a multidimensional concept and does not have a specific measurement method, was also emphasized.
**Purpose of the article:** The article aims to present an assessment of the competitiveness of listed banks in Poland using multidimensional statistical methods, taking into account diagnostic variables determining the economic and intellectual capital of banks.
**Methods:** The article will be based on the critical literature studies referring to domestic and foreign positions in terms of the definition and structure of banks' intellectual capital. Determining comparable diagnostic variables for the research period 2009-2019 will enable the review of reports, rankings and specialist studies related to the banking sector. The selected methods of multivariate statistical analysis will be used in the article - methods of linear ordering. A synthetic measure (aggregate measure) of banks' competitiveness will be developed based on selected diagnostic indicators related to intellectual and economic capital assessment.
**Findings & Value added:** In the article, the author systematized the bank's intellectual capital structure**.** Based on a group of 11 listed commercial banks in Poland

in 2009-2019 created a synthetic measure (aggregate measure) of banks' competitiveness based on selected diagnostic indicators related to the assessment of intellectual and economic capital, which, according to the author, have the most significant impact on competitiveness. As a result, rankings of banks were established in terms of their competitiveness, considering the stratification of the bank's capital, which may serve as a discussion for further investigation in this area. The long-term leadership position may indicate the bank's condition and its intensified activities in intellectual capital development, which may constitute important information for stakeholders.

## Introduction

On the banking services market, a similar product offer, decreasing interest income, and similar functionality of distribution channels draw the managers' attention to the bank's intangible resources, such as knowledge, employee skills, service quality, social relations and image as well as innovation, in other words, broadly understood intellectual capital (IC). As service companies operating in the knowledge-based economy, banks use intellectual (non-financial) capital no less intensively than financial capital (Klimontowicz 2018, p. 252). So far, most of the available analyzes of building the competitiveness of banks have been based on typical financial indicators (profitability or efficiency indicators). The changing conditions for the functioning of the sector in the 21st century require a strong appreciation of activities building the competitiveness of banks and based on the development of intellectual capital subsystems (Ozkan, Cakan, Kayacan, 194) p. 194). The concept of intellectual capital (IC) has long been the subject of discussion in the literature, primarily about the components and principles and methods of measurement effectiveness, mainly due to the components' difficult-to-measure nature. The IC is often seen as hidden relationships in the company's assets and therefore is not presented in the financial statements. The lack of clear-cut definitions results in the absence of consistent classifications of factors that build IC. Researchers agree that the role of human capital is emphasized as the foundation of intellectual capital, which integrates all cooperating intangible assets, but at the same time, is not sufficient to build it on its own. Intellectual capital (IC) is hidden in the relationships and the skills and knowledge of employees, co-bidders, customers or shareholders. It has a significant impact on creating a relational mechanism relating to the organizational sphere, innovation and contacts with the external and internal environment. In consequence, these features of IC and outlining the importance of knowledge in a modern en-

terprise, it can be assumed that in the area of intellectual capital, it is necessary to study (Rosińska-Bukowska 2019, p. 142):

- organizational capital (KORG) - the effectiveness of the organizational system, management principles and organizational structures in the industry dimension ; material values, i.e. trademarks, patents, copyrights, databases and IT systems resulting from the activities of human capital in the organization;
- innovative capital (KINN) - creating innovative products, services or solutions; being a combination of human and technological capital and indicating the innovations and modifications arising from research and development activities;
- institutional capital (KINS) - effectiveness of building relations with the external environment and internal, which enables to adapt to specific market areas, obtain customer loyalty and build the reputation of the organization.

Nowadays, building a bank's competitive position is undoubtedly also associated with the optimization of processes and technologies for rendering services, the bank's appropriate reputation, and the trust of customers (Fedaseyeu, Linck, Wagner, 2018, p. 819). Analyzing the source literature, there is currently no universal catalogue of measures of the competitiveness of a banking institution. Therefore, it is crucial that the banks surveying adopt their measures that emphasize the significance and purpose of the measurement of competitiveness in this regard. Business entities, including banks, must develop new methods of gaining a competitive advantage and then maintaining a favourable market position in the changing conditions of the external environment. Development is achieved thanks to innovation and modern technology and a qualified workforce deemed as essential to implement creative ideas, i.e. broadly understood intellectual capital.

## Research methodology

A bank's competitiveness requires a multidimensional analysis that will take into account all its financial and non-financial components, which will allow the identification of leaders in the banking market, who draw importance to financial efficiency and stability, as well as the innovation, quality of service, employees and other non-material aspects. The author of the article decided to use linear ordering methods, which prioritise the components of the analysed set of objects (ascending or descending order) according to the value of features or diagnostic indicators. In the framework of these methods, the examined phenomenon is assessed from the

perspective of the adopted criteria and shape synthetic indicator, being a measure of the analysed phenomenon. The first stage of the study was the preliminary data analysis, which aimed to assess the properties of individual features and indicators (information value) and their appropriate selection. This study follows the classic coefficient of variation, given by the formula:

$$v_j = \frac{s_j}{\bar{x}_j} \tag{1}$$

where: sj - standard deviation of the j-th feature or indicator, xj - arithmetic mean of the j-th feature or indicator (j = 1, ..., m).

However, the experience of researchers shows that features below the proposed threshold value of 1,2 are often also eliminated by the classical coefficient of variation. Hence, only the classic coefficient of variation was used in this study. The next step is to perform a correlation analysis as a starting point for the final selection of diagnostic variables. The inverse correlation matrix method, compared to the classical analysis of (multiple coefficients) of Pearson's linear correlation, is characterized by better properties, as it uses the multiple correlation coefficient (Zeliaś, Pawełek, Wanat, 2002), which provides information about the strength of the connection between the j-th feature or the indicator (j = 1, ..., m), and with all other features or indicators (p = 1, ..., m), where p ≠ j. First, the inverse matrix R-1 is determined to the correlation matrix R (Malina, Zeliaś,1997, pp. 529-530:

$$R^{-1} = \begin{bmatrix} 1 & \tilde{r}_{12} & \ldots & \tilde{r}_{1m} \\ \tilde{r}_{21} & \tilde{r}_{22} & \ldots & \tilde{r}_{2m} \\ \ldots & \ldots & \ldots & \ldots \\ \tilde{r}_{m1} & \tilde{r}_{m2} & \ldots & \tilde{r}_{mm} \end{bmatrix}, dla: \; R = \begin{bmatrix} 1 & r_{12} & \ldots & r_{1m} \\ r_{21} & 1 & \ldots & r_2 \\ \ldots & \ldots & \ldots & \ldots \\ r_{m1} & r_{m2} & \ldots & 1 \end{bmatrix}, \tag{2}$$

where:

$$\tilde{r}_{jp} = \frac{(-1)^{j+p}\, det(R_{jp})}{\det(R)} \tag{3}$$

Wherein detR is the determinant of the correlation matrix, and detRjp is the determinant of the matrix formed by deleting the j-th row and p-th column.

Then the elements r̃_jj on the main diagonal satisfying the inequality | r̃ |> r_0, i.e. with a value greater than the set threshold value (usually r_0 = 10), are distinguished, and they are stepwise eliminated from the set of permissible features and indicators, i.e. useful for analysis. In this way,

based on high values of r̃_jj, features and indicators excessively correlated with all others are removed, creating a set of features and indicators that are uncorrelated or poorly correlated (diagnostic). The stimulation was then performed, which consists of transforming the values of features and indicators, which are destimulants and nominants, into simulants (Ying, Yuhong 2014, pp. 636-638). It is necessary in the case of the non-model methods of the linear ordering of objects (synthetic indicator). It aims to unify the nature of features and indicators - it precedes the stage of normalization of variables. Finally, due to the presence of negative values in the data, the differential method is given by the formula to stimulate features and indicators in this study:

$$x_{ij}^{s} = \frac{b}{x_{ij}^{D}}, (j = 1, \dots, m), \tag{4}$$

where the fixed b> 0. In special cases, e.g. b=1 $or\ b = \min_{i} x_{ij}^{D}$.

It was also selected because it does not change the variability of indicators - it does not interfere with the values of the analyzed variables. The nominee appearing among the acceptable indicators was not included in the set of diagnostic indicators. There was no need to use the other formulas. After stimulation of the variables, assigned weights to variables has not been satisfactorily solved in the literature so far - there is no universal solution. Each of these approaches is associated with both pros and cons. Therefore, empirical research (as part of the first method) often assumes that diagnostic features and indicators are equally important from the point of view of the examined problem:

$$\alpha j =_1 m, (j = 1, \dots, m). \tag{5}$$

If the synthetic indicator consists of additional *k* aggregates - defined subgroups, then the system of weights equal to (5) may appear within these subgroups, and additionally also among them (6):

$$\beta j =_1 k, (j = 1, \dots, k). \tag{6}$$

One can also adopt a proprietary solution (solutions) based on the arbitrary selection of weights for analysis. However, argumentation for such an

approach should be provided. The linear ordering method should consider the quality assessment of the results obtained - to establish the quality of such a solution against other acceptable solutions. The proper stage of the linear ordering of objects is the normalization of diagnostic features and indicators, choosing the data aggregation formula (features and indicators), evaluating the quality of the obtained results (ordering), and selecting the optimal solution..

Four normalization transformations were used in the article: zero unitization; unitization, standardization and a modified version of standardization, given by the formula:

$$zij = xijts -_1 nTi = 1\frac{nt=1^1_{Txijts}nTi=1\frac{nt=1}{T}\sum^1_{xijts-}\sum^{nt=1}_{nTi=1}Txijts_2^{,j=1,\dots m.}}{\sqrt{\frac{1}{nT}\sum^n_{i=1}\sum^T_{t=1}\left(x^s_{ijt}-\frac{1}{nT}\sum^n_{i=1}\sum^T_{t=1}x^s_{ijt}\right)^2}}(j=1,\dots m) \quad (7)$$

Synthetic indicator with μ_i values for the i-th object (i = 1, ..., n), where z_ij are normalized data values, and α_j (j = 1, ..., m) are weights for features and indicators α_j∈ (0; m ) for which, in particular, $\sum^m_{j=1}\alpha_j = 1$, can be expressed as:

$$\mu_i = \sum^m_{j=1}\left(z_{ij}\alpha_j\right) \quad (8)$$

$$\mu_i = {}^1\!/_m \sum^m_{j=1}(z_{ij}\alpha_j) \quad (9)$$

In general, the formula (8) was used in the article, partial measures were also introduced (for individual types of capital), which required a modification of the weighting method by taking into account the formula (9) inside individual types of capital.

Assessing the quality of the obtained results is an essential stage of the analysis. The purpose of the quality assessment is to help in selection of one final result - considered optimal, in some sense the best one compared to the others. The (doctoral) dissertation is based on the method (Kukuła and Luty, 2015, pp. 2019-231), which is based on the positions in the ranking created on the basis of the value of the synthetic indicator (instead of the values of the synthetic indicator itself). So if we have v different ranking results (for n elements), then the number of possible comparisons between these rankings is:

$$a = \frac{v(v-1)}{2} \tag{10}$$

By comparing the ranking results, this shall be understood as the estimation of the measure of similarities in mrs rankings according to the formula:

$$m_{rs} = 1 - \frac{2\sum_{i=1}^{n} |c_{ir} - c_{is}|}{n^2 - z}, \; r, s = 1,2, \ldots, v \tag{11}$$

where: $c_{ir}$ - position of the i-th object in the ranking with the number *r*, $c_{is}$ – the position of the i-th object in the ranking with the number *s*, while $z = \begin{cases} 0, n \in P \\ 1, n \in P \end{cases}$, where P - a set of even natural numbers

The results of the comparisons "between rankings" can be presented in the form of a symmetrical matrix M with dimensions vxv, where the rankings with the same numbers are compared on the main diagonal, for which $m_{rs} = 1$, dla $r = s, and\ outside\ the\ main\ diagonal\ mrs = msr, for\ r \neq s$.

In order to determine the degree of similarity in the ranking as a result of the r-th method of linear ordering of objects in relation to the other rankings, the sum of the elements of the r-th row (or column) of the matrix M minus 1, should be calculated, according to the formula:

$$\bar{u}_r = \frac{1}{v-1} \sum_{\substack{s=1 \\ r \neq q}}^{v} m_{rs,} \; r, s = 1,2, \ldots, v \tag{12}$$

Ultimately, the linear ordering method must be selected (and associated ranking) for which $\bar{u}_r = \max_r \bar{u}_r$ This result can be considered optimal (best) in the sense that it will be the closest (similar, correlated) to all other ranking results - in other words, it will be the least different from all other ranking results.

## Results

The study of the impact of intellectual capital on the competitiveness of banks in Poland was conducted based on the performance of 11 commercial banks between 2009 and 2019. The database consisted of 27 acceptable indicators, which are presented in Table 1. In the first step, a preliminary data analysis was performed - the measures of descriptive statistics were calculated: mean, standard deviation, asymmetry (skewness), range, mini-

mum and maximum result, and also the variability index vj was calculated for each acceptable indicator.

Such analyzes were performed separately for each year. Table 2 presents selected measures for 2009 and 2019. For all analyzed years, the coefficient of variation was above the acceptable threshold of 0,1 (10%). Variables with right-hand asymmetry (positively skewed) prevail in these years. A stimulant with such an asymmetry is essential, while a simulator with a left-hand skew indicates that most of the objects in the group score above average and thus insufficiently differentiate the tested objects. Initially, the X8 indicator was excluded from the analysis (number of clients actively using the mobile application/number of clients (MB / C)), for which data was only available from 2013.

The next step, the correlation coefficients and inverse correlation matrices, were determined separately for each group of indicators (2009-2019). In this procedure, the diagonal elements of the obtained inverse, assuming that the set of acceptable indicators are stepwise, excluded those indicators for which the values on the main diagonal are greater than 10 (D)

A collective list of diagnostic indicators of indicators (uncorrelated or poorly correlated) for the years 2009-2019 was prepared based on the conducted analyses. The results of the selection of diagnostic indicators for analysis for individual years differed. Therefore, for further research, those indicators were selected that occurred at least 6 times during the period under study. Ultimately, the analysis included 15 indicators, 13 of which were marked as stimulants and 2 as destimulants, as presented in Table 3. In the next step, the stimulation of the X4 and X18 indices (conversion of the destimulant value to stimulants) was performed by the differential method, using the formula (4). In terms of weighing diagnostic indicators, two solutions were adopted in the analysis - the system of equal weights and the auctorial system of weights.

Taking into account the number of diagnostic indicators within the subsystems of intellectual capital, i.e. innovative (2), institutional (3) and organizational (5) capital, as well as economic capital (5)

the equal weights for the indices in these subgroups were 0,50; each, respectively; 0,33; 0,20 and 0,20; and the weights equal for the subgroups (individual types of capital) were 0,25. each. With the second method of weighing the diagnostic indicators - proposed by the author - under the innovative, institutional, economic and organizational capital, the weights for the indicators in these subgroups were 0,50; each, respectively. ; 0,33; 0,20 and 0,20; while the weights for the subgroups (for individual types of capital) were respectively 0,20; 0,20; 0,40 and 0,20. In other words, the author decided to assign a total weight of 0,40 for indicators characterizing

economic capital and a total weight of 0,60 for the total of intellectual capital, where each subsystem of this capital (innovative, organizational, institutional) was assigned 0,20. The exact method of weighting the ratios /types of capital is presented in Table 4.

Moving on to the proper stage of the linear ordering of banks - normalization of diagnostic indicators, aggregation and quality assessment - as a result of applying 4 normalization formulas, i.e. 2 ways of unitarization and 2 ways of standardization; in combination with 2 weight systems (equal, proprietary), finally 8 variants of results (rankings) were obtained for each analyzed year (2009-2019). Table 6 summarizes the above methods of analysis. The results of the linear ordering of banks (rankings), for example, using the author's weighting system and standardization, are presented in Table 7. The construction of the synthetic indicator of banks' competitiveness (KB) for the i-th bank takes into account the classic formula for aggregating diagnostic features based on the arithmetic mean (within individual types of capital) and based on the sum (for individual types of capital) according to the following formula:

$$KB_i = \sum_{j=1}^{k}\left(1/m \sum_{j=1}^{m}\left(z_{ij}\alpha_j\right)\right)\beta_j \qquad (13)$$

For example, according to variant 7 of calculations (ranking 7), the form of the synthetic indicator was as follows:

$$\begin{aligned} KB_i = {} & (0{,}5 * X7 + 0{,}5 * X14) \\ & + (0{,}33 * X12a + 0{,}33 * X22 + 0{,}33 * X23) \\ & + (0{,}2 * X1 + 0{,}2 * X3 + 0{,}2 * X4 + 0{,}2 * X5 + 0{,}2 * X16) \\ & + (0{,}2 * X9 + 0{,}2 * X13 + 0{,}2 * X15 + 0{,}2 * X15a + 0{,}2 * X18) \end{aligned}$$

and the individual parts of the formula are partial measures for each type of capital, respectively innovative, institutional, economic and organizational.
Due to the fact that both rankings 1, 2 and 7 were selected as the best with similar frequency, an analysis of the correlation between the values of the synthetic indicator for these methods of linear ordering was performed. The analysis showed a strong and positive correlation between the values of the measures in both variants of the calculations (ranking 1 and 7 and ranking 2 and 7), which is presented in Table 7.
Based on the analyzes carried out, it was decided to select the ranking 7, as the optimal solution. According to the ranking established on the basis of a synthetic indicator based on author's weights and standardization, over the analyzed years, the highest position in the ranking was occupied by

PEKAO bank - only in 2011 it was ranked 3rd, in the remaining years it was ranked 1st (7- times) or 2nd. (3- times). The lowest in the ranking was Santander Bank, which in 2016 was at position 9, while in the remaining years, position 10 or 11. Bank Millenium in 2009-2017 was ranked 1-3 in the ranking, and then in 2018-2019 it was ranked 5. In 2018-2019 an advance in the ranking for ING Bank was visible - from places 4-7 to position 2. Diagram 1 shows the results obtained for individual banks.

## Conclusions

In today's economic reality, entities that usually succeed are considered to be knowledge-based organizations, i.e. those based on a unique method of acquiring, processing and creating knowledge. Bank managers are increasingly focusing not only on efficiency and financial indicators but precisely on taking into account parameters describing the IC subsystems, including service quality, bank reputation, customer confidence in the bank and the attractiveness and comprehensiveness of its offer as essential determinants of assessment subject. Every modern bank's challenge is to understand the importance of intellectual capital, define its elements, and set measures that enable it to be effectively managed, leading to the improvement and maintenance of substantial capital and competitive position.

The article aimed to present an assessment of the bank's competitiveness, which considers the subsystems of intellectual capital. Proprietary diagnostic indicators were used, created based on the analysis of reports from specialized banks. It can be concluded that such a multidimensional assessment has identified a banking leader who, while effectively managing economic capital and caring for the stability of the financial system, also focuses on the development of intellectual capital. This issue requires further research and development of diagnostic variables to be able to develop a comprehensive measure of the bank's competitiveness. This may constitute a pre-discussion in this matter, as the structure of intellectual capital is also defined differently in the source literature.

The division of intellectual capital adopted in the article emphasizes the importance of human capital, which permeates all other structures, constituting a binding material and cannot be wholly excluded from some elements. Still, there are also many researchers finding human capital as a separate layer of intellectual capital. Different-oriented definition and division of intellectual capital result in the lack of clear recommendations as to the changes that should be made in enterprise management models to improve its competitiveness, using intellectual capital as a critical factor.

## References

Rosińska-Bukowska, M. (2019). Human Capital and Intellectual Capital in Modern International Business - Based on Studies of the Strategies of Transnational Corporations, *Comparative Economic Research-Central and Eastern Europe*, 22(2). doi:10.2478/cer-2019-0017.

Klimontowicz, M. (2018). The role of bank's innovatives in building market efficiency the case of Poland, In C. Bratianu, A. Zbuchea, A. Vitelar (Ed), *Strategica:challenging the status quo in management and economic*, Bucharest.

Ozkan N., Cakan S., & Kayacan M .(2017). Intellectual capital and financial performance: A study of the Turkish Banking Sector, *Borsa Istanbul Review*, 17(3), doi: 10.1016/J.BIR.2016.03.001.

Fedaseyeu, V., Linck, J.S, & Wagner, H.F (2018). Do qualifications matter? New evidence on board functions and director compensation. *Journal of Corporate Finance*, 48(2), doi: 10.1016/ / j.jcorpfin.2017.12.009.

Pedro, E., Leitao, J., & Alves, H. (2018). Intellectual capital and performance: Taxonomy of components and multi-dimensional analysis axes. *Journal of Intellectual Capital,* 19(2). doi: 10.1108/JIC-11-2016-0118.

Malina A., & Zeliaś A. (1997), On building taxonometric measures of living condition, *Statistics in transition: an international journal of the Polish Statistical Association,* 3(2).

Ying Nan, & Yuhong Yang (2014). Variable Selection Diagnostics Measures for High-Dimensional Regression, Journal of Computational and Graphical Statistics, 23(3), doi:10.1080/10618600.2013.829.780.

Kukuła K., & Luty L.(2015). The Proposal for the Procedure Supporting Selection of a Linear Ordering Method, *Przegląd Statystyczny*, 62(2).

## Annex

**Table 1.** Accepted indicators included in the study

| Capital | Symbol | Name | The nature of the indicator |
|---|---|---|---|
| KE | X1 | ROA | S |
| KE | X2 | ROE | S |
| KE | X3 | NIM | S |
| KE | X4 | CIR | D |
| KE | X5 | loans / loans sector (L / SL) | S |
| KE | X6 | sector deposits / deposits (D / SD) | S |
| INN | X7 | number of clients actively using internet banking / number of clients (EB / C) | S |
| INN | X8 | number of clients actively using the mobile application / number of clients (MB / C) | S |
| ORG | X9 | employee benefits / number of employees (C / E) | S |
| KE | X10 | profit / number of employees (P / E) | S |
| KE | X11 | sales revenues / assets (S \ A) | S |
| INS | X12 | Ranking Bankier-place in the ranking | D |
| INS | X12_a | Banker ranking - results in the overall ranking | S |
| ORG | X13 | increase in the number of customers compared to commercial banks (N / C) | S |
| INN | X14 | value of training / employee benefits (T / C) | S |
| ORG | X15 | number of branches / number of branches sector (B / SB) | S |
| ORG | X15_a | number of branches / number of clients (B / C) | S |
| KE | X16 | capital adequacy ratio | S |
| KE | X17 | ROS | S |
| ORG | X18 | number of clients / number of employees (C / E) | D |
| INN | X19 | training value / number of employees (T / E) | S |
| KE | X20 | loans / deposits (L / D) | N |
| KE | X21 | assets / sector assets (A / SA) | S |
| INS | X22 | number of awards granted (INC) | S |
| INS | X22_a | number of awards granted / number of awards commercial banks | S |
| INS | X23 | good CSR (GP) practices | S |
| INS | X23_a | good CSR practices / good practices commercial banks | S |

**Table 2.** Selected measures of the descriptive statistics of admissible indicators

| Symbol | Specification | 2009 | | | 2019 | | |
|---|---|---|---|---|---|---|---|
| | | mean | SD | vj | mean | SD | vj |
| X1 | ROA | 0,0062 | 0,0179 | 2,8803 | 0,0061 | 0,0072 | 1,1763 |
| X2 | ROE | 0,0553 | 0,1085 | 1,9622 | -0,0604 | 0,4210 | -6,9752 |
| X3 | NIM | 0,0227 | 0,0092 | 0,4069 | 0,0273 | 0,0126 | 0,4603 |
| X4 | CIR | 0,7349 | 0,1916 | 0,2607 | -2,3578 | 9,3094 | -3,9483 |
| X5 | loans / loans sector (L / SL) | 0,0507 | 0,0487 | 0,9591 | 0,1582 | 0,2778 | 1,7564 |
| X6 | sector deposits / deposits (D / SD) | 0,0566 | 0,0502 | 0,8873 | 0,0868 | 0,0583 | 0,6718 |
| X7 | number of clients actively using internet banking / number of clients (EB / C) | 0,3850 | 0,1611 | 0,4184 | 0,7724 | 0,1322 | 0,1712 |
| X8 | number of clients actively using the mobile application / number of clients (MB / C) | -3,9483 | -3,9483 | -3,9483 | 0,2179 | 0,1209 | 0,5549 |
| X9 | employee benefits / number of employees (C / E) | 94611,74 | 29544,85 | 0,31 | 117891,25 | 22692,01 | 0,19 |
| X10 | profit / number of employees (P / E) | 51326,14 | 57308,59 | 1,12 | 98129,78 | 116708,00 | 1,19 |
| X11 | sales revenues / assets (S \ A) | 0,0995 | 0,0659 | 0,6626 | 0,0465 | 0,0108 | 0,2329 |
| X12 | Ranking Bankier-place in the ranking | 5,4545 | 3,8932 | 0,7138 | 6,0909 | 4,1877 | 0,6875 |
| X12_a | Banker ranking - results in the overall ranking | 0,0623 | 0,0354 | 0,5687 | 0,5631 | 0,2057 | 0,3654 |
| X13 | increase in the number of customers compared to commercial banks (N / C) | 13,7360 | 39,7128 | 2,8911 | 0,0899 | 0,3196 | 3,5553 |
| X14 | value of training / employee benefits (T / C) | 0,0304 | 0,0391 | 1,2866 | 0,1234 | 0,1251 | 1,0135 |
| X15 | number of branches / number of branches sector (B / SB) | 0,0665 | 0,0598 | 0,8982 | 0,0302 | 0,0258 | 0,8540 |
| X15_a | number of branches / number of clients (B / C) | 0,3485 | 0,1701 | 0,4881 | 0,1012 | 0,0543 | 0,5363 |

**Table 2**. Continued

| Symbol | Specification | 2009 | | | 2019 | | |
|---|---|---|---|---|---|---|---|
| | | mean | SD | vj | mean | SD | vj |
| X16 | capital adequacy ratio | 0,1603 | 0,0649 | 0,4050 | 0,1526 | 0,0454 | 0,2975 |
| X17 | ROS | 0,1015 | 0,1360 | 1,3404 | 0,1531 | 0,1323 | 0,8636 |
| X18 | number of clients / number of employees (C / E) | 224,76 | 199,08 | 0,89 | 439,98 | 159,26 | 0,36 |
| X19 | training value / number of employees (T / E) | 2577,45 | 3175,30 | 1,23 | 14543,47 | 14413,37 | 0,99 |
| X20 | loans / deposits (L / D) | 0,8278 | 0,1370 | 0,1655 | 1,5203 | 2,2813 | 1,5005 |
| X21 | assets / sector assets (A / SA) | 0,0524 | 0,0450 | 0,8580 | 0,0638 | 0,0434 | 0,6801 |
| X22 | number of awards granted (INC) | 10,5455 | 10,0486 | 0,9529 | 18,0000 | 16,1696 | 0,8983 |
| X22_a | number of awards granted / number of awards commercial banks | 0,0909 | 0,0866 | 0,9529 | 0,0909 | 0,1018 | 1,1194 |
| X23 | good CSR (GP) practices | 15,6364 | 5,5477 | 0,3548 | 17,9091 | 6,6668 | 0,3723 |
| X23_a | good CSR practices / good practices commercial banks | 0,0909 | 0,0323 | 0,3548 | 0,0909 | 0,0339 | 0,3726 |

**Table 3.** Diagnostic indicators included in the study and their nature

| Capital / Symbol | Name | The nature of the indicator |
|---|---|---|
| **INN** | | |
| X7 | number of clients actively using internet banking / number of clients | S |
| X14 | value of training / employee benefits | S |
| **INS** | | |
| X12 | Banker ranking | S |
| X22 | number of awards granted (INC) | S |
| X23 | good CSR (GP) practices | S |
| **KE** | | |
| X1 | ROA | S |
| X3 | NIM | S |
| X4 | CIR | D |
| X5 | loans / loans sector | S |
| X16 | capital adequacy ratio | S |
| **ORG** | | |
| X9 | employee benefits / number of employees | S |
| X13 | increase in the number of customers compared to commercial banks (N / C), | S |
| X15 | number of branches / number of branches sector | S |
| X15a | number of branches / number of clients | S |
| X18 | number of customers / number of employees | D |

**Table 4.** System of weights adopted in the analysis

| Specification | INN | INS | KE | ORG |
|---|---|---|---|---|
| Equal weights (for indicators) | 0,50 | 0,33 | 0,20 | 0,20 |
| Equal weights (for subgroups) | 0,25 | 0,25 | 0,25 | 0,25 |
| Author's auctorial weights (for indicators) | 0,50 | 0,33 | 0,20 | 0,20 |
| Author's auctorial weights (for subgroups) | 0,20 | 0,20 | 0,40 | 0,20 |

**Table 6.** Ranking depending on the weighting system and standardization method

| Ranking | Weight system | Normalization method |
|---|---|---|
| Ranking 1 | equal | zero unitarization |
| Ranking 2 | equal | unitarization |
| Ranking 3 | equal | standardisation |
| Ranking 4 | equal | standardization (over time) |
| Ranking 5 | auctorial | zero unitarization |
| Ranking 6 | auctorial | unitarization |
| Ranking 7 | auctorial | standardisation |
| Ranking 8 | auctorial | standardization (over time) |

**Table 7.** Synthetic indicator and ranking of banks with the use of the author's weighting system and standardization

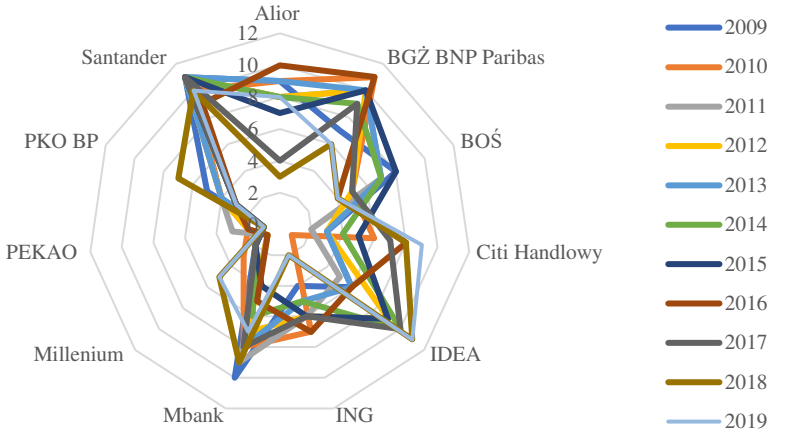
| | 2009 | | 2010 | | 2011 | | 2012 | | 2013 | | 2014 | | 2015 | | 2016 | | 2017 | | 2018 | | 2019 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Measure** | **R** | **measure** | **R** | **measure** | **R** | **measure** | **R** | **measure** | **R** | **measure** | **R** | **measure** | **R** | **measure** | **R** | **measure** | **R** | **measure** | **R** | **measure** | **R** |
| Alior Bank | 1,2766 | 11 | 1,7221 | 9 | 1,9766 | 7 | 2,1317 | 7 | 1,8485 | 9 | 2,5436 | 9 | 2,7252 | 8 | 2,0423 | 11 | 2,9756 | 6 | 1,9800 | 8 | 1,8662 | 9 |
| BGŻ BNP Paribas | 1,5476 | 7 | 1,3146 | 11 | 1,6096 | 10 | 1,6979 | 10 | 1,6351 | 10 | 2,4129 | 10 | 2,5524 | 9 | 2,0864 | 9 | 2,6563 | 10 | 2,2871 | 3 | 2,1841 | 6 |
| BOŚ | 1,5542 | 6 | 2,0827 | 4 | 1,9165 | 8 | 2,1087 | 9 | 2,2342 | 7 | 2,7117 | 6 | 2,8378 | 6 | 2,3643 | 4 | 3,0128 | 5 | 2,2088 | 4 | 2,1130 | 7 |
| Citi Handlowy | 1,9408 | 4 | 1,9055 | 7 | 2,5023 | 2 | 2,4153 | 4 | 2,3076 | 5 | 2,8091 | 5 | 2,7854 | 7 | 2,1182 | 8 | 2,7552 | 8 | 2,1025 | 6 | 2,0586 | 8 |
| IDEA | 1,4919 | 8 | 2,3094 | 2 | 2,3569 | 5 | 2,1175 | 8 | 2,3249 | 4 | 2,5541 | 8 | 2,5250 | 10 | 2,1441 | 7 | 2,7527 | 9 | 1,6843 | 10 | 1,6144 | 10 |
| ING | 2,0306 | 3 | 2,0757 | 5 | 2,1171 | 6 | 2,2872 | 5 | 2,5146 | 2 | 2,9109 | 4 | 3,0829 | 4 | 2,3416 | 5 | 3,2032 | 3 | 2,3631 | 2 | 2,4432 | 2 |
| mBank | 1,3576 | 10 | 1,7878 | 8 | 1,8674 | 9 | 2,1993 | 6 | 2,0734 | 8 | 2,6735 | 7 | 2,9574 | 5 | 2,3073 | 6 | 2,8850 | 7 | 2,1697 | 5 | 2,3702 | 3 |
| Millenium | 2,1888 | 2 | 2,0680 | 6 | 2,4518 | 4 | 2,7354 | 1 | 2,2627 | 6 | 3,0340 | 3 | 3,2386 | 3 | 2,4639 | 3 | 3,0652 | 4 | 2,0420 | 7 | 2,1851 | 5 |
| PEKAO | 2,3578 | 1 | 2,4101 | 1 | 2,6412 | 1 | 2,6701 | 2 | 2,6094 | 1 | 3,3689 | 1 | 3,6016 | 1 | 2,7385 | 2 | 3,5943 | 1 | 2,6270 | 1 | 2,6762 | 1 |
| PKO BP | 1,6563 | 5 | 2,1903 | 3 | 2,4710 | 3 | 2,4911 | 3 | 2,4851 | 3 | 3,2751 | 2 | 3,3175 | 2 | 2,7777 | 1 | 3,2290 | 2 | 1,9318 | 9 | 2,2415 | 4 |
| 1.4746 | 1,4746 | 9 | 1,3194 | 10 | 1,5712 | 11 | 1,5576 | 11 | 1,2241 | 11 | 1,7693 | 11 | 2,0110 | 11 | 2,0570 | 10 | 2,2325 | 11 | 1,5216 | 11 | 1,6114 | 11 |

Measure - value of a synthetic indicator; R - ranking

**Table 8.** Pearson's linear correlations of the values of synthetic indicators for variants 1 and 7 as well as 2 and 7

| Year | Correlation (rankings 1 and 7) | Correlation (rankings 2 and 7) |
|---|---|---|
| 2009 | 0,984 | 0,997 |
| 2010 | 0,956 | 0,997 |
| 2011 | 0,988 | 0,996 |
| 2012 | 0,967 | 0,991 |
| 2013 | 0,983 | 0,997 |
| 2014 | 0,969 | 0,997 |
| 2015 | 0,984 | 0,999 |
| 2016 | 0,947 | 0,998 |
| 2017 | 0,957 | 0,999 |
| 2018 | 0,961 | 0,994 |
| 2019 | 0,979 | 0,993 |

**Figure 1.** Static ranking of banks for a measure of development based on author's weights and standardization



**Adam P. Balcerzak & Michał Bernard Pietrzak (Eds.)**

**Proceedings of the 11th International Conference on Applied Economics Contemporary Issues in Economy: Quantitative Methods**

**Olsztyn: Instytut Badań Gospodarczych // Institute of Economic Research**

**2021**

**DOI: 10.24136/eep.proc.2021.2 (eBook)**
**ISBN 978-83-65605-44-3; ISSN 2544-2384 (Online)**

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# Evaluating fragility in Central and Eastern European countries

**JEL Classification:** *E32; G01; H81; O57*

**Keywords:** *economic decline; fragility conditions; zombie economics*

## Abstract

**Research background:** The coronomic crisis manifested itself in the fact that many countries of the world, including the USA, China and most Central and Eastern European countries, suspended their economies. The lockdown of economic activity primarily concerned tourism and caused a collapse in stock exchanges which directly affected the real sector of the economy.
This COVID-19 crisis and past financial crisis experiences show the research gap that allows to contribute to recognize the determinants of economic fragility and aims at revealing how to mitigate these negative phenomenon in the future and - if happen - offer proper anti-crisis and recovery policy responses.
**Purpose of the article:** The aim of this study is to identify main drivers of economic fragility in Central and Eastern European countries.
**Methods:** This study focuses on fsQCA (Fuzzy set Qualitative Comparative Analysis) in economic fragility and crisis research. The study concentrates on implementing fsQCA method to identify and evaluate the main drivers of economic fragility in Central and Eastern European countries based on Fragile States Index data. Research covers 2020.
**Findings & Value added**: This article shows how an fsQCA approach can overcome the knowledge gap of current conceptual and methodological attempts to expose economic fragility's architecture of causalities.
The research indicates and examines the main reasons for economic fragility in Central and Eastern European countries, e.g.: economic decline, uneven economic development, unemployment rate, demographic pressure, government debt, bankruptcy declarations. As a result of the coronomic crisis and anti-fragility measures the national budgets deficit is growing and its reduction will be one of the main

tasks of the post-crisis period. It points out that anti-crisis measures, by their nature, can create conditions for promoting the zombie-ing of the economy.

## Introduction

The OECD describes fragility as the combination of exposure to risk and insufficient coping capacity of the state, systems and/or communities to manage, absorb or mitigate those risks. Fragility can lead to negative outcomes including violence, poverty, inequality, displacement, and environmental and political degradation. Fragility of countries is assessed by a combination of measurable indicators (OECD, 2020). Failed states, characterized by not meeting the basic needs of citizens, are characterized by low level of economic development, poverty, epidemics and conflicts of various backgrounds.

Over the last 20 years, fragile contexts have gradually increased their connections to international systems, trade, migration and financial networks. For many fragile contexts, this improved economic connectivity has been a source of opportunity, increasing investment in infrastructure, opening access to new markets, facilitating new approaches to social service delivery, and enabling domestic and international finance where it might not otherwise be available. Fragile contexts may be among the hardest hit from reductions in external finance, foreign direct investment (FDI) and remittances, with impacts on tax revenues and significant debt risks. Efforts to support the access of fragile contexts to domestic and international financing should include mechanisms to reduce the volatility of financial flows and prepare for so-called black swan events. A black swan is an “unknown” where its very existence is not recognized or predicted. Black swans are “future circumstances, events or outcomes that are impossible to predict, plan for, or even to know where or when to look for them”. Fuzzy logic based risk assessment considers that a single variable can be a member of multiple groups e.g. it can capture uncertainty, vagueness and aggregated risk that if one event happens this then makes a second event more likely (Manning *at al.*, 2020, pp. 289–290).

The majority research of fragility focuses on financial fragility. Bernanke & Gertler (1990) characterize a "financially fragile" situation as one in which balance sheets are so weak that the economy experiences substantial underinvestment, misallocation of investment resources, and possibly even a complete investment collapse. Determinants of financial instability and the interaction between financial constraints generates cyclical fluctuations characterized by dynamic instability have been pointed out by a prestigious

and diversified tradition of thought including, e.g., Fisher (1933, pp. 337–357).

What have not been thoroughly analyzed are the determinants of economic fragility. In this paper the author intends to contribute to this analysis by identifying and interpreting main drivers of economic fragility in Central and Eastern European countries by using fsQCA[1] (Fuzzy set Qualitative Comparative Analysis) in this research. The purpose of the study is to indicate and interpret main drivers leading to the economic fragility in Central and Eastern European countries.

Jiang *at al.* (2017, p. 342) highlight the necessity and urgency of cleaning up zombie companies. Zombie enterprises are characterized by low operational efficiency and production, and they suffer from long-term losses or insolvency.

## Research methodology

The research sample consist of Central and Eastern European Countries (CEECs). CEECs is an OECD term for the group of countries comprising Albania, Bulgaria, Croatia, the Czech Republic, Hungary, Poland, Romania, the Slovak Republic, Slovenia, and the three Baltic States: Estonia, Latvia and Lithuania (*OECD Glossary of Statistical Terms*…, https://stats.oecd.org/glossary/detail.asp?ID=303). The article uses also Fragile States Index, OECD, Eurostat and International Monetary Fund data.

The study concentrates on implementing fsQCA method to identify and evaluate the main drivers of economic fragility in Central and Eastern European countries based on Fragile States Index data. The research presents the following hypothesis: The level of fragility of CEECs has been increased during the Covid-19 pandemic.

The application of fsQCA to cross-case evidence comprises three distinct phases:

1. selecting cases and constructing a truth table that defines their causally relevant characteristics,
2. testing the sufficiency of causal conditions,
3. deriving and interpreting the results.

[1] fsQCA - fuzzy set Qualitative Comparative Analysis, Ragin & Davey (2014). Fuzzy-set/qualitative comparative analysis 2.5 [software program]. Irvine, CA: Department of Sociology, University of California.

Research methodology describes data matrix and truth table construction. FsQCA comprises several steps. The first step is to construct a truth table. Stage two reduces the number of rows in the truth table. Ragin (2006) recommends a minimum consistency of 0.75. Conversely, cases where the outcome is not present are irrelevant, and are thus absent when testing propositions. During the third stage of analysis, following a review of the truth table, an algorithm simplifies combinations and minimizes solutions.

Qualitative Comparative Analysis (QCA) is an analytic technique for the study of different cases, or configurations of aspects, that can lead to the same outcome. Both theory and the mechanics of the fsQCA 2.5 software program (Ragin, 2008, pp. 87−121; Ragin & Davey, 2014) are useful to obtain information on relevant recipes and have an importance in economic fragility evaluation because "such analyses provide a useful match among the tenets of complexity theory and the inherent complexity of relationships in data" (Woodside, 2014, p. 2502). FsQCA is a program that uses combinatorial logic, fuzzy set theory, and Boolean minimization to point out what combinations of case characteristics are necessary or sufficient to produce an outcome.

The program begins with a data matrix. Although this lists the cases as rows, as with a conventional data matrix, in the columns, case characteristics are not variables in the usual sense, but degrees of membership of a defined category, namely a fragile country case or non-fragile country case. Membership may be binary: cases are either members or non-members of a category, namely fragile and non-fragile cases. A fuzzy set allows the calibration of the degree of set membership, using scores in the interval 0.0 to 1.0. Membership scores above 0.5 indicate that a case is more in than out, while scores close to 1.0 indicate that a case is mostly in, and scores close to 0.0 indicate that a case is mostly out. Full membership (1.0) and full non-membership (0.0) are qualitative states, not arbitrary values (e.g., highest and lowest scores). Conditions use six-value fuzzy set measurement scale (the interval from 0.0 to 1.0, namely: 1 = fully in; 0.8 = mostly in; 0.6 = more or less in; 0.4 = more or less out; 0.2 = mostly out; 0 = fully out) or a dichotomous approach (1 = fully in, 0 = fully out). Fuzzy sets are binary and metric at the same time.

The application of QCA to cross-case evidence comprises three distinct phases: (1) selecting cases and constructing a truth table that defines their causally relevant characteristics; (2) testing the sufficiency of causal conditions; and (3) deriving and interpreting the results.

## Results

This part of the article presents CEECs' Fragile States Index countries evaluation using fsQCA method. QCA comprises several steps. The first step is to construct a truth table. Stage two reduces the number of rows in the truth table. Establishing necessary conditions should highlight cases that lead to the outcome. During the third stage of analysis, following a review of the truth table, an algorithm simplifies combinations and minimizes solutions.

FsQCA method analyses and interprets the CEECs' countries empirical data, which were collected from the Fragile States Index. The study analyses and uses the data of the Fragile States Index that consists of 4 main groups and 12 indicators totally (3 more indicators data relay on Eurostat and International Monetary Fund). The study analyzes 15 indicators totally. These groups indicate: economic, social and cross-cutting, cohesion, and political indicators. All these groups are interconnected and intervene each other. Economic indicators include: the economic decline indicator, the uneven economic development indicator and the human flight and brain drain indicator.

The economic decline indicator considers factors related to economic decline within a country. For example, the indicator looks at patterns of progressive economic decline of the society as a whole as measured by per capita income, Gross National Product, unemployment rates, inflation, productivity, debt, poverty levels, or business failures. It also takes into account sudden drops in commodity prices, trade revenue, or foreign investment, and any collapse or devaluation of the national currency. The economic decline indicator considers the responses to economic conditions and their consequences, such as extreme social hardship imposed by economic austerity programs, or perceived increasing group inequalities. The economic decline indicator is focused on the formal economy – as well as illicit trade, including the drug and human trafficking, and capital flight, or levels of corruption and illicit transactions such as money laundering or embezzlement.

The uneven economic development indicator considers inequality within the economy, irrespective of the actual performance of an economy. For example, the indicator looks at structural inequality that is based on group or based on education, economic status, or region (such as urban-rural divide). The indicator considers not only actual inequality, but also perceptions of inequality, recognizing that perceptions of economic inequality can fuel grievance as much as real inequality. Indicator also takes into account the opportunities for groups to improve their economic status, such as

through access to employment, education, or job training such that even if there is economic inequality present, to what degree it is structural and reinforcing.

The human flight and brain drain indicator considers the economic impact of human displacement (for economic or political reasons) and the consequences this may have on a country's development. On the one hand, this may involve the voluntary emigration of the middle class – particularly economically productive segments of the population, such as entrepreneurs, or skilled workers such as physicians – due to economic deterioration in their home country and the hope of better opportunities farther afield. On the other hand, it may involve the forced displacement of professionals, and specifically the economic impact that displacement may wreak on an economy through the loss of productive, skilled professional labor.

The unemployment rate is the number of unemployed persons as a percentage of the labor force (the total number of people employed and unemployed) based on International Labour Office (ILO) definition. Unemployed persons comprise persons aged 15 to 74 who fulfill all the three following conditions: - are without work during the reference week; - are available to start work within the next two weeks; - have been actively seeking work in the past four weeks or have already found a job to start within the next three months. The indicator monitors high and persistent rates of unemployment and it helps to better understand the potential severity of macroeconomic imbalances. It points towards a potential misallocation of resources and general lack of adjustment capacity in the economy. The unemployment data are seasonally adjusted. The data source is the quarterly EU Labour Force Survey (EU LFS). The EU LFS covers the resident population in private households.

All 15 conditions comprise the five main groups, namely: (1) economic decline and poverty, (2) uneven economic development, (3) government debt, (4) unemployment rate, (5) demographic pressure.

Coverage presents empirical relevance or importance. Consistency scores should be as close to 1.0 (perfect consistency) as possible. With consistency scores below 0.75, to maintain that a subset relation exists is increasingly difficult. Conversely, cases where the outcome is not present are irrelevant, and are thus absent when testing propositions.

According to the results consistency does not exceed 0.75 for any conditions. Thus, any condition on its own assure state fragility. This results does not confirm the hypothesis that the level of fragility of CEECs has been increased during the Covid-19 pandemic. This is in line to French research results that indicate relatively low level of corporate bankruptcy

and good economic standing of French economy, because of public financial support.

## Conclusions

This article shows how an fsQCA approach can overcome the knowledge gap of current conceptual and methodological attempts to expose economic fragility's architecture of causalities.

In this study the author contributes to a theory of economics by identifying and interpreting main drivers of economic fragility in Central and Eastern European countries by using fsQCA in the research.

Because of governments' financial support the economic fragility factors, namely: economic decline and uneven economic development have too low consistency level (minimum is 0.75) and are outside the final model. This is in line to French research results that indicate relatively low level of corporate bankruptcy and good economic standing of French economy, because of public financial intervention.

In the author's opinion, economic factors should gain greater significance in the scope of the discussed issues, but they are limited and marginalized in the index construction.

As a result of the coronomic crisis and anti-fragility measures the national budgets deficit is growing and its reduction will be one of the main tasks of the post-crisis period. It points out that anti-crisis measures, by their nature, can create conditions for promoting the zombie-ing of the economy.

According to the evolutionary theory of Schumpeter, such crisis could indeed foster a new beginning. After the corona crisis and the economic downturn, the phenomenon of Schumpeter's creative destruction; has gained new, different importance.

### References

Bernanke, B., & Gertler, M. (1990). Financial fragility and economic performance. *Quarterly Journal of Economics*, *105*(1), 87-114. doi: 10.2307/2937820.

Fisher, I., 1933. The debt-deflation theory of great depressions. *Econometrica*, *1*(4), 337-357. Digitized for FRASER http://fraser.stlouisfed.org/ Federal Reserve Bank of St. Louis. Retrieved from https://fraser.stlouisfed.org/files/docs /meltzer/fisdeb33.pdf (15.01.2021).

Jiang, X, Li, S., & Song, X. (2017). The mystery of zombie enterprises – ''stiff but deathless". *China Journal of Accounting Research*, 10, 341-357. doi: 10.1016/j.cjar.2017.08.001.

Manning, L, Birchmore, I., & Morris, W. (2020). Swans and elephants: A typology to capture the challenges of food supply chain risk assessment. *Trends in Food Science & Technology*, *106*(2020), 288–297. doi: 10.1016/j.tifs.2020.10.007.

OECD (2020), *States of Fragility 2020*, Paris: OECD Publishing. doi: 10.1787/ba7c22e7-en.

OECD Glossary of Statistical Terms - Central and Eastern European Countries (CEECs) Definition, Retrieved from: https://stats.oecd.org/glossary/detail.asp?ID=303 (23.01.2021).

Ragin, C. C. (2006). Set relations in social research: Evaluating their consistency and coverage. *Political Analysis Advance Access*, *14*(3), 291–310. doi: 10.1093/pan/mpj019.

Ragin, C. C. (2008). Qualitative comparative analysis using fuzzy sets (fsQCA). In B. Rihoux & C. C. Ragin (Eds.), *Configurational comparative analysis*. Thousand Oaks, CA and London: Sage Publications, 87-121.

Ragin, C. C., & Davey, S. (2014). Fuzzy-set/qualitative comparative analysis 2.5 [software program]. Irvine, CA: Department of Sociology, University of California.

Woodside, A. G. (2014). Embrace perform model: Complexity theory, contrarian case analysis, and multiple realities. *Journal of Business Research*, *67*(12), 2495–2503. doi: 10.1016/j.jbusres.2014.07.006.

## Acknowledgments

I thank the anonymous referees for their useful comments and suggestions.

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

**Adam P. Balcerzak & Michał Bernard Pietrzak (Eds.)**

**Proceedings of the 11th International Conference on Applied Economics Contemporary Issues in Economy: Quantitative Methods**

**Olsztyn: Instytut Badań Gospodarczych // Institute of Economic Research**

**2021**

**DOI: 10.24136/eep.proc.2021.2 (eBook)**
**ISBN 978-83-65605-44-3; ISSN 2544-2384 (Online)**

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# Evaluation of changes in the situation in the labour markets of post-communist members of the European Union

**JEL Classification:** *C38; E24*

**Keywords:** *European labour market; linear ordering; Dynamic Time Warping; Ward's method; cluster analysis*

## Abstract

**Research background:** Between 2004 and 2013, the European Union enlarged to include 11 post-communist countries. As a result, these countries started to operate in the common European market, which accelerated the changes taking place in their economies, including changes in their labour markets.
**Purpose of the article:** The aim of the study is to compare changes in the situation in the labour markets of post-communist countries with those of Western Europe between 2002 and 2019.
**Methods:** The TOPSIS method was used to assess the situation in the labour market in individual countries. On its basis, time series of changes in this situation were determined using the Dynamic Time Warping method. The similarity matrix built on its basis was used in the Ward's method to determine homogeneous clusters of countries in terms of changes in the situation in the labour markets.
**Findings & Value added**: Four homogeneous clusters of countries were obtained in terms of changes in the labour market situation. Post-communist countries were included in two of them. One cluster was formed by only three post-communist countries (Bulgaria, Croatia and Slovakia). The remaining post-communist countries together with seven Western European ones (Germany, France, Spain, Portugal, Finland, Malta and Belgium) formed the largest cluster. Thus, the changes taking place in this group of post-communist countries were similar to those in the

Western countries mentioned above. The other two clusters consisted exclusively of Western European countries. The added value of the study is the multivariate assessment of the changes in the labour market situation in post-communist countries.

## Introduction

The process of transition from the centrally planed economy into the free market one started in Europe in late 1980s. Since then, over a dozen of countries began transformation of their economies. Since 2004, until 2013, eleven of them joined the European Union. The largest number of them joined it in year 2004 (Czechia, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia and Slovenia). Two countries (Bulgaria and Romania) joined the EU in 2007 and the last one – Croatia – in 2013. The process of transition of their economies was difficult and exhausting for large parts of their citizens. Many branches of the economy collapsed or decreased (large parts of heavy industries, mining, shipbuilding or textile industries). It caused changes in employment levels and forms. Previously non-existent, non-standard forms of employment (self-employment, or part-time amployment) became more prominent. Although they are much more beneficial for the employer than for the employee, they helped improving the parameters of the labour market, such as decrease of the unemployment rate (Zieliński, 2020).

After thirty years of beginning of the transformation process, we can observe the convergence process for the post-communist countries. As previous researchers show, members of the eurozone (Estonia, Latvia, Lithuania, Slovakia and Slovenia) converge faster with the Western European countries than the countries outside the eurozone (with a few exceptions – Czechia converges similarly as the Western European countries and Greece – similarly as the Eastern European ones) (Monfort *et al*., 2013). As the convergence of the GDP PPP of the post-communist countries with the Western European ones occurs, it would be interesting to check if there is a similarity in the change of the situation in their labour markets with changes of such situation in the Western European ones. It is also worth noting that now the very situation of many post-communist countries (Czechia, Estonia, Poland or Slovenia) in their labour markets is amongst the best in the whole EU (Bieszk-Stolorz & Dmytrów, 2020). Therefore, the goal of the research is assessement of changes of situation in the European Union member states with particular emphasis on the post-communist countries in the period 2002-2019. The first year of the analysis was select-

ed because it was the year, when the EU signed the agreement with the first post-communist countries. The 2019 was selected as the final year of the analysis, because it was the last year, when the EU consisted of 28 countries and it was the last year before the outbreak of the Covid-19 pandemic that complicated the situation in the labour market.

Every year situation on the labour market was analysed by using the TOPSIS composite measure. Pairwise comparisons of changes of the situation in the labour market between all countries were done by means of the Dynamic Time Warping (DTW) method. Computed in such a way distance matrix was then used in the hierarchical clustering, to separate homogeneous groups of countries with respect to changes of situation in their labour markets.

## Research methodology

The research analyses the situation in the labour markets of the EU member states (as of year 2019) in years 2002-2019. Statistical data was obtained from the Eurostat. The situation on the labour market was analysed by means of eight variables:

$x_1$ — registered unemployment rate (share of the unemployed in the number of professionally active persons — %),
$x_2$ — youth unemployment rate (share of the number of unemployed people aged 15–24 in the number of economically active people in this age group — %),
$x_3$ — long-term unemployment rate (share of the number of people unemployed for a period of at least 12 months in the total number of unemployed people — %),
$x_4$ — median unemployment duration (in months),
$x_5$ — activity rate (share of the number of economically active people aged 15–74 in the total number of people in this age group — %),
$x_6$ — employment rate (share of employed persons aged 15–74 in the total number of persons in this age group — %),
$x_7$ — duration of working life (in years),
$x_8$ — age dependency ratio (ratio of the number of people in pre-working and post-working age to the total population).

The research was conducted by means of methods belonging to three groups:

- linear ordering,
- Dynamic Time Warping (DTW),
- cluster analysis.

Linear ordering methods are used in the multivariate statistical analysis. They change the objects, described by multiple variables into the objects described by means of the composite measure. On the basis of the decision theory, methods such as AHP, ANP, Electre, SAW, COPRAS, or TOPSIS were invented (Podvezko, 2011; Saaty & Ergu, 2015). On the other hand, in the field of multivariate statistical analysis such methods as the composite measure of development (Hellwig, 1972) or Generalised Distance Measure, used as the composite measure of development.

In the first step of any linear ordering method, the observation matrix is created $[x_{ij}]$:

$$[x_{ij}] = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1m} \\ x_{21} & x_{22} & \cdots & x_{2m} \\ \vdots & \vdots & \ddots & \vdots \\ x_{n1} & x_{n2} & \cdots & x_{nm} \end{bmatrix} \quad (1)$$

where: $x_{ij}$ – value of *j*-th variable in *i*-th object ($i = 1, \dots, n, j = 1, \dots, m$). The objects are the countries and the variables – previously described ones, depicting the situation in the labour market.

The second step is determination of the character of the variables. There are three types of variables:

- stimulants (the highest possible value of a variable is desired),
- destimulants (the lowest possible value of a variable is desired),
- nominants (specific value of a variable is desired).

In the set of applied in the research variables, $x_2$, $x_3$, $x_4$ and $x_8$ are destimulants, $x_5$, $x_6$ and $x_7$ are stimulants, and $x_1$ is a nominant. It was assumed that the nominal value of the unemployment rate is the natural unemployment rate. Different studies indicate different levels of unemployment, the study assumed a natural unemployment rate of 3%. Before proceeding, nominant was transformed into the stimulant.

The third step of every linear ordering method is assigning weights to the variables. We can apply several methods to determine the weights. They belong to two main groups: the statistical and expert ones. However, if there is no indication, which variables are considered as more important

than the others, it is also possible that weights are the same for all of them. The research assumes that weights of all variables are equal.

The fourth step of linear ordering is normalisation of variables. All variables must be normalised in order to remove units and eliminate the differences in orders of magnitude. In the research, one of the quotient inversions was used:

$$z_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{n} x_{ij}^2}} \tag{2}$$

where $x_{ij}$ – value of the $j$-th variable in the $i$-th object, $z_{ij}$ – normalised value of the $j$-th variable in the $i$-th object, $n$ – number of objects.

Amongst many linear ordering methods, the study uses the well-known TOPSIS (Technique for Order of Preference by Similarity to Ideal Solution). It was invented by Hwang and Yoon (1981). The TOPSIS method has two reference points – the pattern and anti-pattern. In the research, the composite variable obtained by means of the TOPSIS method is calculated every year.

In the second stage of the research, the previously obtained time series of composite variable are pairwisely compared. The aim of the comparison is analysis of similarity of compared time series. It can be done by means of the Dynamic Time Warping (DTW) method. DTW originally was applied for the context speech recognition (Giorgino, 2009). It is used for estimation of the optimal alignment of timeseries by means of the dynamic programming methods. The alignment between the two time series is measured by the cost matrix obtained by means of the taxicab geometry (Manhattan distance metric). Optimal alignment between the two time series is found by minimising the overall cost amongst all possible warping paths. A (N, M)-warping path is a sequence $p = (p_1, \dots, p_L)$, where $p_\ell = (n_\ell, m_\ell) \in [1{:}\,N] \times [1{:}\,M]$ for $\ell \in [1{:}\,L]$, satisfying the following conditions (Müller, 2007, p. 70):

- Boundary condition: $p_1 = (1,1)$ and $p_L = (N, M)$.
- Monotonicity condition: $n_1 \leq n_2 \leq \cdots \leq n_L$ and $m_1 \leq m_2 \leq \cdots \leq m_L$.
- Step size condition: $p_{\ell+1} - p_\ell \in \{(1,0), (0,1), (1,1)\}$ for $\ell \in [1{:}\,L-1]$.

N and M are the lengths of both time series, L is the length of the warping path. The total cost of warping path between series X and Y is defined as follows:

$$c_p(X,Y) = \sum_{\ell=1}^{L} c(x_{n_\ell}, y_{m_\ell}) \tag{3}$$

where $x_{n_\ell}, y_{m_\ell}$ are the coordinates of the warping path $p$. The optimal warping path between the series $X$ and $Y$ is the warping path $p^*$ that minimises the total cost amongst all possible paths. This minimal cost is called the DTW distance between series $X$ and $Y$ and is denoted by DTW($X$, $Y$):

$$\mathrm{DTW}(X,Y) = c_{p^*}(X,Y) = \min\{c_p(X,Y)\} \tag{5}$$

After comparing every pair of countries, the distance (similarity) matrix is obtained. This matrix is used in the third stage of the research. At this stage, the EU countries are grouped with respect to changes of situation in the labour market for the analysed period. It is done by using the hierarchical method of cluster analysis – the Ward's (Ward, 1963). Dissimilarity of clusters on each step are measured by means of the Euclidean metric. The linkage criterion is the unweighed mean:

$$d_{AB} = \frac{1}{n_A n_B} \sum_{x \in A} \sum_{y \in B} d(x,y) \tag{6}$$

where:
$n_A, n_B$ – sizes of clusters $A$ and $B$, respectively,
$d(x,y)$ – distances between objects in clusters $A$ and $B$.

## Results

In the first stage of the analysis the TOPSIS method was applied and the countries were ranked with accordance to the situation in their labour markets. Table 2 presents rankings for years: 2002 – the first year of the analysis, 2004 – the year with the first enlargement of the EU (10 countries), 2007 – year, in which Bulgaria and Romania joined the EU, 2013 – year, when Croatia joined the EU and 2019 – the last year of the analysis.

At the beginning of the observation period, amongst the post-communist countries the best position in the labour market was in Hungary (it was ranked 11th) and the worst – in Croatia (last, 28th place). In the middle of the rate were Czechia and Slovenia. The rest of former communist coun-

tries were at the end of the rate. In the year 2004 (first enlargement of the EU) position of most post-communist countries generally did not change much (with the exception of Slovenia, for which it improved by five positions). In 2007 (the second enlargement of the EU and the onset of the global financial crisis), position of the Baltic States improved drastically (especially in cases of Latvia – improve from 17th to 9th position, and Lithuania – from 21st to 3rd), position of Hungary deteriorated (from 10th to 20th position). In the case of other post-communist countries, their situation did not change much in comparison with year 2004. In 2013 (when Croatia joined the EU amd when the second wave of the glogal financial crisis ended) changes were more visible. Positions of Czechia, Poland and Romania improved drastically (for Czechia from 16th to 10th, for Poland – from 26th to 16th and for Romania – from 22nd to 11th). Slight improvements could be observed for Bulgaria, Estonia, Hungary and Slovakia, no change for Croatia and deterioration for Latvia and Lithuania (in the former case from 9th to 19th position, while for the latter – from 3rd to 15th). The last year of the analysis brought further improvements of position of Poland – it was ranked 1st. Position of Estonia improved to 6th and Croatia – to 20th (from the last but one in 2013). Position of most other post-communist countries returned to more or less the same as at the beginning of the observation period. Summing up, position for post-communist countries after joining the EU in most cases (Bulgaria, Croatia, Czechia, Estonia, Lithuania, Poland, Romania) improved. In remaining four cases (Latvia, Hungary, Slovenia and Slovakia) it remained on more or less the same level. Improvements of position of the post-communist countries were achieved at the costs losing their places in ranking for such countries, as Belgium, Ireland, Greece, Spain, France, Luxembourg, or Portugal.

The time series of the TOPSIS measures calculated for all coutries were then compared by means of the DTW method. After pairwise comparisons, the distance matrix was obtained. On its basis, the Ward's method was applied and the dendrogram was obtained (Figure 1).

Four clusters of EU countries were distinguished. Former Eastern Block countries were in two of them. Eight of them (Czechia, Estonia, Hungary, Latvia, Lithuania, Poland, Romania and Slovenia) was in the largest one, containing also Belgium, Finland, France, Germany, Malta, Portugal and Spain (total 15 countries). The second cluster (Bulgaria, Croatia and Slovakia) consisted only of ex-communist countries. The third cluster (second largest) contained eight countries (Austria, Cyprus, Denmark, Ireland, Luxembourg, the Netherlands, Sweden and the United Kingdom). The last, smallest cluster consisted of only two countries – Greece and Italy. The third cluster can be considered as the one with countries being generally in

the best situation in their labour markets. The two smallest clusters contain countries with generally the worst situation in their labour markets.

## Conclusions

The article presents the research regarding the evaluation of changes in the situation in the labour markets of post-communist members of the European Union. Conducted analysis shows that if we compare changes of situation in the labour markets of analysed countries, the four homogeneous clusters of countries were selected. The post-communist ones were in two clusters (three countries – Bulgaria, Croatia and Slovakia solely created one and the rest of them were the members of another cluster, along with seven Western European ones). The fact that changes of situation of Bulgaria, Croatia and Slovakia in their labour markets differed from other post-communist countries mainly resulted from the fact that these countries during the largest part of the observation period had higher unemployment rate, high long-term unemployment rate, long unemployment duration and relatively low employment/activity rate.

Analysing changes of the situation in the labour market, the positive conclusion for the post-communist countries can be drawn. For majority of them, these changes were similar than in high-developed Western European countries, as Belgium, Germany, Finland, or France.

## References

Bieszk-Stolorz, B., & Dmytrów, K. (2020). Influence of accession of the Visegrad group countries to the EU on the situation in their labour markets. *Sustainability*, *12*(16). doi: 10.3390/su12166694.

Giorgino, T. (2009). Computing and visualizing dynamic time warping alignments in R: The dtw package. *Journal of Statistical Software*, *31*(7). doi: 10.18637/jss.v031.i07.

Hellwig, Z. (1972). On optimal choice of predictors. In Z. Gostkowski (Ed.), *Towards a system of human resources indicators for less developed countries*. Wrocław: UNESCO - Ossolineum, 69-90.

Hwang, C.-L., & Yoon, K. (1981). *Multiple attribute decision making. Methods and applications. A state-of-the-art_survey*. Berlin, Heidelberg: Springer-Verlag. doi: 10.1007/978-3-642-48318-9.

Monfort, M., Cuestas, J. C., & Ordóñez, J. (2013). Real convergence in Europe: a cluster analysis. *Economic Modelling*, *33*. doi: 10.1016/j.econmod.2013.05.015.

Müller, M. (2007). *Information Retrieval for Music and Motion*. Berlin,

Heidelberg: Springer. doi: 10.1007/978-3-540-74048-3.

Podvezko, V. (2011). The comparative analysis of MCDA methods SAW and COPRAS. *Engineering Economics*, *22*(2). doi: 10.5755/j01.ee.22.2.310.

Saaty, T. L., & Ergu, D. (2015). When is a decision-making method trustworthy? Criteria for evaluating multi-criteria decision-making methods. *International Journal of Information Technology and Decision Making*, *14*(6). doi: 10.1142/S021962201550025X.

Ward, J. H. (1963). Hierarchical grouping to optimize an objective function. *Journal of the American Statistical Association*, *58*(301). doi: 10.1080/01621459.1963.10500845.

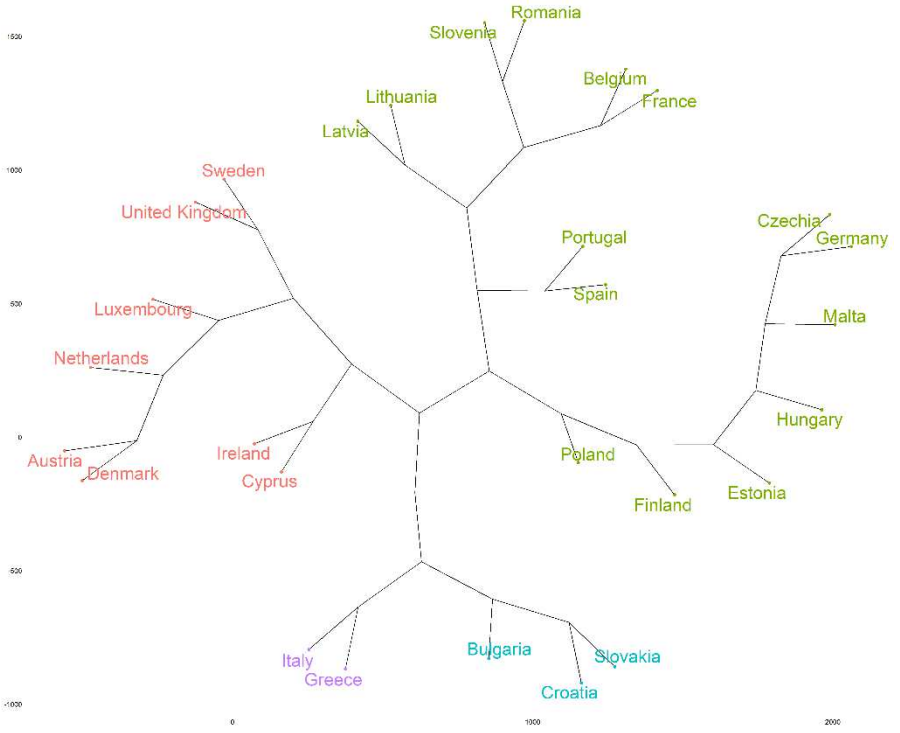
Zieliński, M. (2020). The impact of the unemployment level on non-standard employment forms in the Visegrad Group countries. *Ekonomia i Prawo. Economics and Law*, *19*(2). doi: 10.12775/eip.2020.027.

## Annex

**Table 1.** Rankings of countries with respect to their situation in their labour markets for years 2002, 2004, 2007, 2013 and 2019

| Country | 2002 | 2004 | 2007 | 2013 | 2019 |
|---|---|---|---|---|---|
| Belgium | 18 | 16 | 21 | 13 | 21 |
| Bulgaria | 27 | 25 | 25 | 21 | 23 |
| Czechia | 16 | 19 | 16 | 10 | 9 |
| Denmark | 4 | 3 | 1 | 4 | 7 |
| Germany | 14 | 18 | 23 | 2 | 4 |
| Estonia | 21 | 22 | 14 | 12 | 6 |
| Ireland | 6 | 5 | 6 | 22 | 12 |
| Greece | 22 | 23 | 24 | 28 | 28 |
| Spain | 15 | 13 | 12 | 25 | 25 |
| France | 13 | 14 | 17 | 14 | 24 |
| Croatia | 28 | 26 | 27 | 27 | 20 |
| Italy | 25 | 20 | 19 | 23 | 27 |
| Cyprus | 1 | 2 | 2 | 20 | 17 |
| Latvia | 19 | 17 | 9 | 19 | 19 |
| Lithuania | 23 | 21 | 3 | 15 | 15 |
| Luxembourg | 3 | 6 | 5 | 3 | 14 |
| Hungary | 11 | 10 | 20 | 18 | 10 |
| Malta | 10 | 15 | 15 | 8 | 3 |
| Netherlands | 2 | 4 | 7 | 7 | 2 |
| Austria | 5 | 7 | 4 | 1 | 8 |
| Poland | 24 | 27 | 26 | 16 | 1 |
| Portugal | 9 | 9 | 18 | 24 | 22 |
| Romania | 20 | 24 | 22 | 11 | 18 |
| Slovenia | 17 | 12 | 13 | 17 | 16 |
| Slovakia | 26 | 28 | 28 | 26 | 26 |
| Finland | 12 | 11 | 11 | 5 | 11 |
| Sweden | 8 | 8 | 10 | 6 | 13 |
| United Kingdom | 7 | 1 | 8 | 9 | 5 |

**Figure 1.** Dendrogram of EU countries with respect to similarity of time series of situation in their labour markets



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**2021**

**DOI: 10.24136/eep.proc.2021.2 (eBook)**
**ISBN 978-83-65605-44-3; ISSN 2544-2384 (Online)**

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# The size of a flat as a determinant of the duration of property ownership – an analysis on the example of a housing cooperative stock

**JEL Classification:** *R38; R41*

**Keywords:** *property value; court procedure duration, flat characteristics*

## Abstract

**Research background:** The research on the residential market focuses primarily on analyses of the size and quality of the housing stock, investments, or on seeking dependencies with socio-economic factors and the analysis of prices and the construction of residential property price indices. An equally important issue is assessing the intensity of trade in particular types of flats. A standard view is that those small flats are more frequently traded on the market than the large ones.
**Purpose of the article:** The proposed study analyses the duration of residential property ownership by the same owner (from the date of purchase to the date of sale). It depends on the characteristics of the property, including its size. The research will verify the hypothesis that the ownership of small residential units lasts shorter. The analysis will be carried out on the homogeneous, in terms of ownership rights, cooperative housing market in Stargard. The article focuses on the effects of the building location, resulting in a more frequently sale.
**Methods:** The study assesses the valuation model basing on a case study of a town of Stargard in Poland. In the empirical part of the paper, the regression analysis is employed to examine residential property value in a local housing estate and the duration analysis to explore ownership duration time. The study uses the nonparametric Cox proportional hazard models estimated separately for flats in surface groups and the Cox proportional hazard model with explanatory variables dependent on time.
**Findings & Value-added:** This research is important in the socio-spatial connection to the housing market. It shows that current practice related to buying a small flat as an investment in the housing market is appropriate. Due to the rapid price increase of small flats and their high turnover, the chances for a good investment

are increasing. Using the Cox model, we show that poor location in the old city housing estate and larger floor area increased the risk of a property being sold quickly. The results are essential due to the unique role residential real estate plays in the investment market in Poland.

## Introduction

The housing market operates in an economic, social, legal, and political environment. The relationship and coupling between the elements of this market system change over time; they have a different dimension in analysing individual local markets. In such circumstances, two problems occur. Firstly, whether the selected locations (housing estates) are more popular than others, i.e. transactions occur less often because the dwellers do not want to leave their flats. Secondly, it is important how long the owners stay with the property, and after how many years, on average, they sell the flat. It is also interesting whether the decision to sell faster depends on the location (estate) or the size of the flat. This article considers and questions a common factor between the property ownership time and the property location. The number of days from the last to the next sale of the flat is defined as the property ownership survival. The market situation also determines that owners do not want to sell flats for many years. The analysis conected with is the time of ownership. One local housing market in Poland presents the results of the research.

The scale and scope of research dictated the choice of a specific local market for the study. Data were needed on repeat sales, concluded over a long period.

## Literature review

In numerous studies, the analysis of housing sales deals with housing characteristics and their influence on the transaction price and the construction of regression models (Isakson, 1998, pp. 177-190). Most commonly, hedonic price models are built to account for quantitative characteristics and the effect of time on price (Wu, et al., 2018). There are also models that take location into account, known as spatial models and non-linear models (Miles, 2020, pp. 299-315). There is a debate in the literature on the influence of qualitative variables and subjective opinions of buyers on the price of housing. It concerns the scale of measurement of these variables as well as the acquisition of reliable data and the sources of their acquisition

(Jayantha & Oladinrin, 2020, pp. 357-371). Research reveals often surprising findings about the expectations and preferences of residents in multi-family buildings. In other models - of repeat sales - there is the problem of reliable data on the characteristics of the same flats after a long period of time. These are often series of even several decades, which means that during this time not only the assessments of the technical condition of the flat itself, but also the preferences of buyers may have changed significantly.

However, the literature lacks studies on the time after which owners sell their flats and on the factors influencing these decisions. Of course, there may be many reasons for decisions to sell. They may result from the real estate environment, the owners' individual family situations or other economic reasons observed in the market (Alkay, 2011, pp. 521-539). Consumers are more willing to buy flats with all amenities, but not in mixed-use buildings. Inference about mechanisms in the housing market is hampered by the low informational efficiency of this market (Case & Shiller, 1989, pp. 135-136). Buyers make decisions under conditions of information asymmetry and are guided in their choices by often irrational, emotional reasons.

The article shows the issue of the time that elapses between successive sales of the same flat. The reason for the short- or long-term retention of ownership is analysed. It can be assumed that small flats will sell more often than the large ones. They are in many cases treated as an investment and intended for rental. Large flats tend to meet the housing needs of owners and their families. They are rarely rented out. On the other hand, it is interesting to see whether there are locations where flats are more likely to be sold.

## Research methodology

### *Empirical data*

The research is based on the author's database of transaction, the cooperative housing market in Stargard, in Poland. The data is divided into six cooperative housing estates: Chopin (CH), Kluczewo (K), Letnie (L), Stare Miasto (M), Pyrzyckie (P), and Zachód (Z). The dataset consists of 2266 transactions of sold flats (ownership or cooperative right) between 04 May 2000 and 02 May 2021. Several variables described the individual sales: total price of flat in PLN (Total Price), price per unit in PLN/m2 (Unit Price), transaction data (yyyy-mm-dd), usable flat area in m2 (Area), number of rooms (Room), the floor the flat is located at (Floor), type of build-

ing (1- low-rise building, 0 – high-rise building; Building), age of the building in years between the date of construction and current year (Age), the status of the title (0 - cooperative right, 1 - property law; Right), the duration of ownership as the period between the second and first sale of the flat, in days (Delta). In practice, in many models, I will use LnPrice, the logarithm of the unit price.

*Econometric methods*

The author regressed the flats value on several independent variables using a stepwise multiple linear regression model to estimate the impact of selected variables (Mayers, 1990). Additionally, the expected duration of homeownership was examined (duration analysis) and the effect of several salient variables on survival time were investigated. Methodology stems from the work of Cox and Oakes (1984). The period between the start of the observation (first sale), event that ends the observation (resale), but first of all, its likelihood in subsequent units of time were the subject of this study. Although a 20-year period was examined, there were flats that were sold during that time. If the event did not happen by the end of the observation, the observation was terminated (a censored observation). It was most often censored because of the time of termination (Blossfeld, et al., 1989). In the study, the truncation is censored on the right side, which is often found in other analyses as well. The time of an event incidence t is a random variable of non-negative values. The variable is described by employing a distribute F(t), a density function f(t), a survival function S(t), a hazard function h(t) of randomly chosen non-negative values and a cumulative hazard function o H(t) as well as a plausibility function (L). The measure of the probability that in time ⟨0;t⟩ the selling flat time is a distribution of a random variable t (continuous and non-negative) defined by the following formula:

$$F(t) = P(T \leq t) = \int_0^t f(z)dz,$$

where $F(t) \in \langle 0; 1 \rangle$. A survival function defined by the following formula:

$$S(t) = P(T > t) = exp\left(-\int_0^t h(z)dz\right)$$

The transition intensity rate is a hazard function described as:

$$h(t) = \lim_{\Delta t \to 0} \frac{P(t \leq T < t + \Delta t | T \geq t)}{\Delta t}, \Delta t > 0$$

That provides information about failure levels. It is the momentary potential for an event (sale) to occur, provided that the flat has not been sold by time t. The hazard function represents the probability per unit time, so it can also take values greater than 1. The following formula describes the cumulative hazard function:

$$H(t) = \int_0^t h(z)dz$$

while the plausibility function used for single episodes is described by:

$$L = \prod_k h(t_k)^{\delta_k} \cdot S(t_{k)}$$

where $\delta_k$ a censoring indicator would be of value 1 if the event occurred in the time t or value 0 when information was censored.

One of the methods of estimating the survival (duration) function that does not require arbitrarily defined time variable intervals is the Kaplan-Meier method (Hosmer & Lemeshow, 1999, pp. 28-31). As a result of applying this procedure, truncated observations can also be taken into account.

In duration analysis it may be necessary to divide the set of observations into subgroups. Then for each subgroup the survival function is estimated and subsequently the durations are compared. The significance of differences is assessed by verifying the null hypothesis of no overall differences among survival functions, with the use of non-parametric tests e.g. Mantel-Haenszel with a chi-square distribution statistic. The impact of many features on the expected duration of an unknown survival function can be measured through semi-parametric models, including the Cox proportional hazards model (Cox & Oakes, 19840. The method of estimating the model coefficients is the partial likelihood method or the maximum likelihood method.

## Results

*Variable analysis*

In the article, the author considers the relationship between the characteristics of flats, their price, especially the location of housing estates and the usable area of the flat. In the next step, the author looks for duration dependence of flat using the grouping variables: housing estates and groups of flat usable area. The author used multiple regression analysis to explore potential factors for residential property price. The flat value was regressed on several independent variables using a stepwise procedure. The estimation results are shown in the table below (Tab. 1). The model estimated on a sample of 2266 transactions has a moderate fit to the empirical data (R2=0.68). Three variables were found that significantly affected the flat value. As noted earlier, the value of the flat depends significantly on the time of sale. Flats sold later are more expensive than those sold earlier. Larger floor area of the flat leads to an increase in LNPrice by 1.9%. It has also been shown that the flat ownership is valued higher on the market than cooperative rights. Symmetrical distribution of transactions in six groups corresponding to the area was obtained: group I (<30 m2), group II (<40 m2), group III (<50 m2), group IV (<60 m2), group V (<70 m2) and group VI (70 m2 and more). In the next section, we investigate the duration of ownership.

*Time of ownership duration analysis*

In case of transactions being analysed in this paper, the duration analysis involves estimating a survival function, density function and hazard function. Duration time is a period between the date of the first and the repeat flat sale. Sales that did not repeat by 02 February 2021 were censored (right hand). In this case the duration could not be directly observed after the period of study. The duration analysis focuses on the duration of flat ownership in two perspectives. First, a housing estate is used as a grouping variable. It was checked whether there are housing estates where flats were sold more often. Secondly, the duration of ownership of a flat was analyzed in six groups of flat sizes. Basic statistics for the variable Delta for a repeat flat sale (but only complete observations, i.e. non-censored) were calculated in both cases (Tab. 2 and Tab. 3).

The shortest repeat sale time was seen in group IV - of flats with an floor area ranging from 50 to 60 m2, while the longest time of flat ownership by the same owner was seen in group V (with an floor area of 60-70

m2). This group shows the lowest propensity to sell dwellings. This may mean that the above are optimum flat parameters for many owners. In the case of location, the shortest time between repeated sales was in the Chopin housing estate (CH), while the longest - in the Pyrzyckie estate (P). The Pyrzyckie is very well perceived by residents as it is located in the vicinity of the city's ring road and single-family housing.

The estimation was based on four different distributions: exponential, Weibull, linear and Gompertz with different weights and maximum likelihood test (significant chi-square); they do not allow for a conclusion that the adjusted distribution is not significantly different from the empirical distribution. The estimators from the survival tables depend on the selection of the number and length of lifetime intervals. The estimators independent of data grouping are obtained using continuous survival times Kaplan – Meier method. Survival functions indicate the probability that time to repeat sale will be longer than the given time t. It can be deduced that with a probability equal to 82%, the time between sales will be longer than 21.4 years, with a probability equal to 96%, that the duration time will be longer than 2.4 years, and with a probability equal to 98% that the duration time will be longer than 1.4 years. Contrary to the survival function, the hazard function shows the probability of a flat to be sold within a given time t.

The data were grouped in two separate steps. First, the grouping variable was location (Estate) and second, the floor area variable (Area - in six groups). Six separate survival functions were estimated for each group and flat ownership durations were compared (separately for the variable grouping the housing estates and the flat floor area). The null hypothesis H0 is $S1(t)=S2(t)=S3(t)=S4(t)=S5(t)=S6(t)$ for all t stated that is no difference between the six survival functions. Statistics of chi-square independence value for the first survival function (Fig. 1) indicate that there are some differences between the duration functions ($\chi 2=19.48$, df=5, p=0.00157). It can be seen that the probability of the same owner maintaining ownership of the flat is highest in the Zachód estate and lowest in the Kluczewo estate. The Kluczewo estate is characterised by small flats, an unfavourable location in the city limits, and the quality of the buildings themselves. These are buildings adapted to residential functions after the former Soviet army barracks. The shape of the survival function also indicates a slower/quicker decline compared to other housing estates. After 11 years, the Zachód housing estate is characterised by a slower decline of the survival function, which means that the probability of not selling a flat after that time increases, compared to the other housing estates. Similarly, in case of the second grouping variable, the statistics of chi-square independence value (Fig. 2)

indicate that there are some differences between the determined duration functions ($\chi 2=26.68$, df=5, p=0.00007).

In the case of the survival function with the variable grouping flats by their size (Area), the outlier group 6 - the smallest flats - draws attention. In terms of location, Stare Miasto (M) and Zachód (Z) estates clearly differ from the others. On the other hand, in the case of the variable grouping the flats by their floor size, the smallest flats, which are most often traded on the market, clearly stand out.

To explore duration time in more detail, nonparametric methods like the Cox proportional hazard models can be applied. The method can be used to measure the effect of several variables (measured on different scales) on survival time. The Cox proportional hazard model allows us to examine the risk that a particular outcome (in our case the sale) occurs in time t for a given set of predictors. Several plausible factors that could potentially affect the duration of ownership were used. Two models were estimated with two grouping variables (Estate, Area). The results are shown in the table below (Table 4). In both models, the ownership duration time depended upon the unit price and property right. A stronger property right (ownership) increases the probability of selling a flat. This is the case for housing estates as well as for the analysed groups of flat usable areas. Other independent variables were not statistically significant, thus had limited explanatory value. Estimation results must be treated with caution. Low model fit may suggest that multivariate survival analysis using the Cox proportional-hazard model has limited value in explaining the effect of several factors upon the duration time, especially in the currently available independent variables.

## Discussion

The validity of the results obtained within the study reflects the quality of data available, especially regarding the limited information on characteristics of flats being the subject of sale. The duration of a flat ownership by the same owner is affected by both: (1) location in a particular housing estate, (2) usable floor area of the flat. The results confirm the determined duration functions that differ in their course and dynamics due to the indicated grouping variables. The location on the floor or the height of the building turned out to be insignificant. The influence of the usable area of flats on decisions to sell justifies the conviction that small flats are likely to be more often on the market due to their investment character, but also because they do not sufficiently satisfy the growing housing needs. This

may be related to family enlargement or improved owner's material status. The obtained results are unique, as there are no analyses of this problem in the literature. The problem is important insofar as it also answers the question of the inhabitants' propensity to change their housing conditions. The results indicate rather low residential mobility and low propensity to change housing conditions.

## Conclusions

The article focuses on the analysis of the time elapsed between successive sales of the same flat. The unique nature of the collected data on repeated sales of flats and the time series of more than 20 years permit the formulation of some interesting conclusions and confirm earlier intuitive assumptions. It has been shown that the length of time a flat remains with the same owner depends on the flat price and the ownership right to the premises. It has also been shown that the probability of being sold after a certain time differs considerably between the studied housing estates and with the size of the flat. The results obtained from the estimation of regression models are not entirely satisfactory, which indicates the need for research with additional variables.

Future research should be extended to include qualitative factors influencing sales decisions of residents of the studied housing estates. It is also worth extending the direction of research to demographic factors such as age or structure of families deciding to sell a flat. It should also be supplemented with an analysis of other locations in the city, apart from cooperative housing estates. This would allow excluding the management method (management company) as a factor determining the decision of residential property sellers.

### References

Alkay, E. (2011). The Residential Mobility Pattern in the Istanbul Metropolitan Area, *Housing Studies,* 26(4), 521–539.

Blossfeld, H.P., Hamerle, A., Mayer, K.U. (1989). *Event History Analysis, Statistical Theory and Application In the Social Sciences*, Lawrence Erlbaum Associates Publ., Hillsdale, New Jersey.

Case, K.E., Shiller, R. J. (1989). Association The Efficiency of the Market for Single-Family Homes, *The American Economic Review, 79*(1).

Cox, D.R., Oakes, D. (1984). *Analysis of survival data*, Chapman & Hall, New York.

Hosmer, D.W., Lemeshow, S. (1999). *Applied Survival Analysis. Regression Modeling of Time to Event Data*, John Wiley and Sons Inc.

Isakson, H.R. (1998). The Review of Real Estate Appraisals Using Multiple Regression Analysis, *Journal of Real Estate Research*, 15(2), 177-190.

Jayantha, W. M., Oladinrin, O. T. (2020). Bibliometric Analysis of Hedonic Price Model Using CiteSpace, *International Journal of Housing Markets and Analysis,* 13(2), 357–371.

Mayers, R.H. (1990). *Classical and Modern Regression with Application*, Duxbury, Pacific Grove.

Miles, W. (2020). Home Prices and Fundamentals: Solving the Mystery for the G-7 by Accounting for Nonlinearities, *International Journal of Housing Markets and Analysis*, 13(2), 299–315.

Wu, H., Jiao, H., Yu, Y., Li, Z., Peng, Z., Liu, L., Zeng, Z. (2018). Influence Factors and Regression Model of Urban Housing Prices Based on Internet Open Access Data, *Sustainability,* 10(5), 1-17.

## Acknowledgement

The project is financed within the framework of the minister of science and Higher Education under the name "Regional Excellence Initiative" in the years 2019 – 2022; project number 001/RID/2018/19; the amount of financing PLN 10,684,000.00.

## Annex

**Table 1.** Estimation results (dependent variable is LN Price)

| Variables | B | SE | t(2258) | p |
|---|---|---|---|---|
| Constant | 10.075 | 0.058 | 173.548 | 0.000 |
| T | 0.062 | 0.002 | 31.284 | 0.000 |
| *Area* ($m^2$) | 0.019 | 0.001 | 15.635 | 0.000 |
| *Room* | 0.004 | 0.017 | 0.217 | 0.828 |
| *Floor* | -0.001 | 0.003 | -0.218 | 0.827 |
| *Building* | 0.020 | 0.019 | 1.101 | 0.271 |
| *Age* | 0.001 | 0.001 | 1.306 | 0.192 |
| *Right* | 0.081 | 0.021 | 3.842 | 0.000 |
| $R^2$=0.68 | | | | |

**Table 2.** Group descriptive statistics variable Delta for repeat flat sale (No. of days)

| Group | Mean | Median | Min | Max | Quartile 1 | Quartile 3 | SE | Skewness | Kurtosis |
|---|---|---|---|---|---|---|---|---|---|
| Total | 2 070 | 1 966 | 4 | 6 667 | 966 | 2 881 | 1 430 | 0.68 | 0.08 |
| I | 1 799 | 1 547 | 77 | 6 069 | 349 | 2 773 | 1 543 | 0.79 | 0.01 |
| II | 1 880 | 1 680 | 4 | 6 667 | 707 | 2 666 | 1 534 | 1.07 | 1.25 |
| III | 2 065 | 2 017 | 6 | 5 030 | 1 149 | 3 105 | 1 348 | 0.26 | -0.80 |
| IV | 1 864 | 1 805 | 116 | 4 346 | 1 041 | 2 592 | 1 084 | 0.36 | -0.53 |
| V | 2 852 | 2 163 | 775 | 6 373 | 1 457 | 4 501 | 1 723 | 0.74 | -0.74 |
| VI | 2 205 | 1 996 | 366 | 5 354 | 1 115 | 2 922 | 1 323 | 0.76 | 0.15 |

**Table 3.** Housing estate descriptive statistics variable Delta for repeat flat sale (No. of days)

| Estate | Mean | Median | Min | Max | Quartile 1 | Quartile 3 | SE | Skewness | Kurtosis |
|---|---|---|---|---|---|---|---|---|---|
| Total | 2 070 | 1 966 | 4 | 6 667 | 966 | 2 881 | 1 430 | 0.68 | 0.08 |
| CH | 1 525 | 1 332 | 78 | 4 337 | 512 | 2 448 | 1 149 | 0.74 | -0.08 |
| K | 2 334 | 2 263 | 6 | 6 667 | 1 383 | 3 178 | 1 493 | 0.84 | 1.17 |
| L | 2 213 | 2 118 | 151 | 4 914 | 1 004 | 3 173 | 1 481 | 0.37 | -0.77 |
| M | 1 953 | 1 680 | 4 | 6 069 | 712 | 2 746 | 1 464 | 0.59 | -0.47 |
| P | 2 651 | 2 380 | 137 | 6 354 | 1 586 | 3 739 | 1 597 | 0.67 | -0.11 |
| Z | 2 030 | 1 924 | 43 | 5 470 | 1 179 | 2 842 | 1 242 | 0.62 | 0.23 |

**Table 4.** Evaluation of the parameters of the Cox proportional hazard function

| | B | SE | t | Wald statistics | p-value | Hazard Ratio |
|---|---|---|---|---|---|---|
| Grouping variable *Estate* | | | | | | |
| *Area* ($m^2$) | -0.005 | 0.022 | -0.243 | 0.059 | 0.808 | 0.995 |
| *Unit price* | 0.001 | 0.000 | -5.953 | 35.437 | 0.000 | 1.000 |
| *Room* | -0.204 | 0.159 | -1.287 | 1.657 | 0.198 | 0.815 |
| *Floor* | 0.040 | 0.032 | 1.272 | 1.619 | 0.203 | 1.041 |
| *Building* | 0.141 | 0.201 | 0.700 | 0.490 | 0.484 | 1.151 |
| *Age* | -0.005 | 0.011 | -0.520 | 0.271 | 0.603 | 0.995 |
| *Right* | 0.644 | 0.186 | 3.457 | 11.953 | 0.001 | 1.903 |
| Grouping variable *Area* | | | | | | |
| *Unit price* | -0.001 | 0.000 | -6.000 | 36.005 | 0.000 | 0.999 |
| *Room* | -0.244 | 0.155 | -1.574 | 2.478 | 0.115 | 0.784 |
| *Floor* | 0.046 | 0.031 | 1.481 | 2.192 | 0.139 | 1.047 |
| *Building* | 0.281 | 0.187 | 1.504 | 2.263 | 0.132 | 1.325 |
| *Age* | -0.002 | 0.007 | -0.328 | 0.108 | 0.743 | 0.998 |
| *Right* | 0.666 | 0.186 | 3.576 | 12.791 | 0.000 | 1.947 |

**Figure 1.** Survival functions – Kaplan-Meier Method (grouping variable *Estate*)

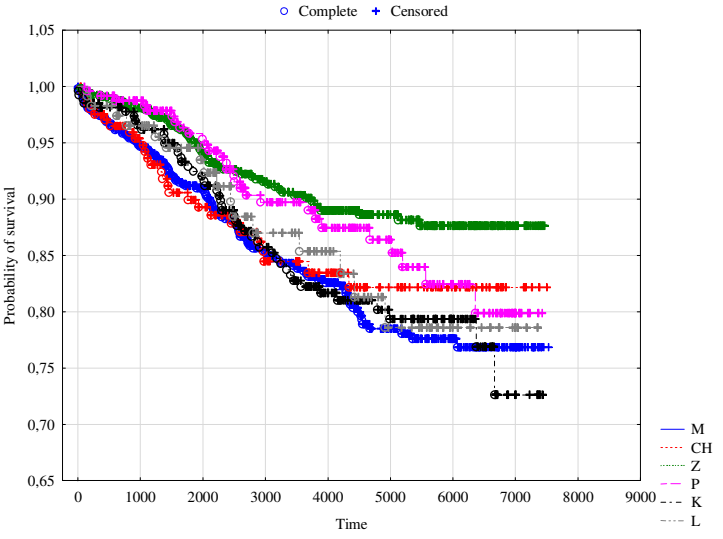
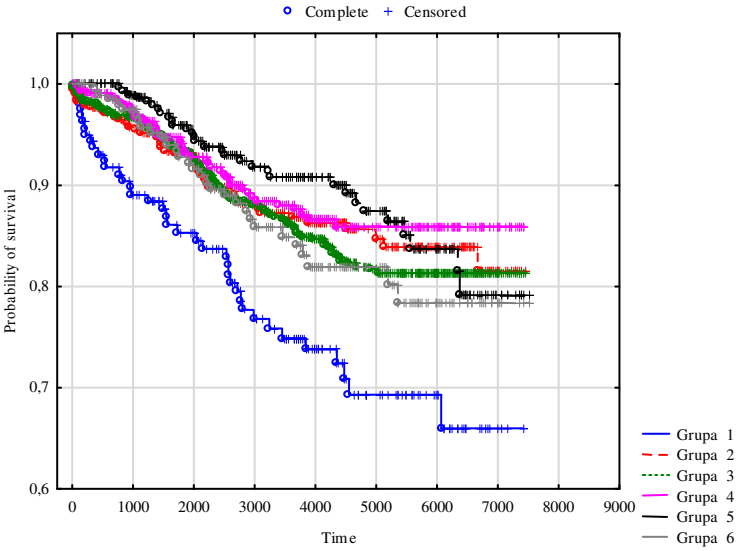


**Figure 2.** Survival functions – Kaplan-Meier Method (grouping variable *Area*)



**Adam P. Balcerzak & Michał Bernard Pietrzak (Eds.)**

**Proceedings of the 11th International Conference on Applied Economics Contemporary Issues in Economy: Quantitative Methods**

**Olsztyn: Instytut Badań Gospodarczych // Institute of Economic Research**

**2021**

**DOI: 10.24136/eep.proc.2021.2 (eBook)**
**ISBN 978-83-65605-44-3; ISSN 2544-2384 (Online)**

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# Wage convergence among the European Union with particular emphasis on the Visegrad Group

**JEL Classification:** *E24; F14; F15; B29*

**Keywords:** *economic convergence; wage convergence; Visegrad Group; euro adoption*

## Abstract

**Research background:** The Visegrad Group: Poland, Hungary, Czechia and Slovakia are now regarded as an example of a successful transition from a centrally planned to a market economy. They are the biggest economies among the New Member States of EU, but the economic welfare stays at lower level compare the EU-average, so they are the catching-up economies. This investigation focus on wage convergence, which is a part of real convergence. Visegrad Group economies can be deemed relatively homogeneous, but Slovakia adopted the euro, the remaining 3 countries were not.
**Purpose of the article:** The aim of the research is to assess the wage convergence among the European Union. Comparing Slovakia's results with the rest of the Visegrad group, an attempt was also made to assess the impact of euro adoption on wage convergence processes.
**Methods:** The research was carried out using the comparative method. Three types of convergence are taken into account: beta (less developed countries exhibit a faster rate of growth than more developed ones), sigma (income differentiation decreases over time), and gamma (countries change their ranks in the ranking). An extension of the implementation of the concept of β (beta), σ (sigma) and γ (gamma) convergence is the estimation of convergence for variables other than GDP, i.e. for the wage growth rate. The analysis covers the 2009-2019 period.
**Findings & Value added:** The study confirms the gross earnings dispersion among examined EU member states is shrinking. If the average growth patterns observed in 2009–2019 continued, the countries of the enlarged EU would need about 26–27 years to reduce the distance to their hypothetical common steady state

by a half. These results point to a relatively slow catching-up process between Central Eastern and Western Europe.

## Introduction

The Visegrad Group consists of Poland, Czech Republic, Slovakia and Hungary. They belong to the group of 10 countries that joined the European Union in 2004. In later years, three more countries belonging to Central and Eastern Europe joined European Union: Bulgaria, Romania and later, Croatia.

On 1 January 2009, Slovakia adopted the Euro as its national currency. Poland, Czechia and Hungary stay by their own currencies. As all new EU-members have committed to joining the euro area in an undefined future, Slovakia's experience is extremely valuable to the societies of these countries. It is a good opportunity to assess the effects of joining the euro zone on wage growth in the medium term through a comparative analysis, because Visegrad Group countries are similar in terms of institutional and economic structure.

The Central-Eastern Europe economies can be deemed relatively homogeneous. This results firstly from the fact that in the transition period, these countries have pursued quite similar systemic transformation strategies, socio-economic policies and structural reforms, geared towards building a fully-fledged market economy, strongly influenced by Western patterns. Secondly, the membership in the EU create similar economic conditions in terms of their institutional environment, economic structure, directions of trade and capital flows (so called integration anchor). Thirdly, all CEE countries have been offered similar windows of opportunity to use the EU aid funds. Hence, it can be assumed that all present members of the enlarged European Union face the same long run equilibrium or steady-state. They should, therefore, tend to equalize income levels as suggested - inter alia - by neoclassical models of economic growth. The process of equalization in GDP per capita levels is further fostered by the objectives of the EU policy, intended to reduce income disparities between countries and regions of the enlarged European Union (Rapacki &Próchniak 2019, p. 6).

Wage convergence is a part of real convergence. Many empirical studies examine the territorial convergence among states in terms of a negative relationship between growth rate and the initial level of GDP per capita or labour productivity and less are focused on the wage. The most frequently used real convergence indicator is GDP per capita, which is the most synthetic measure of economic development level**,** but for people GDP is more

abstract than their own earnings. The problem of wage inequality is one step away from the problem of income inequality (Horodecka &Vozna, 2018, p. 266). Wages and salaries are one of the components of GDP, so the use of average gross earnings is a descent to a lower level of aggregation and a focus on one specific aspect of real convergence.

The concept of wage convergence, which is derived from factor price equalization, can be explored via the literature on international trade and labour economics. In the international trade literature, factor price equalization can be discussed as an outcome of the Hecksher–Ohlin trade model, which is designed for two economies, two products, and two production factors. It is a trade model that shows patterns of trading for those goods that are produced by the factor that is abundant in a certain country. Factor price equalization has certain restrictions such as identical technologies and sufficiently similar factor supply ratio. Moreover, it also demands an absolute equality of prices of commodities and factors, whereas the concept of factor price convergence is more flexible in the sense that it does not require the absolute equality of factor and commodity prices among the countries under free trade (Naz *et al.,* 2017, p. 41-42). The adoption of the common currency facilitates trade and the mobility of production factors, so it can be expected that it will also accelerate the convergence processes.

Process of real convergence is very important, because European Union consist of states on different level of welfare. Less developed countries of Central and Eastern Europe (CEE), which have accessed the European Union in XXI century, are catching-up economies, and the richer 15 countries of Western Europe (EU15) represent the EU's "old core". The aim of the research is to assess the wage convergence among the European Union. The secondary goal is assess if euro adoption boosts wage convergence process. The basis for this assessment is the comparison of Slovakia's results with other countries of the Visegrad group, i.e. the Czech Republic, Poland and Hungary.

## Research methodology

The concept of real convergence is defined as the tendency to level off income among countries. Most research use GDP per capita as an income indicator. But this study concern on wages, so used indicator is annual gross earnings single person without children earning 100% of the average earning in euro. That way the redistribution effect of fiscal policy is not taken into account. The analysis covers the 2009–2019 period for 26 EU countries, Cyprus and Croatia are excluded in the analysis owing to a lack

of data, whereas the UK is included, as it was an EU member state during the analysed time period. The calculations were based on annual gross earnings time series obtained from Eurostat database.

Two research hypotheses were formulated:

1. The convergence of earnings occurs between EU countries, wages in less developed CEE countries, with lower wage level, tend to grow faster than they do in wealthier ones, with higher wages.
2. After the adoption of the euro, Slovakia is characterized by higher wage growth than the other countries of Visegrad group.

The literature on economic growth proposes several methods to capture convergence. This study will use the concept of β (beta), σ (sigma) and γ (gamma) convergence. In general, β convergence reflects a negative association between the growth rates of a variable and the initial values of that particular variable. Wage convergence is actually a part of real convergence. In the context of wages, β convergence is said to exist if growth rates of wages are negatively correlated with the initial values of wage rates for each region. In other words, a country with smaller initial values of factor prices has a higher rate of growth than a country with higher initial values of factor prices (Naz *et al.* 2017, p. 42-43). Therefore, lower-wage member states grow faster than higher-wage one. Thus, in the long run, all labour markets tend to converge toward the same average wage. This convergence can be conditional or unconditional.

To verify empirically the hypothesis of the absolute β-convergence, the following equation should be estimated:

$$\frac{1}{T}(lnY_T - lnY_0) = \alpha_0 + \alpha_1 lnY_0 + \varepsilon_t \quad (1)$$

where:
$lnY_T$ – logarithm value of average gross earning at the end of the analysed period
$lnY_0$ – logarithm value of average gross earning at the beginning of the analysed period
T – periods number
$\alpha_0, \alpha_1$ – equations parameters
$\varepsilon_t$ – random walk.

The explained variable is the average rate of gross earnings growth in examined period (from 0 to T), the explanatory variable is the logarithm of the initial level gross earning, while $\varepsilon_t$ is a random component. A negative and statistically significant value of the $\alpha_1$ parameter means the occurrence

of the β-convergence. In this case, the value of β-coefficient measuring the rate of convergence, can be calculated from the formula (see e.g. Barro& Sala-i-Martin, 2003, p. 467; Heller & Warżała, 2019, p.9):

$$\beta = -\frac{1}{T} ln(1 + \alpha_1 T) \tag{2}$$

In addition, the hypothesis concerning the occurrence of σ-convergence was verified, according to which the decreasing dispersion of annual gross earnings follows among the studied countries. The estimated σ-convergence quotation was as follows:

$$\sigma(lnY_t) = \alpha_0 + \alpha_1 t + \varepsilon_t \tag{3}$$

The logarithms of gross earning standard deviation in individual countries was the explained variable, and time series (t = 1, ..., 11 for the period 2009-2019) was the explanatory variable. The $\varepsilon_t$ - as before - is a random walk component. A negative and statistically significant value $\alpha_1$parameter means existence of σ-convergence.

Generally, γ-convergence occurs when countries change their positions in the ranking ordered in terms of some features (Próchniak 2019, p.228). Gamma convergence (γ-convergence) is defined as the ranking concordance over time of per capita incomes within a group of countries (Siegel, 1956 and Boyle and McCarthy, 1997). In other words, γ-convergence highlights whether, and to what extent, the highest-income and lowest-income countries remain the same within a given country grouping over time. Together with σ-convergence, γ-convergence helps to capture the complex dynamics of time-varying cross-country income distributions (Diaz del Hoyo *et al.* 2017, p.13). The Kendall rank concordance coefficient can be used to verify the γ convergence hypothesis (Próchniak 2019, p.228). Kendall's coefficient of concordance ranges from 0 (no agreement) to 1 (complete agreement). Value of 0 indicates γ convergence and value of 1 indicates no γ convergence.

Annual gross earning as a percentage of EU-15 average was calculated only for Slovakia, Czechia, Hungary and Poland. For the purposes of this analysis, the average growth rate of gross earnings covering the years 2001-2003, 2004-2008 and 2009-2019 was calculated, i.e. the subperiod before accession to the EU, EU membership before accession to euro area, and in the third subperiod Slovakia is a member of the euro area.

## Results

Taking into account the parameters included in table 1 it can be stated, that among examined EU countries the $\beta$-convergence was confirmed. This is because the $\alpha_1$ parameter value is negative and statistically significantly dependent on the initial level of average gross earnings. Moreover, obtained $\alpha_1$ parameter estimation is also negative, t-student statistic value (-7.45375), $p$-value (0.0000) and coefficient of determination value (69.8%) also confirm existing $\beta$-convergence. The catching-up process took place among the 26 countries of the whole examined sample. Countries with lower initial wage levels recorded more rapid growth on average than those with higher initial wage levels.

The $\beta$-coefficients, measuring the speed of convergence, stand at 2.58%. These coefficients allow us to estimate the time needed to reduce the wage gap between the examined countries by a half. If the average growth patterns observed in 2009–2019 continued, the countries of the enlarged EU would need about 26–27 years to reduce the distance to their hypothetical common steady state by a half. These results point to a relatively slow catching-up process between Central Eastern and Western Europe. Based on these estimates, it cannot be expected that CEE countries will reach the wage levels seen in Western Europe soon.

The σ-convergence was measured by gross earnings standard deviation logarithms. To achieve this, the regression equation (3) parameters were estimated. The procedure results are presented in table 2**.** Similarly to results obtained by the β-convergence, also the σ-convergence among countries surveyed in researched period was confirmed. Negative and statistically significant $\alpha_1$ parameter value and other factors placed in table 2 ($p$ values standing at 0,000009, coefficient of determination value at 0.899) demonstrate very good fit of regression function to empirical data. The σ-convergence existence denotes that gross earnings dispersion among examined EU member states is shrinking.

The Kendall concordance coefficient stand at 0.901538462. With $p$-values standing at 0.000000 significance level is high. The indicator at the level of 0.9 should be assessed as the almost complete absence of γ convergence, because value of 0 indicates γ convergence and value of 1 indicates no convergence.

Annual gross earnings as a percentage of EU-15 average were calculated only for four states: Czechia, Hungary, Poland and Slovakia (table 3). Examined countries upon accession to the EU represent a similar, low level of wages at the level of about one fifth of the old EU average. At the end of the analysed period, they reach the level of one third, which con-

firms the process of wage convergence. In the year preceding the accession to the euro area (i.e. 2008), average earnings were the lowest in Slovakia in the entire surveyed Visegrad group. Despite a noticeable increase, 11 years after joining the euro, wages in Slovakia are still somewhat lower than in the compared countries.

The average growth rate of gross earnings in 2009-2019, calculated on the basis of Eurostat data, is 3.75% in Slovakia, 3.59% in the Czech Republic, 3.68% in Hungary, 3.64% in Poland (see Table 4). Although in this group the highest wage growth rate was recorded in Slovakia, the differences are not significant, so it cannot be concluded on this basis about the positive impact of the euro on wages growth acceleration.

## Conclusions

The β– and σ-convergence existence denotes that gross earnings dispersion among examined EU member states is shrinking. The insights are economically substantial and highly statistically significant. The first hypothesis has been confirmed: The convergence of earnings occurs between EU countries, wages in less developed CEE countries, with lower wage level, tend to grow faster than they do in wealthier ones, with higher wages. The catching-up process took place among the EU countries, but based on $\beta$-coefficients estimates, it cannot be expected that CEE countries will reach the wage levels seen in Western Europe soon. If the average growth patterns observed in 2009–2019 continued, the countries of the enlarged EU would need about 26–27 years to reduce the distance to their hypothetical common steady state by a half.

Differences growth rate of gross earnings among Visegrad Group countries were insignificant in the years 2009-2019. The higher rate of wage growth in Slovakia as compared to other countries of the Visegrad group was also not confirmed, so it cannot be concluded on this basis about the positive impact of the euro on wages growth acceleration. The second hypothesis: After the adoption of the euro, Slovakia is characterized by higher wage growth than the other countries of Visegrad group, was verified negatively.

This research used the nominal gross earnings in euro indicator only. This indicator is sensitive to exchange rate fluctuations, which may distort the results in relation to countries outside the euro area. Another limitation is the relatively short time series. We must remember that Slovakia joined to eurozone during last world economic crisis, what must have additional influence on economic indicators.

## References

Barro, R.J. & Sala-i-Martin, X. (2003). *Economic growth*. Cambridge – London: The MIT Press.

Boyle, G.E. & McCarthy, T.G. (1997). A simple measure of β-convergence. *Oxford Bulletin of Economics and Statistics*, *59*(2), 257-264. doi: 10.1111/1468-0084.00063.

Diaz del Hoyo, J.L., Dorrucci, E., Heinz, F.F.,& Muzikarova, S. (2017). Real convergence in the euro area: a long-term perspective. *European Central Bank Occasional Paper 203.* doi: 10.2866/121513.

Heller, J., & Warżała, R. (2019) The effects of entering the eurozone on other Central and Eastern European countries in relation to Poland. *Journal of Competitiveness 11* (1), 5-21, doi: 10.7441/joc.2019.01.01.

Horodecka, A., & Vozna, L. (2018). Wage inequality and macroeconomic stability: a synergetic approach. *Ekonomia i Prawo. Economics and Law, 17*(3): 265–277. doi:10.12775/EiP.2018.019.

Naz, A., Ahmad, N., Naveed, A., (2017), Wage convergence across European Regions: Do international borders matter?, *Journal of Economic Integration, 32*(1):35-64. doi: 10.11130/jei.2017.32.1.35.

Próchniak M. (2019). Konwergencja beta, sigma i gamma krajów postsocjalistycznych do Europy Zachodniej. *Rocznik Instytutu Europy Środkowo-Wschodniej 17*(1), 217-243, doi: 10.36874/RIESW.2019.1.10.

Rapacki, R., & Próchniak, M. (2019). EU membership and economic growth: Empirical evidence for the CEE countries. *The European Journal of Comparative Economics, 16*(1), pp. 3-40. doi: 10.25428/1824-2979/201901-3-40.

Siegel, S. (1956). *Nonparametric statistics for the behavioural sciences.* New York: McGraw-Hill.

## Acknowledgments

This research was fully funded by the University of Warmia and Mazury in Olsztyn, Faculty of Economics, Institute of Economics and Finance statutory sources.

## Annex

**Table 1**. Results of the estimation of regression equation parameters in relation to β-convergence in 2009-2019

| Specification | Value |
|---|---|
| $\alpha_1$ | -0.022464 |
| **standard error** | 0.003014 |
| **t-students statistics** | -7.45375 |
| **Value *p*** | 0.000000 |
| $\alpha_0$ | 0.0250344 |
| **standard error** | 0.029803 |
| **t-students statistics** | 8.40008 |
| **Value *p*** | 0.000000 |
| **N** | 11 |
| **$R^2$** | 0.698335 |
| **$\beta$ convergence** | Yes |
| **$\beta$ ratio** | 0.025803 |

Source: own calculations based on Eurostat database.

**Table 2**. Results of the estimation of regression equation parameters in relation to σ -convergence in 2009-2019

| Specification | Value |
|---|---|
| $\alpha_1$ | -0.017226 |
| **standard error** | 0.001925 |
| **t-students statistics** | -8.94744 |
| **Value *p*** | 0.000009 |
| $\alpha_0$ | 0.820874 |
| **standard error** | 0.013057 |
| **t-students statistics** | 62.86680 |
| **Value *p*** | 0.000000 |
| **N** | 11 |
| **$R^2$** | 0.898941 |
| **$\sigma$ convergence** | Yes |

Source: own calculations based on Eurostat database.

**Table 3.** Annual gross earnings as a percentage of EU-15 average

| Country | 2000 | 2004 | 2008 | 2009 | 2019 |
|---|---|---|---|---|---|
| **Czechia** | 15.1 | 20.0 | 30.9 | 30.6 | 37.8 |
| **Hungary** | 14.0 | 20.6 | 26.3 | 24.9 | 32.5 |
| **Poland** | 19.3 | 18.2 | 27.2 | 23.1 | 32.8 |
| **Slovakia** | 16.9 | 19.4 | 25.0 | 25.9 | 31.3 |

Source: own calculations based on Eurostat database.

**Table 4**. Average growth rate nominal gross earnings in euro

| Country | 2001-2003 | 2004-2008 | 2009-2019 |
|---|---|---|---|
| **Czechia** | 11.1% | 12.26% | 3.59% |
| **Hungary** | 13.86% | 8.71% | 3.68% |
| **Poland** | 2.05% | 9.98% | 3.64% |
| **Slovakia** | 4.36% | 9.0% | 3.75% |
| **EU-15** | 1.94% | 2.26% | 1.62% |

Source: own calculations based on Eurostat database.

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**Proceedings of the 11th International Conference on Applied Economics Contemporary Issues in Economy: Quantitative Methods**

**Olsztyn: Instytut Badań Gospodarczych // Institute of Economic Research**

**2021**

**DOI: 10.24136/eep.proc.2021.2 (eBook)**
**ISBN 978-83-65605-44-3; ISSN 2544-2384 (Online)**

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# Changes in the dynamics and structure of employment in the voivodship of Małopolska in the light of smart specialisations in the region

**JEL Classification:** *J21*

**Keywords:** *employment structure, employment dynamics, regional specialisations*

## Abstract

**Research background:** Among the determinants of the socio-economic development of the region, an important role is played by its endogenous potential, which is reflected in the industry structure of the region, determining the development of regional specialisations. One of the criteria for defining specialisations is the employment structure by sections and divisions of the national economy.
**Purpose of the article:** The main objective of the study is to identify specialisations in Małopolska that should constitute smart specialisations of the region, taking as a criterion the relative advantage of the share of employees in particular industries in the total number of employees in Małopolska in relation to the corresponding share for Poland.
**Methods:** The study is based on GUS unpublished data (Statistics Poland) for 2009 and 2018. It makes use of descriptive statistical analysis methods and structure and dynamics ratios, as well as Florence's specialisation coefficient.

**Findings & Value added:** In the analysed period the region strengthened its specialisations in the service sectors of the economy, especially including sections Information and Communication and Professional, Scientific and Technical Activities. Slightly lower but higher than average employment levels are recorded in the following sections: Arts, Entertainment and Recreation, Accommodation and Food Service Activities, Administrative and Support Service Activities and in the section Construction. The region's specialisation in industrial activities has deteriorated, however it still distinguishes itself in selected areas belonging to this section: i.e. manufacture of leather and leather products, tobacco products, metals, printing and reproduction of recorded media. The region is also characterised by a dynamic development of the division Manufacture of computers, electronic and optical products. The concentration of labour resources in the particular divisions of the national economy is a significant indicator to be considered in assessing regions' endogenous potential while identifying smart specialisations. However, the process of smart specialisations delimitation should be based on various other developmental factors.

## Introduction

In the recent years smart specialisation has been at the centre of socioeconomic development programmes and development policies in EU countries and regions. This concept is regarded by the European Commission as the main pillar of the Europe 2020 strategy, aimed to make the EU a smart and sustainable economy, which supports the idea of social inclusion (European Commission, 2010, p. 2). Due to the experimental character of policies based on smart specialisations there are not any theories, methodological guidelines or recommendations and criteria for selecting priority activities, which results in the adoption of various approaches in this field (Szávics & Benedek, 2020, pp. 22-36). Quantitative analyses recommend that the estimation of a regional economy's level of specialisation be based on economic activity concentration, reflected, for example, in employment rates and the performance of particular sectors (Foray *et al.*, 2012, pp. 29-30). Most empirical analyses are based on data related to the structure of employment (Sobczak, 2012, pp.219-232), the number of businesses, employment dynamics or investment activities (Bal-Domańska *et al.*, 2020, pp. 785-810; Danilova *et al.*, 2019, pp. 2376-2390). Information about employment and its dynamics points to regional key resources reflected in labour force concentration in selected industries. Employment rates translate to the volumes of goods and services and regional value added. In light of the above, an analysis and assessment of employment in particular economic sectors is

a significant but not the only criterion for identifying smart regional specialisations.

The main objective of the study is to identify specialisations in Małopolska that should constitute smart specialisations of the region, taking as a criterion the relative advantage of the share of employees in particular industries in the total number of employees in Małopolska in relation to the corresponding share for Poland. The study is based on GUS unpublished data (Statistics Poland) for 2009 and 2018. It makes use of descriptive statistical analysis methods and structure and dynamics ratios, as well as Florence's specialisation coefficient.

## Literature review

The concept of *smart specialisation* originates from literatures analysing differences in productivity between the USA and Europe, which became visible after the year 1995 (van Ark *et al.*, 2008, pp. 25-44). It was presented for the first time by Dominique Foray and Bart van Ark, who developed it together with other members of the Knowledge for Growth expert group, called into being by the European Commission in 2005 (Foray *et al.*, 2007, pp. 5-9). Originally, the concept was sectoral in character, but in the course of time it was also applied at regional level (Foray *et al.*, 2015, pp. 458-480). In the latter approach it serves as a tool for implementing a policy aimed to support development, competitiveness and creation of innovation strategies in EU countries and regions (OECD, 2013, p. 19).

According to the basic assumption of this concept, development should be based on an endogenous potential, which implies that all regions and countries should identify their individual and unique resources (key success factors), characterised by the greatest development potential and creating conditions for innovativeness, and then select a small number of key areas for possible specialisation based on the previously identified potential (Bański & Mazurek, 2018, pp. 5–30).

Regions' key challenge is to identify those actions and areas in which new R&D and innovation projects are likely to create future potential and inter-regional comparative advantage. According to the analysed concept, the identification of smart specialisation is not based on top-down selection of priorities but on stimulating entrepreneurial discovery processes, understood as a grassroots interactive process in which market forces along with the private sector identify new areas of specialisation which may be productive when supported by the public sector for the purpose of enhancing smart and sustainable growth (Hermosa *et al.*, 2014, pp. 5-22).

## Research methodology

The empirical study is based on unpublished statistical data provided by Statistics Poland for 2009-2018, related to the number of employees in the particular sectors of the national economy. Public statistics does not provide data concerning employees in national economy sectors by regions – it presents information at a higher level of aggregation, i.e. the sectors of the national economy. The original data related to the number of employees originates from a GUS survey concerning demand for labour, based on representative data covering entities with one or more employees.

The empirical study presented in the paper is based on statistical analysis dynamic methods using structure and dynamics indicators. The analysis of Małopolska's regional specialisation based on the employment structure makes use of Florence's location quotient (Billings & Johnson, 2012, pp. 642-647):

$$LQ_i = \frac{\frac{Z_{iR}}{Z_R}}{\frac{Z_{iK}}{Z_K}}$$

where:
$LQ_i$ – specialisation coefficient in i-th division/section of region's economy,
$Z_{iR}$ – value of analysed characteristic in *i*-th division/section of region's economy,
$Z_{iK}$ – value of analysed characteristic in *i*-th division/section of national economy,
$Z_R$ – value of analysed characteristic in all divisions/sections of region's economy,
$Z_K$ – value of analysed characteristic in all divisions/sections of national economy.

## Results

The analysis of changes on Małopolska's labour market with regard to the employment structure in 2009 and 2018 allows for presenting the sectoral concentration of labour force and determining whether the highest concentration rates are recorded in smart specialisation industries.

In the analysed 9-year period Małopolska strengthens its specialisations in economic service sectors. Simultaneously, the position of industrial sec-

tors becomes weaker (Table 1). The process of changes in 2018 leads to creating the region's dominant specialisations. In the service economic sectors Małopolska is distinguished on a national scale by the following sections: Information and Communication, and Professional, Scientific and Technical Activities.

Under the section Information and Communication, the most spectacular progress has been made in *Services related to information***.** This area includes data processing, internet website management, internet portal activities and other information-related services. In 2009-2018, the number of employees in this section increased by 241.9% (the number of employees in Poland in this period increased by 109.3%)[1]. In 2018, this industry represented 0.7% of employees in the voivodeship (an average for Poland – 0.3%). Małopolska accounted for 22.8% of employees representing this section in Poland. This great employment dynamics contributed to the region's specialisation in the area of information-related services. At the end of 2018, the specialisation coefficient reached a very high level of 2.7 (in 2009 – 1.6). Other information and communication activities developed in this section include *Activities related to software and information-related advisory services and related activities.* In the entire analysed period this area represented a much higher labour concentration in Małopolska than in other voivodeships (in 2018 – 2.0% as compared with 1.2% in Poland). In 2018, as many as 13.7% of Poland's employees in this section were employed in Małopolska, while the specialisation coefficient in the region stood at 1.6 (as compared with 1.5 in 2009). Another specialisation of the region are *Activities related to the production of films, video recordings, tv programmes and sound and music recordings.* The specialisation coefficient in this area reached the level of 1.5 in 2018 (in 2009 – 1.3). The region's share in Poland's total employment rose steadily, accounting for 13.1% of all employees in this section in 2018.

Małopolska is also marked by a very large number of employees who represent Professional, scientific and technical activities. Under this section, the region specialises in *Other professional, scientific and technical activities and Legal, accounting and tax advisory activities. Other professional, scientific and technical activities* include specialised design services, photography, translation services and other professional activities not included under other classifications. In 2009-2018, the number of the region's employees in this section rose by 502.1% (an average increase in

[1] The cited data concerning Poland's entire territory, similarly to the case of Małopolska, is based on GUS unpublished information (Poland Statistics). Due to the limitations of this work, individual data for Poland is not presented.

Poland – 38.5%), which resulted in a very high share of the region in Poland's total employment in this area – 18.8% in 2018, while the region's specialisation coefficient was at the level of 2.2 (rising from 0.5 in 2009). A very high level of the specialisation coefficient is also recorded in *Legal, accounting and tax advisory activities* (1.8 in 2018, and 1.3 in 2009)**.** This sector was also marked by high employment dynamics – an increase by 171.2% (average value for Poland – 94.8%). In 2018, it represented 2.5% of the region's employees (an average for Poland – 1.3%), and 15.8% of Poland's total number of employees in this section.

A relatively lower but high specialisation is recorded in the selected areas of the following sections: Arts, Entertainment and Recreation; Accommodation and Food Service Activities, and Administrative and Support Service Activities.

With regard to Arts, Entertainment and Recreation, Małopolska specialises in two areas: *Activities related to libraries, archives, museums and other cultural activities,* and *Creative activities related to culture and entertainment.* The specialisation coefficient for these areas in 2018 was 1.4 and 1.3, respectively. In both cases specialisation was expanded. Małopolska represented 11.9% and 11.0% of Poland's employees in these areas, and the number of employees in the analysed years increased by 31.8% and 24.0%, respectively.

Accommodation and Food Service Activities include two areas of economic activity: *Accommodation* and *Food service activities*. Both areas can be regarded as Małopolska's specialisations. *Food service activities* achieved the region's specialisation coefficient of 1.3 (2018). Its share in Poland's employment in this sector was at a similar level (2018 – 11.0%). In the analysed period the number of employees increased by 55.2%. The specialisation level in *Accommodation* decreased in 2018 as compared with the previous years (the respective coefficient – 1.2). It should be noted that specialisation in the previous years was more visible (from 1.2 to 1.9). Also, the share in the national economy decreased, but in 2018 it was still considerable – 10.6%.

Under the section Administrative and Support Service Activities, Małopolska specialises only in one of six economic areas – *Office administrative activities and other business support activities*, for which the specialisation coefficient reached the level of 1.5 in 2018, but it should be noted that the region's specialisation in this area started as late as in 2016.

Apart from services, Małopolska specialises in Construction, especially in such areas as *Construction works related to erecting buildings* and *Specialised construction works*. In both construction areas the specialisation coefficient in 2018 had the value of 1.3. It should be noted that this value

remained stable throughout the analysed period. As compared with 2009, the number of employees increased in 2018 by 21.1% and 37.9%, respectively (the respective values for Poland – 7.1% and 26.1%). In the last year of the analysis the two areas represented 11.4% and 11.1% of Poland's employees.

As already mentioned, Małopolska's position in the sector of industrial activities became weaker. The economic activities under Manufacturing, in which the region still specialises but on a limited scale, include *Manufacture of leather and leather products, Manufacture of tobacco products, Manufacture of metals, Printing and reproduction of recorded media.* It should be noted that despite a decreased share of these areas in the region's economy, they still represent strong significant specialisations, concentrating a large proportion of the regional and national labour force.

With regard to *Manufacture of leathers and leather products,* the specialisation coefficient in 2018 remained at a very high level of 2.2, although slightly lower as compared with the previous years when its value was as high as 3.2. In 2018, the sector accounted for 0.4% of the region's labour force (twice as high as Poland's average level – 0.2%). Małopolska represented as many as 18.9% of Poland's employees in this sector, but it was well below the level of 2009 – 27.8%. An even larger decline in the number of employees was recorded in *Manufacture of tobacco products.* In 2018, the voivodeship accounted for 16.6% of the industry's labour force in Poland as compared with 51.8% in 2009. In the analogous period, the specialisation coefficient decreased from 6.1 to 1.9. An equally high specialisation coefficient is recorded in *Manufacture of metals* – 1.8. In this case, the value of the coefficient decreased slightly from 2.0 in 2009. In 2018, Małopolska represented a large proportion of Poland's employees (15.6%), but this level was considerably lower as compared with the best period of 2013-2014 when the coefficient exceeded 19.0%. The value of the specialisation coefficient in *Printing and reproduction of recorded media* varied from year to year (reaching the level of 1.6 at the end of 2018). The region's share in Poland's total employment increased from 11.3% in 2009 to 14.0% in 2018.

Among the areas belonging to Manufacturing, a special case is represented by *Manufacture of computers, electronic and optical equipment.* Unlike the above industrial economic sectors, this area is on the rise in the region of Małopolska. Its share in the country's labour force increased from merely 7.9% in 2009 to 11.7% in 2018. The number of employees increased in this period by 51.0% (Poland's average – 2.7%). As a result of these positive changes, the region's specialisation coefficient in this sector increased from 0.9 to 1.4.

## Conclusions

The conducted research study allowed for identifying Małopolska's specialisations, that should constitute smart specialisations of the region based on changes in the dynamics and structure of employment in the particular economic sections of the voivodeship in 2009-2018. In the analysed period the region strengthened its specialisations in the service sectors of the economy. Simultaneously, the significance of industrial sectors decreased. Małopolska's dominant specialisations include activities related to the section Information and Communication (services related to information, software, advisory services, production of films, video recordings, tv programmes, and sound and music recordings), and the section Professional, Scientific and Technical Activities (legal and accounting activities, tax advisory services, and other professional, scientific and technical activities). Slightly lower but higher than average employment levels are recorded in the following sections: Arts, Entertainment and Recreation (libraries, archives and museums, and activities related to culture and entertainment), Accommodation and Food Service Activities, Administrative and Support Service Activities (administrative office services and economic activity support services). Apart from services, the voivodeship specialises in the activities belonging to the section Construction (construction works related to the erection of buildings, and specialised construction works).

Despite the fact that the region's specialisation in industrial activities has deteriorated, it still distinguishes itself in selected areas belonging to this section: Manufacturing, i.e. manufacture of leather and leather products, tobacco products, metals, printing and reproduction of recorded media. Unlike the above mentioned activities, the region is characterised by a dynamic development of the division Manufacture of computers, electronic and optical products, which is reflected in the growing significance of these activities in the regional and national employment structure.

The concentration of labour resources in the particular divisions of the national economy is a significant indicator to be considered in assessing regions' endogenous potential. It reflects a historical process of the development of the population's qualifications and professional experience. Also, a large number of employees in a given sector translates to the effects of its functioning – production output, sales or value added. However, it should be noted that the employment dynamics and structure is one of many criteria for identifying regional smart specialisations. The process of delimitation is based on various other developmental factors. The identification and exploration of other delimitation factors related to regional smart

specialisations is a significant area of further research undertaken by the authors of this paper.

## References

Bal-Domańska, B., Sobczak, E., Stańczyk, E. (2020). A multivariate approach to the identification of initial smart specialisations of Polish voivodeships. *Equilibrium. Quarterly Journal of Economics and Economic Policy, 15*(4), 785–810. doi: 10.24136/eq.2020.034.

Bański J., Mazurek, D. (2018). Smart specialisation and the internal potential of regions in Poland, *Folia Geographica*, 60(1), 5–30.

Billings, S.B., Johnson, E.B. (2012). The location quotient as an estimator of industrial concentration. *Regional Science and Urban Economics*, 42(4), 642-647, doi: 10.1016/j.regsciurbeco.2012.03.003.

Danilova, I., Pravdina, N., Dzenzeliuk, N., Kochegarova, L. (2019). Sector specializations of regions: criteria of localization and efficiency. In: K.S. Soliman (Ed.). *Vision 2025: Education Excellence and management of innovations through sustainable economic competitive advantage*. Madrid: International Business Information Management Association, 2376-2390.

European Commission. 2010a. Europe 2020 – A Strategy for Smart, Sustainable and Inclusive Growth, COM(2010) 2020 final. Retrieved from https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52010DC2020&from=en (16.03.2021)

Foray D., David P., Hall B. (2007). Smart specialisation: the concept. *Knowledge Economists Policy Brief*, 9, 5-9.

Foray, D., Goddard, J., Goenaga Beldarrain X., Landabaso, M., McCann, P., Morgan, K., Nauwelaers, C., Ortega-Argilés, R. (2012). *Guide to Research and Innovation Strategies for Smart Specialisations (RIS 3)*. Luxembourg: Publications Office of the European Union. Retrieved from https://s3platform.jrc.ec.europa.eu/documents/20182/84453/RIS3+Guide.pdf/fceb8c58-73a9-4863-8107-752aef77e7b4 (20.03.2021).

Foray, D., McCann, P., Ortega-Argilés, R. (2015). Smart specialization and European regional development policy. In D. B. Audretsch, A. Link, M. Walshok (Eds.). *Oxford handbook of local competitiveness*, Oxford: Oxford University Press, 458–480.

Hermosa, J. C., Elorduy, J. P., Eguia, B. (2014). Smart specialization and entrepreneurial discovery: Theory and reality. *Revista Portuguesa de Estudos Regionais*, 39, 5-22.

OECD. (2013). *Innovation-driven Growth in Regions: The Role of Smart Specialisation*, Paris: OECD. Retrieved from https://www.oecd.org/sti/inno/smart-specialisation.pdf (17.03.2021).

Sobczak, E. (2012). Smart specialization of workforce structure in the European Union countries – dynamic analysis applying shift-share analysis method. *Comparative Economic Research. Central and Eastern Europe*, 15(4), 219-232. doi: 10.2478/v10103-012-0037-3.

Szávics P., Benedek J. (2020). Smart specialisation priorities of less developed regions. A critical evaluation. In C. Bevilacqua, F. Calabrò, L. Della Spina (Eds.). *New Metropolitan Perspectives. NMP 2020. Smart Innovation, Systems and Technologies*, 177. Cham: Springer, 22-36. doi: 10.1007/978-3-030-52869-0_3.

van Ark, B., O'Mahoney M., Timmer, M. P. (2008). The productivity gap between Europe and the United States: trends and causes. *Journal of Economic Perspectives, 22*(1), 25-44. doi: 10.1257/jep.22.1.25.

## Acknowledgments

Publication financed under the programme of the Minister of Science and Higher Education "DIALOG" carried out in the years 2020-2021, grant No. 0054/DLG/2019/10

## Annex

**Table 1.** Values of Florence's coefficient based on Małopolska's employment structure in 2009 and 2018

| Sections and divisions of national economy | 2009 | 2018 | Trend (rising / unchanging / falling) |
|---|---|---|---|
| **A. AGRICULTURE, FORESTRY AND FISHING** | **0.5** | **0.4** | □ |
| **B. MINING AND QUARRYING** | **0.7** | **0.6** | □ |
| **C. MANUFACTURING** | **0.9** | **0.9** | □ |
| Manufacture of food products | 1.0 | 1.0 | □ |
| Manufacture of beverages | 0.9 | 0.3 | □ |
| Manufacture of tobacco products | 6.1 | 1.9 | □ |
| Manufacture of textiles | 0.3 | 0.9 | ↑ |
| Manufacture of clothing | 0.5 | 0.6 | ↑ |
| Manufacture of leathers and leather products | 2.6 | 2.2 | □ |
| Manufacture of wood and cork products excluding furniture; manufacture of straw and woven products | 0.7 | 1.0 | ↑ |
| Manufacture of paper and paper products | 0.5 | 0.6 | ↑ |
| Printing and reproduction of recorded media | 1.3 | 1.6 | ↑ |
| Manufacture and processing of coke and oil refined products | 0.2 | 1.2 | ↑ |
| Manufacture of chemical products | 0.9 | 1.1 | ↑ |
| Manufacture of basic pharmaceutical substances, medications and other pharmaceutical products | 0.8 | 0.7 | □ |
| Manufacture of gum products and plastics | 1.0 | 0.7 | □ |
| Manufacture of other non-metal mineral products | 1.8 | 1.1 | □ |
| Manufacture of metals | 2.0 | 1.8 | □ |
| Manufacture of metal finished goods excluding machines and equipment | 1.0 | 1.0 | □ |
| Manufacture of computers, electronic and optical products | 0.9 | 1.4 | ↑ |
| Manufacture of electric products | 0.5 | 1.1 | ↑ |
| Manufacture of machines and equipment not classified elsewhere | 1.1 | 1.2 | ↑ |
| Manufacture of vehicles, trailers and semi-trailers excluding motorcycles | 0.4 | 0.7 | ↑ |
| Manufacture of other transport equipment | 0.2 | 0.7 | ↑ |
| Manufacture of furniture | 0.4 | 0.4 | □ |
| Manufacture of other products | 0.6 | 0.8 | ↑ |
| Repair, maintenance and assembly of machines and equipment | 0.8 | 0.6 | □ |

**Table 1.** Continued

| Sections and divisions of national economy | 2009 | 2018 | Trend (rising / unchanging / falling) |
|---|---|---|---|
| **D. ELECTRICITY, GAS, STEAM AND AIRCONDITIONING SUPPLY** | **0.9** | **0.4** | ☐ |
| **E. WATER SUPPLY; SEWARAGE, WASTE MANAGEMENT AND REMEDIATION ACTIVITIES** | **1.0** | **1.0** | ☐ |
| **F. CONSTRUCTION** | **1.2** | **1.2** | ☐ |
| Construction works related to erection of buildings | 1.2 | 1.3 | ↑ |
| Works related to construction of civil and water engineering facilities | 1.2 | 0.8 | ☐ |
| Specialised construction works | 1.2 | 1.3 | ↑ |
| **G. WHOLESALE AND RETAIL TRADE; REPAIR OF MOTOR VEHICLES AND MOTORCYCLES** | **1.1** | **1.0** | ☐ |
| Wholesale and retail trade in motor vehicles, repair of motor vehicles | 1.0 | 0.6 | ☐ |
| Wholesale trade excluding trade in motor vehicles | 1.0 | 1.3 | ↑ |
| Retail trade excluding retail trade in motor vehicles | 1.3 | 0.9 | ☐ |
| **H. TRANSPORTATION AND STORAGE** | **0.8** | **0.7** | ☐ |
| **I. ACCOMMODATION AND FOOD SERVICE ACTIVITIES** | **1.3** | **1.3** | ☐ |
| Accommodation | 1.6 | 1.2 | ☐ |
| Food service activities | 1.2 | 1.3 | ↑ |
| **J. INFORMATION AND COMMUNICATION** | **1.0** | **1.4** | ↑ |
| Publishing activities | 1.0 | 0.8 | ☐ |
| Activities related to manufacture of films, video recordings, tv programmes, and music and sound | 1.3 | 1.5 | ↑ |
| Broadcasting of public and subscribed programmes | 0.4 | 0.4 | ☐ |
| Telecommunication | 0.6 | 0.5 | ☐ |
| Activities related to software and information-related advisory services, and related activities | 1.5 | 1.6 | ↑ |
| Information-related services | 1.6 | 2.7 | ↑ |
| **K. FINANCIAL AND INSURANCE ACTIVITIES** | **0.6** | **0.5** | ☐ |
| Financial services excluding insurance and pension funds | 0.7 | 0.6 | ☐ |
| Insurance, reinsurance and pension funds excluding compulsory social insurance | 0.4 | 0.0 | ☐ |
| Financial service, insurance and pension fund support activities | 0.5 | 0.7 | ↑ |
| **L. REAL ESTATE ACTIVITIES** | **0.8** | **0.8** | ☐ |

**Table 1.** Continued

| Sections and divisions of national economy | 2009 | 2018 | Trend (rising / unchanging / falling) |
|---|---|---|---|
| **M. PROFESSIONAL, SCIENTIFIC AND TECHNICAL ACTIVITIES** | **1.3** | **1.4** | ↑ |
| Legal and accounting activities and tax advisory services | 1.3 | 1.8 | ↑ |
| Head office activities; management advisory services | 1.1 | 1.2 | ↑ |
| Activities related to architecture and engineering; technical research and analyses | 1.7 | 1.1 | □ |
| R&D | 1.2 | 1.1 | □ |
| Advertising, market research and public surveys | 0.8 | 0.9 | ↑ |
| Other professional, scientific and technical activities | 0.5 | 2.2 | ↑ |
| Veterinary activities | 0.7 | 1.4 | ↑ |
| **N. ADMINISTRATIVE AND SUPPORT SERVICE** | **0.9** | **0.8** | □ |
| Rental and leasing activities | 0.4 | 0.8 | ↑ |
| Employment activities | 0.5 | 0.4 | □ |
| Organization of tourism and tourism agents, and other reservation and related activities | 1.1 | 1.1 | □ |
| Detective and security activities | 0.8 | 0.8 | □ |
| Maintenance of buildings and management of green spaces | 1.3 | 0.8 | □ |
| Administrative office services and other business support activities | 1.0 | 1.5 | ↑ |
| **O. PUBLIC ADMINISTRATION AND DEFENCE; COMPULSORY SOCIAL SECURITY** | **0.9** | **0.8** | □ |
| **P. EDUCATION** | **1.1** | **1.2** | ↑ |
| **Q. HUMAN HEALTH AND SOCIAL WORK ACTIVITIES** | **1.0** | **1.1** | ↑ |
| **R. ARTS, ENTERTAINMENT AND RECREATION** | **1.1** | **1.2** | ↑ |
| Creative activities related to culture and entertainment | 1.1 | 1.3 | ↑ |
| Libraries, archives, museums and other culture-related activities | 1.3 | 1.4 | ↑ |
| Gambling and betting | 0.3 | 0.5 | ↑ |
| Sport, entertainment and recreation activities | 1.2 | 0.8 | □ |
| **S. OTHER SERVICE ACTIVITIES** | **1.1** | **1.3** | ↑ |

Source: authors' research based on GUS unpublished data.

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**Proceedings of the 11th International Conference on Applied Economics Contemporary Issues in Economy: Quantitative Methods**

**Olsztyn: Instytut Badań Gospodarczych // Institute of Economic Research**

**2021**

**DOI: 10.24136/eep.proc.2021.2 (eBook)**
**ISBN 978-83-65605-44-3; ISSN 2544-2384 (Online)**

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# China's international trade and global value chains under One-Belt One-Road initiative

**JEL Classification:** *F13; F14; C23*

**Keywords:** *One-Belt One-Road; China, gravity trade models; global value chains*

## Abstract

**Research background:** After China acceded to the WTO in 2001, its foreign trade has expanded rapidly to be the largest share in the world. However, China's economic development changing from high-speed growth to medium high-speed growth in recent years. At the same time, the increase in labour cost and overcapacity also hinder China's international trade. In order to solve these challenges and strengthening ties with other countries, China proposed the "One-Belt One-Road" (OBOR) initiative in the end of 2013.
**Purpose of the article:** In this study, we examine the potential effects of "One-Belt One-Road" (OBOR) initiative on China's trade flows and global value chain connections. The purposes of our research are: (1) examining the impact of OBOR on China's bilateral exports and GVC (2) analyzing and determining which routs (corridors) of OBOR are more important.
**Methods:** The gravity trade model employed in analyzing the impact of OBOR on exports and the samples covers China and 197 partners in the period 2000-2018. It is used in the empirical analysis of domestic value-added and value contributed to China's export.
**Findings & Value added**: Overall, the role of OBOR in China's exports and GVC are positive based on the empirical results. Compared with OLS and FE methods. FE-PPML estimation methods is a superior. In OBOR six corridors, Bangladesh-China-India-Myanmar (BCIM), China-Pakistan (CP) and China Indochina Peninsula (CIP) were proven to play a prominent role in promoting China's export and global value chains.

## Introduction

The "One-Belt One-Road" initiative (OBOR) was proposed by the Chinese government in September 2013. OBOR's 65 countries can be divided into six economic corridors: Bangladesh-China-India-Myanmar (BCIM), China-Central West Asia (CCWA), China-Indochina Peninsula (CIP), China-Mongolia-Russian Federation (CMRF), China-Pakistan (CP) and New Eurasian Land Bridge (NELB) (OECD, 2018, pp. 9-12).

OBOR has made remarkable achievements (eg. CR Express) in the field of trade. Also, considering China is regarded as the "world factor" highly involved in international trade, I expect OBOR to impact China's bilateral trade. Moreover, OBOR is also a cooperation platform that includes strengthening overseas investment, establishing the Asian Infrastructure Investment Bank to promote infrastructure construction and other measures. So there will be a reasonable inference that OBOR affects the global value chain.

In literature, few researches in analyzing OBOR's impact on trade because OBOR did not introduce specific provisions (eg. tariff reduction or lifting.) like trade agreements in the early stage. With the continuous development of OBOR related projects, many researchers have gradually begun to analyse OBOR's effects on trade. Foo *et al*. (2019) verified the significant positive effect of OBOR on the trade between China and ASEAN countries. After that, Yu L. *et al*. (2020) confirmed again that OBOR could promote China's export potential and showed that it was more prominent in capital intensive products. However, they are limited to the gross trade. One expectation is Kohl (2019, pp. 77-104), based on the value-added trade data from 64 countries in 2002-2011, concluded OBOR reduced the trade cost by promoting infrastructure and signing trade agreements. But OBOR was proposed only at the end of 2013 and 2014 is generally regarded as its first year, it has limitations in the sample period. Besides, these researches' data do not cover a wide range of countries.

The purposes of our research are: (1) examining the impact of OBOR on China's bilateral exports and GVC, (2) analyzing and determining which routs (corridors) of OBOR are more important.

## Research methodology

The data of this paper is composed of bilateral trade data set and global value chain data set.

The sample of bilateral trade data set covers China and its 197 partners from 2000 to 2018. Among the variables utilized in further empirical analysis: data on exports come from WITS; gravity variables[1] are taken from CEPII; GDP and GDP per capita from the World Bank. The information about participation in ACFTA is obtained from its official website, involvement in OBOR is based on OECD (2018, pp. 9-12), and membership in WTO is integrated from WTO website (2000-2015) and CEPII (2016-2018).

The data about domestic value-added (DVA), DVA embodied in final and intermediate exports we obtain from the ADB-MRIO2018 database of UIBE GVC Indicators. We then merge this with other variables from the same sources and get the first GVC data set that comprises China and its 60 partners (31 OBOR countries) in 2010-2017.

Then, to explore whether the participating countries in OBOR have closer production ties with China, we use the value contributed by a partner country in China's total exports from UNCTAD-Eora GVC Database, merging other variables. Finally, sample covers China and 177 partners from 2000 till 2018. The summary statistics and detailed descriptions of all variables are shown in Table 1.

Figure 1 presents the export trends of China. Generally, export has grown nearly tenfold from 2000 to 2018. Especially in the ten years after China has been acceded to the WTO in 2001, it has maintained a growth rate of more than 17%, except for the subprime mortgage crisis in 2009. However, exports have entered a medium and low growth rate since 2012, providing a trade background for the proposal of OBOR strategy. Although OBOR was put forward in 2013, China's exports still had negative growth in 2015 and 2016. That also explains why previous researchers did not pay special attention to its trade effect.

We show the share of China's main partners in its total export in Figure 2. The primary partners are AUS, DEU, GBR, HKG, IND, JPN, KOR, MYS, RUS, SGP, THA and USA. Overall, the proportion of these 12 countries decreased from 73.43% to 59.53% and the USA kept the largest share. For non-OBOR countries, except Australia, others had decreased or remained the similar percentages from 2000 to 2018. Among them, Japan is only one-third of its original in 2000 (16.72% to 5.90%). On the contrary, we find that the shares of countries along OBOR had nearly doubled except Singapore (2.31% to 2.00%). Especially, India's proportion had increased from 0.63% to 3.08% almost five times.

[1] The gravity variables including contiguity, bilateral distance, colonial relationship, same country before and common language.

Figure 3 presents the share of different economic corridors in China's exports. First, the share of OBOR increased from 12.56% to 26.06%. For details, the CIP, which is highly coincident with the ASEAN region, has the largest share with 10.7% in 2018. Additional, BCIM (1.45% to 4.43%) has the fastest growth. In contrast, CMRF and NELB have the smallest share, which is 2.2% and 2.60%, respectively.

Finally, many researchers believe that total exports can not fully reflect international trade status, especially countries' involvement in the global value chains. Figure 4 describes the trend of domestic value-added in China's exports in 2010-2017. Except for negative growth in 2015 and 2016, it achieved stable growth (39.2% compared with 2010). From the perspective of final and intermediate products, the proportion of DVA_I increased from 43.01% to 47.05%, which also reflects the deepening of China's participation in GVC.

*Gravity model of trade*

Considering gravity model's outstanding performance in analyzing trade flows, we also run our empirical analysis on the bases of it. Based on the previous studies and above-mentioned descriptive statistic, the following hypothesis can be proposed:

*Hypothesis 1: OBOR plays a positive role in promoting China's international trade.*

*Hypothesis 2: China's DVA in export is larger when partners are members of OBOR.*

*Hypothesis 3: The partner will contribute more value in China's total exports when partners belong to OBOR.*

*Hypothesis 4: Some OBOR corridors are more critical in China's international trade.*

Based on Borchert *et al*. (2020), we estimate the augmented version of gravity model in log-log form:

$$lnX_{rp,t} = \alpha + \beta_1 lnGDP_{r,t} + \beta_2 lnGDP_{p,t} + \beta_3 lnGDPpc_{r,t} + \beta_4 lnGDPpc_{p,t} + \beta_5 lnDist_{rp} + \beta_6 Lang_{rp} + \beta_7 Contig_{rp} + \beta_8 Colony_{rp} + \beta_9 Smctry_{rp} + \beta_{10} WTO_{rp,t} + + \beta_{11} ACFTA_{rp,t} + \beta_{12} OBOR_{rp,t} + \epsilon_{rp}$$

Estimation of gravity model can cause some challenges, in order to limit the potential problems we follow closely the procedures proposed by Head & Mayer (2014, pp. 131-195) and Yotov *et al.* (2016, pp. 9-54). First, we

need to solve the multilateral resistances problem proposed by Anderson. The method is the inclusion of fixed effect of reporter-time and partner-time. However, it should be noted that in our study we only need to impose a fixed effect on the partner-year. Secondly, to solve the problem with zero trade flows and heteroscedasticity, it is recommended to use the Poisson Pseudo Maximum Likelihood (PPML) estimator as the regression method. Correia *et al*. (2020, pp. 95-115) proposed a new PPML estimator that deals with the zeros while controlling for multiple fixed effects (FE-PPML). Considering the impact of macroeconomic background (e.g. economic cycles), we should employ time fixed effect in the regressions (Yang & Martinez-Zarzoso, 2014, pp. 138-151). Also, the standard error will be underestimated if we ignore clustering in data with multiple aggregation levels. We cluster the errors in the regression analysis (Shepherd, 2016, pp. 17-30). Finally, to solve the endogenous problem, Yotov *et al*. (2016, pp. 9-54) suggest imposing a fixed effect on the country pair.

However, fixed effect will absorb some variables (eg. exporter-time and importer-time fixed effects will absorb the size variables and all other observable and unobservable country characteristics, which change over time).

## Results and discussion

Firstly, we use OLS and FE to test the effect of OBOR on exports, results are shown in Table 2. Consistent with the traditional conjecture, Two GDP show a positive effect on exports, while distance hinders it. China exports more to countries that share a common language, has neighbouring or colonial relations. But OBOR turns not to be statistically significant determinant of trade.

Next, Table 3 shows the results of using FE-PPML. For exports, we get statistically significant positive correlation results of WTO, ACFTA and OBOR. OBOR is relatively tiny. Specifically, $\alpha = 0.287$ means that if the partner country is a participant of OBOR, China's exports to the partner will be \$287 more at a significant level of 1%.($\alpha \times 1000$, ceteris paribus). As DVA only includes 480 observations, some of our results don't seem to be very significant. However, the results of OBOR are positively correlated with three kinds of DVA ( bigger results in DVA_I), while WTO is negatively correlated. The coefficient of 0.233 means that if the partner country is a participant in OBOR, China's DVA embodied in intermediate exports will be \$233000 more. The most results shows there is a positive correlation between OBOR and the value contributed by partner countries in Chi-

na's total exports. It means the greater the country's value in intermediate products imported by China. In other words, it means that China's production ties with this country are closer.

Finally, we explore the economic corridors in Table 4. For exports, we find that BCIM, CIP, and CP are positively correlated with it. That means if a country is a member of any of these 3 economic corridors, China will export more to it. Then, we find that BCIM, CCWA and CP have positive and significant effects on DVA, DVA-FIN and DVA_I. Additional, the results of CIP is positive. In VCp_IN_Er, we have positive results in all economic corridors, but only BCIM, CIP and CMRF are significant. Among them, we find that the countries from CMRF corridor will have more contribution value to China's exports. However, it is negatively correlated with exports and DVA. In other words, members from CMRF benefit from their bilateral trade with China. Overall, we find that BCIM, CIP and CP are more critical for China.

## Conclusions

This paper studies the impact of OBOR and its corridors on China's international trade and GVC. As far as we know, there is no discussion on the impact of OBOR and its economic corridors from the perspectives of bilateral trade and GVC.

According to the statistical analysis and previous literature, we employ an argumented gravity model as our research method. Our results reveal that 1) OBOR has a statistically significant positive effect on China's exports, DVA and participant contribution value to China's exports. However, results under OLS and FE methods are not robust. In contrast, FE-PPML shows its unique advantages. 2) At the economic corridor level, BCIM, CIP and CP are critical in China's international trade and GVC. It is worth noting that CMRF harms China's export and DVA trade and promotes countries in its region benefit from the trade with China.

Our research is helpful in 1) clarification the role of OBOR in promoting trade and deepening the industrial links between China and participating countries; 2) introducing the differences of varied economic corridors and point out the weak areas for the promotion of OBOR.

This study's main limitations are as follows: 1) limited in the number of countries in DVA. 2) The study is conducted at the aggregate level without distinguishing different sectors.

Finally, this paper's future research can be divided into two aspects: 1) Extending the study to the specific industries between specific countries or

regions. 2) Considering that research on trade can also start from the dimension of bilateral trade variety, we can verify whether and how OBOR affects export variety between country pairs.

## References

Borchert, I., Larch, M., Shikher, S., & Yotov, Y. (2020). Disaggregated Gravity:Benchmark Estimates and Stylized Facts from a New Database. *School of Economics Working Paper Series 2020-8, LeBow College of Business, Drexel University*.

Correia, S., Guimarães, P., & Zylkin, T. (2020). Fast Poisson estimation with high-dimensional fixed effects. *The Stata Journal: Promoting Communications On Statistics And Stata*, *20*(1), 95-115. doi: 10.1177/1536867x20909691.

Foo, N., Lean, H., & Salim, R. (2020). The impact of China's one belt one road initiative on international trade in the ASEAN region. *The North American Journal Of Economics And Finance*, *54*, 101089. doi: 10.1016/j.najef .2019.101089.

Head, K., & Mayer, T. (2014). Gravity Equations: Workhorse,Toolkit, and Cookbook. *Handbook Of International Economics*, 131-195. doi: 10.1016/b978-0-444-54314-1.00003-3.

Kohl, T. (2019). The Belt and Road Initiative's effect on supply-chain trade: evidence from structural gravity equations. *Cambridge Journal Of Regions, Economy And Society*, *12*(1), 77-104. doi: 10.1093/cjres/rsy036.

OECD. (2018). The Belt and Road Initiative in the global trade, investment and finance landscape. In *OECD Business and Finance Outlook 2018.* Dordrecht: OECD Publishing, Paris, 9-12. doi: 10.1787/9789264298828-en.

Shepherd, B. (2016). *The gravity model of international trade: A user guide (An updated version)*. United Nations ESCAP, 17-30.

Yang, S., & Martinez-Zarzoso, I. (2014). A panel data analysis of trade creation and trade diversion effects: The case of ASEAN–China Free Trade Area. *China Economic Review*, *29*, 138-151. doi: 10.1016/j.chieco.2014.04.002.

Yotov, Y., Piermartini, R., Monteiro, J., & Larch, M. (2016). *An Advanced Guide to Trade Policy Analysis: The Structural Gravity Model.* WTO, Geneva/UN, New York, 9-54. doi: 10.30875/abc0167e-en.

Yu, L., Zhao, D., Niu, H., & Lu, F. (2020). Does the belt and road initiative expand China's export potential to countries along the belt and road?. *China Economic Review*, *60*, 101419. doi: 10.1016/j.chieco.2020.101419.

## Annex

**Table 1**. Descriptive statistics

| Variable | N | Mean | SD | Min | Max |
|---|---|---|---|---|---|
| Log of exports of China to partner (1000 US$ ) | 3730 | 12.819 | 2.904 | 0.300 | 19.989 |
| China's DVA embodied in its export to partner (millions of US$) | 480 | 18804.492 | 38932.531 | 21.104 | 3.03e+05 |
| China's DVA embodied in its intermediate export to partner (millions of US$) | 480 | 8584.425 | 14559.973 | 8.922 | 1.06e+05 |
| China's DVA embodied in its final export to partner (millions of US$) | 480 | 10220.067 | 25288.229 | 9.017 | 1.97e+05 |
| The value contributed by a partner country in China's total exports(1000 US$ ) | 3363 | 1.19e+06 | 4.31e+06 | 3.034 | 5.79e+07 |
| Log of China's GDP (current US$) | 3731 | 29.150 | 0.820 | 27.823 | 30.242 |
| Log of partner's GDP (current US$) | 3570 | 23.786 | 2.423 | 16.553 | 30.654 |
| Log of China's GDP per capita (current US$) | 3731 | 8.142 | 0.791 | 6.866 | 9.187 |
| Log of partner's GDP per capita (current US$) | 3570 | 8.415 | 1.573 | 4.718 | 11.685 |
| Log of distance between China and partner's capitals (km) | 3731 | 8.997 | 0.532 | 6.696 | 9.868 |
| Lang: 1 if trading partners share a common language with China | 3731 | 0.020 | 0.141 | 0.000 | 1.000 |
| Contig: 1 if trading partners share a common border with China | 3731 | 0.081 | 0.274 | 0.000 | 1.000 |
| Colony: 1 trading partners were ever in a colonial relationship with China | 3731 | 0.005 | 0.071 | 0.000 | 1.000 |
| Smctry: 1 if trading partners were united with China in the past | 3731 | 0.015 | 0.123 | 0.000 | 1.000 |
| WTO: 1 if trading partners and China are all the members of WTO at time t | 3731 | 0.709 | 0.454 | 0.000 | 1.000 |
| ACFTA: 1 if trading partners and China are all the members of ACFTA at time t | 3731 | 0.046 | 0.209 | 0.000 | 1.000 |
| OBOR: 1 if trading partners and China are all the members of OBOR at time t | 3731 | 0.082 | 0.274 | 0.000 | 1.000 |

**Table 2**. Estimation results of the gravity model for exports, OLS/FE

| | **lnexport** | | |
|---|---|---|---|
| | **OLS** | **OLS** | **FE** |
| $lnGDP_{rt}$ | 0.723*** | 0.839*** | 0.839*** |
| | [0.098] | [0.085] | [0.082] |
| $lnGDP_{pt}$ | 0.994*** | 1.308*** | 1.308*** |
| | [0.045] | [0.283] | [0.276] |
| $lnGDPpc_{pt}$ | -0.263*** | -0.535* | -0.535* |
| | [0.067] | [0.292] | [0.284] |
| $lnDist_{rp}$ | -0.319 | -0.168 | |
| | [0.194] | [0.865] | |
| $Lang_{rp}$ | 1.495*** | 0.931 | |
| | [0.336] | [0.587] | |
| $Contig_{rp}$ | 0.256 | 1.388 | |
| | [0.336] | [1.233] | |
| $Colony_{rp}$ | 1.203** | | |
| | [0.495] | | |
| $Smctry_{rp}$ | 0.871 | -0.06 | |
| | [0.568] | [0.627] | |
| $WTO_{rpt}$ | 0.499** | 0.014 | 0.014 |
| | [0.233] | [0.098] | [0.095] |
| $ACFTA_{rpt}$ | 0.549** | -0.251* | -0.251* |
| | [0.242] | [0.151] | [0.146] |
| $OBOR_{rpt}$ | -0.186 | -0.066 | -0.066 |
| | [0.120] | [0.078] | [0.076] |
| year | yes | yes | yes |
| Par | | yes | |
| Cluster (Dist) | yes | yes | yes |
| N | 3570 | 3570 | 3570 |
| R2 | 0.84 | 0.97 | 0.82 |

Notes: FE: fixed effects estimations when panel id=Reporter x Partner,
* p<0.10, ** p<0.05, *** p<0.01

**Table 3**. Estimation results of the gravity model for exports, DVA and value contributed by a partner country in China's total exports, FE-PPML

| | **exports** | **DVA** | | **DVA_I** | | **DVA_FIN** | **$VC_p$_IN_$E_r$** | |
|---|---|---|---|---|---|---|---|---|
| $WTO_{rpt}$ | 0.044 | -0.058 | -0.162* | -0.004 | -0.098 | -0.04 | -0.147 | 0.074 |
| | [0.147] | [0.110] | [0.096] | [0.131] | [0.096] | [0.103] | [0.104] | [0.056] |
| $ACFTA_{rpt}$ | 0.323* | | | | | | | 0.344*** |
| | [0.169] | | | | | | | [0.117] |
| $OBOR_{rpt}$ | 0.287*** | 0.173*** | 0.055 | 0.233*** | 0.06 | 0.099* | 0.025 | 0.138*** |
| | [0.064] | [0.040] | [0.066] | [0.039] | [0.079] | [0.052] | [0.069] | [0.044] |
| year | yes | | yes | | yes | | yes | yes |
| Par | yes | yes | yes | yes | yes | yes | yes | yes |
| Cluster(Rep#Par) | yes | | yes | | yes | | yes | yes |
| N | 3730 | 480 | 480 | 480 | 480 | 480 | 480 | 3363 |

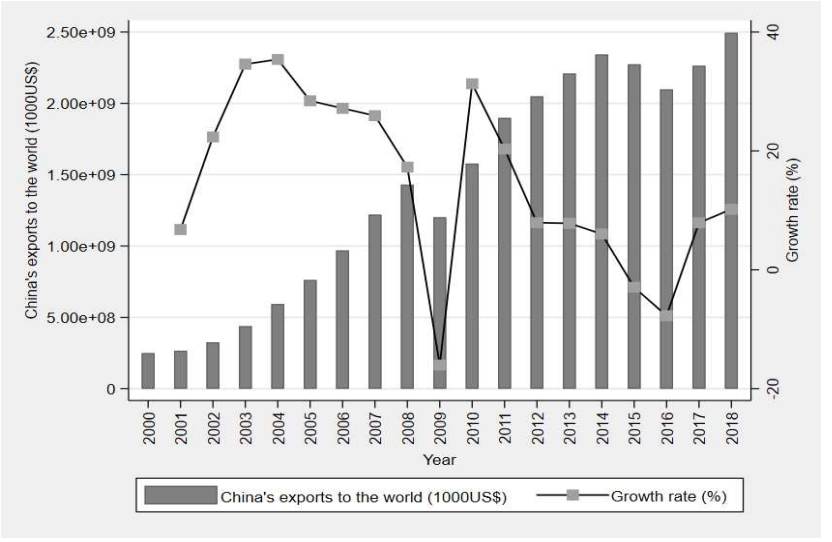
Notes: * p<0.10, ** p<0.05, *** p<0.01

**Table 4**. Estimation results of the gravity model, various economic corridors among independent variables, FE-PPML

| | **exports** | **DVA** | **DVA_I** | **DVA_F** | **$VC_p$_IN_$E_r$** |
|---|---|---|---|---|---|
| $BCIM_{rpt}$ | 0.372*** | 0.072* | 0.051 | 0.081 | 0.207*** |
| | [0.067] | [0.037] | [0.042] | [0.053] | [0.040] |
| $CCWA_{rpt}$ | 0.131 | 0.101** | 0.112** | 0.089** | 0.061 |
| | [0.085] | [0.046] | [0.056] | [0.045] | [0.054] |
| $CIP_{rpt}$ | 0.374*** | 0.16 | 0.13 | 0.149 | 0.088* |
| | [0.145] | [0.125] | [0.144] | [0.101] | [0.046] |
| $CMRF_{rpt}$ | -0.178 | -0.198*** | -0.207*** | -0.169** | 0.155*** |
| | [0.117] | [0.067] | [0.076] | [0.067] | [0.058] |
| $CP_{rpt}$ | 0.182** | 0.294*** | 0.186*** | 0.395*** | 0.056 |
| | [0.092] | [0.024] | [0.039] | [0.019] | [0.045] |
| $NELB_{rpt}$ | -0.048 | -0.064 | -0.04 | -0.122 | 0.063 |
| | [0.149] | [0.129] | [0.065] | [0.229] | [0.042] |
| year | yes | yes | yes | yes | yes |
| Par | yes | yes | yes | yes | yes |
| Cluster(Rep#Par) | yes | yes | yes | yes | yes |
| N | 3730 | 480 | 480 | 480 | 3363 |

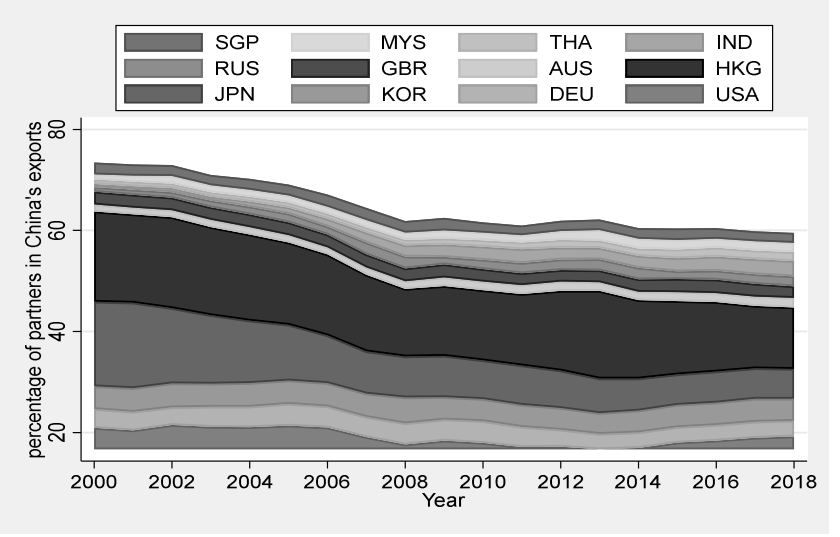
Notes: This table is a summary of the parameters of each economic corridor from different regressions, where corridors are not included simultaneously but one by one. The additional variables include: WTO and ACFTA, not included in the table due to the space constraints. * p<0.10, ** p<0.05, *** p<0.01

**Figure 1**. The trend and growth rate of China's exports to the world



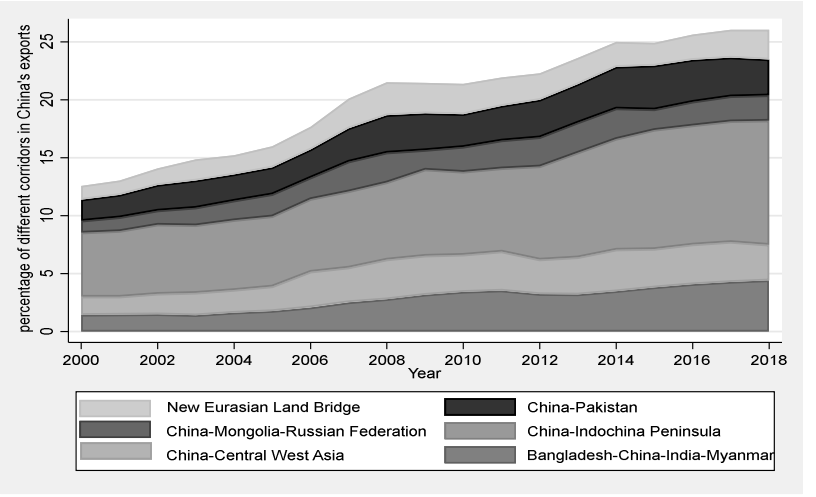

Source: own elaboration based on data from UN Comtrade database extracted through WITS

**Figure 2**. Proportion of major trading countries in China's total exports



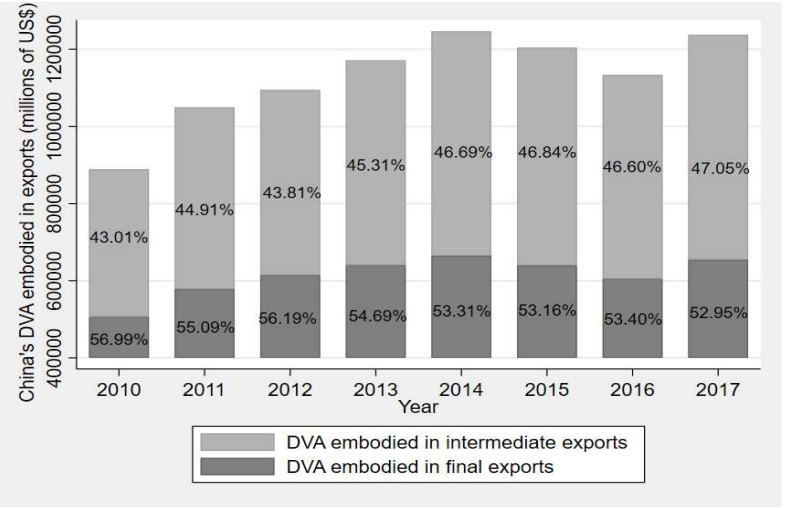

Source: own elaboration based on data from UN Comtrade database extracted through WITS.

**Figure 3**. Proportion of OBOR's different economic corridors in China's total exports




Source: own elaboration based on data from UN Comtrade database extracted through WITS.

**Figure 4**. The trend of China's domestic value-added




Note: The initial value of the ordinate is 400000 (millions of US $)

Source: own elaboration based on data from ADB-MRIO2018 database of UIBE GVC Indicators.

**Adam P. Balcerzak & Michał Bernard Pietrzak (Eds.)**

**Proceedings of the 11th International Conference on Applied Economics Contemporary Issues in Economy: Quantitative Methods**

**Olsztyn: Instytut Badań Gospodarczych // Institute of Economic Research**

**2021**

**DOI: 10.24136/eep.proc.2021.2 (eBook)**
**ISBN 978-83-65605-44-3; ISSN 2544-2384 (Online)**

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# How to grow the property valuation business in Poland?

**JEL Classification:** *L21; L25, L26; L85*

**Keywords:** *property valuation; business growth, business growth factors; business development; business performance*

## Abstract

**Research background:** According to literature studies, the most objective measure of business success is business growth. However, the diversity of business entities and their environment raises the importance of considering the unique nature of the industry when selecting performance measures. Property valuation can be considered a specific professional activity that enables a business to operate and grow. Based on our research, Polish valuers confirm that their business has grown over the last three years. As signs of company growth, valuers point primarily to increases in: the number of valuations carried out, new clients, remuneration for valuation services, company brand recognition, number of employees, staff qualifications as well as improved facilities and the establishment of new branches.
**Purpose of the article:** The main objective of this article was to identify the factors that significantly affect the growth prospects of companies providing valuation services in Poland. As professional practice shows there are different business models for property valuation, differing in organizational and legal form, but also in the type of valuations performed, the type of client served, or the scope of services provided.
**Methods:** Our study was based on survey data from 277 respondents representing the valuation businesses. In order to analyze the results of the survey the logistic regression was used.

**Findings & Value added:** The research confirms the relationship between the way of conducting real estate valuation activities and its chances for growth. The survey results show that a firm's growth prospects are affected by the type of clients served, and the gender and age of the owner-valuer. This research is the first to address the growth factors of companies providing valuations. The added value of the study is to expand knowledge in the area of business practice in property valuation sector.

## Introduction

Success of the companies can be measured both by the subjective goals of the company founder (Garengo & Bernardi, 2007, pp. 518-532; Dalborg *et al.*, 2012, pp. 289-315) as well as by traditional financial performance (Glancey 1998, pp. 18-27; Carton & Hofer, 2006). Due to the vague evaluation of personal goals of entrepreneurs, the most objective measure of business success is company growth (Carton & Hofer, 2006).

It is pointed out that the growth of small enterprises is a function of decisions made by the entrepreneur, which depend on his individual characteristics and aspirations, as well as internal and external business conditions (Gilbert *et al.,* 2006, pp. 926-950), Differences in the attitude to business growth result from the characteristics of the entrepreneurs themselves (Dalborg *et al.*, 2012, pp. 289-315; Kirkwood, 2016, pp. 594-615) and the general conditions of business performance, such as state of the market and industry characteristics (Gilbert *et al.,* 2006, pp. 926-950).

Real estate valuation is a specific type of business. Narrowing the literature analysis to real estate valuation firms, it was found that such firms are mainly described in terms of the valuation profession itself, valuation methodology (Adair *et al.*, 1996), client relationships (Amidu *et al.*, 2008, pp. 89–106; Małkowska *et al.,* 2019) or the scope of services provided (Małkowska & Uhruska, 2019, pp. 27-38). To date, no detailed research has been conducted on the issue of the growth of businesses operating in this particular industry.

This research is the first to address the growth factors of companies providing valuations. Our main objective was to identify the factors that significantly affect the growth prospects of companies providing valuation services in Poland. Our study was based on survey data from 277 respondents who were owners or co-owners of valuation businesses. For the analysis, a logistic regression model was used. The survey results show that a firm's growth prospects are affected by, inter alia, the spatial coverage of valuations offered, the type of clients served, and the gender and age of the owner-valuer.

## Data and research methodology

*Research data*

The data used in the study was collected through a 2018 survey conducted among Polish real estate valuers. 277 questionnaires were admitted for analysis, all completed by individuals with at least 4 years of professional experience by the date of the survey, who identified themselves as owners or co-owners of a real estate valuation business. The detailed structure of responses is shown in Table 1.

The range of information on valuation activity gathered through the survey was very broad. Specifically, valuers were asked whether they considered their business had grown in the past three years, what the manifestations of that growth were, and whether the business's revenue had increased in the past three years. Among those surveyed, 42,6% felt their company had grown in the past three years. The growth signs perceived by valuers primarily included an increase in: number of valuations completed, new clients, remuneration for valuation services, company brand recognition, number of employees, staff qualifications, as well as improved facilities and the establishment of new branches.

*Estimation strategy*

In order to identify the growth factors of a real estate valuation companies, we used a logistic regression model, which allows the dichotomous qualitative variable Y to be explained.

The general form of the logit model can be written as follows:

$$logit(Y) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_k X_k + \varepsilon$$

where

$$logit(Y) = \log\left(\frac{P(Y=1)}{P(Y=0)}\right)$$

and
$Y$ is qualitative predicted variable
$\beta_0$ is the intercept,

$\beta_1, \beta_2, \ldots, \beta_k$ are regression parameters,
$X_1, X_2, \ldots, X_k$ are predictor variables,
$\varepsilon$ is the error term

Because the $\beta$ parameters show the effect of the independent variables on the logit, which is awkward to interpret, we will show their exponents - odds ratios (OR) in the outcome tables,

$$OR_i = e^{\beta_i}$$

which present the effect of independent variables on the odds of an interesting outcome occurring.

For our study, we examined the impact of valuation company specifics ($X_3$, $X_4$) and the range of the services provided ($X_{5a\text{-}d}$ –$X_{17}$) on the odds of business growth ($Y_1$). We also controlled for the valuers' individual characteristics – gender ($X_1$) and age ( $X_2$) of respondents. Both dependent variables and all independent variables are dichotomous. A detailed description of the variables included in the models is provided in Table 2.

## Research results and discussion

The estimation results of the logit models for the dependent variable defined as firm growth are presented in Table 3, The analysis was based on three models, with each subsequent one extended to include an additional set of variables. Initially, we began estimation with two variables characterizing valuation companies - form of ownership ($X_3$) and number of valuers employed ($X_4$), also controlling for the gender of the owner-valuer ($X_{1)}$ and his or her age ($X_{2a\text{-}d}$). We then extended the basic model to include the spatial coverage of valuations ($X_{5a\text{-}d}$)) and the scope of business activity ($X_6$), which reflected the situation when the company solely provides valuation services. In a final step, we expanded the variables from the mid-model to include those related to potential business diversification ($X_7$ – $X_9$) and specialization in serving specific client groups ($X_{10\text{-}17}$).

The multiple logistic regression model showed that the significant ($p<0.05$) independent predictors of company growth odds in the last three years were as follows: male gender of the owner-valuer, belonging to one of the top two age groups (especially young or middle-aged valuers), collaboration or employment of one or more valuers (in addition to the owner-valuer), performing valuations on a supra-regional basis, frequent work for developers.

In particular, the male gender of the owner-expert raised the odds of business growth by 93% compared to if the owner was female. On the other hand, it is worth noting that although the direction of the effect of gender on development chances in all models was consistent, these results were statistically significant only in model 3. A strong predictor of growth opportunity was the age of the valuer. In particular, the impact of belonging to the youngest age group of valuers (under 40) increased the odds of firm growth by more than 10 times in each of the estimated models.

Having more than one valuer working for the company (including the owner) also increased the chances of growth, more than two to three times depending on the model. The spatial extent of valuations was also an important predictor of growth prospects. On average, there was a four times increase in growth odds for those businesses that valued real estate in a supra-regional area compared to those that operated strictly locally. This was an interesting observation which showed that it was worth balancing the area of activity by choosing the widest possible coverage but within the limits, which allow the valuer to guarantee the quality of valuation that results from knowledge of the market in which he or she operates. Regarding the scope of activity and companies' specialization, the increase of development opportunities concerned those companies which often served banks. The results of model 3 indicated, in fact, that frequent ser-vices to banks increased business growth odds by more than two times. Providing services to banks, assures the volume of orders and stability of cooperation usually in the long-term.

## Conclusions

The growing number of valuers in Poland has led some to express concerns about excessive competition in the market, price dumping or poor quality of the services provided. The range of professional activities and potential areas of valuation specialization are diverse. Such heterogeneity within the profession raises questions about the factors that can contribute to success in the market.

In general, the study findings indicate that property valuation businesses owned by men were more likely to develop than those owned by women. A strong predictor of development was also the age, up to 41 years, although also people in the middle age group of up to 50 years belonged to the group of business owners with higher growth odds than the older ones.

Surprisingly, the mere fact that a valuer diversifies his or her business or limits himself or herself to valuation services did not affect growth oppor-

tunities. Rather, such opportunities lay in the spatial extent of the market served, the certain types of services accompanying real estate valuation (like brokerage) and the clients served. Greater growth potential was associated with going beyond the local valuation market, accepting valuation orders across at least two neighboring voivodeships. The owner-valuer's cooperation with at least one additional valuer (through employment or some other form of partnership) was also more likely to increase odds of company growth. Also important for growth opportunities was cooperation with banks, who are usually long-term clients from the business sector. Our preliminary analyses did not show that valuer characteristics such as education profile or length of work practice translated into opportunities for business growth. Therefore, these variables were omitted from further estimations and results presentation.

In formulating the above conclusions, we were aware of the limitations of our study. The first was the time constraint of the study, which did not capture the dynamics of change over time. The second was limiting the research to business development in terms of growth, without examining other soft success factors like job satisfaction or business continuity. These gaps open up new fields of research, especially in the context of the challenges of the impact of new technologies and the Covid-19 pandemic on the real estate market and its players. Also an interesting line of study is the impact of gender on doing business in valuation and the analysis of soft success factors in this professional activity.

## References

Adair, A., Downie, M. L., McGreal, S. (1996). *European valuation practice. Theory and techniques.* London: Taylor & Francis. doi: 10.4324/9780203475522.

Amidu, A.R.; Aluko, B.T.; Hansz, J.A. (2008). Client feedback pressure and the role of estate surveyors and valuers, *Journal of Property Research, 25*, 89–106.

Carton, R.B. & Hofer, C.W. (2006). *Measuring Organizational Performance – Metrics for Entrepreneurship and Strategic Management Research*, Cheltenham: Edward Elgar Publishing.

Dalborg, C., Friedrichs I. v., Wincent, J., (2012), Beyond the numbers: qualitative growth in women's businesses, *International Journal of Gender and Entrepreneurship, 4*(3), 289-315. doi: 10.1108/17566261211264163.

Garengo, P., Bernardi, G., (2007). Organizational capability in SMEs performance measurement as a key system in supporting company development, *International Journal of Productivity and Performance Management, 56*(5/6), 518-532. doi:10.1108/17410400710757178.

Gilbert, B. A., McDougall, P. P., Audretsch D. B., (2006), New Venture Growth: A Review and Extension, *Journal of Management, 32*(6), 926-950. doi: 10.1177/0149206306293860.

Glancey, K. (1998). Determinants of growth and profitability in small entrepreneurial firms, *International Journal of Entrepreneurial Behaviour & Research, 4*(1),18-27.

Kirkwood, J.J. (2016). How women and men business owners perceive success, *International Journal of Entrepreneurial Behavior & Research, 22*(5), 594-615. doi: 10.1108/IJEBR-01-2016-0024.

Małkowska, A. & Uhruska, M., (2019), Towards Specialization or Extension? Searching for valuation services models using cluster analysis, *Real Estate Management and Valuation, 27*(4), 27-38.

Małkowska, A., Uhruska, M. Tomal, M. (2019). Age and Experience versus Susceptibility to Client Pressure among Property Valuation Professionals – Implications for Rethinking Institutional Framework. *Sustainability*, *11*, 6759.

## Acknowledgments

This project has been financed by the Ministry of Science and Higher Education within the "Regional Initiative of Excellence"; Programme for 2019-2022. Project no.: 021/RID/2018/19.Total financing: 11 897 131,40 PLN.

## Annex

**Table 1.** Descriptive statistics for the survey sample

| Variables | Frequency (%) |
|---|---|
| **Gender** | |
| Male | 50.90 |
| Female | 49.10 |
| **Age** | |
| Below 41 | 26.35 |
| 41-50 | 24.55 |
| 51-60 | 24.91 |
| Above 60 | 24.19 |
| **Ownership** | |
| Sole proprietorship | 89.89 |
| Partnerships | 10.11 |
| **Employment** | |
| One | 83.75 |
| More than one | 16.25 |
| **Valuation spatial coverage** | |
| Local | 35.74 |
| Regional | 25.27 |
| Supra-regional | 15.52 |
| Country | 23.47 |
| **Business scope** | |
| Only real estate valuations | 42.60 |
| Additional services | 57.40 |
| **Additional service types** | |
| Real estate brokerage | 15.88 |
| Companies valuation | 27.44 |
| Surveying/construction | 14.80 |
| **Frequently clients served** | |
| Individuals | 46.93 |
| Companies | 40.43 |
| Banks and financial institutions | 25.63 |
| Developers | 14.44 |
| Courts | 35.38 |
| Bailiffs | 22.38 |
| Public governments | 34.30 |
| **Services in the foreign language** | |
| Foreign language service availability | 36.10 |

**Table 2.** Variables description

| Variables | | Description |
|---|---|---|
| $Y_1$ | Business growth | Respondent's answers to the question: in your opinion, has your business grown in the last 3 years? Possible answers: strongly yes, rather yes, hard to say, strongly no, rather no. The dummy variable takes the value 1 for strongly yes, rather yes, 0 otherwise. |
| $X_1$ | Gender | Gender of the respondent. The dummy variable takes the value 1 for male, 0 for female. |
| | | Set of dummy variables for respondents' age. |
| $X_{2a}$ | $Age_{(below41)}$ | The dummy variable takes the value 1 if respondent is under age 41, 0 otherwise. |
| $X_{2b}$ | $Age_{(41-50)}$ | The dummy variable takes the value 1 if respondent is between 41 and 50 years old, 0 otherwise. |
| $X_{2c}$ | $Age_{(51-60)}$ | The dummy variable takes the value 1 if respondent is between 51 and 60 years old, 0 otherwise. |
| $X_{2d}$ | $Age_{(above60)}$ | The dummy variable takes the value 1 if respondent is above age 60, 0 otherwise. |
| $X_3$ | Ownership | Legal form of the respondent's company. The dummy variable takes the value 1 for sole proprietorship, 0 for partnership. |
| $X_4$ | Employment | Number of valuers employed by the company, including owner. Possible answers: only one valuer, more than one valuer. The dummy variable takes the value 1 for more than one valuers employed, 0 for one valuers. |
| | | Set of binary variables for the spatial coverage of valuations. |
| $X_{5a}$ | Local | The dummy variable takes the value 1 if the valuer operates locally (within the nearest poviats), 0 otherwise. |
| $X_{5b}$ | Regional | The dummy variable takes the value 1 if the valuer operates regionally (within one voivodship), 0 otherwise. |
| $X_{5c}$ | Supra-regional | The dummy variable takes the value 1 if the valuer operates across regions (within several voivodships), 0 otherwise. |
| $X_{5d}$ | Country | The dummy variable takes the value of 1 if the valuer operates nationwide, 0 otherwise. |
| $X_6$ | Business scope | The dummy variable takes the value of 1 if the valuer's company provides only real estate valuations, 0 otherwise. |
| $X_7$ | Brokerage | The dummy variable takes the value 1 if the valuer's company also provides real estate brokerage services, 0 otherwise. |
| $X_8$ | Company valuation | The dummy variable takes the value 1 if the valuer's company also provides enterprise valuations, O otherwise. |
| $X_9$ | Surveying/ construction | The dummy variable takes the value 1 if the valuer's company also provides surveying and construction services, O otherwise. |
| $X_{10}$ | Individuals | The dummy variable takes the value 1 if the valuer's company frequently serves individuals, 0 otherwise. |
| $X_{11}$ | Companies | The dummy variable takes the value 1 if the valuer's company frequently serves enterprises (excluding banks and developers), 0 otherwise. |
| $X_{12}$ | Banks | The dummy variable takes the value 1 if the valuer's company frequently serves banks and other financial entities, 0 otherwise. |
| $X_{13}$ | Developers | The dummy variable takes the value 1 if the valuer's company frequently serves developers, 0 otherwise. |
| $X_{14}$ | Courts | The dummy variable takes the value 1 if the valuer's company frequently serves courts, 0 otherwise. |
| $X_{15}$ | Bailiffs | The dummy variable takes the value 1 if the valuer's company frequently serves bailiffs, 0 otherwise. |
| $X_{16}$ | Public governments | The dummy variable takes the value 1 if the valuer's company frequently serves public governments (at all levels), 0 otherwise. |
| $X_{17}$ | Foreign language | The dummy variable takes the value 1 if the valuer's company provides services in a foreign language |

**Table 3.** Logit models estimation for business growth as dependent variable

| **Business growth** | **Logit1** | | | **Logit2** | | | **Logit3** | | |
|---|---|---|---|---|---|---|---|---|---|
| | **OR** | **z** | **P>\|z\|** | **OR** | **z** | **P>\|z\|** | **OR** | **z** | **P>\|z\|** |
| Gender (male) | 1.62 | 1.73 | | 1.69 | 1.82 | | 1.93 | 2.15 | * |
| $Age_{(below41)}$ | 11.9 | 5.83 | *** | 12.8 | 5.88 | *** | 10.3 | 4.99 | *** |
| $Age_{(41-50)}$ | 2.40 | 2.16 | * | 7 | 2.30 | * | 4 | 1.79 | |
| $Age_{(51-60)}$ | 1.89 | 1.59 | | 2.58 | 1.95 | | 2.21 | 1.88 | |
| $Age_{(above60)}$ | Ref. | - | | 2.26 | - | | 2.36 | - | |
| | | | | Ref. | | | Ref. | | |
| Ownership | 1.21 | 0.37 | | 1.17 | 0.30 | | 1.78 | 0.96 | |
| Employment | 3.33 | 2.91 | ** | 3.48 | 2.89 | ** | 2.84 | 2.16 | * |
| Local | | | | Ref. | - | | Ref. | - | |
| Regional | | | | 1.12 | 0.31 | | 1.17 | 0.38 | |
| Supra-regional | | | | 3.98 | 3.08 | ** | 4.14 | 2.91 | ** |
| Country | | | | 1.70 | 1.31 | | 1.63 | 1.07 | |
| Business scope | | | | 1.59 | 1.46 | | 2.39 | 1.84 | |
| Brokerage | | | | | | | 2.31 | 1.85 | |
| Company valuation | | | | | | | 1.32 | 0.64 | |
| Surveying/construction | | | | | | | 0.65 | -0.81 | |
| Individuals | | | | | | | 1.35 | 0.92 | |
| Companies | | | | | | | 0.81 | -0.56 | |
| Banks | | | | | | | 2.33 | 2.40 | * |
| Developers | | | | | | | 1.44 | 0.77 | |
| Courts | | | | | | | 1.36 | 0.85 | |
| Bailiffs | | | | | | | 1.42 | 0.87 | |
| Public governments | | | | | | | 1.63 | 1.52 | |
| Foreign language | | | | | | | 1.52 | 118 | |
| Constant | 0.14 | -3.27 | *** | 0.07 | -3.84 | *** | 0.02 | -4.45 | *** |
| N | 277 | | | 277 | | | 277 | | |
| Pseudo R2 | 0.1551 | | | 0.1865 | | | 0.2368 | | |

** p<0.05, ** p<0.01,*** p<0.001*

**Adam P. Balcerzak & Michał Bernard Pietrzak (Eds.)**

**Proceedings of the 11th International Conference on Applied Economics Contemporary Issues in Economy: Quantitative Methods**

**Olsztyn: Instytut Badań Gospodarczych // Institute of Economic Research**

**2021**

**DOI: 10.24136/eep.proc.2021.2 (eBook)**
**ISBN 978-83-65605-44-3; ISSN 2544-2384 (Online)**

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# Data quality in international trade by commodity group

**JEL Classification:** *F14; C10; C82*

**Keywords:** *Intra-Community trade; CN chapters*

## Abstract

**Research background:** Intra-Community trade data are mirrored data. Transactions are recorded in two sources, on the side of the seller's country and on the side of the buyer's country. An inconsistency between the data is called mirror data asymmetry. International trade data are important in many macroeconomic analyses. Therefore, their accuracy is essential. Research papers focus on the causes of discrepancies and methods to analyse them.
**Purpose of the article:** The aim of the paper is to identify the asymmetry of mirror data by commodity group (CN chapters). The indicators used allow for the indication of commodity groups with high mirror data compatibility and those with data asymmetry. Value-based and quantity-based approaches used in analyse. The data were aggregated by country.
**Methods:** Based on the literature on the subject and previous their own research, the Authors have developed a group of methods for studying the asymmetry of mirror data. The proposed indicator formulas are based on various data aggregation approaches. The research used data by 97 chapters of the Combined Nomenclature (CN). The data comes from the Comext database, provided by Eurostat.
**Findings & Value added:** The results of the analysis are rankings of the Combined Nomenclature (CN) chapters by the quality of data. Thus, areas of necessary intensification of the work of public statistics services to improve data reliability were identified.

## Introduction

International trade is an important factor affecting the dynamics of overall economic development. The benefits of foreign trade affect a society's standard of living and contribute to the creation of its wealth. Trade in goods is the primary form of cooperation with foreign countries. Foreign trade of a country affects the size of GDP (gross domestic product) and its structure, the development of entrepreneurship, competitiveness, specialization, expansion of markets, access to new products and technologies, etc. It is therefore a very important economic category influencing economic decisions. Therefore, it is very important to obtain reliable data on the exchange of goods of individual countries, as well as groups of countries (e.g. EU) and on global trade turnover in general. Foreign trade statistics have a mirrored character. This means that information about the exchange of goods is recorded in the supplier country (as exports) and in the recipient country (as imports). The literature uses the terms 'mirror data' (Javorcik & Narciso, 2008, Markowicz & Baran, 2020), 'bilateral trade statistics' (Hong & Pak, 2016) often additionally warning against 'misreporting trade' (Kellenberg & Levinson, 2018). This form of information collection allows the comparison of two quantities concerning the same event (a trade transaction as an export quantity on the one hand and an import quantity on the other). By definition, these two quantities should be equal. However, this is not the case. There are greater or lesser differences in these quantities. There are many reasons for this situation. These include, for example, errors in data aggregation (at the level of the economic entity or the country), incorrect coding of the country of the supplier or the recipient, inaccurate coding of goods, failure to distinguish between the invoice value and the statistical value, etc. In addition to these unintentional errors, there are also intentional errors in reporting. We are talking about the under- or over-estimation of merchandise exchanges with foreign counterparts. These are the result of tax fraud.

Differences in official data on international trade have been written about for a long time. These are mirror data – recorded by trading counterparties. We believe that the first researcher of the phenomenon of data asymmetry in foreign trade was Morgenstern (1963) who did not only cover the analysis of world export and import data but also proposed tools to study the differences between them. In his opinion, misreported bilateral transactions are evidence of concealment of illicit financial flows. Farhad *et al*. (2018) acknowledge positive correlations for both tariff and VAT rates with import under-reporting.

Research on mirror data asymmetry focuses on its spatial domain. The results are supposed to identify countries as places where data errors occur. In contrast, in this paper the Authors focus on commodity groups and identification of those with poor data quality.

The discussion on mirror data asymmetry in international trade is still ongoing in the literature. We note two streams of this discussion. The first focuses on considering the reasons for the discrepancies in data (e.g. Federico & Tena, 1991, Javorcik & Narciso, 2008). The second stream, on the other hand, focuses on the methodology for investigating these discrepancies, that is, examining the quality of international trade data (e.g. Parniczky, 1980, Ferrantino & Wang, 2008, Markowicz & Baran, 2019).

The study of the quality of international trade data is important for the tax system in any country (Betz, 2019, Fisman & Wei, 2004, Ferrantino, *et al*. 2012). A very important factor in increasing tax collection is institutional quality (Bird & Zolt, 2008). The results of the study may have implications for increasing this quality.

For several years, the authors have been studying the discrepancy of mirror data in intra-Community trade in goods and ways to assess the quality of such data. The methodology developed so far has been used to assess the quality of data by EU countries. The aim of this paper is to adapt these methods to the study of asymmetry of mirror data by commodity groups. In this study, the quality of data on trade within specific commodity groups (CN chapters) in intra-Community trade was compared. The data were aggregated by country. The indicators used allow for the indication of commodity groups with high mirror data compatibility and those with data asymmetry between intra-Community supplies (ICS) and acquisitions (ICA). Moreover, the commodity groups for which the value-based and quantity-based approaches give similar results have been identified.

## Research methodology

The Authors' methods for studying the quality of foreign trade data have been developed for several years, based on the literature on the subject and their own research. Previous studies were based on Comext data and concerned intra-EU exchanges. The analyses were carried out in order to determine the level of data quality for individual EU countries or their groups – e.g. the so-called 'new' and 'old' EU In these studies, exports and imports of goods were aggregated by commodity groups (HS chapters).

Currently, however, we are focusing on analyzing the quality of data on intra-Community trade in goods divided by commodity group. The data

were aggregated by country. The indicators used allow for the indication of commodity groups with high mirror data compatibility and those with data asymmetry between intra-Community supplies (ICS) and acquisitions (ICA). Moreover, the commodity groups for which the value-based and quantity-based approaches give different results have been identified.

In our research, we propose different index formulas. They are based on data on the value of transactions (value-based formula), on the weights of goods traded (quantity-based formula) or as a quantity-based formula adjusted by the share in the value of ICS or ICA.

The research used data on intra-Community supplies and acquisitions of goods broken down into 97 chapters of the Combined Nomenclature/Harmonized System (CN/HS). Differences between the ICS and ICA in distinct commodity groups were aggregated for all pairs of EU countries.

In the article we used two types of indicators of mirror data quality – an aggregated value-based index (1) and a new proposal by the Authors, called a value-weighted aggregated index for quantity (2).

An aggregated value-based data quality index for exports of goods (from *k*-th HS chapter) is given by:

$$ {}_{Z}W_{E}^{AU}(k) = \frac{\sum_{i=1}^{n}\left|E_{AB_i}^{k} - I_{B_iA}^{k}\right|}{K} \tag{1}$$

where: $E_{AB_i}^{k}$ – declared value of exports of goods classified in *k*-th HS chapter from country *A* to the country $B_i$,,
$I_{B_iA}$ – declared mirror value of acquisitions of goods shipped from country *A* to country $B_i$, as reported in the receiving country ($B_i$) statistics,
$K = \sum_{i=1}^{n} \frac{\left(E_{AB_i}^{k} - I_{B_iA}^{k}\right)}{2}$ – a hypothetical true value of the above said exports.

Our newly proposed aggregated quantity index with value-based weights (value-weighted quantity-based quality index) is calculated following the formula:

$$ {}_{Z}W_{{}_{m}E}^{AU}(k) = \frac{\sum_{i=1}^{n}\left|{}_{m}E_{AB_i}^{k} - {}_{m}I_{B_iA}^{k}\right| \cdot L_i}{K} \tag{2}$$

where: ${}_{m}E_{AB_i}^{k}$ – declared weight of exports of goods classified in *k*-th HS chapter from country *A* to the country $B_i$,
${}_{m}I_{B_iA}^{k}$ – declared mirror value of acquisitions of goods shipped from country *A* to country $B_i$,

$L_i = \frac{E^k_{AB_i} + I^k_{B_iA}}{\sum_{j=1}^{n}\left(E^k_{AB_j} + I^k_{B_jA}\right)}$ – correction factor – the share of the value of exports of country *A* to country $B_i$ in total ICS.

$K = \sum_{l=1}^{n} \frac{\left(mE^k_{AB_i} + mI^k_{B_iA}\right)}{2} \cdot L_i$ – the sum of average (hypothetical) quantity of exports and mirror imports from country *i* to countries *j* corrected with $L_i$ factors.

The study was conducted according to the following steps:

1) selection of EU countries whose export value of goods exceeds the threshold (10% of the turnover of the country with the highest turnover)
2) aggregation of both value and weight of exports from selected countries (cf. point 1 above) to all EU member states for each HS chapter (96 chapters from 1 to 97 considered, specific chapters 98 and 99 excluded),
3) calculating index (1) for each HS chapter and ranking the chapters, then indicating the chapters with the highest and the lowest data quality,
4) calculating index (1) for each HS chapter and ranking the chapters, then indicating the chapters with the highest and the lowest data quality according to such modified index,
5) comparing indices (1) i (2) for every HS chapter in selected countries (graphical presentation included).

To exclude from consideration results that are due to randomness and are not the result of the sought regularity, the study was limited to countries with the largest turnover in intra-Community trade. The selection was made in such a way that the study included countries whose turnover in the examined period exceeded 10% of the turnover of the country with the largest volume, i.e. Germany. Under this condition, the study group consisted of 12 countries, Germany itself accompanied by the Netherlands, Belgium, France, Italy, Poland, Spain, United Kingdom (it was a member of the EU in the period under consideration), Czechia, Austria, Hungery, and Sweden The order of coutries listed corresponds with their respective declared ICS volumes. We used Eurostat's Comext data on intra-Community trade in 2017 in our numerical example.

## Results

We calculated all values of index (1) for every country from our list, obtaining vectors of 96 indices for every country. We continued by adding up the indices for the same *k*-th chapter in 12 countries which provided us within aggregate. Then these 96 aggregates were sorted in order to find out

which HS chapters data can be considered of best and worst quality in every country. Eventually, we present the distributions of the actual indices among the 12 countries in order of the aggregates (fig. 1 shows ten HS chapters with best and ten with worst data quality among the 12 considered countries). We repeated the procedure with indices given by (2) and obtained another ordering of chapters, resulting in a chart analogous to the previous one (fig. 2).

Although the selection of HS chapters in each diagram is different, we can still observe chapters that are among those with best/worst data quality regardless of the method, i.e. calculating data quality index based on weight can help in spotting those commodity groups that are reported correctly throughout the EU and those reported erroneously in many countries regardless of the method, the former group includes chapters 4, 18, 19, 39, 48, and 72, the latter – includes chapters 13, 36, 50, 89, and 97. In particular, it's the latter list of commodity groups that needs special attention from the official statistics services.

We calculated indices for every chapter in every country, so we could compare values of index (1) and index (2) in their respective data. In order to compare the indices we simply draught scatterplots in which index (1) is put along the x-axis and index (2) – along y-axis. We also counted the chapters for which index (1) takes a value higher than index (2) and those, for which index (2) > index (1). It appears, that Poland, Czechia and the Netherlands are the only countries for which the values of index (1) are higher than values of index (2) in most chapters while for most countries it is index (2) that has higher values in most of HS chapters. This result seems to be counterintuitive as index (2) was introduced to overcome the high volatility of index (1). However, the explanation to this lies perhaps in value-oriented statistical thresholds introduced in intra-Community statistics. Trade of low value may well be under the reporting threshold and thus not reported, leading to small discrepancies between mirror data. The same does not hold for weight of goods, because there exist many commodities that are both heavy and inexpensive. This result however is only speculative and we need further investigation to prove it.

We also observe that for huge economies the discrepancies in all chapters are low (points in diagrams tens to cluster in bottom-left corner) regardless of the method of calculating data quality which is both an expected and desired result.

## Conclusions

The results of the study lead to some conclusions. It seems that the most important conclusion is a relative constancy of badly reported groups, regardless of the method of calculating data quality indicator - based on the value or quantity of goods. Thus, there is an easily identifiable group of goods that should be monitored as closely as possible.

The second important finding is the non-intuitive nature of the relationship between index (1) (classic one) and index (2) – index (2) was supposed to eliminate differences between mirrored data, but in most cases it rather sharpens them.

Therefore, at this time it seems appropriate to use not one of the proposed indexes, but both, and interpret their results together.

### References

Betz, T. (2019). Tariff evasion and trade policies. *International Studies Quarterly*, *63*(2), 380-393. doi: 10.1093/isq/sqz008.

Bird, R. M., & Zolt, E. M. (2008). Tax policy in emerging countries. *Environment and Planning C: Government and Policy*, *26*(1), 73-86. doi: org/10.1068/cav3.

Farhad, M, Jetter, M, Siddique, A, & Williams, A. (2018). Misreported trade. *CESifo Working Paper Series, 7150*.

Ferrantino, M. J., Liu, X., & Wang, Z. (2012). Evasion behaviors of exporters and importers: Evidence from the U.S.–China trade data discrepancy. *Journal of International Economics*, *86*(1), 141–157. doi: 10.1016/j.jinteco.2011.08.006.

Fisman, R., & Wei, S-J. (2004). Tax rates and tax evasion: evidence from 'missing imports' in China. *Journal of Political Economy*, *112*(2), 471–496. doi: 10.1086/381476.

Hong, K. P., & Pak, S. J. (2016). Estimating trade misinvoicing from bilateral trade statistics: the devil is in the details. *The International Trade Journal, 31*(1), 3–28. doi: 10.1080/08853908.2016.1202160.

Kellenberg, D., & Levinson, A. (2018). Misreporting trade: tariff evasion, corruption, and auditing standards. *Review of International Economics, 27*(1), 106–129. doi: 10.1111/roie.12363.

Markowicz, I., & Baran, P. (2019). ICA and ICS-based rankings of EU countries according to quality of mirror data on intra-Community trade in goods in the years 2014-2017. *Oeconomia Copernicana*, *10*(1), 55–68. doi: 10.24136 /oc.2019.003.

Markowicz, I., & Baran, P. (2020). A new method for calculating mirror data asymmetry in international trade. *Oeconomia Copernicana, 11*(4), 637–656. doi: 10.24136/oc.2020.026.

Morgenstern, O. (1963). *On the Accuracy of Economic Observations*. Princeton University Press, New Jersey.

## Acknowledgments

The work is a part of a project financed within the framework of the program of the Minister of Science and Higher Education under the name "Regional Excellence Initiative" in the years 2019–2022; project number 001/RID/2018/19; the amount of financing PLN 10,684,000.

## Annex

**Figure 1.** Distributions of HS chapters positions in quality rankings based on index (1) calculated for individual countries (10 best and 10 worst chapters)

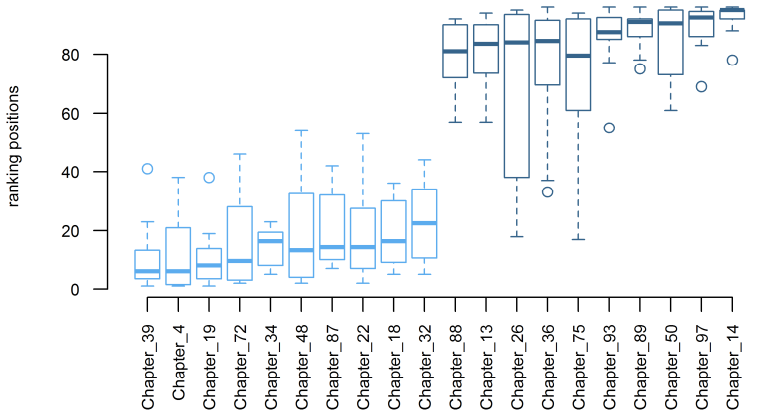



**Figure 2.** Distributions of HS chapters positions in quality rankings based on index (2) calculated for individual countries (10 best and 10 worst chapters)

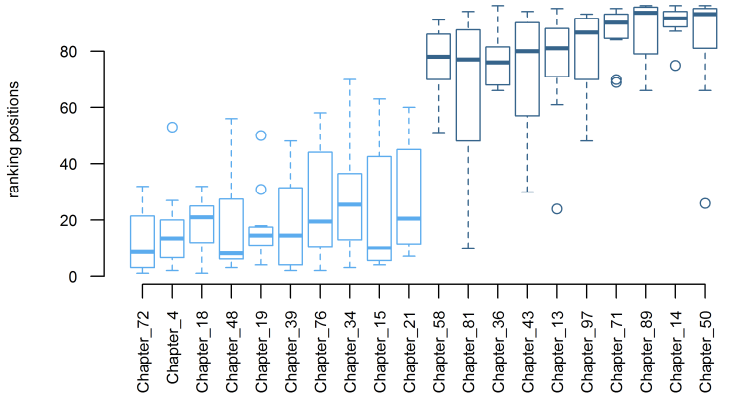
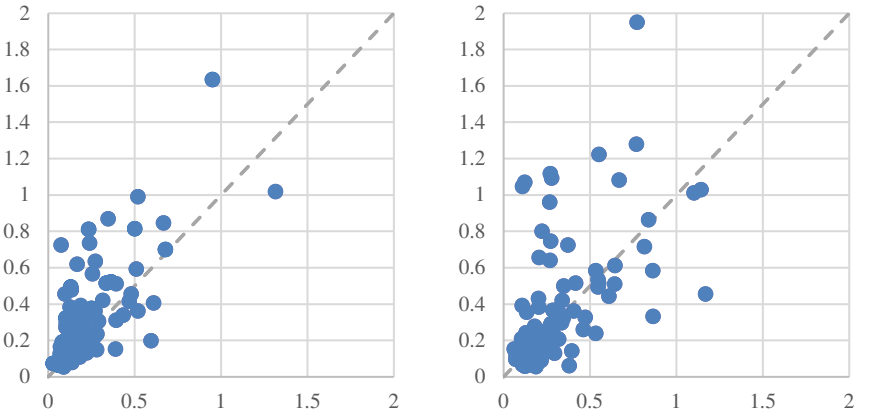


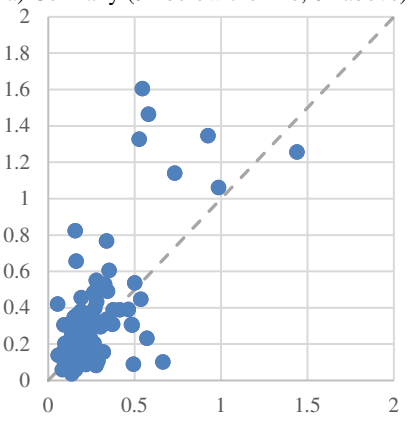
**Figure 3.** Values of index (1) vs. index (2) for every HS chapter in countries under examination (a-l)



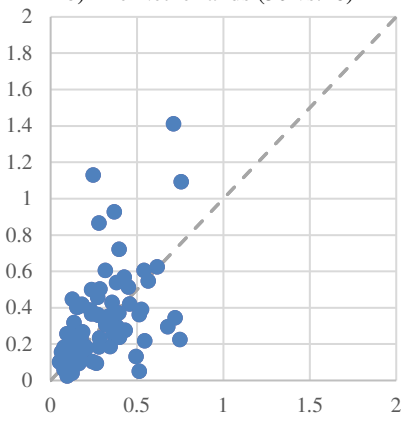

a) Germany (34 below the line, 62 above)



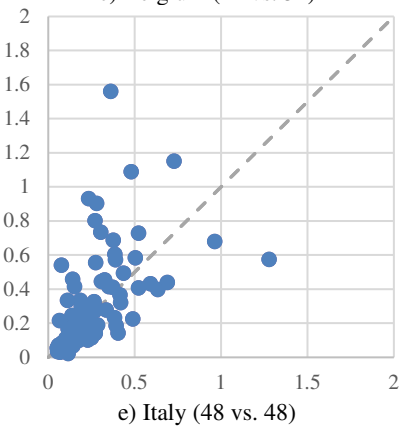

b) The Netherlands (50 vs.46)



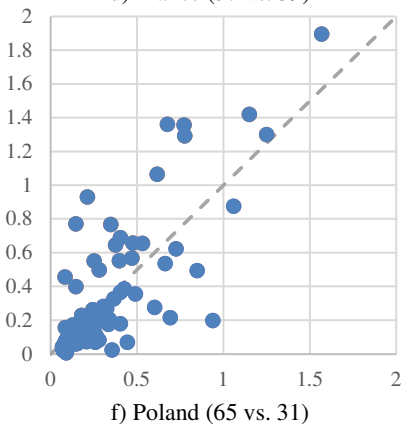

c) Belgium (44 vs. 52)




d) France (37 vs. 59)

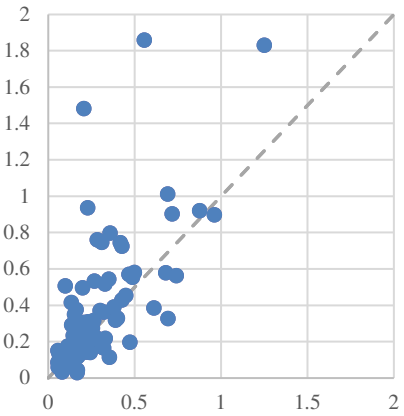



e) Italy (48 vs. 48)

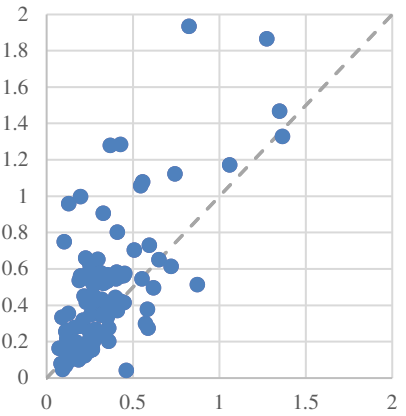



f) Poland (65 vs. 31)

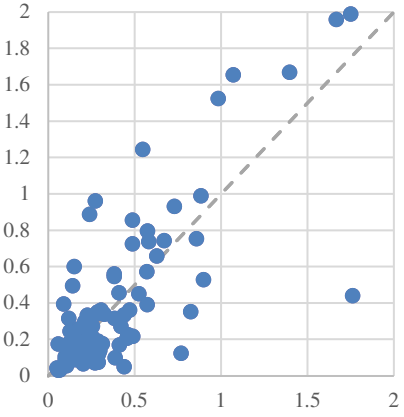
**Figure 3.** Continued



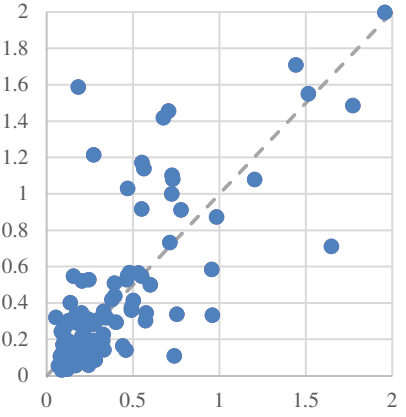

g) Spain (40 vs. 56)



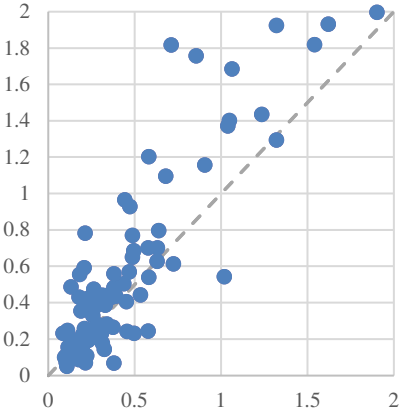

h) United Kingdom (39 vs. 57)



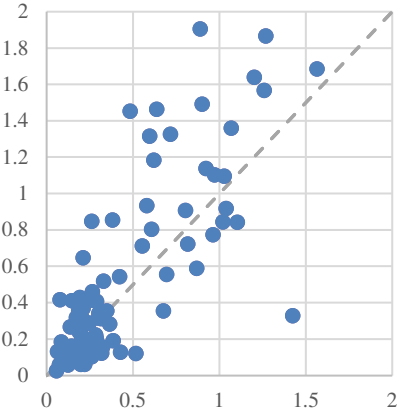

i) Czechia (53 vs. 43)




j) Austria (46 vs. 50)




k) Hungary (41 vs. 55)




l) Sweden (47 vs. 49)

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**Proceedings of the 11th International Conference on Applied Economics Contemporary Issues in Economy: Quantitative Methods**

**Olsztyn: Instytut Badań Gospodarczych // Institute of Economic Research**

**2021**

**DOI: 10.24136/eep.proc.2021.2 (eBook)**
**ISBN 978-83-65605-44-3; ISSN 2544-2384 (Online)**

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# Productivity effects of corporate sustainability performance (CSP) in the largest U.S. companies

**JEL Classification:** *D24; F23; M14*

**Keywords:** *sustainable development, corporate sustainability, CSP–CFP relationship*

## Abstract

**Research background:** The sustainable development at the enterprise level is understood as the integration of economic, environmental and social dimensions aimed at meeting the needs of all firm's stakeholders in the present and in the future. Therefore, it is crucial to evaluate the relationship between economic, environmental and social sustainability performance of a company and its financial performance.
**Purpose of the article:** Considering the business model for sustainability as well as the debatable results of empirical research on the relationship between corporate sustainability performance (CSP) and corporate financial performance (CFP), the essential aim of the paper is to answer the question whether the improvement of corporate sustainability performance in its particular dimensions brings about the higher total revenues (TR) of a company.
**Methods:** The main method of empirical research is panel regression models based on Cobb-Douglas production function, which has been extended to include variables of corporate sustainability scores. The selection between polled OLS model, random-effects model and fixed-effects model has been made with the use of the F-test, the Breusch-Pagan test and the Hausman test. Additionally, the Pearson correlation coefficients have been analyzed. The empirical studies were conducted in the period 2014–2019 among the 59 largest U.S. companies listed in the Fortune 500 ranking between 2015–2020.
**Findings & Value added:** The research hypothesis assuming the existence of positive relationship between corporate sustainability performance (CSP) at both aggregate and disaggregate levels and corporate financial performance (CFP) ex-

pressed by TR due to the occurrence of certain statistically insignificant coefficients in estimated panel regression models cannot be positively verified.

## Introduction

The corporate sustainability can be described as *meeting the needs of firm's direct and indirect stakeholders (...) without compromising its ability to meet the needs of future stakeholders* (Dyllick & Hockerts, 2002, p. 131). In order to meet the needs of various stakeholder groups, corporations must actually satisfy all three dimensions of sustainability (Gond *et al.,* 2012, pp. 219–220) by maintaining and enhancing economic, environmental and social capital simultaneously (Oželienė, 2017, pp. 97–101). It is necessary to emphasize that the pre-condition for economic, environmental and social sustainability of a company is good governance, currently treated as the fourth dimension of corporate sustainability (UNSDSN, 2013, p. viii).

The implementation of corporate sustainability principles and practices by organizational members, who are emotionally involved to attain mission of a company results in the improvement of performance in economic, environmental, social and governance dimensions, which in turn increases the satisfaction of stakeholders enhancing corporate reputation and brand equity as well as emotional involvement of organizational members (compare Kantabutra & Ketprapakorn, 2020, pp. 18–19; Barnett, 2007, p. 803). Bearing in mind this business model for sustainability as well as the debatable results of empirical research on the relationship between corporate sustainability performance (CSP) and corporate financial performance (CFP), the essential aim of the paper is to answer the question whether the improvement of corporate sustainability performance in its particular dimensions brings about the higher total revenues of a company.

In order to realize the goal of this article, the empirical research in the years 2015–2019 among the largest U.S. companies with the use of panel regression models was conducted. These panel regression models are based on Cobb-Douglas production function, which includes variables of corporate sustainability scores. The selection between polled OLS model, random-effects model and fixed-effects model has been made according to the analysis of the F-test, the Breusch-Pagan test and the Hausman test. The Pearson correlation coefficients have been also analyzed.

The further part of the paper is structured as follows. The next section contains the description of research methodology. Section 3 reveals the results of empirical studies on the relationship between corporate sustainability performance (CSP) and corporate financial performance (CFP) and

discusses them. Section 4 shows concluding remarks. The last section includes annex.

## Research methodology

The research sample includes the largest non-financial U.S. companies, which were listed in the Fortune 500 ranking in the first hundred positions in each year of the period 2016–2020. The adoption of such a condition for listed companies allowed to qualify a relatively large number of enterprises for the research sample whose top position in the ranking was stable. On the basis of the preliminary criterion, 71 firms were qualified for the research sample but 12 of them were excluded due to a change in the form of activity as a result of an acquisition (1), running business activity as a non-publicly traded company (5) or activity sponsored by the government (2) and the lack of necessary data for the whole period of the analysis (4). The final research sample is a balanced panel dataset of 59 companies over the five-year research period, so it consists of 295 firm-year observations.

The research period covers the years 2015–2019, but because one-year lagged variables and variables expressed as average values were employed, it was necessary to collect all required data for the period 2014–2019. The financial and sustainability data of investigated companies from the years 2014–2019 were retrieved from *Refinitiv Thomson Reuters Eikon* database and all calculations based on these data were made applying a statistical package *Gretl*.

Bearing in mind the business model for sustainability and results of empirical studies on the CSP–CFP link the following research hypothesis was formulated:

H: *The effect of corporate sustainability performance at both aggregate and disaggregate levels on corporate financial performance as expressed by total revenues is positive.*

The empirical verification of the research hypothesis aims to estimate three regression models based on the augmented production function, which in a logarithm form (compare Conte & Svejnar, 1988, pp. 139–151) looks as follows:

$$lnV = lnA + \alpha_1 lnK + \alpha_2 lnL + \beta X \qquad (1)$$

From the collected data, three operating variables are constructed:

- *V* (output) – value of total revenues, which is the major criterion of classifying the largest U.S. companies in the Fortune 500 ranking,
- *K* (capital input) – average value of fixed assets and
- *L* (labor input) – average number of employees.

Taking into account constructed variables as well as denoting companies by *i*, the time period in years by *t* (*t* = 1, 2, …) and residual by $\mu$, the basic Cobb–Douglas production function is:

$$lnV_{i,t} = \alpha_0 + \alpha_1 lnK_{i,t} + \alpha_2 lnL_{i,t} + \beta X_{i,t-1} + \mu_{i,t} \qquad (2)$$

In order to reach the aim of this paper, the following three regression models, differing in the vector X, are considered.
The first regression model looks as follows:

$$lnV_{i,t} = \alpha_0 + \alpha_1 lnK_{i,t} + \alpha_2 lnL_{i,t} + \beta_1 LTRPS_{i,t-1} + \\ + \beta_2 ESGS_{i,t-1} + \mu_{i,t} \qquad (3)$$

where vector X is composed of:

- *LTRPS* – long-term returns pillar score, which measures a corporate ability to manage its long-term economic sustainability and
- *ESGS* – aggregate environmental, social, governance score based on weighted scores of particular pillar scores.

The second regression model is expressed by the given equation:

$$lnV_{i,t} = \alpha_0 + \alpha_1 lnK_{i,t} + \alpha_2 lnL_{i,t} + \beta_1 LTRPS_{i,t-1} + \beta_2 WEPS_{i,t-1} + \\ + \beta_3 WSPS_{i,t-1} + \beta_4 WGPS_{i,t-1} + \mu_{i,t} \qquad (4)$$

where vector X comprises the long-term returns pillar score (*LTRPS*) as well as weighted scores of particular pillars:

- *WEPS* – weighted environmental pillar score,
- *WSPS* – weighted social pillar score and
- *WGPS* – weighted governance pillar score.

The third regression model is described by the following formula:

$$lnV_{i,t} = \alpha_0 + \alpha_1 lnK_{i,t} + \alpha_2 lnL_{i,t} + \beta_1 LTRPS_{i,t-1} + \beta_2 EPS_{i,t-1} + \\ + \beta_3 SPS_{i,t-1} + \beta_4 GPS_{i,t-1} + \mu_{i,t} \qquad (5)$$

where vector X contains the long-term returns pillar score (*LTRPS*) and disaggregate pillar scores without weights:

- *EPS* – environmental pillar score, which shows how effectively a company avoids environmental risk and takes advantage of environmental opportunities,
- *SPS* – social pillar score, which refers to the company's reputation and the status of its license to operate and
- *GPS* – governance pillar score, which reflects a company's capacity to direct and control its rights and responsibilities.

The decision which kind of panel model should be used – pooled OLS, fixed-effects or random-effects model – to estimate considered regression models was taken after analyzing the results of the F test, the Breusch-Pagan test and the Hausman test (see Table 2). In the first regression model, the random-effects model should be employed because p-values of the F test and the Breusch-Pagan test were below 0.05 while the p-value of the Hausman test was higher than 0.05. In the next two regression models p-values of all tests were lower than 0.05, which means that in these cases the fixed-effects model should be applied.

Additionally, the study presents analysis of the Pearson correlation coefficients.

## Results

The research sample consists of 295 firm-year observations – 59 largest U.S. companies over the years 2015–2019 are examined.

The correlation analysis (see Table 1) revealed that there are statistically significant correlations between a dependent variable – total revenues (*TR*) and some independent variables. The correlation of *TR* with the average value of fixed assets (*AFA*) is moderate ($r_{xy}$ = 0.4407) while the correlation of *TR* with the average employment (*AE*) is weak ($r_{xy}$ = 0.2808). Both of these correlations are positive and statistically significant at the 0.01 level. Analyzing correlations of *TR* with corporate sustainability scores, different results are observed. The positive and very weak ($r_{xy}$ = 0.1516) correlation between *TR* and the long-term returns pillar score (*LTRPS*) is statistically significant at the 0.01. level. On the other hand, the correlation between *TR* and the aggregated environmental, social and governance score (*ESGS*), which also demonstrates the existence of positive and very weak relationship is statistically insignificant. The correlations of *TR* with corporate environmental scores are not coherent because the correlation with weighted environmental pillar score (*WEPS*) implies a negative relationship while the correlation with disaggregated environmental pillar score (*EPS*) indicates a positive relationship but none of them is statistically significant. The cor-

relations of *TR* with corporate social scores point out negative and very weak relationships, however, the correlation with the weighted social pillar score (*WSPS*) is statistically insignificant while the correlation with the disaggregated social pillar score (*SPS*) ($r_{xy}$ = 0.1121) is statistically significant at the level of 0.1. The correlations of *TR* with corporate governance scores are consistent due to the fact that the correlation with weighted governance pillar score (*WGPS*) ($r_{xy}$ = 0.1257) and the correlation with disaggregated governance pillar score (*GPS*) ($r_{xy}$ = 0.1672) show positive and very weak relationships, which are statistically significant at levels of 0.05 and 0.01, respectively. Considering correlations between explanatory variables in particular regression models, it should be emphasized that any statistically significant correlations between these variables do not exceed the critical threshold of $|0.8|$ (compare Soana, 2011, pp. 133–148)

In the first regression model, the coefficients at the variables of capital and labor inputs are positive and statistically significant at the 0.01 level, which means that the total revenues (*TR*) increase with an increase in the company's average fixed assets and average employment (coefficients are 0.2728 and 0.1279, respectively). The coefficient at the long-term returns pillar score (*LTRPS*) is positive ($\beta_1$ = 0.0019) and statistically significant at the 0.1 level while the positive coefficient at the aggregated environmental, social and governance score (*ESGS*) is statistically insignificant, so the increase in *TR* is due to the improvement in corporate economic performance rather than improvement in overall sustainability performance of a company. In the second regression model, the coefficients at the variables of capital and labor inputs are positive (coefficients are 0.2768 and 0.1123, respectively) and statistically significant but the coefficient at the capital input is significant at the 0.01 level and the coefficient of labor input at the 0.1 level. The coefficient at the long-term returns pillar score (*LTRPS*), while positive, is statistically insignificant. Among weighted scores in environmental, social and governance pillars, only the coefficient at the weighted social pillar score (*WSPS*), which is positive ($\beta_3$ = 0.0041), is statistically significant at the 0.1 level, which implies that the improvement in corporate social performance causes the increase in *TR*. The statistically insignificant coefficients at the weighted environmental (*WEPS*) and governance (*WGPS*) pillar scores are positive and negative, respectively. In the third regression model, the coefficients at the variables of capital and labor inputs are positive (coefficients are 0.2769 and 0.1042, respectively), however, the coefficient at the capital input is statistically significant at the 0.01 level while the coefficient at the labor input is statistically insignificant (*p-value* = 0.1011). The coefficient at the long-term returns pillar score (*LTRPS*) is positive but statistically insignificant. Within disaggregated

environmental, social and governance pillar scores, only the coefficient at the governance pillar score (*GPS*), which is negative, is statistically insignificant. The coefficients at the environmental (*EPS*) and social (*SPS*) pillar scores are positive ($\beta_2$ = 0.0015 and $\beta_3$ = 0.0018) and statistically significant at the 0.1 level, which indicates that the improvement in corporate environmental and social performance leads to the increase in *TR* (see Table 2) (compare Wagner, 2010, pp. 1553–1560).

## Conclusions

The empirical studies revealed that in the estimated panel regression models there are statistically significant coefficients at the variables of corporate sustainability performance. Among these statistically significant coefficients there are coefficients at the long-term returns pillar score (*LTRPS* – model 1) and disaggregated environmental pillar score (*EPS* – model 3) as well as weighted social pillar score (*WSPS* – model 2) and disaggregated social pillar score (*SPS* – model 3). All statistically significant coefficients are positive, which means that the improvement in economic, environmental and social sustainability performance leads to the increase in total revenues (*TR*). Unfortunately, in the considered panel regression models, the coefficients at the overall sustainability performance (*ESGS* – model 1) and weighted environmental performance (*WEPS* – model 2) as well as weighted governance performance (*WGPS* – model 2) and disaggregated governance performance (*GPS* – model 3) are statistically insignificant. The occurrence of certain statistically insignificant coefficients in estimated panel regression models do not allow to positively verify the research hypothesis assuming the existence of positive relationship between corporate sustainability performance (CSP) at both aggregate and disaggregate levels and corporate financial performance (CFP) expressed by *TR*.

The findings of our empirical studies should not be generalized because of their limitations. First of all, measures of corporate sustainability performance expressed by the overall corporate sustainability scores as well as weighted and disaggregated pillar scores, that were retrieved from *Refinitiv Thomson Reuters Eikon* database are calculated based on the information reported by companies, so information is not deprived of subjectivism. Moreover, the research period, which covers only five years seems to be too short to fully discover the CSP-CFP relationship but the main reason for taking into consideration such a short analysis period was the lack of long-term returns pillar score calculations before 2014. On the other hand, it was crucial to incorporate the economic performance alongside other

variables of corporate sustainability performance into estimated panel regression models because to the best of the author's knowledge, it is not a commonly used approach in spite of the fact that the economic sustainability is one of the key corporate sustainability dimension.

The future empirical research should be conducted with consideration of corporate economic sustainability performance as a variable that can affect corporate financial performance to make cross-sectoral and cross-country comparisons. Managers should also pay more attention to this specific link in particular, as the author managed to find the slight evidence for its existence.

## References

Barnett, M. L. (2007). Stakeholder influence capacity and the variability of financial returns to corporate social responsibility. *Academy of Management Review, 32*(3), 794-816. doi: 10.5465/amr.2007.25275520.

Conte, M. A., & Svejnar, J. (1988). Productivity Effects of Worker Participation in Management, Profit-Sharing, Worker Ownership of Assets and Unionization in U.S. Firms. *International Journal of Industrial Organization*, *6*(1), 139-151. doi: 10.1016/0167-7187(88)90011-2.

Dyllick, T., & Hockerts, K. (2002). Beyond the case for corporate sustainability. *Business Strategy and the Environment, 11*(2), 130-141. doi: 10.1002/bse.323.

Gond, J., Grubnic, S., Herzig, C., & Moon, J. (2012). Configuring management control systems: Theorizing the integration of strategy and sustainability. *Management Accounting Research, 23*(3), 205-223. doi:10.1016/j.mar.2012.06.003.

Kantabutra, S., & Ketprapakorn, N. (2020). Toward a theory of corporate sustainability: A theoretical integration and exploration. *Journal of Cleaner Production*, *270*, 1-22. doi: 10.1016/j.jclepro.2020.122292.

Oželienė, D. (2017). A review of enterprise sustainable development models: Critical appraisal. *International Scientific Journal "Science. Business. Society", 2*(2), 97-103.

Soana, M-G. (2011). The relationship between corporate social performance and corporate financial performance in the bank sector. *Journal of Business Ethics, 104*(1), 133-148. doi: 10.1007/s10551-011-0894-x.

United Nations Sustainable Development Solution Network (UNSDSN) (2013). *An action agenda for sustainable development*. New York: UN.

Wagner, M. (2010). The role of corporate sustainability performance for economic performance: a firm-level analysis of moderation effects. *Ecological Economics, 69*(7), 1553-1560. doi: 10.1016/j.ecolecon.2010.02.017.

## Acknowledgments

The research presented in this article was fully financed by the Faculty of Economics and Sociology, University of Lodz.

## Annex

**Table 1.** Pearson correlation matrix

| Specification | *lnV* | *lnK* | *lnL* | *LTRPS* | *ESGS* | *WEPS* | *WSPS* | *WGPS* | *EPS* | *SPS* | *GPS* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *lnV* | 1.0000 | | | | | | | | | | |
| *lnK* | 0.4407*** | 1.0000 | | | | | | | | | |
| *lnL* | 0.2808*** | 0.2462*** | 1.0000 | | | | | | | | |
| *LTRPS* | 0.1516*** | -0.1679*** | 0.2273*** | 1.0000 | | | | | | | |
| *ESGS* | 0.0378 | 0.1527*** | 0.3114*** | 0.0723 | 1.0000 | | | | | | |
| *WEPS* | -0.0297 | 0.2313*** | 0.0783 | -0.3105*** | 0.4559*** | 1.0000 | | | | | |
| *WSPS* | -0.0332 | 0.2432*** | 0.3486*** | 0.0532 | 0.7186*** | 0.0719 | 1.0000 | | | | |
| *WGPS* | 0.1257** | -0.2081*** | 0.0989* | 0.3635*** | 0.5292*** | -0.2526*** | 0.1333** | 1.0000 | | | |
| *EPS* | 0.0045 | 0.2276*** | 0.2871*** | -0.0226 | 0.7007*** | 0.6474*** | 0.4905*** | 0.0723 | 1.0000 | | |
| *SPS* | -0.1121* | 0.2009*** | 0.4008*** | 0.0337 | 0.8329*** | 0.2945*** | 0.8903*** | 0.2261*** | 0.6050*** | 1.0000 | |
| *GPS* | 0.1672*** | -0.0965* | -0.0302 | 0.1315** | 0.5367*** | 0.0810 | 0.0454 | 0.7848*** | 0.0157 | 0.0918 | 1.0000 |

Note: *, **, *** denote statistical significance at the 10%, 5%, and 1% level, respectively.

**Table 2.** Estimation results of panel regression models

| Specification | Model 1 | | Model 2 | | Model 3 | |
|---|---|---|---|---|---|---|
| | **coefficient** | **p-value** | **coefficient** | **p-value** | **coefficient** | **p-value** |
| *Intercept* | 6.6432 | 0.0000 | 6.7615 | 0.0000 | 6.8291 | 0.0000 |
| *lnK* | 0.2728 | 0.0000 | 0.2768 | 0.0000 | 0.2769 | 0.0000 |
| *lnL* | 0.1279 | 0.0074 | 0.1123 | 0.0771 | 0.1042 | 0.1011 |
| *LTRPS* | 0.0019 | 0.0774 | 0.0015 | 0.1937 | 0.0014 | 0.2083 |
| *ESGS* | 0.0012 | 0.2788 | | | | |
| *WEPS* | | | 0.0045 | 0.1825 | | |
| *WSPS* | | | 0.0041 | 0.0711 | | |
| *WGPS* | | | -0.0034 | 0.1126 | | |
| *EPS* | | | | | 0.0015 | 0.0994 |
| *SPS* | | | | | 0.0018 | 0.0750 |
| *GPS* | | | | | -0.0010 | 0.1188 |
| F test | 135.4050 | 0.0000 | 124.147 | 0.000 | 114.398 | 0.0000 |
| Breusch-Pagan; $\chi^{(1)}$ | 539.4310 | 0.0000 | 501.719 | 0.000 | 459.977 | 0.0000 |
| Hausman; $\chi^{(K)}$ | 3.2817 | 0.5118 | 15.303 | 0.018 | 24.962 | 0.0003 |

**Adam P. Balcerzak & Michał Bernard Pietrzak (Eds.)**

**Proceedings of the 11th International Conference on Applied Economics Contemporary Issues in Economy: Quantitative Methods**

**Olsztyn: Instytut Badań Gospodarczych // Institute of Economic Research**

**2021**

**DOI: 10.24136/eep.proc.2021.2 (eBook)**
**ISBN 978-83-65605-44-3; ISSN 2544-2384 (Online)**

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# Similarities and differences in the production of renewable energy in Central and Eastern Europe countries

**JEL Classification:** *Q42; Q43; P28*

**Keywords:** *renewable energy sources; RES; Central and Eastern Europe; GDP*

## Abstract

**Research background:** In the era of climate change, environmental degradation, but also growing pub-lic awareness, there is a need to look for new ecological energy sources. This condition can be met by renewable energy sources (RES). The EU seeks to have a 32% share of its gross final energy consumption from renewable sources by 2030. While the EU as a whole is on course to meet its targets, the question is if production of renewable energy at a given level is not a chal-lenge for selected Central and Eastern Europe countries (CEECs) trsditionslly dependent on fossil fuels. In order to take steps to develop RES in the studied countries, there is a need to analyze their diversity in terms of the potential. The results of such analyses should support the implementation of adopted strategies.
**Purpose of the article:** The article divides the CEECs into similar groups by the structure and volume of energy production from RES. This production was compared with the value of Gross Domestic Product (GDP) of each studied country, the number of in-habitants and its area.
**Methods:** Cluster analysis. The research based on the data provided by Eurostat.
**Findings & Value added:** The division of the studied region into subgroups depends on how the RES energy production is related to the GDP value, the number of inhabitants and the area of individual country. This reference allows to reflect the specificity of individual countries in more appropriate way than just an analysis of the absolute values of this production. The applied approach allows for a broader look at RES production for selected countries in the region. The obtained re-

sults can be used for the development of a common energy and climate policy to create and develop their own renewable energy markets.

## Introduction

Traditional energy sources based on oil, coal, and natural gas are considered the most popular and effective drivers of economic progress, but at the same time they are also harmful to the environment and to human health (Zou, Zhao, Zhang & Xiong, 2016). In the era of climate change, environmental degradation, and also growing public awareness (Rousseau & Deschacht, 2020), there is a need to look for new green energy sources (Ramanathan & Carmichael, 2008; Bölük & Mert, 2014). This condition may be met by renewable energy sources (RES), i.e. those generated by infinite resources. They include, for example, biomass, wind, solar, hydropower, and geothermal energy sources. Renewable energy may serve as a potential way to restore balance between economic growth and environmental quality (Arndt, Arent, Hartley, Merven & Mondal, 2019; Inglesi-Lotz, 2016). These issues affect rapidly growing world economies with increasing energy demand, including economies of European Union members, as one of the largest greenhouse gas emitters and major energy consumers in the world (González, Landajo & Presno, 2014).

Pursuing a green economy, mainly understood as a low-emission economy, means the EU's climate policy is largely focused on RES on the way to climate neutrality. Climate neutrality refers to zeroing greenhouse gas emissions, i.e. reducing their emissions from the industry, transport, and energy sectors as much as possible and offsetting the emissions that could not be eliminated by increasing their removals. Under the 2015 Paris Agreement (COP21), the European Union promotes an energy union aimed at building energy security and solidarity as well as a fully-integrated internal market, supporting research and competitiveness, accelerating energy efficiency, and climate-oriented actions for a carbon-neutral EU economy by 2050. A target for increasing the share of renewable energy sources has been set, according to which it is to reach at least 32% by 2030 in line with the EU climate and energy framework. The main reason for these actions is to provide EU consumers with safe, sustainable, competitive, and affordable energy. Charles Michel, the President of the European Council, said that "climate neutrality is no longer a question of choice, it is beyond doubt a necessity".

To be successful in this field, it was necessary to carry out an effective and fast transformation of the energy industry process. Even though the EU

as a whole is on track to meet its targets, the question is whether the generation of renewable energy at a given level is a challenge for selected Central and Eastern Europe countries (CEECs) dependent on fossil fuels. The following countries were included in the research area: Bulgaria, Czechia, Estonia, Latvia, Lithuania, Hungary, Poland, Romania, Slovenia, Slovakia. It can be expected that some countries generating energy from nuclear sources (Hungary, Czech Republic), i.e. from sources that do not emit $CO_2$, will be less inclined towards the development of RES. Undoubtedly, CEECs include countries whose share of energy from renewable sources was much more than 20% already in 2019 (Estonia 32%, Latvia 41%) (Figure 2). Still, Central and Eastern Europe countries also include those for which RES is still unimportant enough, with the share of energy from renewable sources remaining low (Poland 12.2%, Hungary 12.6%) (Figure 2).

To take action for RES development in the examined countries, it is necessary to analyse their differences in terms of potential. These differences depend on the energy policies of individual countries as well as the environmental awareness of societies. The economic aspect is also important. It is undeniable that energy production from RES is considerably more expensive than from conventional sources. As a result, many CEECs are unable to cover these costs from their own resources, which undoubtedly limits the potential for renewable energy development. The potential and availability of individual renewable energy sources are also of great importance. For this reason, analyses have been carried out to identify similarities between CEECs in terms of the structure and volume of RES energy production. They consider the number of inhabitants of individual countries (demographic potential), its gross domestic product (economic potential), and area (geographic potential). They include the eight major renewable energy sources: hydro, geothermal, wind, and solar as well as primary solid biofuels, biogases, renewable municipal waste, and liquid biofuels. For each case analysed, groups of Central and Eastern Europe countries with the highest similarly were identified. So far, no analyses focusing on CEECs with these factors have been conducted in the literature, which is undoubtedly a new approach to the issue. The results of such analyses should support the implementation of the adopted strategies. It is known that one of the main factors affecting the pace of changes is the amount of public spending on energy transition (Nicolini & Tavoni, 2017); therefore, the pro-environment policy implemented and required to be continued by the EU must be adapted to the uniqueness of CEECs. In addition, the awareness of mutual similarities among CEE countries should promote cooperation and acceleration of actions towards energy transition.

The paper is organized as follows: an overview of the related literature is provided in the second section. The methodology and data are described in the third section. In the next two sections results and discussion are shown. The conclusion is presented in the final section.

## Research methodology

The research method applied in this paper is cluster analysis. It is a method of multidimensional statistics used to separate homogeneous subsets of population objects, which are Central and Eastern Europe countries, based on variables describing the examined countries, i.e. the value of energy produced from renewable sources (hydro, geothermal, wind, solar, primary solid biofuels, biogases, renewable municipal waste, liquid biofuels). The main idea behind cluster analysis is to group objects (countries) in such a way that objects in the same group are similar to each other and diverse from objects from other groups as much as possible. To do so, the Euclidean distance was used as a measure of distance, which is given by:

$$d(\mathrm{x},\mathrm{y}) = \sqrt{\sum_{i=1}^{p}(x_i - y_i)^2},$$

where $x = (x_1, \dots, x_p)$ and $y = (y_1, \dots, y_p)$, and in this case $p = 8$, which is the number of variables that characterise a country. The greater the distance between two countries, the more diverse they are. As a result, a cluster includes countries close to each other and far away from others that form separate clusters. Before the determination of distance matrices, the variables were standardised using the formula:

$$z_i = \frac{x_i - \bar{x}}{s_x},$$

where $\bar{x}$ and $s_x$ refer to the mean and standard deviation of the sample.

The analysis was performed for four variants. The first variant involved the absolute values of these energies, the second variant compared them to the number of inhabitants, the third variant to the value of GDP of individual countries, and the fourth variant to the area of a country.

The agglomerative hierarchical clustering algorithm was applied in the first step of cluster analysis. The agglomeration method was Ward's method, which is used to minimise the sum of the squares of within-cluster variance. This resulted in a graphical illustration of the agglomeration pattern in the form of a diagram referred to as a dendrogram and the preparation of the number of clusters to which the countries are to be assigned. The number of clusters was required for the second step of the analysis, K-means non-hierarchical clustering, which assumes that the number of clusters is known a priori. Finally, the optimum number of clusters for each of the four variants was determined with the use of the Silhouette index:

$$S(u) = \frac{1}{n}\sum_{i=1}^{n}\frac{b(i)-a(i)}{\max\{a(i),b(i)\}}, \qquad \mathrm{S(u)} \in [-1,1],$$

where $u$ is the number of classes, $n$ is the object (country) number, $a(i)$ is the mean distance of the country with index $i$ from other countries belonging to class number $r$, $r = 1, \dots, u$. $b(i)$ is the mean distance of the country with index $i$ from other countries belonging to class number $s$, $s = 1, \dots, u$. The criterion based on the Silhouette index indicates the selection of the number of classes $u$, for which index $S(u)$ takes the maximum value.

Data on the structure of RES energy production for CEECs were taken from the Eurostat database for 2019. Eight variables describing the volume of energy production from selected renewable sources were converted per capita, per one square kilometer of the area of a country and were compared with a country's GDP.

## Results

Using the algorithms discussed in the previous section, an analysis was conducted to select subgroups among the 10 selected CEECs based on 8 variables characterising the volume of energy production from various RES. The analysis was made for four variants: in terms of the structure and volume of energy production from RES in total (absolute values), per capita, in relation to the area of a country (relative values) and as well as in relation to a country's GDP. The number of clusters for each variant was determined with the use of hierarchical clustering and Ward's method (Figure 3) and with the use of the Silhouette index (Figure 1). The determined values were taken a priori in the K-means method. Diversity indices within

and outside the clusters were calculated and the most significant clustering variables in terms of their discriminatory power were identified.

Grouping the CEECs according to the similarity of the structure of total energy production from RES resulted in two clusters. The countries that stand out from the rest include Poland, Czechia, and Hungary. The analysis of variance revealed that the renewable municipal waste variable was the main criterion for cluster membership. A significant difference between the examined countries in terms of RES energy production was not identified for the remaining variables.

The second variant involved the division of the CEECs after converting the volume of RES energy production per capita. In this variant, 5 clusters were formed (Figure 3), three of which were homogeneous and included Estonia, Hungary, and Slovenia. This division is considerably different from the division in the first variant. The following variables displayed the highest effect on the division in the second variant: liquid biofuels, primary solid biofuels, wind, renewable municipal waste and hydro.

Three clusters were formed in the third variant, which involved the conversion of energy produced from RES in relation to the area of a country. The countries that stand out most from the remaining countries classified under Cluster 1 are Estonia, Poland, and Slovakia. It was found that, as in the case of the previous variant, the liquid biofuels variable had the greatest impact on the division of the CEECs into subgroups. Other significant variables included hydro and solar.

In the four and last variant, which considers the volume of energy production from various RES in relation to a country's GDP, six clusters were identified, four of which were homogeneous and included Bulgaria, Hungary, Estonia, and Slovenia. The remaining countries form two three-member clusters as shown in Figure 3. Once again, the liquid biofuels variable, had the greatest impact on cluster membership. Other significant variables included wind and primary solid biofuels.

## Conclusions

The fact is that energy production is moving toward renewables. Fossil fuels are gradually taking a step back giving way to more environmentally friendly resources. The European Union has chosen to be an active player in this transition, and although there are difficulties along the way, all member states are moving in the same direction, which is the creation of a new and efficient energy system. A common feature of the CEECs analysed in the article is that winter heating still involves heavy use of fossil

fuels such as coal or gas, although it is known that less pollution leads to a healthier atmosphere. The benefits are positive for both restoring the local ecosystem and improving human health. In this context, RES offers great opportunities, but requires proper use and support from the government. This is because CEE countries diverge the most from the best developed EU countries (Brodny & Tutak, 2020). It is therefore a sphere that should mark an area of particular interest within the framework of energy policy, although the implementation of these goals will require very high investment outlays. However, increasing use of renewable energy will help economies in transition achieve both economic growth and clean environment goals (Adedoyin, Abubakar, Bekun & Sarkodie, 2020).

The circumstances of increasing the share of RES in the energy system are very complex and the evaluation of the energy sector is capital intensive and includes expensive installations. Their rapid replacement does not pay off until there is a return on invested capital. This may also explain why of some of the economies studied are so reluctant to the proposed changes. The factor limiting the results of the article was the lack of comparable data for countries from the region, such as Ukraine and Bulgaria. Including these two additional countries could enrich the analyses.

The research and results presented in this article are intended to support this process and expand the knowledge of the structure of renewable energy production in CEECs. The presented approach to the analysis of energy production, taking into account the demographic, geographic and economic potential of individual countries, enabled the acquisition of new knowledge in this field and supported the assessment of the current state of RES. It also showed the diversity of these countries. In addition, common social policy is very important in this regard. Countries with similar problems need to take action of a similar nature in relation to internal energy production, technological development or community policy. Investments should be made to promote the purchase and use of RES installations, such as a system of subsidies or regulatory mechanisms. In addition, commonality across countries in the region may increase the available potential for RES development in these countries combined. It seems that cooperation in the form of joint projects or joint support systems should be intensified.

The conducted research and formulated conclusions provide contribution to further research in this field. The use of taxonomic methods to analyze the structure and volume of energy production from RES in individual countries could be used in the other relations, for example to the import and export energy.

Based on the research conducted and the results obtained, it can be concluded that some CEECs are not making the most of their demographic

potential, the size of their area or their economic potential. Unless they take urgent action, their performance will remain low and their 2030 goals will remain unattainable.

## References

Adedoyin, F., Abubakar, I., Bekun, F. V. & Sarkodie, S. A. (2020). Generation of energy and environmental-economic growth consequences: Is there any difference across transition economies? *Energy Reports 6*, 1418-1427. doi: 10.1016/j.egyr.2020.05.026.

Arndt, C., Arent, D., Hartley, F., Merven, B & Mondal, A.H. (2019). Faster Than You Think: Renewable Energy and Developing Countries. *Annual Review of Resource Economics 11:1*, 149-168. doi: 10.1146/annurev-resource-100518-093759.

Bölük, G. & Mert, M. (2014). Fossil & renewable energy consumption, GHGs (greenhouse gases) and economic growth: Evidence from a panel of EU (European Union) countries. *Energy, 74*, 439-446. doi: 10.1016/j.energy.2014.07.008.

Brodny, J. & Tutak, M. (2020). Analyzing Similarities between the European Union Countries in Terms of the Structure and Volume of Energy Production from Renewable Energy Sources. *Energies 13*(4), 1-37. doi: 10.3390/en13040913.

González P.F., Landajo M. & Presno M.J. (2014). Tracking European Union CO2 emissions through LMDI (logarithmic-mean Divisia index) decomposition. The activity revaluation approach. *Energy 73*, 741-750. doi: 10.1016/j.energy.2014.06.078.

Inglesi-Lotz, R. (2016). The impact of renewable energy consumption to economic growth: A panel data application, *Energy Economics 53*, 58-63. doi: 10.1016/j.eneco.2015.01.003.

Nicolini, M. & Tavoni, M. (2017). Are renewable energy subsidies effective? Evidence from Europe. *Renewable and Sustainable Energy Reviews 74*, 412-423. doi:10.1016/j.rser.2016.12.032.

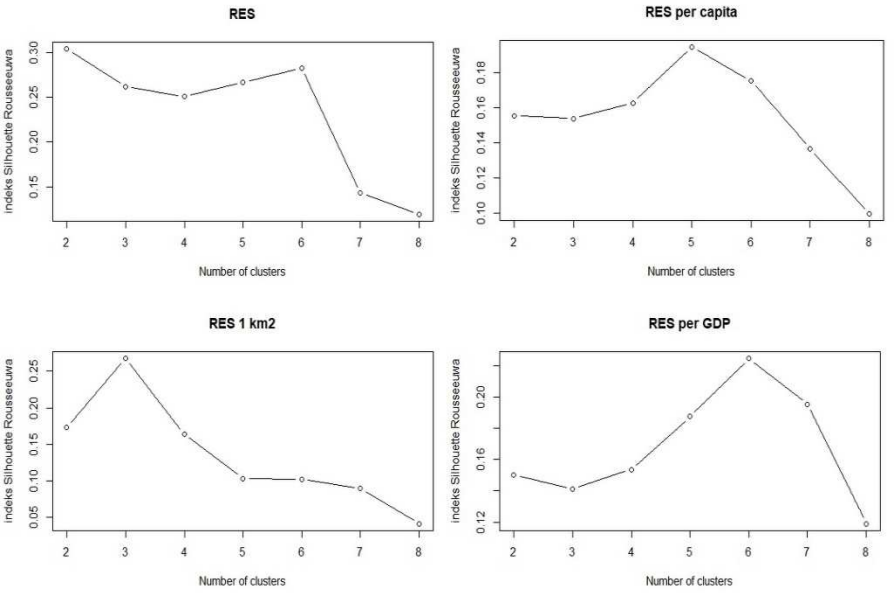
Ramanathan, V. & Carmichael, G. (2008). Global and regional climate changes due to black carbon. Nature Geosci 1, 221–227. doi: 10.1038/ngeo156.

Rousseau, S. & Deschacht, N. (2020). Public Awareness of Nature and the Environment During the COVID-19 Crisis. *Environ Resource Econ 76*, 1149–1159. doi: 10.1007/s10640-020-00445-w.

Zou, C., Zhao, Q., Zhang, G., Xiong, B. (2016), Energy revolution: From a fossil energy era to a new energy era. *Natural Gas Industry B 3,* 1-11. doi: 10.1016/j.ngib.2016.02.001.

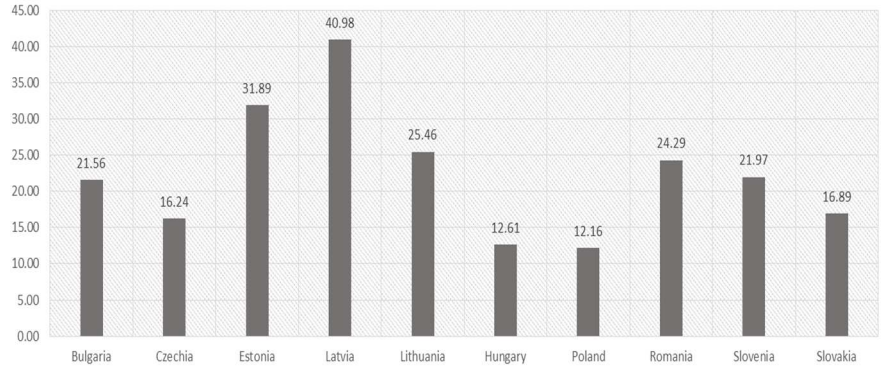
## Annex

**Figure 1.** Optimal number of clusters based on the Silhouette index.



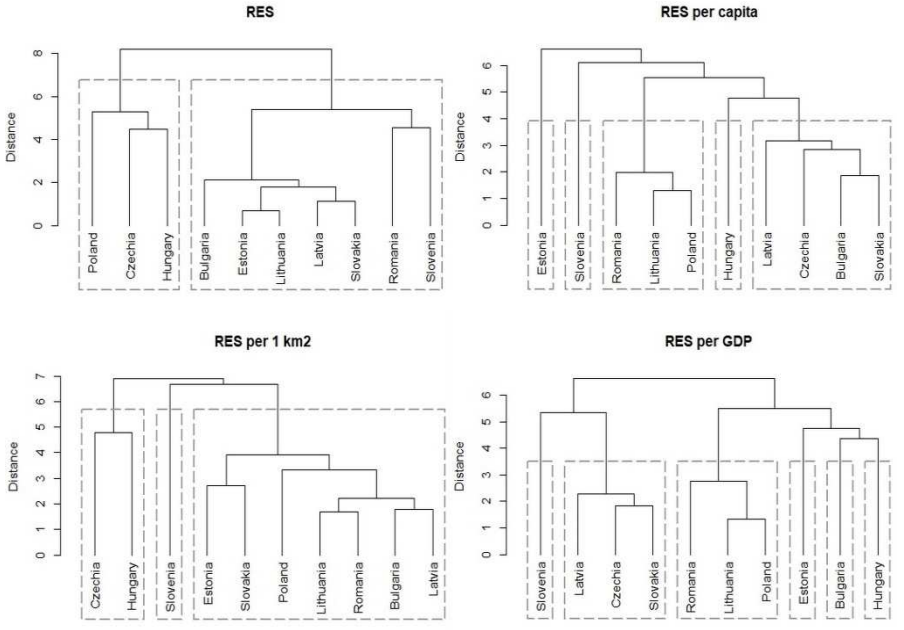

Source: own calculations in R program.

**Figure 2.** Share of energy from renewable sources in the CEECs in 2019.




Source: own calculations based on data from Eurostat (online data code: NRG_IND_REN_ custom_ 716443).

**Figure 3.** Results of the hierarchical grouping of similarities between the CEECs in energy production from RES in 2019 using the Ward's method




Source: own calculations in R program.

**Adam P. Balcerzak & Michał Bernard Pietrzak (Eds.)**

**Proceedings of the 11th International Conference on Applied Economics Contemporary Issues in Economy: Quantitative Methods**

**Olsztyn: Instytut Badań Gospodarczych // Institute of Economic Research**

**2021**

**DOI: 10.24136/eep.proc.2021.2 (eBook)**
**ISBN 978-83-65605-44-3; ISSN 2544-2384 (Online)**

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# Relationship between unemployment and new firm dynamics – a sectoral approach

**JEL Classification:** *R12; R30*

**Keywords:** *entrepreneurial activity; unemployment rate; industries*

**Abstract**

**Research background:** The study investigates the relationship between unemployment and new business formation explained by the unemployment push hypothesis. In addition, the distinction between necessity and opportunity entrepreneurship is considered.
**Purpose of the article:** The main goal of the paper is to explore the driving role of unemployment in new firm formation in Poland for the period 2003–2018.
**Methods:** The relationship between unemployment rate changes and gross business entry rate was estimated using Driscoll-Kraay panel fixed effect estimators. The analyses were performed at the regional level (NUTS-2). Moreover, the research approach distinguished between main industry sectors: manufacturing, construction, operational services, and knowledge-based business-oriented services.
**Findings & Value added:** The research contributes to the better understanding of business entry dynamics by providing further insights into the relationship between unemployment rate and new firm formation, in particular with respect to Central and Eastern European countries.

## Introduction

According to the endogenous growth theory, the foundations for economic development are created by innovation and investments in physical and human capital. Thus, entrepreneurship has been recognised as an important development factor, because it intensifies and improves the use of endoge-

nous resources. Special attention is paid to newly formed enterprises, as they have the ability to challenge existing market structures and to promote innovation, employment and economic growth (Wang, 2006). Hence, differences in start-up activities could explain the uneven socio-economic development across countries or regions (Stam, 2007).

There is no universal pattern of effects that entrepreneurship has on economic development. The results are determined by specific local and regional features. The impact of entrepreneurship also depends on the type of entrepreneurship. It is not only about the sectoral structure of new firms (modern, innovative sectors versus traditional, non-innovative ones), their size (large companies versus small-scale ones) but also about the motives behind starting a business. Considering the latter, a distinction between opportunity and necessity entrepreneurship is emphasised. The former type of entrepreneurship refers to entrepreneurs starting businesses in response to market opportunities, whereas the latter involves entrepreneurs forced into starting a new business by unemployment or, more generally, by the lack of work opportunities. Moreover, opportunity entrepreneurship is associated with greater impact on technological progress and innovation and the creation of more growth-oriented businesses (Fairle & Fossen, 2018).

Thus, unemployment is placed among a wide range of entrepreneurship determinants. The relationship between unemployment and business entry rate is complex. This is because unemployment rate has a two-fold contradictory effect on establishing new businesses (Fritch et al., 2015):

- it can foster new firm formation, which is referred to as the unemployment push effect, or
- it could hamper start-up activities due to limited market opportunities during a recession or due to the lower entrepreneurial skills of the unemployed.

The links between unemployment and new business formation are conditioned by sectoral specificity. In particular, small-scale non-innovative sectors (due to lower entry barriers) are commonly assumed as more vulnerable to unemployment rate changes (Roman et al., 2013). Konon et al. (2018), however, found a positive correlation between unemployment and entries of large-scale businesses between 1995 and 2013 in German regions. This was explained by the decreasing operating costs of businesses (due to lower labour costs, greater supply of labour and lower interest rates), which were conducive to establishing large-scale enterprises in particular.

Furthermore, the relationship between unemployment and new firm dynamics may differ among countries, depending on their legal and institutional framework. In particular, the relationship may develop differently in

developing or post-communist countries (van der Zwan et al., 2016). Remarkably, studies on the links between the labour market and entrepreneurship for these countries are limited (Naudé, 2008).

In order to fill in this research gap, the main goal of the paper is to explore the driving role of unemployment in new firm formation in the Polish economy. The research hypothesis assumes that increases in unemployment rate have a positive effect on subsequent new firm formation. It is argued that the unemployment push effect is conditioned by industry specificity and is expected to be stronger in operational services.

## Research methodology

In order to capture the heterogeneous phenomenon of entrepreneurship, based on the Polish Activity Classification PKD 2007 (NACE Rev. 2-compatible), the main business sectors were identified: manufacturing (section C), construction (F) and service activities (G-T). Within the broad service sector, activities were grouped using the knowledge-intensity criterion (Glückler & Hammer, 2011) into: operational services (G-I) and knowledge-based business-oriented services (J-N).

Following Wang (2006), Caree et al. (2008), Fritsch et al. (2015) and Konon et al. (2018), the panel fixed effect model was applied to explore the relationship between unemployment and new firm registrations. The following regression equation was estimated:

$$Y_{ij,t} = \alpha_0 + \alpha_i X_{j,t-1} + \beta_i GDPgr_{j,t-1} + Z_{j,t-1} + \mu_{j,t} + \varepsilon \quad (1)$$

where:
$Y_i$ – business gross entry rate (the number of newly registered businesses per 1,000 workers) in business sector *i;*
$X_j$ – registered unemployment rate in region *j;*
$GDP_{gr,j}$ – GDP growth rate in region *j*;
$Z_j$ – set of control variables in region *j*;
*i* – type of business activity; *j* – region (NUTS-2); *t* – year; $\alpha_0, \alpha_i, \beta_i$ – regression coefficients, $\mu_{j,t}$ – fixed effects, $\varepsilon_{j,t}$ – error term of the specification.

As the analyses were performed at the regional NUTS-2 level, control variables reflecting region-specific determinants of entrepreneurship were simultaneously considered (Konon et al., 2018; Caree et al., 2008):

- human capital availability approximated by the share of population with tertiary education ($Z_1$)
- research output and knowledge spillovers presented by the number of patents per 1,000 workers ($Z_2$)
- infrastructural development and access to funding approximated by urbanisation rate ($Z_3$)
- sectoral specialisation of the regional economy approached by the share of services in the employment structure ($Z_4$)
- the entrepreneurial climate and tradition approximated by the total number of registered businesses per worker ($Z_5$)
- opportunity costs of self-employment reflected by average monthly gross wages in relation to the national average ($Z_6$).

As the Breitung panel unit root test reveals, the levels of explanatory variables (except GDP growth rate) are not stationary; they were included in the regression equation in first differences (a dependent variable was included in the logarithmic form). In order to reduce possible endogeneity problems, the explanatory variables were included into the regression equation with a time lag of one period (Fritsch et al., 2015).

The parameters of the regression equation were estimated using Driscoll-Kraay fixed effects estimators, as they are robust with regard to very general forms of cross-sectional, spatial and temporal dependence (Hoechle, 2007). Due to the data availability of covariates, the analyses cover the 2013–2018 period. Data are taken from the Local Data Bank of the Polish Central Statistical Office.

The present study is limited to the short-term one-way effects of unemployment on start-up activity. Despite distinguishing between main industry sectors, the level of data aggregation is still relatively high. The applied research methods, however, can reflect the effect of unemployment on entrepreneurship and, thus, allow for the verification of the research hypotheses.

## Results

New business dynamics are strongly related to the type of industry. For all industries, about 333,828 new businesses were established in Poland per year during the 2003–2020 period. Most of them (113,613; 34%) were registered in operational services, followed by business-oriented services (84,804; 25%). The third place was occupied by construction (51,341; 15%). The lowest num-

ber of new businesses was registered in manufacturing (25,934; 8%). These numbers correspond to the sectoral distribution of business entry rate (Table 1).

The process of new firm formation also varied across regions. Regional disparities measured by the coefficient of variation ($V_x$) were pronounced in the case of knowledge-based business-oriented services (0.394) and construction (0.407). In relative terms, the lowest regional diversity was observed for operational services (0.194) (Table 1).

Regional inequalities were also observed in terms of the main determinants of entrepreneurship. The greatest polarisation occurred for knowledge-related factors, such as the number of patents (0.596) and the share of population with tertiary education (0.280). Finally, regions followed different development trajectories, as manifested by the disparities in regional GDP growth rates ($V_x$=0.571).

Unemployment rate also varied considerably across regions ($V_x$=0.386) and over time. Between 2003 and 2020, three sub-periods were identified (Figure 1):

- a downward trend with unemployment rate failing from 18% in 2003 to 9.5% in 2008, followed by
- a rise in unemployment rates to 13.4% in 2013;
- in the subsequent period (2014–2019), the unemployment rate gradually decreased to 5.2% in 2019.

With regard to business entry rate fluctuations, operational services stand out. When unemployment was decreasing, the number of new business registrations was quite stable (2003–2008) or even fell slightly (2014–2019). During the stagnation phase (2008–2013), a rising tendency in newly established operational service businesses is visible. While new firm dynamics in operational services seems to be counter-cyclical, new business registrations in construction seem to move pro-cyclically. The business entry rate in construction rose when unemployment rates were declining. New business registrations in manufacturing, as well as in business-oriented services, do not follow a cyclical trend. While business-oriented services were characterised by gradually increasing numbers of new firms registered throughout the entire 2003–2018 period, the values of business entry rate in manufacturing were quite stable.

The results of the correlation analysis confirm that a rise in unemployment rate was accompanied by an increased number of newly formed businesses in operational services (r=0.167; p=0.006). The businesses entry rate changes were, however, unrelated to the unemployment fluctuations in other business sectors: construction (r=0.230; p=0.71), manufacturing (r=0.050; p=0.411), and business-oriented services (r=0.092; p=0.132).

The estimations results (Table 2) support these observations. At the aggregate level, a rising unemployment rate, ceteris paribus, led to a subsequent

increase in the total number of newly formed businesses (est. 1). This results suggest the presence of the unemployment push effect in the Polish economy, which is in line with the assumed research hypothesis.

In-depth analyses reveal, however, that the unemployment push effect was noticed solely in operational services (est. 2). Moreover, new business dynamics in operational services were more vulnerable to unemployment rate fluctuations than overall industry registrations, which confirms the second hypothesis. This result is in line with Fritsch et al. (2015), reporting a positive effect of unemployment rate on the gross entry rates in small-scale traditional service businesses. The occurrence of the unemployment push effect in operational services is linked to the lower capital and knowledge requirements in this sector.

It is worth noting that an increase in unemployment had no significant effect on the gross entry rate in other business sectors: business-oriented services (est. 3), manufacturing (est. 4) and construction (est. 5). This is partially in line with the previous findings. In Germany, as reported by Konon et al. (2018), entry rates in financial services have no statistically significant relationship with unemployment fluctuations. They found, however, a positive correlation between unemployment and entries of both innovative and non-innovative large-size (manufacturing) businesses. In the US, Plehn-Dujowich (2012) demonstrates a positive Granger causal effect of unemployment on entrepreneurship in professional and business services, in financial services and in construction.

The ambiguous results regarding the sectoral diversity of the unemployment push effect across countries are linked to the explanatory power of cross-country differences (in terms of institutional framework, the state of the economy etc.) (Roman et al., 2013). For example, in liberal economies, a high business entry rate is primarily observed in the innovation sector. Considering the level of development, residents of peripheral regions are more likely to establish new businesses and, thus, improve the condition of the labour market. Such entrepreneurship, however, provides only a temporary solution to the unemployment issue (e.g. due to less favourable survival rate).

## Conclusions

There is distinct sectoral variation in how unemployment rates are correlated with new firm registrations in Poland. The empirical results partially support the unemployment push hypothesis across Polish industries. Although overall business entry rate was affected by unemployment changes,

in-depth investigation reveals that this effect occurred in operational services.

New business formation in operational services is positively correlated with unemployment changes. Thus, this sector is exposed to the significant presence of necessity entrepreneurs. Conversely, the counter-cyclical character of operational services suggests that they may serve as a buffer against business fluctuations. Such a function seems to be short-termed, as necessity entrepreneurs are considered as temporary, less growth-oriented businesses ("try and see" behaviour, preference of wage employment).

Although the study distinguishes between main industry sectors, it has some limitations. The level of data aggregation is still relatively high. The results highlight the need for a narrower sectoral approach and more detailed analyses of individual industry sections. Moreover, the research methods should recognise and solve more adequately the endogeneity problem, which results from the two-way relationship between unemployment and entrepreneurship.

## References

Carree, M., Santarelli, E., & Verheul, I. (2008). Firm entry and exit in Italian provinces and the relationship with unemployment. *International Entrepreneurship and Management Journal*, *4*, 171–186. doi: 10.1007/s11365-007-0060-1.

Fairlie, R.W., & Fossen, F.M. (2018). Defining Opportunity versus Necessity Entrepreneurship: Two Components of Business Creation. *IZA Discussion Paper Series*, 11258.

Fritsch, M., Kritikos, A., & Pijnenburg, K. (2015). Business cycles, unemployment and entrepreneurial entry – evidence from Germany. *International Entrepreneurship and Management Journal*, *11*, 267–286. doi: 10.1007/s11365-014-0326-3.

Glückler. J., & Hammer, I. (2011). Pragmatic service typology: Capturing the distinctive dynamics of services in time and space. *The Service Industries Journal, 31(6)*, 941-957. doi: 10.1080/02642060903078743.

Hoechle, D. (2007). Robust Standard Errors for Panel Regressions with Cross-Sectional Dependence. *The Stata Journal*, 7(3), 281–312. doi: 10.1177/1536867X0700700301.

Konon, A., Fritsch, M., & Kritikos, A.S. (2018). Business cycles and start-ups across industries: An empirical analysis of German regions. *Journal of Business Venturing*, *33(6)*, 742–761. doi: 10.1016/j.jbusvent.2018.04.006.

Naudé, W., Gries, T., Wood, E. & Meintjies, A. (2008). Regional determinants of entrepreneurial start-ups in a developing country. *Entrepreneurship & Regional Development: An International Journal*, 20(2), 111-124. doi: 10.1080/08985620701631498.

Román, C., Congregado, E., & Millán, J. M. (2013). Start-up Incentives: Entrepreneurship Policy or Active Labour Market Programme? *Journal of Business Venturing, 28(1,* 151–175. doi: 10.1016/j.jbusvent.2012.01.004.

Stam, E. (2006). Why Butterflies Don't Leave: Locational Behavior of Entrepreneurial Firms. *Economic Geography*, 83(1), 27-50. doi: 10.1111/j.1944-8287.2007.tb00332.x.

van der Zwan, P., Thurik, R., Verheul, I., & Hessels, J. (2016). Factors influencing the entrepreneurial engagement of opportunity and necessity entrepreneurs. *Eurasian Business Review*, *6*, 273–295. doi: 10.1007/s40821-016-0065-1

Wang, S. (2006). Determinants of New Firm Formation in Taiwan. *Small Business Economics*, 27, 313-321. doi: 10.1007/s11187-005-8722-2.

## Acknowledgments

This work has been supported by the funds of the Ministry of Science and Higher Education granted to University of Rzeszow within the subsidy for maintaining research potential.

## Annex

**Table 1.** Descriptive statistics for new business registrations and explanatory variables

| Variable | Mean | Std. dev. | Min | Max | $V_x$ |
|---|---|---|---|---|---|
| **Business entry rate (average 2003–2020)** | | | | | |
| All industries | 12.6 | 3.0 | 6.4 | 21.5 | 0.240 |
| Operational services | 4.4 | 0.9 | 2.6 | 6.6 | 0.194 |
| Business oriented services | 2.9 | 1.2 | 1.3 | 8.8 | 0.394 |
| Manufacturing | 1.0 | 0.3 | 0.4 | 2.0 | 0.294 |
| Construction | 2.1 | 0.9 | 0.5 | 4.9 | 0.407 |
| **Explanatory variables (average 2003–2018)** | | | | | |
| Unemployment rates | 13.48 | 5.20 | 3.20 | 30.30 | 0.386 |
| GDP growth rates | 3.64 | 2.08 | -1.50 | 10.00 | 0.571 |
| Population with tertiary education | 17.08 | 4.79 | 9.00 | 33.70 | 0.280 |
| Patents per labour force | 0.22 | 0.13 | 0.02 | 0.74 | 0.596 |
| Urbanization rate | 59.02 | 9.81 | 40.36 | 78.90 | 0.166 |
| Share of service sector | 0.49 | 0.07 | 0.37 | 0.66 | 0.149 |
| Registered enterprises per labour force | 146.55 | 28.33 | 98.83 | 242.66 | 0.193 |
| Wage level (% national average) | 0.93 | 0.10 | 0.83 | 1.30 | 0.109 |

Source: own elaboration based on CSO data.

**Table 2.** Fixed effect Driscoll-Kraay estimates of equation (1) (N=208)

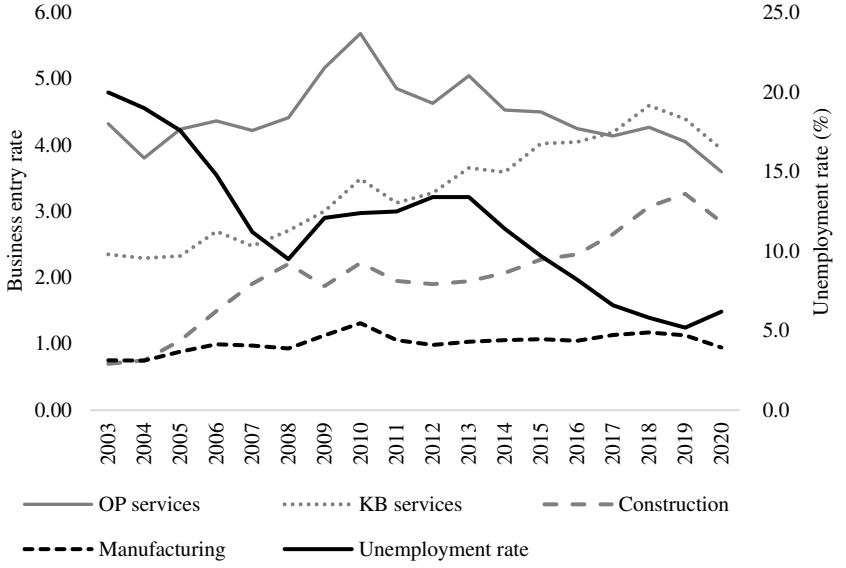
| Estim. | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| $Y_i$ | **All industries** | **Operational services** | **Business services** | **Manufacturing** | **Construction** |
| Const. | 2.55*** | 1.49*** | 1.081*** | 0.068 | 0.686*** |
| | (0.048) | (0.033) | (0.054) | (0.040) | (0.099) |
| *Unempl. rate* | **0.023**** | **0.036***** | 0.012 | 0.015 | -0.011 |
| | **(0.008)** | **(0.008)** | (0.021) | (0.009) | (0.015) |
| *GDP growth* | -0.001 | 0.007** | -0.013 | -0.005 | 0.008 |
| | (0.007) | (0.003) | (0.011) | (0.005) | (0.012) |
| *Education* | 0.004 | 0.019** | -0.004 | 0.001 | -0.018 |
| | (0.007) | (0.007) | (0.014) | (0.009) | (0.134) |
| *Patents* | -0.134 | -0.157 | -0.118 | -0.363* | -0.100 |
| | (0.154) | (0.113) | (0.264) | (0.170) | (0.302) |
| *Urbaniz. rate* | 0.048 | -0.038* | 0.065 | 0.015 | 0.171** |
| | (0.038) | (0.019) | (0.061) | (0.048) | (0.066) |
| *Share of services* | 1.89* | 0.099 | 2.75 | 2.48** | 4.89* |
| | (0.89) | (1.05) | (1.80) | (0.83) | (2.53) |
| *Registered buss.* | 0.010 | -0.006 | 0.021 | -0.004 | 0.018 |
| | (0.011) | (0.004) | (0.014) | (0.008) | (0.019) |

**Table 2.** Continued

| Estim. | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| $Y_i$ | **All industries** | **Operational services** | **Business services** | **Manufacturing** | **Construction** |
| *Gross wages* | 0.217<br>(0.673) | -0.386<br>(0.911) | -0.429<br>(0.89) | -0.120<br>(0.97) | 2.17<br>(2.59) |
| within $R^2$ | 0.274 | 0.395 | 0.217 | 0.257 | 0.168 |
| F-model test (p-value) | 0.0002 | 0.000 | 0.036 | 0.000 | 0.020 |

Notes: *, **, *** indicate statistical significance: * p < 0.1; ** p < 0.05; ***p < 0.01. Drisc/Kraay standard errors in parentheses. For all estimations: robust test for differing group intercepts: p<0.001.

**Figure 1.** Unemployment and new business registrations in specific industry sectors in Poland, 2003–2020




Source: own elaboration based on CSO data.

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The project implemented with Narodowy Bank Polski under the economic education programme

ISBN 978-83-65605-44-3

ISBN: 978-83-65605-44-3
ISSN: 2544-2384 (Online)
DOI: 10.24136/eep.proc.2021.4