Contemporary Issues in Economy

9

Proceedings of the International Conference on Applied Economics: **QUANTITATIVE METHODS**

edited by
ADAM P. BALCERZAK,
MICHAŁ BERNARD PIETRZAK

Toruń, Poland

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Gender as Determinant Factor of Routes for Registered Unemployment Exit

JEL Classification: *C41; J64*

Keywords: *competing risk; cumulative incidence function; the Lunn-McNeil model; unemployment; gender*

Abstract

Research background: Numerous studies show that men's and women's situation on the labour market differs. Women's disadvantageous position on the labour market has been confirmed by statistical data. Finding a job is just one of many causes why an individual is crossed out from the labour office register. The registered unemployed can retire, apply for invalidity pension, receive early retirement benefits or start full time studies. One of the most common causes of de-registering is the unemployed person's unjustified refusal to accept a job offer. The above causes are regarded as competing risks of various kinds.
Purpose of the article: The purpose of this article is to assess the effect of the unemployed individual's gender on the probability and intensity of de-registering from the labour office lists due to finding a job, de-registering or other causes.
Methodology/methods: The study made use of the survival analysis methods. The assessment of the probability of de-registration due to a specific cause was made by means of the cumulative incidence function. The intensity of de-registration was tested with the Lunn-McNeil model. Differences in the effect of gender on the de-registration possibility were tested with the use of Gray's test. The study was based on individual data of people registered by the Labour Office in Szczecin.
Findings: Among women, job-finding was the most common cause of de-registration, followed by the removal from the register. In the case of men the order was reversed, the most probable de-registration cause was the removal, followed by job-finding. The remaining causes were of marginal significance, both for men

and women. Women took up a job more intensively than men and were less intensively removed from the register. The differences between males and females in the intensities of de-registering due to the remaining causes were not statistically relevant.

Introduction

Numerous studies confirm the difference between the situation of men and women on the Polish labour market. According to BAEL in the 4th quarter of 2015 the economic activity rate in a group aged 15 plus was 56.5% (women: 48.6%, men: 65.0%). The unemployment rate in that period was 6.9% (women: 7.1%, men: 6.8%). The analysis of the mean unemployment time shows that women remain in the labour office records 1.7 months longer than men (i.e. 13.4 months versus 11.7 months). More difficult situation of women results from several barriers and obstacles that still have to struggle with. In the recent years the women's situation has been changing gradually. This process is associated with changes on the modern labour market. Still, the disadvantageous position that women have to cope with when seeking jobs results mainly from their double role as professionally active mothers or caregivers (Kotowska *et al*., 2007, pp. 21-26). Currently observed changes on the labour market, such as increasingly more popular flexible forms of employment, may turn out women beneficial for. Women are more willing to take advantage of subsidised forms of employment offered by labour offices, they more often join programmes that promote economic activity, even though these programmes is lower than expected. Research reveals poor results of Polish labour market policies (Hadaś-Dyduch *et al*., 2016, p. 7). Finding a job is just one of many causes why an individual leaves the labour office register. The registered unemployed have the opportunity retire, apply for invalidity pension, receive early retirement benefits or enrol for full time studies. One of the most common causes of de-registration is the unjustified refusal to accept a job offer.

The purpose of this article is to analyse the effect of the unemployed person's gender on the probability of de-registration from the labour office lists due to job-finding, removal from the register or other causes. These three types of causes are different kinds of competing risks. The competing risk is an event whose incidence rules out the incidence of another event or fundamentally alters the probability for this another event to happen (Gooley *et al*., 1999, pp. 695-706). This would be on the assumption that both events are mutually independent, i.e. the incidence of an event of a given type does not influence the probability of any other events to happen (Crowder, 1996, pp. 195-209). The individual under examination is simultaneously exposed to different types of risk. However, the possible event is assumed to result from only one of the factors that are referred to as 'the cause of failure' (Aly *et al*., 1994, pp. 994-999).

The study applies selected methods of the survival analysis that employ censored observations. The competing risks are assessed by means of the cumulative incidence function (*CIF*). The event intensity is evaluated with the Lunn-McNeil model. The study is based on individual data of the unemployed local residents registered by the Poviat Labour Office in Szczecin.

Research methodology

The survival analysis methods can be applied in studies on the duration of social and economic phenomena. What is analysed here is the individual's survival time in a specific state (random variable T) until a specific end-point event occurs. We can use the survival analysis methods to examine duration of firms (Markowicz, 2013, pp. 23-36), population's economic activity (Landmesser, 2009, pp. 385-392) or duration of unemployment (Bieszk-Stolorz & Markowicz, 2015, pp. 167-183).

The elementary term used in the survival analysis is a survival function:

$$S(t) = P(t > T) \tag{1}$$

where T is the event duration.

$S(t)$ specifies the probability that the event will occur at least by the time t. When the event is defined as finding a job by a registered unemployed individual, then the survival function estimator specifies the probability of remaining in the labour office register.

Usually, the study using survival models is based on the observation of individuals belonging to a specific cohort, i.e. to a set of objects singled out from a population due to an event or process simultaneously occurring for the whole set. For each individual, the time of survival in a given state or the time of duration of a given process are observed. If in the study the period of individuals' observation is fixed, some part of them can fail to survive by the end of this period. Such observations are referred to as right censored. In scientific research the right censored observations are also the situations when the examined individual disappears from the field of observation or the endpoint event occurs which rules out the incidence of the appropriate event (Pepe, 1991, pp. 770-778) (i.e. the competing risk). What is interesting, however, is the application of competing risk models (Klein & Moeschberger, 1984, pp. 50-57; Klein & Bajorunaite, 2004, pp. 291-312).

Cumulative incidence is a cumulative probability of the incidence of an event due to the cause k by the time t, basing on the assumption that the individual is exposed to any of the competing risks k (Bryant & Dignam, 2004, pp. 182-190). The cumulative incidence function is written (Klein & Moeschberger, 2003, p. 52):

$$CIF_k(t) = P(t \le T, \delta = k) = \int_0^t S(u) dH_k \text{ for } k = 1, 2, 3, \ldots, K \tag{2}$$

where:
$H_k(t)$ – specified (for a fixed k) function of cumulative hazard function,
$S(t)$ – survival function.

Let t_j be event times, d_j – number of events, d_{kj} – number of events that have occurred due to the cause k, n_j – number of individuals at risk at the time t_j. The cumulative hazard function $H_k(t)$ for the cause k can be expressed by the Nelson-Aalen estimator:

$$\hat{H}_k(t) = \sum_{j:t_j \le t} \frac{d_{kj}}{n_j} \tag{3}$$

$S(t)$ is usually estimated by means by the Kaplan-Meier estimator (Kaplan & Meier, 1958, pp. 457-481):

$$\hat{S}(t) = \prod_{j:t_j \le t} \left(1 - \frac{d_j}{n_j}\right) \tag{4}$$

Having combined the above two estimators (3) and (4), we can estimate the cumulative incidence function due to the cause k (CIF_k) as (Marubini & Valsecchi, 1995, pp. 331-364):

$$\hat{CIF}_k(t) = \sum_{j:t_j \le t} \hat{S}(t_{j-1}) \frac{d_{kj}}{n_j} \tag{5}$$

The CIF_k helps determine the patterns of the event incidence due to the cause k as well as estimate to what extent each of the causes contributes to the total failure.

In the case of competing risks, the equality of CIF_k for K sub-groups is verified by the Gray test (Gray, 1988, pp. 1141-1154) which compares weighted means of the hazards of the cumulative incidence function. The null hypothesis assumes the absence of differences between CIF_k determined for the sub-groups. The test statistic has a chi-square distribution with $K - 1$ degrees of freedom.

In order to estimate the relative intensity of the incidence of a given event by the time t we can use the Lunn-McNeil model. We introduce to the model the dummy variables D_k that represent K types of risk: D_k equals 1 for the k type risk and 0 for the remaining risk types. If $g = 1, 2, \ldots, K$ denotes the strata being the risk types, the Lunn-McNeil model (the alternative version) can be defined as a stratified Cox regression model with interactions (Kleinbaum & Klein, 2005, p. 423):

$$h_g(t, X) = h_{0g}(t) \exp\left(\sum_{k=1}^{K} \sum_{j=1}^{p} \delta_{kj} D_k X_j \right) \tag{6}$$

where:
X_j – the explanatory variables,
D_k – dummy variables.

In the Lunn-McNeil model we do not interpret the parameters δ_{kj} directly, but we choose their $\exp(\delta_{kj})$ form. If X_j is an explanatory dichotomous variable, then:

$$HR_{g=k}\left(X_j = 1 / X_j = 0\right) = \exp\left(\delta_{kj}\right) \tag{7}$$

is interpreted as the relative hazard (relative intensity) of the incidence of the k-type event.

Data used in the study

The study uses anonymous individual data obtained from the Poviat Labour Office (PUP) in Szczecin. The study covered 22 078 unemployed individuals registered in 2013 and observed by the end of 2014. The analysis focused on the time between the registration and de-registration due to a specific cause. Today, the registers provide information on several dozens of de-registration causes. The causes were categorized into three groups according to competing risks involved: job-finding, removal from the register and other. Some observations did not end with an event, i.e. with the de-registration during the analysed period of time. Such observations are considered right censored. The sizes of all the groups are shown in Table 1.

Each of the major de-registration causes is composed of several sub-causes. The job-finding (Job) consists of three main subgroups: finding a job or another form of employment; taking up a government subsidised form of employment; economic activity. The Removal from Register category includes the unemployed individual's reluctance to cooperate with the labour office and have been removed from the register through their own fault or on their own request. The remaining causes of de-registration (Other) are less numerous and, as previous research showed, each of them had a marginal effect on the probability of de-registration. Therefore, they have been considered to form a separate group (taking up residence outside the area of the local PUP's authority, incapacity to work due to medical condition or addiction treatment in a closed rehabilitation establishment, emigration, death, military service, taking up full time education, a disability allowance or a rehabilitation benefit; a permanent social benefit, disability insurance, retirement allowance).

Table 1. Size of groups of specific de-registration

Groups	De-registration causes			Censored observations	Total
	Job	Removal	Other		
Women	4809	3264	784	913	9770
Men	4824	5701	840	943	12308
Total	9633	8965	1624	1856	22078

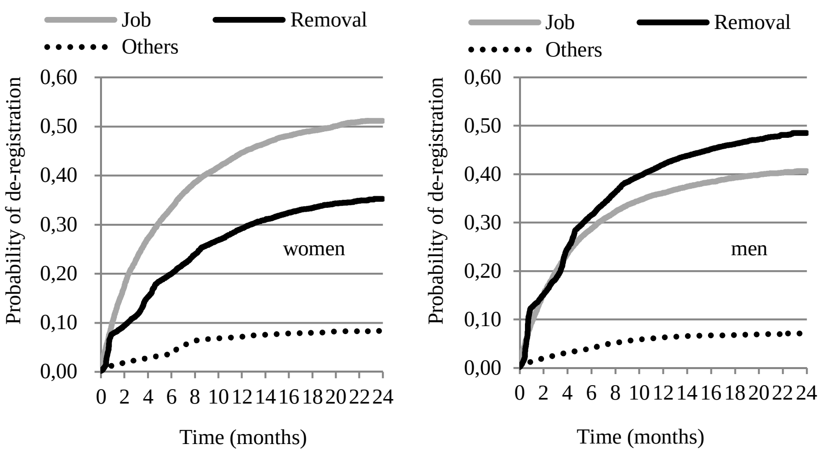
Source: own study.

Analysis of gender effect on causes of de-registering from labour office

The analysis consisted of two stages. In the first stage, CIF_k was used to estimate the probability of the unemployed men's and women's de-registration from the labour office lists. Three types of endpoint events were adopted: job-finding, removal and other, being the competing risks. The censored data were those observations which had not been concluded by the end of 2014. That allowed for the estimation of the probability of the major causes of de-registration of the unemployed men and women.

Taking up a job was the most frequent cause of de-registration among women throughout their whole unemployment spell. The second most common cause was the removal from the labour office register. As far as men are concerned, the most probable de-registration cause was the removal (staring from the 4th month from registration), followed by job-finding. Other causes were on the third position both in the male and female group and were of marginal importance (Figure 1). The Gray test indicates differences in the plots of the CIF_k determined for each gender group (Table 2). After 24 months of being registered, the probability of women's de-registration due to job-finding was at 0.51 (men 0.41), due to removal from the list – at 0.35 (men 0.49) and due to other causes – at 0.084 (men 0.071).

Figure 1. Estimators of CIF_k of unemployed women and men



Source: own study.

Table 2. Gray test results for groups of the unemployed by gender

De-registration causes	Gray test (chi-square)	*p*
Job	190.786	0.000
Removal	413.120	0.000
Others	10.932	0.001

Source: own study.

It is worth noticing that the plots of the estimators of the de-registration cause described as Job are regularly curved. The estimators of Removal and Other do not have such a property. In their plots sudden leaps in value can be observed. In the Other category a slight jump in value is seen in the 7th month after registration, for men and women alike. A detailed analysis of data reveals that it was caused by an increased number of de-registrations due to granting the unemployed individuals with the right to an early retirement benefit/allowance. In the case of Removal, a marked leap within the first month after registration was a result of a higher number of de-registrations because of the failure to appear in the labour office in due time. The above causes of de-registration concerned both men and women.
In the further part of the study the Lunn-McNeil model (the alternative version) was used to examine the effect of gender on the intensity of various routes of unemployment exit. For the dychotomous Gender variable X (1 for women and 0 for men) and for three types of competitive risk (Job: g = 1, Removal: g = 2, Other: g = 3) the model takes the form:

$$h_g(t, X) = h_{0g}(t)\exp\left(\sum_{k=1}^{3} \delta_k D_k X\right) \tag{8}$$

The dummy variables D_k specify the type of competitive risk and adopt the value of 1 for the risk number k and 0 in any other case. The parameter significance level was adopted at 0.01. The results of the model parameter estimation are shown in Table 3.

Table 3. The results of the Lunn-McNeil model parameter estimation

Parameters	Assesment of parameters	Standard error	Wald statistics	*p*	Hazard ratio
δ_1	0.1270	0.0204	38.8026	0.0000	1.1354
δ_2	–0.4389	0.0220	399.2858	0.0000	0.6448
δ_3	0.0390	0.0500	0.6168	0.4322	1.0398
χ^2 = 451.836, p = 0.0000					

Source: own study.

The conducted analysis reveals that women took up a job 14% more intensively than men and were removed from the labour office register with intensity a little higher than 35%. The intensities of de-registering for other causes were similar in both groups (the lack of significance δ_3).

Conclusions

The assistance provided to the unemployed individuals in finding a job is one of the main objectives of labour offices. Taking up a job was generally the most common cause of de-registering from the labour office list. The study conducted with the aid of CIF_k pointed to differences in the plots of the de-registration causes. Job-finding was the most probable cause of de-registering in the group of women, while Removal – in the group of men. The obtained results imply that the will to take up a job was not the only impulse to register in the labour office. Other causes were of marginal importance.

If all the observed individuals had been de-registered by the end of 2014, then the sum of CIF_k estimators for all the risk types in the 24th month would have been equal 1. However, some of the observations were censored, therefore the sum was less than 1. The resulting non-zero difference allows to determine the probability of remaining in the labour office register longer than 24 months after registration. That probability was 0.05 for women and 0.04 for men. The probability of remaining in the register was decreasing over time. It was at 0.19 for women and 0.16 for men after 12 months after registration. It follows that women were exposed to a higher probability to enter long-term unemployment.

The differences in the gender effect on the routes of unemployment exit were also confirmed by the Lunn-McNeil model parameters. Over the whole period of observation, women were taking up jobs more intensively than men, while men were more intensively removed from the labour office register. The unemployed individual's gender did not have any effect on the intensity of de-registration due to other causes.

The presented study has brought up an interesting methodological point. If there are different types of endpoint events, it seems worthwhile to distinguish competing risks and estimate the probability of their incidence. From the point of view of the labour market policies, it is important to analyse not only the job-finding events, but also the determinants of other routes of unemployment exit. Models of cumulative incidence make it possible to estimate the probability of job-taking and to compare them with other causes of de-registration. The Lunn-McNeil model can be used to determine the relative intensity of de-registration due to many causes.

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Multidimensional comparative analysis of the competitiveness of the European Union countries' economies

JEL Classification: *C38, O11, P36*

Keywords: *competitiveness of the economies, multidimensional comparative analysis, the European Union*

Abstract

Research background: The basic question we ask is, whether it is possible to talk in today's globalizing world about the uniform of the competitiveness of the economies. Posing such questions is particularly important in the case of such political and economic structures such as the European Union. The strategic developmental objectives of the EU include the aspiration to harmonious development of all of its members but it is very difficult task. The competitiveness of the economies is now one of the most frequently discussed topics. It is very difficult to precisely define the notion of competitiveness unambiguously, particularly in terms of international competitiveness of economies. The competitiveness of economies can be discussed both in the context of : a) international competitive capacity, b) international current competitiveness or c) international competitive standing of national economy. In this work, due to the context of the conducted research (international comparisons of the EU countries' economies) the competitiveness of international economies will be considered in terms of international competitive capacity with regard to investment attractiveness of a country. In addition to the problems associated with defining this concept they are also important dilemmas associated with the measurement of the competitiveness. In the performed comparative analyses of

European economies the research results presented within reports of „Global Competitiveness Index" will be used.
Purpose of the article: The aim of the work is multidimensional comparative analysis of the competitiveness of the European Union countries' economies.
Methodology/methods: In the work to study the spatial differentiation of the EU countries' economies in the context of their competitiveness, the taxonomic measure of development based on median vector Weber has been used.
Findings: As a result the classification and the typological groups of the EU countries obtained by means of the taxonomic measure of development calculated on the basis of the characteristics of their competitiveness arises.

Introduction

A steady development of the European Union in various socio-economic areas is one of the EU's strategic development objectives. This is a difficult task to implement, mainly due to the significant differences in the rate of development of individual member states, internal differences and historical developmental conditions of these countries.

In the literature of the subject (Porter, 1988; Krugmann, 1994, 1996; Feinberg, 2000, pp. 155-167; Thompson, 2004, 62-97; Bossak & Bieńkowski, 2004; Pearce, 2006, pp. 39-74; Pearce & Zhang, 2010, pp. 481-498; Castro-Gonzales et.al., 2016, pp. 373-386) a lot was devoted to analyzing the level of development of the European Union, including: sustainable development, technological development, innovation, quality of life and many others. These are mainly comparative analyzes showing the differences and similarities in the development of individual EU Member States.

In recent years, in the face of many changes and crises in the European Union such as 2007-2008 economic crisis, the Great Britain's decision to leave the EU structures (so-called Brexit) or the ongoing migration crisis, addressing the possibility of further EU development is particularly important. One of the important directions of research in this area is the analysis of the competitiveness of the economies of individual EU Member States and the uniformity of Union development in this area. The EU economy, in many sources, is referred to as the second world economy (after the USA economy), (Stefanescu & On, 2012, pp. 889-898). The competition from the high-tech economy of the United States as well as from developing economies in Asia is, however, significant, and the pursuit of increased competitiveness of the Union economy is included in all strategic EU documents. The pursuit of competitiveness of national economies has been at the top of the priorities of all political forces for years at all latitudes. The very concept of competitiveness of the economy is very popular today and is often abused. Paul Krugmann (1996) described it even in his work as "dangerous obsession". It must be mentioned that in the past not all authors was agree with the opinion that competitiveness might be considered with regard to national economy. Such doubts were expressed mainly by M.E. Porter (1988) and P. Krugman (1994). In the next years that view was slightly verified by Porter in his later works (Porter 1998).

In view of these concerns, there is nothing surprising in the fact that it is very difficult to define precisely the term of competitiveness, particularly in the context of international competitiveness of economies. One of the first definitions of international competitiveness was the notion developed by the Presidential Council on Competitiveness founded by Ronald Regan in 1983, according to which: „competitiveness is the degree to which a nation can, under free and fair market conditions, produce goods and services that meet the test of international markets while simultaneously maintaining or expending the real incomes of its citizens". Similarly as the references to competitive capacity found in definitions developed by: European Commission, Office Analysis of the New York Stock Exchange, Competitiveness Policy Council, OECD and World Economic Forum.

The literature (ex. (Bossak, 1984; Durand, 1986; Porter, 1988; Krugman, 1994; Porter et al., 2000; Bossak & Bieńkowski, 2004; Misala, 2011) contains many different definition of this notion e.g.:

a) international competitive capacity defined as a power (the capacity) of a given country in the rivalry for the benefits gained from the participation in the international division of work (Durand, 1986; Bossak and Bieńkowski, 2004);
b) international current competitiveness of national economy (Misala, 2011), reflects the present condition and the directions of changes in inherent ability to compete up to now;
c) international competitive standing of national economy (Bossak, 1984), refers to owned shares in the widely understood international business.

In this work due to the context of the conducted analysis (international comparisons) the competitiveness of European Union economies, it was decided to consider in terms of competitive capacity. The aim of the work is therefore a multidimensional comparative analysis of the competitiveness of the European Union countries' economies.

The paper is organized as follows: the introduction contains a brief review of the literature in the area of competitiveness of national; the second part presents basic information about the research of competitiveness of the world's economies carried out annually by the World Economic Forum (WEF) and presented in the report: The Global Competitiveness Index (GCI) and the last one looks at contemporary analysis in the field of competitiveness of the EU economies. In the last section the authors formulate conclusions.

Method of the research

A comparative analyzes of the competitiveness of economies of individual Member States of the European Union are based on the following assumptions:

1. Due to the context of the conducted analysis (international comparisons) the competitiveness of EU economies is considered in terms of competitive capacity defined as a power (the capacity) of a given country in the rivalry for the benefits gained from the participation in the international division of work.
2. The study was based on the data from 2006 (first published report), (Lopez-Claros, 2006) and 2016 (last edition), (Schwab, 2017) gathered by World Economic Forum and published in the reports: „Global Competitiveness Index".
3. The original data base included 70 diagnostic features describing 12 area of the GCI index. Hellwig's parametric method was used for the purpose of the selection of the representatives of respective sets (Nowak, 1990).

To the final set of features which are characterized by high spatial variability with low correlation within the selected sets and asymmetric distribution, 17 variables were selected: x_1 - intellectual property protection (in the scale 1-7, where 7 is the best), x_2 - burden of government regulation (1-7, best), x_3 – available airline seat km/ week, millions, x_4 – fixed telephone lines/ 100 pop., x_5 – mobile telephone subscriptions/ 100 pop., x_6 – gross national savings, % GDP, x_7 – general government debt., % GDP, x_8 – tuberculosis cases/ 100,000 pop., x_9 – tertiary education enrollment, gross %, x_{10} – quality of math and science education (1-7, best), x_{11} – effectiveness of anti-monopoly policy (1-7, best), x_{12} – hiring and firing practices (1-7, best), x_{13} – flexibility of wage determination (1-7, best), x_{14} – FDI and technology transfer (1-7, best), x_{15} – exports as a percentage of GDP, x_{16} – domestic market size index (1-7, best), x_{17} – local supplier quantity (1-7, best). Features: x_7 and x_8 are destimulants, other features are stimulants. The stimulants are numbers whose bigger values indicate a higher level of progress of a given phenomenon, while the destimulants are diagnostic characteristics whose smaller values signify a higher level of development[1] (Bąk, 2014, pp. 134-145).

In the work to study the spatial differentiation of the EU countries' economies in the context of their competitiveness, the taxonomic measure of development based on median vector Weber (1971) has been used. The median Weber is a multi-dimensional generalization of the classical notion of the median. It is about vector that minimizes the sum of Euclidean distance (Euclidean distance) of the data points representing the considered objects, and therefore is somehow "in the middle" of them, but it is also immune to the presence of outliers (Weber, 1971).

The positional option of the linear object assignment takes a different standardization formula, based on a quotient of the feature value deviation from the proper coordinate of the Weber median and a weighed absolute median deviation, using the Weber median (Weber, 1971):

$$z_{ij} = \frac{x_{ij} - \theta_{0j}}{1{,}4826 \cdot m\tilde{a}d(X_j)} \tag{1}$$

where: $\theta_0 = (\theta_{01}, \theta_{02}, ..., \theta_{0m})$ is the Weber median, $\mathrm{m\tilde{a}d}(X_j)$ is the absolute median deviation, in which the distance from the features to the Weber vector is measured, i.e.: $\mathrm{m\tilde{a}d}(X_j) = \underset{i=1,2,...,n}{\mathrm{med}} \left| x_{ij} - \theta_{0j} \right| \quad (j = 1,2,...m)$. The aggregate measure is calculated with the following formula:

$$\mu_i = 1 - \frac{d_i}{d_-} \tag{2}$$

where: d_- = med(**d**)+2,5mad(**d**), where d=(d_1, d_2,…,d_n) is a distance vector calculated with the formula: $d_i = \underset{j=1,2,...m}{\mathrm{med}} \left| z_{ij} - \varphi_j \right| \quad i = 1,2,...,n$, $\phi_j = \underset{i=1,2,...,n}{\max} z_{ij}$ – the coordinated of the development pattern vector, which is constituted of the maximum values of the normalized features.

[1] Sometimes the category of *nominants* is used. In their case the most favourable situation is when they reach a fixed value or number interval.

The assignment of objects with a positioning measure is the basis for a division of objects into four classes:

- Class I: $\mu_i > \mathrm{med}_1(\mu)$,
- Class II: $\mathrm{med}(\mu) < \mu_i \le \mathrm{med}_1(\mu)$,
- Class III: $\mathrm{med}_2(\mu) < \mu_i \le \mathrm{med}(\mu)$,
- Class IV: $\mu_i \le \mathrm{med}_2(\mu)$.

The Weber median was calculated in *R program: l1median* of package: *pcaPP*.

Study results

Table 1 shows the results of the classification and the typological groups of the EU countries obtained by means of the taxonomic measure of development. It is clear that the positions of individual countries in the obtained rankings were usually different, with only the one exception of Romania (26th position in the rank). Thirteen EU countries improved their situation in 2016 in comparison to 2006 (the United Kingdom, Malta, Sweden, the Netherlands, the Czech Republic, Germany, Portugal, Belgium, Slovenia, Lithuania, Greece, Croatia and Bulgaria). The greatest leaps were observed in the case of Malta which was on the 13 position in the 2006 ranking and then in 2016 jumped 18 positions higher to the 3rd positions. The situation in the field of competitive capacity in 2016 compared to 2006 deteriorated in the case of 14 EU countries – the most affected were Italy (down from the 13th to the 28th position), Spain (the fall from the 6th to the 19th position) and the Slovak Republic (down from 10th to the 18th position).

Both rankings are characterized by low positions occupied by both Southern and Eastern European countries. In both rankings in the last two groups, which includes t countries with the lowest scores almost all countries in these geographical regions of Europe are classified. Similar changes have also been described in the papers describing the situation of European countries in areas such as sustainable development, investment attractiveness and socioeconomic development in general. On the other hand, in the case of Eastern European countries, despite the traditionally low position occupied by such countries as Romania or Bulgaria, attention should be paid to the significant improvement in the position occupied by the Czech Republic, which for several years has been perceived by investors as an attractive location for investment. Among the countries of Eastern Europe, it is the Czech Republic that was the best in 2016 ranking. The first two groups were classified primarily by countries located in Northern and

Western Europe. The first place in 2016 was the United Kingdom, which in 2006 was also classified in the first group but only in position 5. Despite the events of last year and the decision to leave the European Union by this country, the United Kingdom was ranked first in the 2016 ranking. Comparing the results of both rankings, one should also pay attention to the wider range of results achieved in 2016, which should be interpreted as a greater variation in the countries studied during that period.

Table 1. The EU countries sorted by their competitive capacity in: 2006 and 2016

Country	Value of meter (μ_i)	Rank	Group	Country	Value of meter (μ_i)	Rank	Group
	2006				2016		
Luxembourg	0,680	1	I	United Kingdom	0,789	1	I
Denmark	0,626	2		Luxembourg	0,529	2	
Finland	0,568	3		Malta	0,523	3	
Ireland	0,556	4		Sweden	0,492	4	
United Kingdom	0,552	5		Netherlands	0,466	5	
Spain	0,542	6		Denmark	0,448	6	
Estonia	0,505	7		Czech Republic	0,426	7	
Sweden	0,440	8	II	Germany	0,422	8	II
Netherlands	0,432	9		Estonia	0,417	9	
Slovak Republic	0,404	10		Finland	0,408	10	
Czech Republic	0,387	11		Ireland	0,378	11	
France	0,377	12		Portugal	0,374	12	
Italy	0,376	13		Belgium	0,372	13	
Belgium	0,375	14		Slovenia	0,333	14	
Hungary	0,371	15	III	France	0,333	15	III
Austria	0,365	16		Hungary	0,307	16	
Germany	0,309	17		Lithuania	0,305	17	
Portugal	0,305	18		Slovak Republic	0,302	18	
Poland	0,293	19		Spain	0,301	19	
Slovenia	0,291	20		Austria	0,297	20	
Latvia	0,256	21		Greece	0,271	21	
Cyprus	0,239	22	IV	Poland	0,261	22	IV
Greece	0,233	23		Cyprus	0,250	23	
Malta	0,228	24		Croatia	0,204	24	
Lithuania	0,186	25		Bulgaria	0,156	25	
Romania	0,158	26		Romania	0,140	26	
Croatia	0,124	27		Latvia	0,082	27	
Bulgaria	0,103	28		Italy	0,080	28	

Source: own calculations based on WEF data.

Conclusions

The results published annually by the World Economic Forum were used to examine the competitive capacity of the economies of the European Union. The original database contained 70 variables describing different areas of competitiveness, or rather the competitive capacity of the world economy. According the definition of WEF the competitiveness is defined as "the set of factors that determine the level of productivity of a country and this level of productivity determined the level of prosperity earned by an economy". The Global Competitiveness Index (GCI) is calculated based on data covering 12 categories gathered in the so-called pillars of competitiveness, which together describe the competitiveness of the economies. Finally, 17 characteristics were selected for the study describing different areas of competitiveness (competitive ability) of economies of European Union countries. The results obtained confirm the observations of other authors where it is clear that so far a division of Europe into a more developed West and less developed East, or a division into so called "old" and "new" EU Member States are not supported by indicators used by the WEF to examine the competitiveness of countries.

The results of the analyzes presented in this paper are particularly important in the light of recent developments in the European Union, which face a number of crises and in the context of the proposed changes and divisions of the European Union into so called Europe of two speeds.

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Social Efficiency of Sectoral Employment in Polish Regions

JEL Classification: *D61; E24; I31; J21; O11; O15; R11; R15*

Keywords: *social efficiency; employment; three sectors; regions*

Abstract

Research background: Regions that are able to use their resources in the most efficient way could be perceived as valuable benchmarks when shaping socio-economic policy. The efficiency, however, can be related not only to pure economic categories but to social goals as well. These two dimensions: economic and social overlap and often have some common stems, among which sectoral structure of employment seems to be an important one.
Purpose of the article: The aim of the study was to compare the social efficiency of employment in three sectors in Polish voivodeships. Not only were we evaluating the relative performance of each region but we were also paying attention to the efficiency of engagement of human resources in agricultural, industrial and service sectors.
Methodology/methods: We adopted DEA method to assess the social efficiency of Polish regions. We evaluated social cohesion concerning its two output dimensions: positive, that could be described by social activity and negative, that could be reflected in a form of social exclusion stemming from material sources. We took into account a level of employment in agricultural, industrial and service sectors as inputs in the model and thus focused our attention on the three sectoral structure of regional economies. Our model assumed non-radial developmental paths and was input oriented (NR-CCR). Data were describing the 16 Polish voivodeships in the 2015 year and were extracted from the Central Statistical Office of Poland's databases.
Findings: The conducted research indicate that Polish regions which were the most efficient in terms of social integration were simultaneously those with the

best economic results in terms of GDP per capita. The highest social efficiency was characteristic for employment in the service sector, while the lowest – for agriculture. Thus, structural development appears to be favourable for regional economies also in terms of social cohesion, which is often neglected in the literature.

Introduction

The search for an optimal sectoral distribution of employment has been an important aspect of research about a socio-economic development of countries and regions at least since a three-sectoral theory was created by Fisher (1935), Clark (1940) and Fourastié (1949). However, consequences of a sectoral shift are typically reduced to problems of productivity differences between sectors and its changes, which influence an economic growth and convergence (e.g. O'Leary & Webber, 2015; Maudos *et al.*, 2000; Sassi, 2011). Social results of the structural modernisation in terms of distributive and relational cohesion are usually neglected. Meanwhile, modernisation may rise prosperity but also escalate inequality and thus it changes an individual life satisfaction (Abbott *et al.*, 2016, p. 654, 668) as well as conditions for social cohesion. Hence, this papers looks at some social effects of a distribution of labour between three sectors: agriculture, industry and services. An aim of the study is to compare the social efficiency of employment in the three sectors in Polish voivodeships. As a category of efficiency is understood as a relationship between outputs and inputs (e.g. Kaasa, 2016, p. 12), in the paper the results of economic activity are perceived in social terms. The study evaluates a relative performance of each region but also assesses social results of engagement of human resources in each sector.

An aim of achieving social cohesion is specified as a key policy goal in the European Union. The Council of Europe states that social cohesion is the capacity of a society to ensure the welfare of all its members, minimising disparities and avoiding polarisation (New Strategy…, 2010, http, p. 2). Social cohesion is perceived as the glue that keeps the members of a social system together (a family, an organisation, a neighbourhood, or society as a whole) (Dekker & Bolt, 2005, p. 2448). Most authors claim that enhancing cohesion include reducing economic and social disparities and strengthening the connections and relations (Hulse & Stone, 2007, p. 112), or in other words: enhancing the equity and harmonising the relationships between different social groups (Andrews, 2014, p. 705). Thus distributive (economic) and relational (structural) dimensions of social cohesion are specified (e.g. Loktieva, 2016, pp. 148-150). These classifications of social effects may be adopted to evaluate results of modernisation, enabling to clarify outputs when assessing the social efficiency.

This research use two aspects of social results of employment: distribution of incomes (relative poverty) and engagement in social activities (participation in social organisations). The first dimension reveals a pursuit to equity, broad inclusion and security in terms of economic conditions, while the second represents an active attitude of people who share common goals and feel empowered to take up actions favourable for the whole community. Both aspects may be supported by employment, as it enables to avoid monetary marginalisation as well as it creates a sense of personal capability and relational inclusion resulting in social solidarity. We try to investigate to which extend the three sectors' engagement allows to fulfil these goals in the Polish regions.

The research focuses on the performance of 16 Polish voivodeships, which may be treated as relatively homogenous units. However, we try to identify the regions that gain the best social results and thus can create a benchmark for the others. Basing on the experience of the leaders it is possible to suggest an optimal structural solution and shape an industrial policy.

The analysis is conducted for the 2015 year and an evaluation of the modernisation is done in a comparative way. It assumes a typical pattern of the sectoral shift as described in the three sectoral theory (from agriculture to industry and then to services). Relative results of each sector allow to conclude about social benefits induced by the modernisation.

The paper is organised as follows. In the next section, the research methodology is described in a more detailed way. The third section presents results of research and their discussion and the final section concludes.

Research methodology

The paper uses DEA (Data Envelopment Analysis) method as proposed by Charnes, Cooper and Rhodes (1978) to compare the social efficiency of sectoral employment in the Polish regions. As the aim is to compare social results of each sector we adopt a non-radial model NR-CCR, which allows for different multipliers (θ) for each input.

The data in our model include three inputs and two outputs. Inputs are specified as employment per 100 population in sector n (agriculture, industry and services) in the 16 Polish voivodeships in the 2015 year. To minimise a distortion caused by different sizes of the regions the number of employees was related to the number of population. Thus, the input indicators reflect, additionally to the importance of each sector, also demographic conditions of each region and situation at a labour market (influencing unemployment and economic inactivity).

Output in r dimension of cohesion is specified as: in the distributive dimension – 100% minus the rate of population (%) endangered by the relative poverty in the voivodeships and in the relational dimension – the number of foundations and social organisations registered in REGON per 1000 inhabitants in the voivodeships. We assumed that in a cohesive society there are not many people suffering from economic exclusion and poverty and a participation in social activities, which reflects solidarity with others and individual sense of empowerment, is high.

The statistical data were derived from the Central Statistical Office of Poland's databases available on-line: the Local Data Bank (GUS, http, 02.12.2016, 27.03.2017) and STRATEG (GUS, http, 03.12.2016).

We used the EMS application to resolve the linear programming problem assuming the inputs minimising. Moreover, as the main issue under consideration was specified as the intersectoral differences in efficiency, there were calculated indicators of substitution for each pair of inputs and a general indicator of substitution of inputs z (as a geometric mean of the individual indicators of the values not least than 1).

Realising the aim of the study we calculated the relative efficiency scores of each voivodeship adopting the model specified above. We identified benchmark regions and compared an average efficiency score of each sector to evaluate the modernisation. We used the indicators of substitution to indicate its directions enhancing cohesiveness.

Results and discussion

The social efficiency of the Polish regions (table 1) reaches at average 79% of the optimal level for the group. 5 regions achieve optimal results, namely: mazowieckie, śląskie, wielkopolskie, zachodniopomorskie and dolnośląskie and these are mostly the richest voivodeships. Moreover, one of the poorest region – świętokrzyskie appears the least efficient one in terms of social cohesion. In świętokrzyskie only 56% of the current employment is efficiently engaged considering cohesive results. The fact additionally supports the pattern of mutually enhancing relations between GDP per capita and social results. Thus, a recipe to strengthen social cohesion seems to be common with measures to leverage a level of production per capita. The rank correlation between GDP p.c. in 2015 year (GUS, http, 27.03.2017) and the compound social cohesion results is 0,68 and confirms the conclusion. It supports the view about mutual strengthening interrelations between these phenomena, however, it does not prejudge their succession. Nevertheless, we can generally conclude that in Poland the rich regions are simultaneously the most cohesive ones. Thus any actions supporting one of these phenomena should be favourable also for the other.

Table 1. Efficiency scores of the sectoral employment in terms of the social cohesion in the Polish regions in 2015

	voivodeship	benchmarks	θagr	θind	θser	θ
1	łódzkie	11 (0,98)	40%	64%	70%	58%
2	mazowieckie	0	100%	100%	100%	100%
3	małopolskie	11 (0,96)	54%	81%	90%	75%
4	śląskie	0	100%	100%	100%	100%
5	lubelskie	11 (0,97)	23%	87%	75%	61%
6	podkarpackie	11 (0,94)	39%	81%	95%	72%
7	podlaskie	11 (0,91)	23%	89%	88%	67%
8	świętokrzyskie	11 (0,90)	21%	67%	79%	56%
9	lubuskie	11 (0,99)	96%	69%	85%	83%
10	wielkopolskie	0	100%	100%	100%	100%
11	zachodniopomorskie	11	100%	100%	100%	100%
12	dolnośląskie	0	100%	100%	100%	100%
13	opolskie	11 (0,97)	59%	68%	92%	73%
14	kujawsko-pomorskie	11 (0,94)	41%	74%	86%	67%
15	pomorskie	11 (0,97)	83%	67%	75%	75%
16	warmińsko-mazurskie	11 (1,04)	50%	89%	98%	79%
		mean	64%	83%	90%	79%

θ - a relative efficiency score (subscripts: agr, ind, ser stand for: agriculture, industry, services; an indicator without any subscript reveals a general efficiency score calculated as a mean efficiency of the three sectors)

Source: own calculations based on statistics from the Central Statistical Office of Poland available in STRATEG (GUS, http, 03.12.2016) and Local Data Bank (GUS, http, 02.12.2016) databases.

Although 5 regions are fully efficient, only zachodniopomorskie is a real benchmark for the other voivodeships. Thus, features of employment in zachodniopomorskie are important to be tracked to find the best way to enhance social cohesion. The region is a deindustrialised one, with a share of employment in the service sector reaching 62%, in the industry 30% and only 8% in the agriculture. Apart from mazowieckie, it is the voivodeship with the highest proportion of a labour force in services. However, the sectoral structure of employment in mazowieckie is less developed as the agriculture engages a relatively high share of employment, reflecting polarised situation within the region.

Comparing the cohesive efficiency of employment in different sectors, it is possible to conclude about socially favourable results of modernisation. As a modern shift in employment is specified by labour movement from agriculture and industry into a service sector, it may enhance social cohesion because the service sector achieves the best efficiency followed by industry and then agriculture.

Employment in the service sector allows to gain an average level of social efficiency of 90%. The best performance is observed in the 5 affluent regions that are fully efficient (mazowieckie, śląskie, wielkopolskie, zachodniopomorskie, dolnośląskie). On the other hand, łódzkie is the least efficient voivodeship and 30% of its service employment is wasted concerning the social yields.

The best results of the service sector can be explained by their classical features specified by a predominant role of personal interactions within the service process. It may induce a general prosocial activity of the employees who more willingly participate in actions undertaken also in non-profit organisations. Moreover, the results also suggest that the service employment allows to limit the poverty the most. It may be connected with an inclusive character of the heterogenic service sector that creates workplaces also for the manual workers who are less educated and professionally qualified as well as for women or the young and the old who are more commonly discriminated. The employment can give them an opportunity to earn and thus to avoid poverty and material exclusion. Unemployment or economic passivity is the alternative pushing them into exclusion.

An engagement in the other sectors also brings positive social gains, however, they are generally weaker. The industrial employment allows to achieve an average level of the social efficiency of only 83%. There are 5 efficient regions (as previously) and the looser (łódzkie) gains efficiency of 64%.

The poorest efficiency scores may be attributed to the agriculture. At average 36% of the employment does not bring any social gains when assessing the cohesion. The least efficient region is świętokrzyskie and it is followed by lubelskie and podlaskie. In these voivodeships about 77-79% of the agricultural employment does not enhance social cohesion. It is connected with over-employment in the agricultural sector, hiding the real unemployment and thus inducing low incomes that do not protect from poverty. Generally, agricultural character of the regions is associated with their comparably low level of socio-economic development.

As the social efficiency of employment in the three sectors appears to differ, it is suitable to specify some desirable directions of structural changes that would be favourable in terms of social gains. Table 2 presents indicators of substitution of employment in the three sectors in pairs as well as an aggregate indicator of substitution of inputs (z).

Table 2. Indicators of substitution of inputs enhancing social efficiency of employment in the Polish regions in 2015

	voivodeship	agr(ind)	agr(ser)	ind(ser)	ind(agr)	ser(agr)	ser(ind)	z
1	łódzkie	0,62	0,56	0,91	1,61	1,77	1,10	1,46
2	mazowieckie	1	1	1	1	1	1	
3	małopolskie	0,67	0,60	0,89	1,49	1,66	1,12	1,40
4	śląskie	1	1	1	1	1	1	
5	lubelskie	0,26	0,30	1,16	3,81	3,29	0,86	2,44
6	podkarpackie	0,49	0,41	0,84	2,04	2,42	1,18	2,46
7	podlaskie	0,26	0,26	1,01	3,86	3,81	0,99	2,46
8	świętokrzyskie	0,31	0,26	0,84	3,20	3,79	1,18	2,43
9	lubuskie	1,38	1,13	0,81	0,72	0,89	1,23	1,24
10	wielkopolskie	1	1	1	1	1	1	
11	zachodniopomorskie	1	1	1	1	1	1	
12	dolnośląskie	1	1	1	1	1	1	
13	opolskie	0,88	0,64	0,73	1,14	1,56	1,37	1,35
14	kujawsko-pomorskie	0,55	0,48	0,87	1,82	2,09	1,15	1,64
15	pomorskie	1,23	1,11	0,90	0,81	0,90	1,10	1,15
16	warmińsko-mazurskie	0,56	0,51	0,91	1,79	1,97	1,10	1,57
	Poland*	0,77	0,72	0,93	1,30	1,39	1,07	1,25

*indicators of substitution of inputs calculated basing on the average efficiency scores for the 16 regions
Source: own calculations based on statistics from the Central Statistical Office of Poland available in STRATEG (GUS, http, 03.12.2016) and Local Data Bank (GUS, http, 02.12.2016) databases.

The general pattern of structural change in the Polish regions that could enhance social cohesion may be described by the three sectoral theories' conclusions for the developed countries. The shift from agriculture into service sector is mainly needed, followed by the movement from agriculture into industry. The decrease in industrial employment in favour of the service sector is also necessary, however, the substitution does not have to cover such numerous group of employees. Generally, about 25% of employment should be substituted to improve social results.

The most important structural changes are required in podlaskie, podkarpackie, lubelskie and świętokrzyskie voivodeships, which are also the poorest ones. The shifts are evaluated at a level of nearly 150% of the current employment. In all these 4 regions the labour force should move from agriculture into both industry and services. However, while in podkarpackie and świętokrzyskie there is a need of limiting employment in industry in favour of services, lubelskie and podlaskie require to be industrialised even to the detriment of services. Nevertheless, the deagrarian trend seems to be the most important revealing an early level of structural development of these poor regions.

Conclusions

The conducted research allows to conclude that results of the modernisation of three sectoral structure of employment in the Polish regions are favourable for social cohesion. The best social results are gained when employing people in the service sector, while an employment in the agriculture appears to be the least efficient.

Moreover, it is possible to conclude that the most affluent regions are simultaneously the most cohesive ones. Thus, the same measures might be used to strengthen social cohesion and to increase a level of GDP per capita. Deindustrialisation and deagrarisation seem to constitute trends favourable for the regional development. Nevertheless, the comparisons suggest that a high share of service employment is not enough to balance social losses connected with an agrarian over-employment. Hence, a developmental path in Polish regions should follow a pattern described in the three sectoral theories with a phase of industrialisation.

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Safety climate and its impact to the productivity of Polish construction enterprises

JEL Classification: *J11; J24; L74: I18*

Keywords: *safety climate; occupational health; civil engineering; productivity*

Abstract

Research background: Problems Safety Climate manifesting on occupational health and safety decreasing are commonly occurred in the construction industry. Important factor in the occupational safety in construction industry is scaffold use. All scaffolds used in construction, renovation, and demolition shall be erected, dismantled and maintained in accordance with safety procedure. However Key of dealing with scaffolds safety and risk assessment in construction industry is important, thus, way on doing assessment and liability of assessment seems to be crucial for professionals. However, it is found that those professionals prone to heavily rely on their own experiences and knowledge on decision making on risk assessment, which lack of a systematic approach and lack of ways to check the reliability of the decisions.
Purpose of the article: Purpose of the paper was to indicate crucial parameters that could be modeling with RAM use for improving both building enterprise productivity and/or developing potential and Safety Climate. The developed RAM could be benefit for predicting high-risk construction activities and thus preventing accidents occurred based on a set of historical accident data.
Methodology/methods: A Risk Assessment Model (RAM) has been developed for assessing risk levels as various construction process stages with various work trades impacting different spheres of enterprise activity. The RAM is the result of

research project realized at the above 60 construction sites, both in Poland and Portugal where 450 observations have been completed including also harmful physical and chemical factors, stress level, also worker habits, as well as a hundreds ex-post reconstruction of construction accidents scenarios. genetic modeling tool has been use for develop the RAM.
Findings: Common types of trades, accidents, and accident causes have been explored, in addition to suitable risk assessment methods and criteria. We have found the initial worker stress level is more direct predictor for developing of the unsafe chain leading to the accident than the work load, and concentration of harmful factors at the workplace or even training frequency and management involvement.

Introduction

Occupational safety is a critical issue in all areas of industrial and construction activity. According the US Bureau of Labor Statistics report in 2011, an estimated 39 million workers had a nonfatal occupational injury or illness in the US (Bureau of Labor Statistics, 2016). Compensation cost to employers due to injured workers was $73.9 billion in 2009 (Chetty & Finkelstein, 2013). In 2006, OSHA reported that lost productivity from workplace injuries and illness had cost companies $60 billion. Manufacturing accounted for nearly 20% of all musculoskeletal injuries (Bureau of Labor Statistics, 2016). The costs of occupational accidents and work-related injuries and illness are substantial. In the EU-27 in 2007, 5,580 accidents at the workplace resulted in death and 2.9 % of the workforce had an accident at work that resulted in more than three days of absence. Additionally, approximately 23 million people had a health problem caused or made worse by work across a 12-month period (Eurostat, 2010)(Eurostat, 2014). In 2013 the standardized rate of fatal injury in UK was 0.51 per 100,000 employees, while in other large economies such as France (2.94 per 100,000 employees), Germany (0.81 per 100,000 employees), Italy (1.24 per 100,000 employees) and Spain (1.55 per 100,000 employees) (Salguero-Caparros et al., 2015). In 2013, 1.4% of UK workers reported an injury occurring at work that resulted in sick leave in Spain (1.8%), Italy (1.8%) and France (3.1%). The same period in Poland (0.7%) (Eurostat, 2015). The same year 1.9% of workers reported taking time off work due to one or more work-related health problems UK and Italy in Spain (2.8%), France (5.4%) and Poland (7.7%) (Eurostat, 2015).

A healthy and safe work environment not only is desirable from the perspective of workers, but also contributes considerably to labor productivity and, as a consequence, promotes economic growth. OSH increases the competitiveness and productivity of enterprises by reducing costs resulting from occupational accidents, incidents and diseases and by enhancing worker motivation. Moreover, a decrease in accidents and illness relieves pressure on public and private social protection and insurance systems. Risks to health and safety at the workplace abound worldwide. The International Labor Organization (ILO) estimates that 2.34 million people died from work-related injury or illness in 2008: 2.08 million from illness and 321,000 from accidents. Additionally, it is estimated that there were 317 million non-fatal accidents leading to an absence of four or more days, mostly in South-East Asia and Western Pacific countries (Tomei & Belser, 2011). An estimated 160 million people suffer from work-related diseases (ILO, 2003). Some incidents, such as industrial accidents, can cause major environmental damage that affect people beyond the workplace. These risks are not restricted to developing countries. In the EU-27 in 2007, 5,580 accidents at the workplace resulted in death and 2.9 % of the workforce had an accident at work that resulted in more than three days of absence from work. Approximately 23 million people had a health problem caused or made worse by work in a 12-month period (Salguero-Caparros et al., 2015). The likelihood of being affected by workplace accidents varies considerably when accounting for gender and location as well as industry. Across a selection of European countries, incidence rates of fatal accidents per 100,000 workers ranged from over five in Poland to less than one in Germany, Denmark, the Netherlands, the United Kingdom and Slovakia, although some figures may be subject to underreporting, as discussed later (Brookes et al., 2013). In terms of industries, within the EU-27 in 2009, the construction, manufacturing, transportation and storage, and agriculture, forestry and fishing sectors accounted for more than two-thirds of all fatal accidents at work. The construction sector alone accounted for 26.1 % of all fatal work accidents (Salguero-Caparros et al., 2015). In addition to accidents, exposure to hazardous substances at work is believed to contribute significantly to mortality through carcinogenic and respiratory diseases. For example, exposure to occupational carcinogens alone is estimated to result in a global disease burden of 152,000 deaths and nearly 1.6 million disability-adjusted life years (Driscoll et al., 2005). In addition, prevalence rates among European workers indicate that in 2007 a total of 23 million workers or 8.6 % of the workforce (aged between 15 and 64 years) suffered from work-related health problems. The health problems most often reported in 2007 were MSDS (musculoskeletal disorders), stress, depression and anxiety (Eurostat, 2010). These injuries and deaths not only cause human suffering for workers and their families but also result in significant economic costs to individuals, businesses, government and society. Potential negative effects include costly early retirements, loss of skilled staff, absenteeism, as well as presenteeism (when employees go to work despite illness, increasing the likelihood of errors occurring), and high medical costs and insurance premiums. Organization for Economic Co-operation and Development (OECD) countries already spend 2.4 % of gross domestic product (GDP) on incapacity-related benefits (OECD, 2006). At the same time, the ILO estimates that many of these tragedies are preventable through the implementation of sound prevention, reporting and inspection practices. The ILO puts the loss of global GDP due to occupational diseases and accidents at 4 % (International Labour Organization (ILO), 2003).

Method of the research

Taking into consideration the frequency of accidents and high occupational risk in the construction industry with scaffold use, it is important to take the necessary steps to reduce this exposure. In these conditions the research project Scaffold Use Risk Assessment Model for Construction Process Safety (SURAM) - *PBS3/A2/19/2015* – financed by National Centre for Research and Development (NCBiR) have been developed in Poland from early 2016. The SURAM project's objective is to develop a model for assessing the risk of construction disasters, accidents and hazardous events at workstations using building scaffolding, especially during construction work. For project effects to be easily accessible and more useful to users, research results and a risk assessment model will be developed in the form of a computer program containing a database and the ability to determine the risk of work on the scaffold or its surroundings. In the empirical layer, the project takes into account the research that will enable the probability of occurrence of unwanted events arising from work on the scaffolding or its surroundings, which could result in a threat to human life or health or substantial material loss. The research problem is complex because there are many causes and factors and interactions between factors that may lead to the occurrence and development of a hazardous situation and then the occurrence of a building accident or disaster at the workstation on the scaffolding and their assembly. A terse view of the cause of a dangerous situation, and then its development only in violation of security procedures, cannot withstand criticism in the light of available literature. Causes and groups of factors are in multilayered, interrelated and dynamically changing causal sequences, which should be identified and the likelihood of an accident situation evolving. This applies equally to a potentially accidental situation. The project focus on the evaluation the likelihood of adverse events leading to the development of potential accidents, accidents and construction disasters as a result of synergies between causes and factors. A multidimensional matrix of technical, social, organizational, external and internal factors will be built, which, by means of multivariate analysis, will create a hierarchy of causal relationships between various factors. The end result will be the identification of groups of risk factors and their description, among others. The factors affecting adverse events have been divided into the following groups:

- Technical condition of the scaffolding (tested by static-strength calculations),
- The level of taking into account the requirements of ergonomics, safety engineering and safety regulations in shaping scaffolds,
- Level of consideration of employee work load, ergonomics requirements, safety engineering, safety procedures and regulations during assembly, use and dismantling of scaffolds,
- The psychophysical condition of scaffolding and workforce users working in the scaffold environment, including stress, physiological parameters and staff experience,
- Influence of external factors such as noise, mechanical vibration from the ground or building, lighting, dustiness, climatic conditions,
- Influence of selected socio-economic factors, e.g.: number of investments connected with the inflow of EU funds, economic situation of the region, State Labor Inspection (PIP) inspections,
- Other, e.g. company type, scaffolding assembler experience, etc.

The research is carried out within a consortium consisting of the following units: Lublin University of Technology, Lodz University of Technology, Wroclaw University of Technology. At least 120 construction sites with scaffold use in Poland and 20 in Portugal (as the control group) will be examined during the research project period. Subsequently, a random sampling procedure was conducted to select individual workers at each construction site; 234 individual workers of those sites potentially exposed to occupational hazards were selected in the first year of the project. For the purpose of the SURAM 800 individuals should be interviewed. An original questionnaire for risk perception and safety climate assessment at the construction site has been developed. Instrumental methods are also involved to assess harmful and cumbersome work conditions (sound, vibration, microclimate), workload of employees during the work shift (heart rate changes, skin temperature changes), concentration on the work and stress levels (mobile eye-tracking, biochemical parameters control). Analysis of the accident documentation during past 10 years will be used to assume the dynamic of risky situation development and accident rate regarding the socio-economic conditions in different part of Poland. In Poland, we have three sources of information on life-threatening situations at construction sites: State Labor Inspection (PIP) reports on building safety inspections, (Construction Safety Board) GUNB reports on construction disasters and (Central Statistical Office) GUS reports about accidents, including falls from the heights, which are almost 100% fall from scaffolding. The most information about work on scaffolding can be found in PIP reports. PIP reports contain a percentage of the percentage of violations of safety regulations at construction sites where scaffolds are used. Unfortunately, the PIP reports contain only infringement information and there is no information on the extent to which this state of affairs is affected. For obvious reasons related to the specificity of the functioning of the PIP, if an accident is found in the accident investigation, the indirect causes and the distribution of factors leading to the development of the accident situation are to a low degree. The GUNB and GUS reports, on the other hand, are already showing the results, but unfortunately also without analyzing or even explaining the causes of unwanted events.

Costs of the accidents

Accidents at work cost both businesses, victims and their families and the whole of society. For businesses, accidents at work can have an impact on the increase in social insurance contributions and also cause increased absenteeism resulting in the need for replacements or overtime, lower productivity and quality of work and, in addition, material losses, And adversely affect the company's image. The costs of accidents at work are also borne by the victims and their families because the cash and material benefits they receive from their employers, ZUS or the NFZ, the victims or their family members do not cover all losses caused by accidents at work. Much of the cost of accidents, especially of more serious consequences, is incurred by the Social Insurance Institution (ZUS) in the form of benefits paid to victims and their families and by the National Health Fund (NFZ), which funds the costs of treating accidents at work and who have been diagnosed with occupational disease. The method developed at Central Institute for Labor Protection (CIOP-PIB) assumes that the social cost of an accident at work constituting the sum of the costs incurred by businesses, victims and their families and costs transferred to society is calculated according to formula (1):

$$K_{SO} = K_{ZO} + K_{PO} + K_{PSO} \tag{1}$$

where:
K_{SO} - social cost of total accident at work
K_{ZO} - the total cost borne by the company
K_{PO} - total cost incurred by the victim and his family
K_{PSO} - total cost transferred to society

Components of the cost of accidents at work on the company. Calculate the general cost of an accident in an enterprise should be in accordance with formula (2):

$$K_{ZO} = (K_{CS} + K_{PMiT} + K_N + K_Z + K_{ZP} + K_{SM} + K_{NP} + K_{OW} + K_I) - O \tag{2}$$

where:
K_{ZO} - the total cost borne by the company
K_{CS} - cost of lost time
K_{PMiT} - the cost of medical care and transportation
K_N - cost of overtime
K_Z - the cost of replacements
K_{ZP} - cost of production interruptions
K_{SM} - cost of material loss
K_{NP} - cost of repairs
K_{OW} - cost of compensation financed with own resources
K_I - other costs
O - compensation received from insurance institutions.

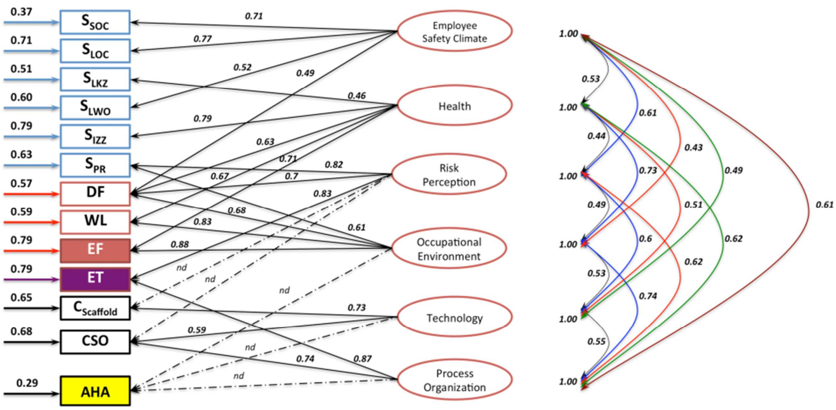
The formula (2) shows that the cost of an accident incurred by an enterprise is the difference between the sum of the components of the accident costs and the compensation received from the insurers.

Results

After first year of the research project we would be able to develop a Beta version of SURAM Model presented on Figure 1. Figure 1 presents the results of the SURAM structural analysis. To make it clearer, it shows only the values of the structural equation, but not the measuring models. Except the questionnaire scales the SURAM have been developed including worker psycho-physiological parameters monitoring before the shift as well as the part of the shift after a break corresponding to the workload during the shift (WL). The wide range of demographic factors (DF) collected both at the construction site as well as from local statistical offices have also been used for model construction. Environmental parameters at the construction site have been monitored on 2 up to 3 levels of the scaffold (depending of its size) during at least five days working week including sound level, illumination, microclimate (EF). Then the diversity from the standard levels has been evaluated as the measure for the matrix construction. To evaluate worker visual concentration on the critical areas or elements of working zone the mobile eye-tracking equipment have been used (ET). Stability and quality of scaffold set-up and maintenance have been evaluated ($C_{Scaffold}$) as well as construction site organization level (CSO). The complementary element of SURAM especially for model teaching period was Historical Accident Analysis module (AHA). As the model presented at the Figure 1 is a beta one prepared after first year of the projects some of the relations could not be calculated precisely – *nd* values. Therefore even in those partial data it shows potential for use in improving safety at the construction sites with scaffold use. In accordance with the suggestions and indications given by Amiri (Amiri, Ardeshir, Fazel Zarandi, & Soltanaghaei, 2016) and Pinto (Pinto, 2014) the goodness of fit (GF) model had to be considered first. Within a GF model, it is required to consider three indicators: the measure of absolute fit, the measure of increased fit and the measure of decreased fit. In our model, this indicator has the value of 0.9 which, according to the above-mentioned academics, is an indicator of good correspondence.

At this stage of the research project development we have found the initial worker stress level (monitored by the bio-physical parameters at the beginning of shift and after the break + ET) is more direct predictor for developing of the unsafe chain leading to the accident than the work load (WL), and concentration of harmful factors (EF) at the workplace (López Arquillos, Rubio Romero, & Gibb, 2012).

Figure 1. Structural model of SURAM



S_{SOC} (life coherence and social associations), S_{LOC} (sense of control), S_{LKZ} (health state), S_{LWO} (value hierarchy), S_{IZZ} (occupational praxis and psychical attitude), S_{PR} (risk perception), DF(demographic factors), WL(work load),EF(environmental factors), ET(eye tracking),$C_{scaffold}$ (scaffold construction), CSO (construction site organization), AHA(historical accidents analysis).

Source: own calculations.

Conclusions

The result of the project will be a significant increase in the safety of people in scaffolding construction, achieved through the use of incident patterns and the development of adverse events (constructed on a causal basis), taking into account the importance of each cause for the development of the hazardous situation and gravity of the consequences of construction disasters and accidents involving scaffolding. Statistical methods will be used to construct and validate the model. The database will include an extensive range of information that will be explored using a dedicated user interface that will help one find the possible causes of an accident on the one hand, and evaluate the risk of scaffolding on the other. It is also planned that the software will have a function to assist in completing accidental records. Implementing of the results of the Research Project should be fruitful in cutting the costs caused by accidents.

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Repeat sales index for residential real estate in Krakow

JEL Classification: *C18,C43, R31*

Keywords: *repeat sales index, Poland, housing market, house price, real estate*

Abstract

Research background: There are several methods to construct a price index for infrequently traded real estate assets (mainly residential, but also office and land). The main concern to construct a valid and unbiased price index is to address the problem of heterogeneity of real estate, or put differently to control for both observable and unobservable quality attributes. Most frequently used is probably hedonic regression methodology (classic, but recently also spatial and quantile regression). An alternative approach to control for unobservable differences in assets' quality is provided by repeat sales methodology, where price changes are tracked based on differences in prices of given asset sold twice (or multiple times) within the study period. The later approach is applied in famous S&P CoreLogic Case-Shiller house price indices.
Purpose of the article: The goal of the paper is to assess the applicability of repeat sales methodology for a major housing market in Poland. Previous studies used hedonic methodology or mix adjustment techniques and applied for major metropolitan areas. Most known example is a set of quarterly house price indices constructed by NBP – especially for primary and secondary market. The repeat sales methodology has not been adopted with significant success to date – mainly be-

cause of concern regarding relative infrequency of transactions on housing market in most metropolitan areas (thus potentially small sample of repeated sales)..
Methodology/methods: The study uses data on repeat sales of residential transactions in Krakow from 2003 to 2015. We apply different specifications of repeat sales index construction and compare respective values to hedonic price index for Krakow estimated by NBP.
Findings: Findings suggest that repeat sales house sales indices can be used to track price dynamics for major metropolitan areas in Poland. The study suggests problems that need to be addresses in order to get unbiased results – mainly data collection mechanism and estimation procedure.

Introduction

In order to construct a valid and unbiased real estate price index is to address the problem of heterogeneity. In other words, the key issue is to control for both observable (measurable) and unobservable attributes (location, neighbourhood, structural and environmental). While difficult to build, real estate indices are extremely useful to investigate log-run economic processes. Among remarkable examples are Shiller's (2014, pp. 1486–1517, 2015) analysis of economic turbulences in US (1890-2014), Nicholas and Szczerbina's (2013, pp. 278–309) investigation into house price movement in 1920s and 1930s, not to mention historic studies of house prices in a long run in Netherlands(1628-1973) conducted by Eichholtz (1997, pp. 175–192), as well as China (1644-1840) conducted by Raff, Wachter, and Yan (2013, pp. 368–386). Two former studies have one thing in common – in both cases repeat sales methodology was used.

Repeat sales method of index construction is a way to account for unobservable differences in a given asset's quality by investigating price changes between sales. The method was introduced by (Bailey, Muth, & Nourse, 1963). The data requirements include the sample of real estate sold twice (or multiple times) within the study period. The modified repeat sales approach, based on a seminal paper by Case and Shiller (1987), has been applied in renowned S&P CoreLogic Case-Shiller house price indices. Although praised for theoretical soundness, the method has some limitations, one of them being the need for relatively active real estate market (thus large sample of repeat sales). It is by no means easy to suffice this particular data requirement on thin real estate markets. As the result, repeat sales methodology is rarely used as a method for applied index construction. To date, repeat sales house price index methodology has not been applied in Poland. The paper aims to address this gap, by analysing properties of residential repeat sales index in Krakow.

Literature review

There is by no means a consensus regarding the methodology of real estate price construction. Nevertheless, in most cases two competing approaches, to deal with observed and unobserved heterogeneity of real estate have been used in the literature – i.e. hedonic and repeat sales methods. The difference between both methods has for long drawn attention of economist studying real estate price movements, mostly because in many cases they tend to produce incomparable insights into market volatility (Dorsey, Hu, Mayer, & Wang, 2010, pp. 87–105). Nevertheless, in most cases results remained inconclusive regarding the choice of appropriate house price index methodology (B. Case, Pollakowski, & Wachter, 1991).

The extensive summary of repeat sales methods of property price index construction provides a list of advantages and disadvantages of the technique (Prud'homme & Diewert, 2011, pp. 1–10). The list of former contains: limited data requirements, relative calculation ease, ease of reproduction, control for salient real estate characteristics (Prud'homme & Diewert, 2011, pp. 1–10), while latter can be contributed to: lack of depreciation correction, sample selection bias, data inefficiency, continuous revision problem (Prud'homme & Diewert, 2011, pp. 1–10).

The shift from classic house price indices towards a hybrid approach (Jones, 2010, pp. 95–97; Nagaraja, Brown, & Wachter, 2014, pp. 23–46), has been followed by other innovative solutions to the old problem of measuring the house prices dynamics.

Bourassa, Hoesli, and Sun (2006, pp. 80–97) tested sale price appraisal ratio (SPAR) method in New Zeland, and compared it to both hedonic and repeat-sales indices based on the same data. In the SPAR the ratio between transaction price and previously assessed property values is calculated. The SPAR house price index was also constructed using Dutch data (de Vries, de Haan, van der Wal, & Mariën, 2009, pp. 214–223). Others has addressed depreciation problem, and suggested techniques to disentangle pure time effect from property depreciation (Cannaday, Munneke, & Yang, 2005, pp. 320–342; Englund, Quigley, & Redfearn, 1998, pp. 175–192). In yet another article Francke (2010, pp. 24–52) analyzed the methods to estimate repeat sales index for a thin market

Recently scholars has begun advocating for more robust method of index estimation, especially in presence of outliers. Zhang and Yi used quantile regression approach to construct repeat sales index in Beijing (Zhang & Yi, 2017, pp. 85–96), and Gwangju, Korea (Yeon, 2016, pp. 260–267), while the others experimented with pseudo-repeat sales techniques based on matched data (Guo, Zheng, Geltner, & Liu, 2014, pp. 20–38).

Both hedonic and repeat sales indices are difficult to build, and update on regular bases. Institutional background of constructing real estate price index was described based on French experiences (Gouriéroux & Laferrère, 2009, pp. 206–213).

Real estate price index construction has been discussed in Polish economic literature. The selection of articles discussing various methodological issues include Foryś (2012, pp. 41–52), Kokot (2014, pp. 14–27, 2015, pp. 84–100), and Trojanek (2010, pp. 119–132, 2013, pp. 224–231). The most discussed and well-known house price index in Poland is published by National Bank of Poland. It has three major variants: (1) average, (2) median based as well as (3) hedonic index. The latter was discussed in Widlak and Tomczyk (2010, pp. 203–227). Recent developments on hedonic index construction, involving the regression splines and spatial methods to addresses spatial autocorrelation and smoothing issues was suggested recently (Widłak, Waszczuk, & Olszewski, 2015). To authors' best knowledge repeat-sales approach has not been applied on housing data in Poland, although an interesting adoption of the method to the art market was proposed by Kempa and Witkowska (2011, pp. 181–186).

Method of the research

Data sources and management

Although there are multiple sources of information used to construct real estate price indexes - for example asking prices, sale prices, valuations (Pollakowski, 1995), for obvious reasons the choice is limited in case of repeat-sales index. The most valid and reliable source of information, although not always efficient in terms of information provided, are notary acts.

Our empirical data comes from database managed by Institute of Real Estate Market Institute mrn.pl, which is a professional organization of property valuers (Polish chartered surveyors), property market consultants and market experts. Based on address and land register we matched all transactions involving the same properties, and identified repeat sales from 4 quarter 2002 to 3 quarter 2015. As the research is focused on secondary market, we dropped all sales from the primary market (sold by developers) from the sample. As the result, we identified 2584 properties sold 2 times, 246 properties sold 3 times, 23 properties sold 4 times and 1 property sold five times during the study period. We decided to recode the data and match all transactions sold multiple times in pairs (first-second transaction).

For example, information on 246 properties sold 3 times allowed us to create 492 repeat sales pairs. We used three-step sampling procedure.

Firstly, we eliminated all observations where the time difference between sales was less than 180 days, to eliminate abnormal transactions (Englund et al., 1998, p. 195).

In the second stage, we checked whether apartments did not change significantly between sales. All pairs, where properties undergone significant improvements were dropped from the sample.

Thirdly, we eliminated all properties with abnormal values or with additional clauses that significantly affect price (distressed properties, municipal sales, sale between relatives).

After data cleaning procedure we got our final sample (effective) of 2704 repeat sales. The comparison of basic descriptive statistics between sales and repeat sales samples reveals interesting differences. On average, the apartments in both repeat sales subsamples were smaller (average floor area of 46.6 or 47.1 sqm of usable space compared to 55.5 in the whole sample) and central locations were overrepresented.

Estimation procedure

During data management phase we have prepared a dataset on residential properties n sold more than once over the study period t=0,…T. Within each pair we compare price at first sale p_n^s to the price at resale p_n^t. Due to data limitation (sample size) we decided to construct a quarterly residential properties price index. Repeat sales regression is based on a following specification (Balk, De Haan, & Diewert, 2011, p. 66):

$$\ln\left(\frac{p_n^t}{p_n^s}\right) = \sum_{t=0}^{T} \gamma^t D_n^t + \mu_n^t$$

where D_n^t is a time dummy variable (it takes value -1 in time period of the first sale, 1 in time period of the second sale, and 0 otherwise), wheras μ_n^t is an error term.

Repeat sales index can be calculated based on regression coefficients (Balk et al., 2011, p. 67):

$$I^{0t} = \exp\left(\hat{\gamma}^{t}\right) \cdot 100$$

The model is subject to heteroskedasticity, thus several methods, alternative to standard OLS, were suggested to overcome this problem. Following guidelines from the literature we estimated three repeat sales indices, based on: (1) OLS, (2) WLS three-step procedure introduced by Case and Shiller (1987, pp. 45–56) and quantile estimation suggested by McMillen and Thorens (2006, pp. 567–584).

Results and discussion

We investigated the price dynamics in Krakow using repeat sales dataset. Based on estimation procedures described in previous section we calculated three alternative repeat sales indices (RSIs) for residential properties in Krakow: baseline RSI_OLS, weighted RSI_WLS and quintile (median) RSI_QL. Than we compared the results with the values of two benchmark indices – hedonic house price index for secondary market in Krakow calculated by (HPI), and simple weighted average residential price index based on full sample of mrn.pl data (WAI). Weigting was location based. Average prices were calculated based on transaction subsamples in 4 major districts in Krakow (Nowa Huta, Podgorze, Krowodrza and Srodmiescie). Weighting was based on transaction volume in the first period (4 quarter 2002). The comparison period ranged from 4Q 2002 to 3Q 2007. In case of HPI the first index values come from 3Q 2006, which was set as a base period (I=100) for all indices.

The results were presented in the Figure 1. They imply substantial differences between indices. Both RSI_OLS and RSI_WLS were in line with simple weighted average residential price index WAI. On the other hand, all three indices differed significantly from hedonic price index (HPI) calculated by NBP. The main difference can be attributed to higher price appreciation during housing boom period, and less apparent price decrease since the market peak in 2 or 3 quarter 2007. A quantile (median) repeat sales index (RSI_QL) yielded different results, and suggested more rapid price decrease from the market peak in 3Q 2007.

Figure 1. Comparison of residential real estate indices in Krakow (2002-2015)

Source: own calculations.

Conclusions

In the paper explored properties of repeat sales index for residential properties in Krakow. Based on a sample of 2704 repeat sales drawn from a larger transaction database, we estimated three repeated sales house price indices. The results were later compared to renown National Bank of Poland hedonic house price index for secondary housing market in Krakow and simple weighted average index based on a mrn.pl transaction database.

The results imply significant differences between repeat sales indices and NBP hedonic index – especially regarding market cycle. Repeat sales indices suggest that housing market peaked about 1 quarters later (in 3 quarter 2007). The results should be treated with caution. Although mrn.pl database in more detailed and significantly larger, the sample alone does not explain the differences found.

One concern regarding repeat sales index in Krakow is a sample selection problem. We found that properties sold twice or multiple times differed significantly from full sample of housing transactions, both in terms of size and location. On average they were smaller, and central locations were overrepresented.

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Foreign direct investment and export growth: empirical evidence from Macedonian economy

JEL Classification: *F14; F21; F23*

Keywords: *FDI; automotive industry; export; competitiveness*

Abstract

Research background: Foreign direct investment is perceived as a valuable tool for economic growth. The growth could be realized less and more as a set of benefits depending on the FDIs features. In the period from 2009 to 2014 it is noticed a remarkable increase in the share of FDIs inflow in automotive sector in Macedonian economy, from 2.8% to 11.2%. Thus, the issue of FDIs inflow in automotive sector is a strong reason and an incentive to be examined from different aspects of influence on the economic growth.
Purpose of the article: The aim of the paper is to analyze the influence of the increased FDIs inflow in automotive industry as a reason behind the remarkable export growth. The research interest of the study is to recognize the importance of the FDIs inflow structure as a determinant of the export structure.
Methodology/methods: Within the paper it is developed a model that identifies the FDIs as a factor of growth of the export performances. A regression analysis is used to examine the correlation between the FDIs inflow and export. Since the correlation doesn't explain the causality, within the paper the Granger causality test is applied to examine causality between the FDIs inflow and increased export.
Findings: The results suggest that FDIs create a good base for qualitative shift in the export structure of Macedonian economy. The paper associates growth of sectoral export with the growth of FDIs in that sector. Due to the increased FDI inflow in automotive industry this sector significantly has increased its share in total Macedonian export. The paper indicates that FDIs can be considered as a way of en-

gagement in the global supplying chains which additionally influences positively to the competitiveness and export potentials of the host suppliers.

Introduction

FDIs are potentially seen as a source of important productivity externalities for the host economies. FDIs can create or enhance opportunities for value creation by their decisions to invest in particular location (Pavlinek & Zizalova, 2014, pp. 1-33). The directions and benefits of the FDIs to the host economy depend largely on the structure, local policies as well the level of development.

The paper is directed to make visible the process of relationship between the qualitative shift of FDI inflow and its influence to the quality of the export structure in Macedonian economy. Most of the FDI inflow, since 2010, has been green field investments and they have been concentrated in the export-oriented manufacturing sector against to the period before, when the market and resource oriented FDIs in financial, transport, mining and textile sectors had dominant share. The challenge for this analysis is twofold.

First, Macedonian economy as a small former transition economy experienced insufficiently amount and poor quality of FDIs inflow during the whole transition period. Although the FDI based development strategy was declared and determined as a main strategy for economy growth and restructuring, the data for FDI inflow reveals unsatisfactory results. It was expected FDI to be a tool for economic restructuring, as was the experience of the most of the former transition economies. According to Bandelj (2010, pp.481) the FDIs for the transition economies from CEE has become one of the basic criteria of successful economic transformation. Economic development requires the transformation of a country’s economic structure that involves diversifying into new sectors (Henn et al., 2015, pp.6).

Due to the limitations connected to the national and regional business and political environment as well the constraint caused by the nature of FDIs inflow, Macedonian economy had not experienced FDI based development. The increasing trend in FDIs inflow, since 2010, in automotive sector as a more capital intensive investment, should be seen as a good challenge to examine the influence to the local economy.

Second, the importance of the analysis is determined by the tendencies in the export structure and its sensitivity on FDIs inflow structure. Exactly, through compiling the export growth model the paper tries to identify whether the improvement in the quantity and quality of FDI inflow has boosted the export performances and in which direction.

The academic significance contribution to the topic lies in the revealing the effect how a structure of FDI inflow can determine and cause significant shift in the export structure in the case of an open small economy and how the engagement in the global supplying chain can be used as an export platform.

Literature review

Many empirical studies have tried to assess and examine the relationship between the FDIs and export growth. They investigate the role of FDIs to the export performance in developed as well developing economies. The results can vary according to the nature, motivation and geographical aspects of FDI. Radulesku & Serbanescu (2012, pp. 26) have examined the effects of FDIs on the host economy and emphasize the export dependency on the type of investment.

Majority of the studies report that FDIs can be considered to be as a significant “engine of export”. FDI inflows may be export-promoting in two ways: directly, through export of the multinational’s subsidiaries, or indirectly, by engaging the host firms in the supplying linkages and improved access to world markets. Analyzing the effects of FDI inflows to the export performance of 14 transition economies in Central and Eastern Europe (CEE), Kutan & Vuksic (2007, pp.430-445) show that FDI has improved the export performance of the host economies by increasing their supply capacities. Greenaway et al. (2001) stress the export advantages of FDIs and their influence to export performance of local companies. Many researches examine the causal relationship between inward FDIs and the manufacturing export performance. Some of them indicate a two way causality (Liu et al., 2001, pp.190-202; Zhang & Felmingham, 2001, pp.82-99; Ekanayake et al., 2003, pp.59-72; Baliamoune-Lutz, 2004, pp.49-56), and the others (Dritsaki et al., 2004, pp. 230-235; Zhang, 2006, pp.50-55; Khan & Leng, 1997, pp.40-60), reveal unidirectional causal relationship between FDI and export with a direction from foreign direct investment to export and reversely causal relationship.

Remarkable upgrading of export performance, extremely high growth of export and considerable changes in the export structure to goods with higher value added are result of FDI inflow in CEE countries. Due to the increased FDI inflow in automotive industry this sector becomes a dominant across CEE, significantly increasing its share in total export and production

(Pavlinek, 2015, pp.209-255). The direction of the FDI flows is of key importance for the export restructuring and growth of an economy (Damijan et al., 2013, pp. 8).

Particular emphasis on FDI is placed on the contribution of FDIs to increasing productivity and competitiveness of the host industry. The FDIs inflows may raise the productivity of the host companies forcing them to exit or by increasing their share in the market of intermediaries. Damijan et al., (2011, pp. 486-509) point the dynamic aspects of FDI in CEE countries by fostering the processes of manufacture restructuring and potentials for future export growth directly through the export performance of FDI's subsidiaries and indirectly through the knowledge spillover to local suppliers engaged in backward linkages restructuring. Jindra et al. (2009, pp. 167-179) consider FDIs as a major force in the economic development of CEE countries. Damijan et al. (2013, pp. 1-36) examining the determinants of the transition economies' export performance stress the importance of the "global supplying chains" and the "supply capacity". Using industry-level analysis they reveal that FDI has significantly contributed to export restructuring in the CEE countries. As one result of FDI in CEE countries according to Lipsey (2006, pp. 9) is a shift in the export comparative advantages of these countries toward the machinery and transport equipment sector. Global supplying chains and the trade between "headquarter" and "factory" economies are suggested by Baldwin (2012, pp. 15) as a way of increasing competitive advantages of emerging economies.

The quality and structure of FDI influence the quality and structure of the host economy export. Some analysis claiming the size and composition of FDI as a crucial factor in shaping productivity and strengthening the competitiveness of an economy (Christodoulakis & Sarantides, 2011, pp. 1-42). The UNCTAD's (2005, pp. 61) analysis reveal a positive and significant relationship between export performance and FDI, stressing the strong contribution of FDI to the technological upgrading and structural evolution of the export sector

Since the structure of automotive industry is consisted of several tiers that represent the value added chain, FDIs in automotive industry actually open a possibility of engagement of the host economy in the value creation process. According to Baldwin (2011b, pp.1-32) joining international supply chains is faster and surer route to global markets as a new strategy for 'emerging market economies'. UNCTAD (2012, pp.88) analyzing the influence of FDI to the transitional economies emphasizes that FDI as a bundle of assets including access to advanced technology and management techniques, allow developing countries to leapfrog into more sophisticated areas of production.

Methodology of research

The analysis of the influence of FDI inflow to Macedonian export are conducted in two steps. The first step is concerning to creation of a regression model for correlation and it is followed by a causality test analysis. The proposed regression model is based on the predecessor models that examine the influence of FDI to export in two empirical cases. The first is the research of Damijan, Kostevc and Rojec (2013, pp.1-34) and the model through which they test the impact of FDI inflow on export within the Global supplying chains (GSC) in CEE. The second reference model is result of the empirical examination by Zhang (2006, pp.7) in China case, where the FDI is treated as a factor of export performance.

To examine the existence and rate of correlation between the increased FDI inflow in automotive sector and export performances of Macedonian economy the following model is quoted:

$$Exp_t = \beta_0 + \beta_1 FDIauto_{t-1} + u \qquad (1)$$

where Expt as a dependent variable is denoting the total export of the economy and FDIautot-1 stands for the cumulative stock of FDI inflow in automotive sector. The model has narrowest shape only to present the relationship between the FDI inflow and export. If the model is exempted from the other factors and omitted variables and measurement or u =0, the regression model has obtained the following form:

$$Exp_t = \beta_0 + \beta_1 FDIauto_{t-1} \qquad (2)$$

Regression model can provide only a partial explanation for the existence of a correlation between the examined variables. The theory also suggest on examining the existence of causal relationship between the FDI inflow and export growth. The application of Granger causality test actually means more sophisticated form of regression model and its purpose is to explain whether changes in FDI inflow in the automotive industry lead to improved export performances. The Granger causality test in the paper is presented through two regression equations that confirm or reject null hypotheses and determine the direction of causality.

$$Exp_t = C_1 + \sum_{i=1}^{p} \alpha_i \, Exp_{t-1} + \sum_{i=1}^{p} \beta_i \, FDI_{t-1} + u_i \qquad (3)$$

$$FDIauto_t = C_2 + \sum_{i=1}^{p} \gamma_i \, FDIauto_{t-1} + \sum_{i=1}^{p} \delta_i \, Exp_{t-1} + u_i \qquad (4)$$

The goal of the Granger causality test is to explain whether the shift in Macedonian export performance is caused by the change in the structure of FDI inflow. The Granger causality test within the analysis is used as a complementary method to correlation test.

The estimation and analysis in the paper is performed on the base of database available in the National Bank of the Republic of Macedonia and the State Statistical Office. Two sets of data are employed in the analysis. The first set relates to data for FDI inflow in automotive sector sourced by the National Bank of the Republic of Macedonia for the period 2005-2015. Since 2010, it is visible huge shift in the amount of FDI inflow in automotive sector (Table 1). FDIs has gradually branched out of traditional sectors such as food, textile industry and metal processing into more technology-intensive industries like automotive.

Table 1. Stock of FDI inflow in automotive industry (in mill/euro)

2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
12.6	12.8	12.9	88.4	88.4	165.1	249.8	264.5	360.7	449.9	557.6

Source: National Bank of the Republic of Macedonia

Since the investment takes time to materialize (Moran, 2005, pp. 281-313), within the model is considered a time lag for FDI effect to start. For that purpose and due to the necessity to stress the continuity in the FDI inflow, cumulative stock of FDI in automotive sector is taken in the analysis.

The second set of data reflects the size of the export as a dependent variable. The data in table 2 reveal increasing tendencies in the export of products referring to automotive industry. According to SITC classification the share of automotive export in total export increases enormously, from 4.86% in 2005 to 27.11% in 2016.

The dominant share of automotive industry in FDI structure is a significant room for improvement in the overall quality of Macedonian export structure. The FDIs promote founding of new Reveal comparative advantage (RCA). RCA has diversified away from the traditional export products such as textiles, food, tobacco, flat-rolled products of iron or non-alloy steel to the more capital intensive goods such as supported catalyst with precious metal, ignition wiring sets and other wiring sets

Table 2. Comparison between total export and automotive export (in mill/euro)

Year	Total Export	Automotive export
2005	1,644.36	80.00
2006	1,917.51	85.45
2007	2,477.14	95.06
2008	2,697.56	104.73
2009	1,937.04	90.33
2010	2,534.89	132.93
2011	3,214.91	231.90
2012	3,123.95	288.48
2013	3,235.21	409.02
2014	3,746.61	765.40
2015	4,051.23	966.80
2016	4,329.27	1,174.0

Source: National Bank of the Republic of Macedonia and State Statistical Office

Results

In order to investigate the correlation between the increased inflow of FDI in automotive industry and its influence to structural shift in export composition it is used OLS estimation of equation 2. The results in table 3 reveal substantial positive correlation between the export growth due to the higher inflow of FDI in automotive sector. The R Square coefficient detects strong and substantial effect of FDI inflow. It implies that 86% of the export growth is explained with the increased inflow of FDIs in automotive sector. The value of FDI stock significantly affects the value of exports which is verified with the probability coefficient equal to 0.000039.

Table 3. Regression analysis of the export dependency on FDI inflow in Macedonian economy

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2211.020	144.7756	15.27205	0.0000
FDI_AUT	3.952754	0.530518	7.450749	0.0000
R-squared	0.860495			
Adjusted R-squared	0.844994			
S.E. of regression	315.5267			
Sum squared resid	896013.9			
F-statistic	55.51365			
Prob(F-statistic)	0.000039			

Source: Own calculation.

The second part of the analysis reveals the results obtained by the Granger causality test between the FDI inflows in automotive sector and the export growth, presented in table 4. For that purpose it is set up two hypothesis:

H0: FDI_AUT does not Granger Cause EXP

H0: EXP does not Granger Cause FDI_AUT

Applying the equations (3) and (4), and a time lag = 2, as a minimum time discrepancy between the inflow of FDI and start of the manufacturing process, it is reached the following result (Table 4)

Table 4. Granger causality test between FDI inflow in automotive sector and export

Null Hypothesis:	Obs	F-Statistic	Prob.
FDI_AUT does not Granger Cause EXP	9	67.5798	0.0008
EXP does not Granger Cause FDI_AUT		0.76247	0.5242

Source: Own calculation

The value of p suggests existence of causality only in the first hypothesis, as p is less than 0.05 meaning rejection of the first null hypothesis. It implies that in the equation (3) FDI inflow in automotive industry are Granger reason for export growth. For the equation (4) the associated p-value is higher than the accepted significance level that suggest on the approval of the second hypothesis that export does not cause FDI inflow in automotive sector. The results from the Granger causality test reveal a unidirectional causal relationship between FDI inflow and the export with direction from FDI to export.

Conclusions

The correlation issue between the move of capital in the form of FDI and the host country has been in the focus of extensive theoretical and empirical research interest specially in the case of developing and former transition economies. The main challenge of the paper is to examine the impact of FDI inflow in automotive industry to the export performances of the Macedonian economy. Within the paper it is developed a model that takes into account only the narrow relationship between the FDI inflow in automotive industry and the export performances.

During the whole period of transition the export structure of Macedonian economy was displaying significant monotony where low capital intensive goods had dominated. The qualitative shift in the structure of FDI inflow has resulted in the change of the export content toward more capital intensive products. Using the regression analysis, the paper examines the contribution of FDI inflow in automotive sector to the performance and structural change of Macedonian export. The results of the analysis reveal an influential and crucial impact of the FDI inflow to the quantitative and qualitative shift in the export structure. The dramatically improvement of the export performances is additionally supported by the results of the Granger causality test, that proves existence of an intensive one way causality between the FDI inflow and export performances.

Production stemming from the FDI inflow initiates and push up the process of creation new revealed comparative advantages with an active involvement of the host supporting and supplying related entities. Engagement in the supplying chains of automotive industry as a kind of a global platform allows for significant market access gains because the activities of FDI subsidiaries are closely related to the MNE network (Jindra et al., 2009, pp. 171) and diversifies toward a more capital intensive export structure. The higher technology intensity of the FDI inflow should be seen as a prerequisite for the shift to the more technology intensive export structure. As Damijan et al. (2013) have noticed the higher technology intensity of the implanted industries and products the higher will be the benefits for the host economy. From the papers' analysis it could be concluded that increased FDI inflow in automotive industry as export oriented FDI should be seen as a useful platform for upgrading local advantages toward more capital and technology intensive production.

Since the paper verified the dependency of export performances on the increased FDI inflow in automotive sector, as a possible path of further research could be development of a simulation model for examining and analyzing a situation of exemption of the FDI inflow in automotive sector and its influence on the different aspects of the economic growth.

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Technological effectiveness of urban transport in selected Polish cities

JEL Classification: *O18; R58; C10*

Keywords: *technological effectiveness; urban transport; city management*

Abstract

Research background: An efficient and effectively functioning transport in the city is of great importance both for the people residing in its territory, as well as companies doing business there. However, apart from a positive impact, transport also carries many social costs including congestion, traffic accidents and a negative influence on the natural environment. Consequently, urban transport is an increasingly important area of city management.
Purpose of the article: The aim of this study is to analyze and to assess the transport technological effectiveness in selected Polish cities. The author received a ranking of cities and identified ways to improve the efficiency.
Methodology: The test procedure used non-parametric method of Data Envelopment Analysis. Data for analysis were draw from the Local Data Bank of the Central Statistical Office defining expenses in the transport section as well as data on the condition and use of transport infrastructure. The calculations have been made using Frontier Analyst Application software. The performance results were determined using the BCC model.
Findings: The main result is the author's ranking of transport effectiveness in Polish cities. The analysis showed that urban transport characterized by a rather low technological effectiveness.

Introduction

Urban transport is an increasingly important area of city management (Pact of Amsterdam, 2016). However, apart from having a positive impact, transport also carries many social costs including congestion, traffic accidents and a negative influence on the environment. According to data presented by the European Commission this situation, over the next few decades, may become significantly worse in many European cities. Forecasts show that the intensity of freight transport in cities will increase by 40% by 2030 and rise by over 80% by 2050 when compared to 2005. At the same time it is expected that passenger transport will also increase by approximately 34% by 2030 and by more than 50% by 2050 (in comparison to 2005) (White Paper, 2011). One of the things which the European Union requires of its member countries is the need to develop a sustainable mobility strategy, including both passenger and freight transport (Hajduk, 2016). Unfortunately many cities, in their plans and activities regarding the field of transport, included only those tasks that relate to the movement of people, often without consideration for freight (National urban policy, 2015).

City management concerning the field of urban transport could be viewed as management which is directed both to the inside (the city office management) and to the outside (the city management as a whole) (Noworól, 2011, pp. 25-41). On the one hand it involves the identification within the organizational structure of city hall of those responsible for the coordination of the flow of people and goods. It becomes their task to formulate long-term goals in this area. On the other hand, it is the municipal government, in cooperation with other stakeholders including residents, forwarders, recipients, transport companies and public transport operators, who should emerge as the initiator of actions which aim to improve the flow of people and goods in the city. Nevertheless, it is the municipal government who should become the coordinator and initiator of all activities meaning to improve urban transport, for example, by including it into some area of city management.

The assumptions of sustainable development established in the 1990's have become a priority in the transport policy of the European Union. The need to change trends in transport is also visible in the Europe 2020 Strategy and documents resulting from this strategy (Toledo Declaration, 2010). Reducing the use of natural resources for the purposes of transport has become a priority within the transport policy of many countries (Transport Development Strategy, 2013).

The aim of this article is to examine, through the use of Data Envelopment Analysis, transport effectiveness of Polish cities. This method requires the definition of variables representing inputs on the one side and outputs on the other. The study used information from the Local Data Bank of the Central Statistical Office of Poland defining expenses within the transport department (expenditures) and data on the condition and use of transport infrastructure (effects). The analysis was conducted for 18 cities with district status meaning those having from 150 to 500 thousand inhabitants. The territorial units were then compared and a ranking of the effectiveness of urban transport was prepared.

Background literature

In recent years many institutions have created state of development rankings of countries, regions and industries. These mainly concern economic performance, investment attractiveness, the level of innovation and research potential. Assessment is made on the basis of analysis of variables both quantitative and qualitative in character, which in turn allows the ranking of the units surveyed in terms of resources and achieved results. It may be interesting to create a ranking of cities in terms of effectiveness.

The simplest definition of efficiency describes it as the ratio of achieved effects to incurred expenses. According to the principle of rational management, the greater the effect per unit of expenditure the higher the effectiveness. Nowadays, high competition requires an increase in effectiveness and this poses a challenge. Economists understand effectiveness as a lack of stoppage time and unnecessary waste generation in the company. Effective enterprises are located at the lowest possible cost curve, which means that they achieve results in the cheapest way possible.

The Data Envelopment Analysis method was initially presented in 1978 by Charnes, Cooper and Rhodes. These researchers based their assumptions on the concept of productivity formulated by Debreu and Firrelle and understood as the quotient of a single result and a single effort. The DEA method was used in situations in which there is more than one effect and more than one effort. Using linear programming to estimate the efficiency measures they created their first model called CCR with constant return-to-scale in which they accepted the assumption that scale effects are constant. In time both the methodology and its application become more widely used. In 1984, Banker, Charnes and Cooper proposed a model, called BCC with the variable return-to-scale. These models are used to study company efficiency.

The DEA method focuses on studying the dependence between the level of multiple inputs and outputs. The technological efficiency score is calculated without knowing the initial weights. The DEA calculations are based on searching weights that maximize the efficiency of each object. Finally, the DEA method allows the determination the limiting curve of effectiveness. If objects are on the curve then they are considered to be efficient. Otherwise, they are seen as inefficient (Guillermo, & Vincent, 2016, pp. 328-350; Nazarko *et al.*, 2008, pp. 89-105). The object's effectiveness is measured in relation to other objects being studied. Analysis units of the DEA are called Decision Making Units's (DMU). The subject of analysis, on the other hand, is the productivity with which DMU's transforms inputs to outputs. The measure of efficiency is the dependence between the productivity of a given object and its maximum productivity or that which can be achieved under specific technological conditions.

The DEA models can be used to determine effectiveness but also, at times, for setting benchmarks, the benefits of scale, ranking objects, as well as for figuring out ways to improve the efficiency and structure of optimal technologies for inefficient objects. An important advantage of the DEA method is its non-parametric character, allowing its use without the knowledge of functional dependencies between outputs and inputs. Another advantage of this method is the possibility of using data expressed in different units of measure for both inputs and outputs. In relation to variables, the configuration of the DEA model is therefore characterized by high flexibility which significantly affects the range of applications in which the method can be used (Sarkar, 2016, pp. 740-751; Chodakowska, 2015, pp. 112-125). Environmental variables which influence DMU's effects or inputs and which are not controlled by the object can also be introduced as part of analysis. These variables reflect geographical, legal or economic conditions. The DEA method also present some limitations including: high sensitivity to erroneous data and variables which differ significantly from others, sensitivity to changes to the number of test items or the need for appropriate balance between the number of objects and the number of variables.

DEA is a method which is well-known worldwide and is often used to solve problems related to the analysis of effectiveness. This is supported by a very rich bibliography available through many foreign studies, connected to this method (Liu *et al.*, 2013, pp. 3-15). In Poland this method has been mainly used to analyze the effectiveness of financial and educational institutions. This is the reason this study attempts to use the DEA method to investigate urban transport effectiveness.

Methodology of investigations

The research focuses on technological effectiveness of urban transport. The study uses the BCC model. The scope of the research consist of three steps which includes: selection, evaluation and analysis.

Source data comes from the Local Data Bank of the Central Statistical Office and refers to the year 2015. The selection of variables in the model was carried out based on the analysis of literature and was determined by the limited scope of the statistics given concerning city (Díaz, & Charles, 2016, pp. 328-350; Wiśnicki et al., 2017, pp. 9-15). The sample for analysis includes 18 cities with poviats status from 150 to 500 thousands inhabitants. The calculation has been made using Frontier Analyst Application software dedicated to the DEA method.

Prior to initiating the study an assessment was made whether all the variables included in the expenditures are characterized by sufficiently high volatility. Coefficients of variation were calculated for each feature (V). It was found that all variables were characterized by high volatility and therefore could carry important information about the phenomena being examined. In order to determine the technological effectiveness for the transport cross-section of cities with poviat status the following variables were isolated, which included three effects:

Y_1 - the length of gmina and poviat hard surface roads per 10 thousand residents (kilometrs/10000 residents);

Y_2 - the length of bus-line per 10 thousand square kilometrs (kilometrs/10000 square kilometrs);

Y_3 - the length of bicycle paths per 10 thousand square kilometrs (kilometrs/10000 square kilometrs).

Adopted a set of results included a one variable: X - expenditure of poviats budgets in the transport section (PLN/1 person).

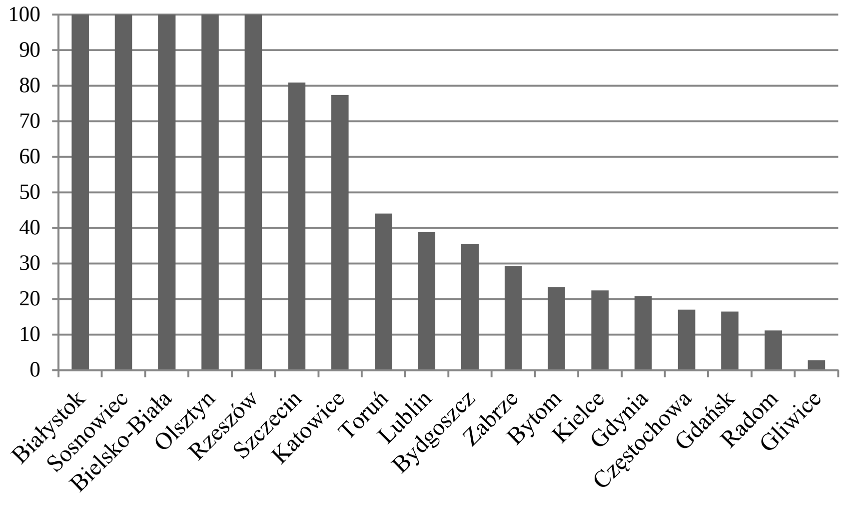
Variables used in the model and expressed as expenditures were also checked in in respect to the existence and the strength of their correlation with the effects. The highest correlation was shown between the length of bicycle paths (Y_3) and the expenditures for transport (X).

Results and discussion

The technological efficiency results, shown in figure 1, were determined using the BCC model. The initial step of the study was to create a ranking of urban transport efficiency and to identify city-benchmarks. Units which are considered to be fully efficient achieved a factor of 100%. The ranking of the objects in order of efficiency from highest to lowest can show which cities are inefficient and which can be classified as leaders. Five cities have been established as benchmarks: Białystok, Sosnowiec, Bielsko-Biała, Olsztyn, Rzeszów. Eight cities did not reached the 30% threshold of efficiency. This class includes Zabrze, Bytom, Kielce, Gdynia, Czestochowa, Gdańsk, Radom, Gliwice. The lowest level of efficiency of 2.77% was attained by Gliwice. Cities which were considered in the study display an average technological efficiency of 51.11% with standard deviation reaching 36.97%.

The analysis of the classes of efficiency was the next step within the research process. Efficient cities made up the most numerous class. These benchmarks represented 27.7% of all objects considered in the study. The next step of research was concerned the examination of the relationship between the efficiency score and transport expenditures. An increase in transport expenditures reduced the efficiency score. Cities displaying full efficiency allocate anywhere from PLN 21.26 to PLN 902.24 per 1 inhabitant for transport. In contrast, the city with the lowest efficiency spends as much as PLN 2110.04 per 1 inhabitant.

Figure 1. The technological efficiency of the urban transport



Source: author's elaboration.

Designated lambda values show how the level of technology in ineffective cities should be adjusted for them to become effective. The last step of the study was to determine ways in which inefficient cities could improve in relation to benchmarks. For instance, Szczecin's level of technology should be equal to the sum of technologies of: (1) Bielsko-Biała multiplied by 13.1, (2) Sosnowiec multiplied by 59.7 and (3) Olsztyn multiplied by 27.2. The same interpretation applies to other inefficient cities, ie. Katowice, Toruń, Lublin, Bydgoszcz, Zabrze, Bytom, Kielce, Gdynia, Częstochowa, Gdańsk, Radom, Gliwice. Lambda values for inefficient cities present table 1.

Table 1. Lambda values for inefficient cities

DMU	Białystok	Sosonowiec	Bielsko-Biała	Olsztyn	Rzeszów
Szczecin	0.0	59.7	13.1	27.2	0.0
Katowice	0.0	65.5	10.2	24.3	0.0
Toruń	68.1	0.0	27.3	0.0	4.6
Lublin	31.0	0.0	3.0	66.0	0.0
Bydgoszcz	0.0	59.3	0.0	40.7	0.0
Zabrze	0.0	94.9	0.0	5.1	0.0
Bytom	0.0	67.3	0.0	32.7	0.0
Kielce	0.0	5.7	2.3	92.0	0.0
Gdynia	0.0	66.9	0.0	33.1	0.0
Częstochowa	0.0	48.2	20.3	31.5	0.0
Gdańsk	0.0	28.6	1.8	69.9	0.0
Radom	0.0	75.2	0.0	24.8	0.0
Gliwice	0.0	77.7	20.9	1.5	0.0

Source: author's elaboration.

Conclusions

The DEA method enriches the methodology used by scientists to study urban transport efficiency. In comparison to parametric methods it presents many advantages. It makes the determination of the unit's effectiveness in the presence of many inputs and outputs possible. At the same time it does not require knowledge of functionality between the variables. Additionally, it allows the expression of inputs and outputs in different units.

The article presents the evaluation of urban transport efficiency on the basis of one input (transport expenditures) and three outputs (the length of urban roads, the length of bus-lines, the length of bicycle paths). The study shows that full efficiency occurred in 27.8% of units. The average urban transport efficiency was 51,1% in the BCC model and the lowest efficiency was only 5.56. This means that substantial parts of cities do not use optimal inputs. The analysis shows that urban transport of considered cities was characterized by a rather low technological effectiveness. Although the method involved a number of simplifications these results provide a general overview of the level of efficiency of the units surveyed, and can be a starting point for more detailed analysis of the efficiency of individual units. An important advantage of measuring effectiveness using this method is the identification potential improvements which inefficient units may implement and objects which they could imitate.

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Comparative analysis of the influence of FDI inflows on economic development between Serbia and Poland

JEL Classification: *A11*

Keywords: *FDI; economic growth; development; investments*

Abstract

Research background: The aim of this paper is to measure the impact of the FDI on the economic growth in Poland and on the economic growth in Serbia and further to make comparative analysis of the impact between these two countries.
Purpose of the article: Empirical studies showed that FDIs can make crowding-out effect, i.e. FDIs can out crowd domestic investments which further have more impact on the economic growth. Because this effect depends on the specific level of the development of the country, the aim is to compare the influence of the FDI on economic growths on both of them as long as Poland is classified as a developed country and Serbia is a country which belongs to the group - countries in transition.
Methodology/methods: Panel data includes variable values from 1999-2007, until global economic crisis period and 2008-2015, period after crisis in order to see flows and make comparison between these two periods. GDP is the main indicator which represents economic growth. According to that, using regression analysis, the aim is to measure influence of FDIs as the independent variable on real GDP growth, as dependent variables. Besides, a group of control variables are included in the method. As long as GDP is enhanced by lower inflation, inflation will be used as independent variable. Our model also includes determinants of monetary

and government sectors such as official exchange rate, inflation and government consumption.
Findings: Using two multiple linear regression models we found the significant influence of FDI inflows on economic growth in Poland. Using the same models for observations in Serbia we haven't found significant effects of FDI Inflows on economic growth.

Introduction

There is a great number of differences between Poland and Serbia such as geographical size, population and most important their economy classifications. Poland's economy belongs to the group of developed countries and Serbia has transitional economy. Overall Poland is a member of the European Union and Serbia is EU membership candidate. It is believed that FDIs can make beside positive, negative effect on the private investment and further more on economic growth at all. Our aim is to measure the influence of FDI inflows on economic growth between these two different countries.

One of the most important in this field was published by Borensztein, Gregorio and Lee. The most robust finding of this paper is that the effect of FDI on economic growth is dependent on the level of human capital available in the host economy. They also found some evidence of a crowding-in effect, namely that FDI is complementary to domestic investment (Borensztein, 1995, pp. 123, 134).

Havrylyshyn et al. (1999) concluded that different growth rates can be explained by different circumstances at the beginning of the transition (poorer countries grow faster), and that the possession of resources is not a guarantee for higher growth, but that an unfavourable geographical location can make it more difficult. Economic policies, together with institutional, legal and political framework, have a strong influence on growth (Bodroža, 2016, pp. 51-52).

Blomström and Kokko focused on the diffusion and transfer of technology from foreign multinationals to their host countries, the impact of foreign MNCs for the trade performance of host countries, and the effects on competition and industry structure in host countries. They stated that exact nature of the relation between foreign multinational corporations and their host economies seems to vary between industries and countries (Blomström & Kokko, 1996, pp. 32). Gorodnichenko et al. have found no support for the hypothesis that spillovers are greater for FDI with more advanced technology. FDI spillovers hence vary by sectors and types of firms (Gorodnichenko, 2007, 13-15).

According to Garibaldi's research, foreign direct investments grow was a result of a favourable macroeconomic environment or stable foreign exchange rate, but they are negatively dependent on internal privatisation (Mora *et al.*, 2002, pp. 136-137).

In her study, Alfaro (2007) examined the various links between different "types" of FDI and growth. She found FDI at the industry level to be associated with higher growth in value added. The relation is stronger for industries with higher skill requirements and for industries more reliant on external capital. FDI quality is also associated with positive and economically significant growth effects (Alfaro, 2007, pp. 20).

The most recent work related to FDI and GDP in Poland includes period 1999-2012. The impact of GDP is stronger with respect to attracting FDI inflows than the impact of FDI on GDP. A weaker, though confirmed impact of FDI on economic growth results from the structure of FDI inflows, which are characterised by a considerable share of debt securities (Kosztowniak, 2016, pp. 327).

Kastratović found a statistically significant positive correlation between the foreign direct investment inflows and the gross domestic product of Serbia. He stated that the value of the coefficient of determination equals 50.19% which indicates that 50.19% of the gross domestic product variations can be explained by the movements in the gross domestic product (Kastratović, 2016, pp. 83-85).

Methodology research

One of models that explains the relationship between economic growth and economic variables is the Keynesian model, and the formula base is explained as follows:

$$GDP=C(GDP) + I\,(GDP, r) + G + X(T, e) - M(T, e).$$

where: GDP is the Gross Domestic Product (economic output), C is Private Consumption (dependent of GDP), I is Domestic Investment (depending on GDP and Interest Rate r), G is government expenditure, X and M are exports and imports, which are assumed to be dependent of the incomes of other countries (T) and the Exchange Rate (e) (Machado *et al.*, 2015, pp. 3).

Barro in his study which included a broad panel of countries over 30 years showed that with the respect to government policies, the growth rate of real per capita GDP is enhanced by better maintenance of the rule of law, smaller government consumption, and lower inflation (Barro, 1996, pp. 70).

Empirical specifications of conditional convergence growth in line with Barro’s work have become standard starting point in empirical analysis of growth among the researchers (Bodroža, 2016, pp. 86). Our panel data includes selected macroecomic indicators relevant to the economic growth for the period 1999-2015. Basic assumptions for our models are found on the Borensztein’s approximation to equation:

$$g = c_0 + c_1 FDI\ x\ H + c_2 FDI\ x\ H + c_3 H + c_4 Y_0 + c_5 X$$

Where: FDI is foreign direct investment, H is stock of Human capital, Y_0 initial GDP per capita, and X a set of other variables that are frequently included as determinants of growth in cross-country studies, such as government consumption and variables representing foreign exchange and trade distortions (Borensztein, 1995, pp. 124).

Taking everything into account, we specified two models for the multiple linear regression analysis. The first model is:

$$y = \beta_0 + \beta_1 FDI + \beta_2 G + \beta_3 Def + \beta_4 Exch + \varepsilon$$

where the variables are denoted as follows: y = real GDP per capita growth, β_0 – constant, FDI - FDI inflows as percentage of GDP, G - General government final consumption expenditure as percentage of GDP, Def - GDP deflator, $Exch$ - Official exchange rate and ε – random error that includes the effect of the all other variables which are not included in our model.

The second model for the multiple log-linear regression analysis is:

$$y = \beta_0 + \beta_1 FDI + \beta_2 Exch + \beta_3 Inf + \varepsilon$$

where the variables are denoted as follows: y = real GDP growth, β_0 – constant, FDI – logarithm value of FDI inflows as percentage of GDP, $Exch$ - logarithm value of Official exchange rate, Inf - logarithm value of Inflation CPI, and ε – random error that includes the effect of the all other variables which are not included in our model.

Results of the comparative analysis

Our first model includes real GDP per capita growth as dependent variable, FDI inflows as percentage of GDP, General government final consumption expenditure as percentage of GDP, GDP deflator and Official exchange rate. As long as our sample is small (N = 17, 1999-2015), we will focus on the adjusted R square as distinct from R square. In the case of Poland 75,6% and in the case of Serbia 54,7% of the variability of the dependent variable is explained by the variability of the independent variables.

Table 4. Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
Poland	.904[a]	.817	.756	.83262
Serbia	.812[a]	.660	.547	3.43058

Source: Authors' calculations using SPSS.

As long as both α < 0,05 – Sig POL = 0,000 and Sig SER = 0,008 we can conclude that coefficient of determination differentiates from 0. Not only Sig but also the F values which are 13.402 and 5.820 (greater than 4) confirm this conclusion.

Table 5. ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1 **POL**	Regression	37.165	4	9.291	13.402	.000[b]
	Residual	8.319	12	.693		
	Total	45.484	16			
1 **SER**	Regression	273.994	4	68.499	5.820	.008[b]
	Residual	141.226	12	11.769		
	Total	415.220	16			

Source: Authors' calculations using SPSS

According to Beta - Standardized Coefficients, FDI in Poland contributes the most to explanation of dependent variable (0.872 compared to -0.152, -0.022 and -0.212). All observed Tolerance values are above 0.10 – 0.72, 0.935, 0.654, 0.945 and VIF values are not quite close to 10, so multicollinearity assumption can be rejected.

Table 6. Poland - Coefficients[a]

Model	Unstandardized Coefficients		Stand. Coefficients	t	Sig.	95,0% Confidence Interval for B		Collinearity Statistics	
	B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
(Constant)	15.813	11.003		1.437	.176	-8.161	39.787		
FDI	.920	.154	.872	5.994	.000	.586	1.255	.720	1.388
G	-.701	.590	-.152	-1.188	.258	-1.988	.585	.935	1.069
GDP defl.	-.021	.140	-.022	-.147	.885	-.325	.284	.654	1.528
Exch. Rate	-.663	.397	-.212	-1.670	.121	-1.528	.202	.945	1.058

Source: Authors' calculations using SPSS.

The most important values in table 6 are given in column Sig. As long as $\alpha > 0.05$ for three variables, in case of Poland using our regression model we can conclude that only FDI inflows as % of GDP gives statistical significant contribution to prediction of GDP per capita growth rate.

According to standardized regression coefficients whose values are given in the column Beta - Standardized Coefficients table 7, Government consumption contributes the most to explanation of dependent variable (0.653 compared to 0.274. 0.041 and 0.049) in case of Serbia. Tolerance and VIF values give us the same important information like for the Poland. Tolerance values are closer to 1 contrary to 0,1 and VIF values are below 10 – 1.394, 1.244, 1.453 and 1.333 so multicollinearity assumption can be rejected.

Analyzing values in column Sig for the FDI inflows as a % of GDP that is above 0.05 (table 7.), so using this model we couldn't find any statistical significant contribution to prediction of GDP per capita growth rate. Government consumption as % of GDP, GDP deflator and Exchange rate have $\alpha < 0,05$ and further more gives us statistical significant contribution to prediction of GDP per capita growth rate.

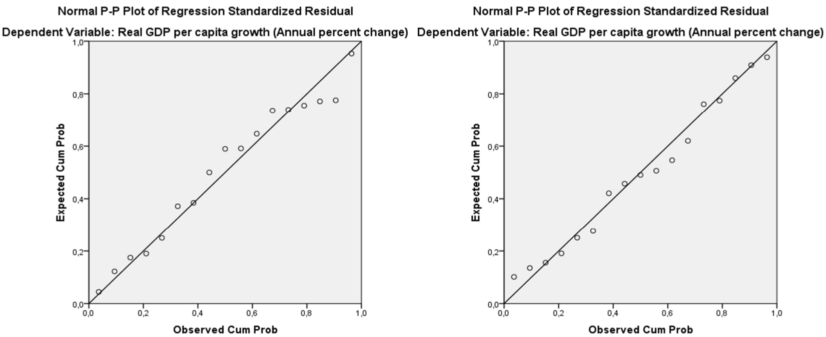
Table 7. Serbia - Coefficients[a]

Model	Unstandardized Coefficients		Stand. Coeffici-ents	t	Sig.	95,0% Confidence Interval for B		Collinearity Statistics	
	B	Std. Error	Beta			Lower Bound	Upper Bound	Tole-rance	VIF
(Constant)	-59.741	14.164		-4.218	.001	-90.601	-28.881		
FDI	.411	.274	.298	1.500	.159	-.186	1.007	.718	1.394
G	2.505	.653	.720	3.835	.002	1.082	3.928	.804	1.244
GDP defl.	.095	.041	.474	2.334	.038	.006	.184	.688	1.453
Exch. Rate	.157	.049	.624	3.210	.007	.050	.264	.750	1.333

Source: Authors' calculations using SPSS.

Based on the diagram dispersion of standardized residuals Scatterplot, diagram 1. shows that the variance of the residuals about the predicted values of the dependent variables are along with the straight line from the lower left to the upper right corner, which indicates that the assumption of homoscedasticity random errors is not significantly impaired.

Diagram 1. Normal P-P Plot of Regression Standardized residuals, Poland and Serbia, respectively

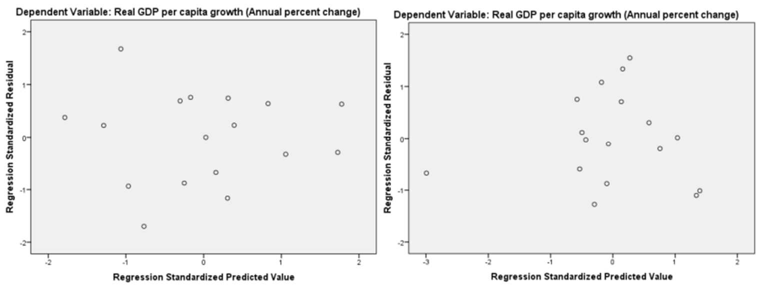


Source: Source: Authors' using SPSS.

Scatterplot of standardized deviations is used to detect whether there are cases where the standardized residual are less than -3.3 or greater than +3.3. Atypical values can be detected on the basis Mahalanobis distance -

comparing the maximum value Mahal. distance, with the corresponding critical value, for a given number of independent variables. As long as we used four independent variables, our critical value is 18,47 and our values are – Poland 6,607 and Serbia 13,185. Mahalanobis distance values do not exceed critical value.

Diagram 2. Scatterplot, Poland and Serbia, respectively



Source: Source: Authors' using SPSS.

Our second model includes real GDP growth as dependent variable, logarithm values of FDI inflows as percentage of GDP, Inflation rate and Official exchange rate.

Table 8. Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
Poland	.743[a]	.553	.449	1.26200
Serbia	.752[a]	.566	.466	3.74200

Source: Authors' calculations using SPSS.

In the the second model for Poland 44,9% of the variability of the dependent variable is explained by the variability of the independent variables and 46,6% for Serbia. Sig. values are not low as in the previous model but both are $\alpha < 0,05$. The level of α for Poland is 0,013 and for Serbia 0,011. Both F value, in case of Poland for Serbia are greater than 4 so we can conclude that regression model is significant for both countries.

Table 9. ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1 **POL**	Regression	25.578	3	8.526	5.353	.013[b]
	Residual	20.704	13	1.593		
	Total	46.282	16			
1 **SER**	Regression	237.384	3	79.128	5.651	.011[b]
	Residual	182.033	13	14.003		
	Total	419.418	16			

Source: Authors' calculations using SPSS.

As mentioned, Beta coefficients are independent of units of measurement. According to this, in case of Poland FDI contributes the most to explanation of dependent variable (0.682 compared to -0.348, and -0.020). All observed Tolerance values are above 0.10 – 0.959, 0.974, 0.939 and VIF values are far away from the value 10, so multicollinearity assumption can be rejected. In case of Poland using our regression model we can conclude that only FDI inflows as % of GDP gives statistical significance contribution to the prediction of real GDP growth.

Table 10. Poland - Coefficients[a]

Model	Unstandardized Coefficients		Stand. Coefficients	t	Sig.	95.0% Confidence Interval for B		Collinearity Statistics	
	B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
(Constant)	6.713	2.434		2.758	.016	1.454	11.972		
LOG FDI	3.143	.873	.682	3.599	.003	1.257	5.029	.959	1.043
LOG Exch. Rate	-8.510	4.599	-.348	-1.851	.087	-18.445	1.425	.974	1.026
LOG Inflation	-.073	.703	-.020	-.104	.919	-1.592	1.446	.939	1.065

Source: Authors' calculations using SPSS.

In case of Serbia, Inflation contributes the most to explanation of dependent variable (0.751 compared to 0.666 and 0.420). Tolerance and VIF values give us the same important information like for the Poland. Tolerance values are above 0.1 and VIF values are below 10 - 1.817, 1.479 and 1.798. Exchange rate and Inflation have $\alpha < 0.05$ and further more gives us statistical significance. We can conclude that these two independent variables gives contribution to prediction of real GDP growth rate.

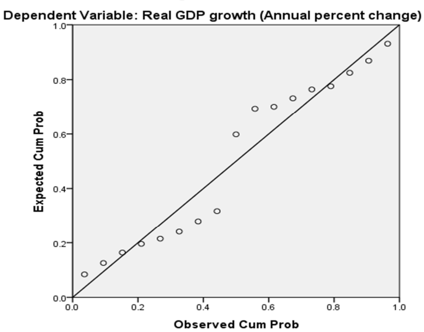
Table 11. Serbia - Coefficients[a]

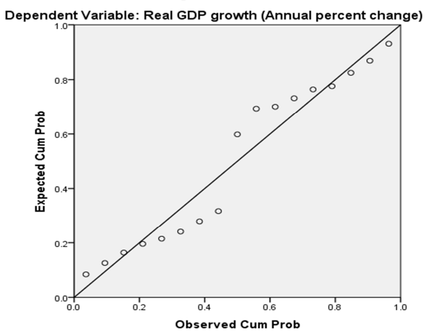
Model	Unstandardized Coefficients		Stand. Coefficients	t	Sig.	95.0% Confidence Interval for B		Collinearity Statistics	
	B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
(Constant)	-39.690	11.051		-3.591	.003	-63.564	-15.815		
LOG FDI	5.646	3.311	.420	1.705	.112	-1.506	12.798	.550	1.817
LOG Exch. rate	16.612	5.540	.666	2.999	.010	4.644	28.580	.676	1.479
LOG Inflation	8.232	2.686	.751	3.065	.009	2.430	14.034	.556	1.798

Source: Authors' calculations using SPSS.

The assumption of homogeneity of variance random errors is not significantly impaired based on variance of the residuals for the predicted values of the dependent variables which are along with the straight line from the lower left to the upper right corner.

Diagram 3. Normal P-P Plot of Regression Standardized residuals, Poland and Serbia, respectively

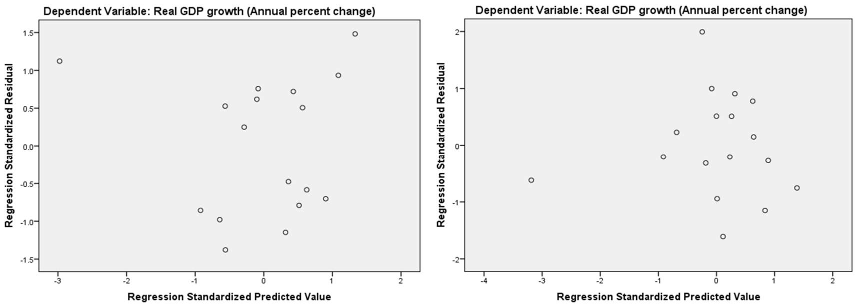




Source: Source: Authors' using SPSS.

Atypical values are detected on the basis Mahalanobis distance - comparing the maximum value Mahalanobis distance with the corresponding critical value for a given number of independent variables. As long as we used three independent variables, our critical value is 13.82 and our values are – Poland 12.078 and Serbia 14.107.

Diagram 4. Scatterplot, Poland and Serbia, respectively



Source: Source: Authors' using SPSS.

Mahalanobis distance value for Serbia exceeds critical value. That is shown on scatterplot of standardized deviations where the standardized residual is greater than -3.3. In both cases Cook's distance is above 1, 7,373 for Poland and 25,389 for Serbia which indicates that extraordinary observations influence the confidence of our model.

Conclusions

Our time series data set included period 1999-2015. Analyzing the effects od FDI inflows using multiple resgression linear model which included real GDP per capita growth as dependent variable, FDI inflows as percentage of GDP, General government final consumption expenditure as percentage of GDP, GDP deflator and Official exchange rate, we found statistically significant effect of FDI inflows on economic growth in Poland. Using the same model for observations in Serbia, our results haven't shown significant effects of FDI on economic growth, but government consumption, exchange rate and GDP deflator effects have.

The second model we used included GDP growth and we used logarithm values of FDI inflows as percentage of GDP, Inflation rate and Official exchange rate. Once again, given results have shown the positive statistically significant effect of foreign direct investent inflows on economic growth in Poland. The same multiple resgression linear model applied on data from Serbia gave the results from which we concluded influence of the official exchange rate and inflation on economic growth in Serbia. Nevertheless, we don't have enough arguments to claim that foreign direct investment inflows contribute to prediction of real GDP growth rate.

In addition, in both cases Cook's distance is above 1, 7,373 for Poland and 25,389 for Serbia which indicates that extraordinary observations influence the confidence of our model.

Although it seems that FDI inflows do not statistically affects economic growth in Serbia, we belive that there is positive corellation. Contradictory given results using the same models in both countries, authors describe as a differences in the level of development, external debt, the structure of FDI inflows (type and sector) and efficiency of investments.

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The dynamics of regional inequalities and economic growth in Central and Eastern Europe

JEL Classification: *C51, O11, O47, R11*

Keywords: *regional inequalities; economic growth; Williamson hypothesis; econometric modeling; Central and Eastern Europe*

Abstract

Research background: The processes of economic convergence observed in many developing countries are characterized by reduction of economic differences on the between-country level, which are accompanied by growing internal economic inequalities. This may stem from the fact that in catching-up countries, a more dynamic growth is observed in the economically strongest regions, which is initially reflected in spatial polarization and increasing regional inequalities. However, just as the countries reach higher levels of development, the diffusion of growth-inducing impulses to the remaining areas should lead to the spatial equalizing of the development levels and reducing regional inequalities.
Purpose of the article: The aim of the paper is to determine the relations between the level of economic growth in Central and Eastern European (CEE) countries and observed economic inequalities. The theoretical frame adopted to describe and explain those relations was the so-called Williamson hypothesis in which the relation between the scale of regional inequalities and economic growth is illustrated by a curve shaped like an inverted U.
Methodology/methods: The research procedure was intended to verify Williamson hypothesis by estimating parabolic econometric models. Indicators of economic growth along with measure of regional inequalities (Williamson's coefficient of variation) were used in the regression modeling. The research period spans over the years 1995-2014.

Findings: In the light of the conducted study of CEE countries, it was possible to observe both convergence symptoms as well as divergence tendencies. It can be thus stated that the analyzed CEE countries followed a similar path to the one observed earlier by Williamson in other developing countries. However, the analyses conducted by the authors on the national and regional levels of CEE countries were equivocal and did not fully support the theoretical assumptions of Williamson's hypothesis.

Introduction

The dynamics of spatial economic inequalities has long been of interest to economists endeavoring to identify tendencies and explain mechanisms of convergence or polarization of state or regional economies. The issue of economic convergence or divergence although commonly addressed in empirical verification procedures, still gives rise to controversy and basically remains unsolved. The supporters of the convergence hypothesis argue on the basis of neoclassical growth models, that countries (regions) with lower per capita GDP usually achieve higher rates of economic growth, which leads to reduction of economic disparities (Barro, 1991). On the other hand, equally popular are the post Keynesian concepts (promoted by e.g. Myrdal (1957)), which stipulate that economic growth is a spatially cumulative phenomenon. This means that rich countries or regions thanks to accumulated capital and access to resources attract next business activities thus diminishing the possibilities of growth for under-developed areas. Although the latter can benefit from the so called spillover effect (i.e. growth impulses induced by expansion of the thriving economies), the benefits may be upended by the backwash effects (negative economic effects inhibiting growth, such as drain of workforce, capital, products and services to the privileged areas). These processes tend to lead to an increase of economic inequalities, which is often referred to as economic divergence.

The heated scientific debate that has been carried out for years is currently gaining special political and practical importance. It is connected to EU regional policy aimed at guaranteeing economic and social cohesion within the Community by reducing spatial imbalances. Pursuing cohesion policy by definition should lead to obtaining convergence, and the role of its institutions is to provide for such distribution of European funds so as to secure equalization of profound differences in growth with respect to spatial distribution (Markowska-Przybyła, 2010).

However, it is not stipulated clearly in the Treaty on which level of territorial organization the inequalities in socioeconomic growth should be rectified – state or interregional (or perhaps even intraregional). This confusion appears to be of significant importance considering the fact that research papers representing new economic geography approach indicate (see e.g. Martin & Ottaviano, 2001; Brakman *et al.*, 2005) that growing dynamics in a given spatial-economic system entails an increase in discrepancies between its parts (Kisiała *et al.*, 2015).

This situation may stem from the fact that in developing countries a more dynamic growth of economically strongest regions can be observed, which is initially reflected by spatial polarization and increasing regional inequalities. However, with time, as the economies are upgraded to higher levels of growth, the processes of growth impulse diffusion to other areas should result in spatial equilibration of growth levels and a decrease of regional disparities (Domański, 2012).

In this context, the aim of the paper was defined as determining the relationship between the level of economic growth and observed economic disparities in Central and Eastern European (CEE) countries. The theoretical frame adopted to describe and explain those relations was the so-called Williamson's hypothesis (1965) in which the relation between the scale of regional inequalities and economic growth is illustrated by a curve shaped like a parabola opening to the bottom.

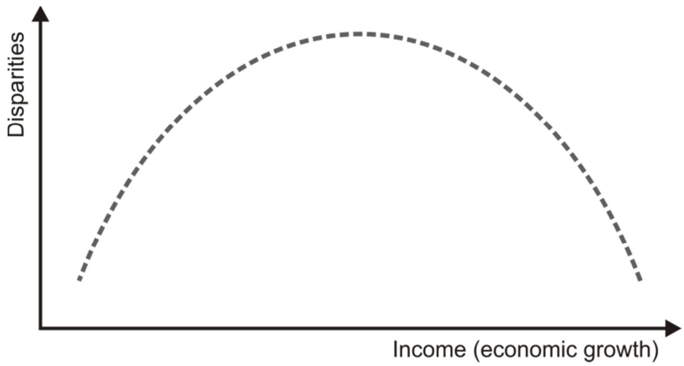
The time series of the study covered the period of 1995-2014 (analysis on the state level) and 2000-2014 (analysis on the regional level). The time span was determined by availability of statistical data.

Williamson's hypothesis of an inverse U-shape curve

The first attempts to identify patterns in economic inequality evolution were based on research concerning households' income distribution. One of the most wide-spread prognosis of this type was formed by Kuznets (1955) who conjectured that there was a link between the level of inequality in allocation of income between citizens, and the level of economic growth. The results of his research showed that the graphic representation of the subject interdependence was bell-shaped. In the early phase of countries' economic growth process (during industrialization and urbanization of agricultural societies) the disparities increased, then they leveled out to be considerably reduced in the maturity phase of well-developed industrialized economies (see e.g. Barrios & Strobl, 2009; Piketty, 2015).

The spatial dimension of the interdependency described above was introduced by Williamson (1965) who had thoroughly investigated the empirical validity of Kuznetz curve. On replacing the measure of personal income diversity with regional inequality rate, he observed that the regional differentiation was higher in under-developed countries, and lower in well-developed ones. Furthermore, he noted that with time the regional inequalities in the first group of countries showed a growing tendency, while in the latter – they tended to decrease. As a result, he conjectured that there was a link between regional convergence and divergence processes, and the phases of economic growth of the country, and described the relation with an inverse U-shape curve (see Figure 1).

Figure 1. Graphic representation of Williamson's hypothesis with an inverse U-shape curve



Source: own elaboration based on Williamson (1965) and Szörfi (2007).

In the initial phases of growth of the national economy, interregional differences increased while in the subsequent stages – interregional convergence occurred. Such interdependency could be explained by the fact that in under-developed countries there were few regions that boasted the characteristics of the so called “growth poles”. In these areas, due to high concentration of production factors and better technical equipment of work, one could observe growing productivity and increased pace of development in comparison to other regions of the country. Along with the national growth though, more and more regions gained access to growth factors, such as capital, technology, and new markets. This could be due to the growing production cost and increasing barriers to growth in well-developed regions (e.g. access to infrastructure and public utilities, environmental pollution, lack of new land for development), that accompanied by growing production factor mobility, knowledge and technology diffusion, as well as peoples’ attitudes resulted in placing investments in under-developed regions. Exceeding the growth threshold by under-developed regions triggered convergence processes in the economy structure, workforce efficiency and income per capita (Gawlikowska-Hueckel & Zielińska-Głębocka, 2004; Wang & Ge, 2004; Szörfi, 2007; Barrios & Strobl, 2009).

Williamson (1965) emphasized the two development gaps characteristic for developing countries. The first referred to differences in the level of growth of a country in comparison to well-developed countries. The second reflected the internal economic inequalities observable within the "catching-up" country. According to the mechanism explained by Williamson's hypothesis, achieving the between-country convergence entailed an increase in regional disparities in the initial phase, and only in the long run an internal development gap was levelled out and regional cohesion obtained.

Research methodology

The testing of Williamson's hypothesis was conducted by means of econometric modeling. The spatial scope of analysis covered Central Eastern European countries (CEE) that joined the EU in 2004 or later (Bulgaria, Croatia, the Czech Republic, Estonia, Lithuania, Latvia, Poland, Romania, Slovakia, Slovenia and Hungary).

The research started with the selection of variables representing the level of economic growth of countries and their regional disparities (on the state and regional level NUTS 3). The statistical data on the economic growth of countries and regions (GDP per capita) were obtained from the Statistical Office of the European Union Eurostat. A version of the rate based on purchasing power standard (PPS) was used, which facilitated between-country comparison with respect to the level of real income.

As a measure of between-country and intra-national economic inequality, a weighted coefficient of variation V_W was adopted after Williamson (1965):

$$V_W = \frac{\sqrt{\sum_{i=1}^{n}(x_i - \bar{x})^2 \frac{l_i}{L}}}{\bar{x}},$$

where:
x_i – GDP per capita (in PPS) of the i^{th} state (region),
$\bar{x}$ – average GDP *per capita* (in PPS) calculated for all analyzed countries (regions),
l_i – population of the i^{th} country (region),
L – total population of all analyzed countries (regions).

Due to the parabolic shape of Williamson's inverse curve, in the course of the research parameters of the second degree polynomial were estimated, using the following analytical form of the regression function:

$$y_t = b_0 + b_1 x_t + b_2 x_t^2 \ (b_2 \neq 0).$$

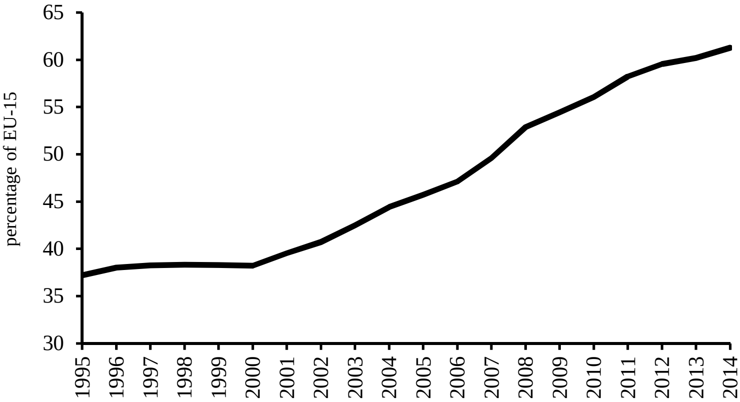
This means that Williamson's coefficient of variation in year t (dependent variable y) was explained by the quadratic function of GDP per capita in selected units in year t (independent variable x). The estimation of regression equation parameters was done by the least squares method, according to the rules accepted for linear models with respect to parameters.

The verification of Williamson's hypothesis comprehended the analysis of configuration of points in scatterplots (spot charts depicting pairs of analyzed variables in subsequent years). It also embraced testing the values and statistical significance of the estimators of the regression function parameters (b_1 and b_2). When the estimator b_2 was negative and statistically significant, the function had an inverse U shape, which was in line with Williamson's hypothesis. In any other case, ($b_2 > 0$ and statistically significant), the chart was U-shaped. The lack of statistical significance of the estimate of parameters indicated the incorrect analytical form of the model.

Research findings

The conducted analysis showed that in the analyzed period, the level of economic development of the CEE countries approached the level that had been previously reached by EU-15 countries (member countries in the *EU* prior to the accession of ten countries in 2004). In the years 1995-2014, the average annual growth rate of GDP per capita in the countries surveyed was 5.5%, whereas in the EU-15 it was a meager 2.8%. In the first year of analysis (1995), GDP per capita in CEE accounted for only 37% of the EU-15 average. By 2014, this relationship increased to 61% (see Figure 2).

Figure 2. Dynamics of the economic growth in CEE (PPS per inhabitant in percentage of the EU-15 average)



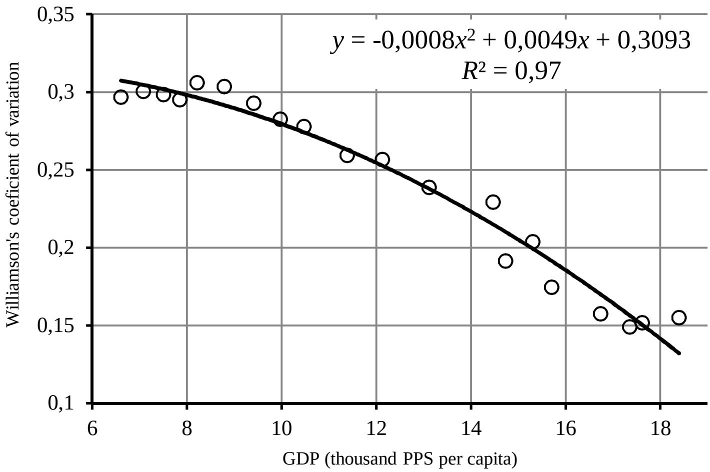
Source: own elaboration based on Eurostat.

These results demonstrated that the CEE countries entered the path of external convergence with the countries of the "old" Union. The systemic transformation and the EU membership entailed reducing the development gap at the national level. As a result, in the next part of the study it was examined whether the cross-country convergence underwent in accordance with the mechanism described by Williamson.

The regression modeling aimed at determining the statistical parameters of the relationship between the economic growth and disparities and verifying Williamson's hypothesis were carried out for the CEE countries first on the national level, and then NUTS3 level.

During the period under analysis, the CEE economies continued to increase (from 6.6 to 18.3 thousand PPS). Along with the economic growth, the disproportions between the countries surveyed declined substantially. Williamson's coefficient decreased from 0.3 in 1995 to 0.15 in 2014 (see Figure 3). At the beginning of the analyzed period, the variation value was stable oscillating around 0.3. In 2001 it started to decline. Certain deviations from the prevailing downward trend were noted in connection with the economic crisis that began in 2008. The economies of the surveyed countries responded differently to the global shock – large decreases in economic activity were noted in the Baltic States (Estonia, Latvia, Lithuania), much smaller in the Czech Republic and Hungary. In Poland, the increase of GDP per capita was unimpeded.

Figure 3. Relation between economic growth and inequalities in CEE countries



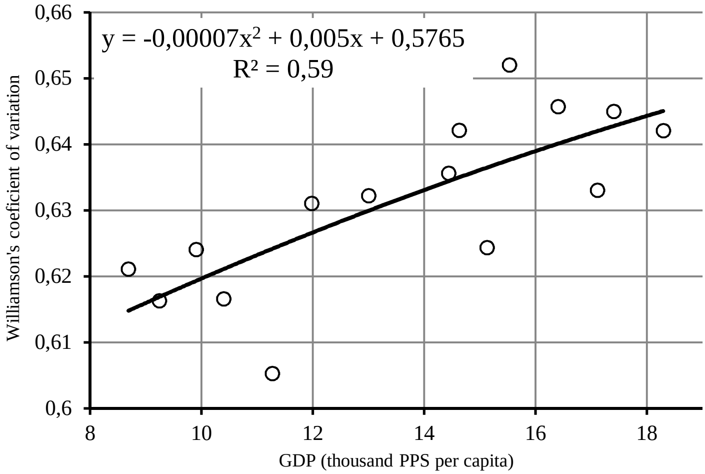
Source: own elaboration based on Eurostat.

The obtained statistical data allowed for estimation of the parabolic regression function opening downwards ($b_2 < 0$) as shown in Figure 3. The coefficient of determination for the estimated model was 0.97, indicating a very good match between empirical data and data obtained from regression function. The estimation of parameter b_2 was statistically different from zero (p-value = 0.0025). Thus, it was possible to validate Williamson's inverted-U hypothesis on the relationship between the economic growth and cross-country disparities.

A contradictory picture emerged under the analysis of the relationship between the economic growth and inequalities at the NUTS3 level (see Figure 4). First of all, a significantly higher level of economic inequalities was identified (Williamson’s coefficient reached values from 0.62 to 0.64). At the same time, a growing diversification of economic growth at the regional level was observed.

The estimated econometric model of the test relationship at NUTS3 level was not well fitted to the empirical data (it explained only 58% of the regional variation). The regression coefficients, although pointing at the parabola opening to the bottom, were not statistically significant. It was assumed that the test relationship could not be described by a quadratic function, and thus the Williamson’s hypothesis could not be positively verified at the NUTS3 level.

Figure 4. Relation between economic growth and regional inequalities in CEE countries (at the NUTS 3 level)



Source: own elaboration based on Eurostat.

The reason for this situation (lack of statistical significance of the independent variables) could be a relatively short period of analysis. It was assumed that the models estimated with data covering subsequent years (2014+) were eligible for inference concerning the nature of the relationship subject to the authors' deliberations.

The growing regional disparities stemmed primarily from the above-average growth rates recorded in metropolitan regions (often comprising capital cities) that remained beyond the reach of other regions. The privileged regions boasted the highest demographic and socio-economic potential and as such benefited most from the development impulses emerging after the period of political transformation in CEE. However, as the so-called diseconomies of scale emerge and the conditions for diffusion of growth impulses occur, further income growth in these regions will no longer outperform growth in other regions. This situation could be interpreted as a symptom of the relationship described by Williamson's inverse U-shaped curve.

Conclusions

In the light of the research conducted, it may be concluded that in the analyzed group of countries both convergence symptoms (reflected in moving of national economies toward each other), and divergent tendencies (reflected in the increase of economic diversification at NUTS 3 level) were observed. It was also noted that the CEE countries in the process of economic integration with the EU passed an analogous path to the one that had been identified before by Williamson among other developing countries and described in the form of an inverse U-shaped curve.

Williamson's hypothesis that explains the level of regional inequalities as dependent from economic growth could not be verified unequivocally. While the econometric models estimated at the cross-country level confirmed the parabolic shape of the relationship studied, the lack of statistical significance of the independent variables in the regional model indicated a non-parabolic shape of the sought function. Nevertheless, the high values of the coefficients of determination suggested that attempts to explain the variations of economic inequality observed in the analyzed years by the quadratic function of GDP per capita were justified, and the statistical data gathered in subsequent years confirmed the validity of observations that had been made half a century ago.

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Associations among employment and industries of Slovak economy

JEL Classification: *J21; Q01;R12*

Keywords: *employment; value chains; industry*

Abstract

Research background: Urban areas are as important as rural ones for regional development. This paper observes especially the position of cities, urban areas in the context of global value chains – GVC. Global value chains reflect specialization and labour division of companies, mostly multinational enterprises – MNEs. MNEs can be considered for flagships of some industries. Such flagship influence suppliers and purchasers. MNEs are a part of networks or do have got an access to such networks that combine dispersion of the value chain the boundaries of the firm and across national borders and.

Purpose of the article: The impetus of this humble work was to look at position of Slovak cities (Bratislava, Žilina) in order to look for sectors that can help to develop the city and its adjacent regions, particularly cross-border regions. The paper discussed how the attribute of the cross-border regions gives the cities more advantageous position in GVC.

Methodology/methods: Applying method of location quotient allowed to shed a light on GVC, which cities participate in. Some cities were in a position to take advantage of participation in GVC.

Findings: Examined cities are located in the western part of Slovak Republic. Discussion about the attribute of the cross-border regions can stimulate new ideas for finding causalities in city sprawl or in specialization patterns in industrial structure of the city. Discussion further fosters the comparison of two cities strengths and weakness of each of them that were summarized in terms of employment and industrial exploitation of GVC. It is the first finding and value added of the paper.

Second one, method of location quotient is simple, but provides clear evidence on the regional development or decline in particular industries and time of observation.

Introduction

Cities position in global world can either be embedded in the region or get disconnected from its own region. There exist particular sectors to urban economy such as services that observed rapid changes in a last few decades. The growth of these global cities is fed by location of transnational corporations, which does not have to apply to cities of smaller scale. Nonetheless, what applies is that "cities are key sites for the production of services for firms."(Sassen, 2002, pp. 13-30). The overview of the dispersion in terms of various jobs in production in two Slovak cities by sectors was a motivation for writing this paper. Similarly, the motivation could be found in observation of strengths and weakness of two cities with significant position in Slovak economy and at the same time cities being specific for its location both as a part of bordering regions and in western part of Slovakia.

Paper is organized in two parts. Part one it briefly names numerous literature that gives a context for explanation of objectives and relevant theories, followed by a notes on methods applied. Part two is analysis itself, i.e. examination of location quotient throughout industries in the urban area of two major cities located in boarder regions. Analysis took into consideration the skewness of the location quotient that resulted in an additional point of view. Method of location quotient was applied with dataset of employment in these two cities only in one year. The analysis emphasizes employment and companies` particularities and peculiarities in regions in question. Following description of entrepreneurial activities specific recommendations could be derived. Discussion provides reader with limitation of this paper as well as plausible or problematic parts of the research. Nonetheless conclusions are both general and particular for the cities observed. In this paper, the focus of research was to identify one possible way of measurement of the outputs and inputs in all industries in two city-regions of Slovakia: Bratislava and Žilina city.

Theoretical impetus

Living in a city or in some rural area have pros and cons as it is generally known. Science has come up with additional negative side effects of living in a city, namely sprawl. Authors of this term reflect a reality, which is preferred option by employed people. The option is to work in city and at the same time live very close to city, so to say half-way to rural area. To be accurate half-way to rural area means suburb of a city (Brueckner, 2000, pp. 160-171; Johnson, 2001, pp. 717-735; Jun, 2009, pp. 311-327). The sustainability of the city could be a future envisioned in the life of the regions, particularly the cross-border ones (Nevens, Frantzeskaki, Gorissen, & Loorbach, 2013, pp. 11-122). The methodology for multi-criterial assessment of city`s development in perspective of sustainability was suggested by Yigitcanlar at al. (Yigitcanlar, Dur, & Dizdaroglu, 2015, pp. 36-46). For instance, they introduce Micro-level Urban-ecosystem Sustainability Index.

Urban growth (Baus, Kováč, Pauditšová, Kohutková, & Komorník, 2014, pp. 104-111) is distinguished from urban sprawl (Pazúr, Feranec, Štych, Kopecká, & Holman, 2017, pp. 135-146; Verbeek, Boussauw, & Pisman, 2014, pp. 48-59). While the urban growth has meaning in population growth and growth of economic activities, the notion of urban sprawl emphasis stretching the boarders of city with some regard to economic activities as well to population. Urban sprawl is rather uncontrolled (Uhel, 2006), cities that are characterised by “non-sprawl” are also called “edge cities” or polycentric such as probably Manchester, Leeds (Pratt, 2009, pp. S109-S114). The need to travel might decrease due to an increase of jobs for “knowledge workers”, it is a picture of new worker and new human (Stallings, 2001, pp. 3-14). The more educated people live in the city the more they spend on local products and create a demand for further goods and services and vivid city life (Marlet & Van Woerkens, 2007, pp. 2605-2626). According to this study the presence of creative class in the city fosters urban development in terms of employment. Thus employing creative class distinction is valuable variable for explaining city growth in terms of employment and availability of jobs.

Exchange of routines or new managerial experience is fostered by labour market mobility, input-output linkages and reverse engineering (Fratesi & Senn, 2008). It is foreign direct investments – FDI that are noticeable at regional and national level as capital flows in the network of companies. As Zeleny correctly points out, the outsourcing process allowed that value added is being searched for more and thus the Shih`s smile curve is broader and deeper (Zeleny, 2007). Explanation was that added value is the measure of human knowledge, which again is searched globally.

The Heckscher-Ohlin-Vanek model – HOV - gives a basis to understanding the impact of globalization on labour market. This theory can apply to cities located near borders (Leamer, 2000, pp. 17-49). For instance, the food processing firms, once they produce in a value chain, they benefit from some kind of spillovers that make productivity a less stringent requirement for export (Giovannetti & Marvasi, 2016, pp. 110-125). This is also why the study provides an insight to export jobs.

Based on this context the main objective is to find out sectors localized in the cities that have a relatively significant position regarding the proportion with Slovak national localization. As it is explained in details with methodology and later illustrated with brief description. Identifying and confirming of these sectors could be considered factors for sprawl, growth and other phenomena presented above.

Research methodology

Location quotient (LQ) are the starting point of this humble research. As there exist several options on how to calculate location quotient as referred to book by Miller and Blair (Miller & Blair, 1985). In general, one can use location quotients to describe the situation of an area. In this paper the emphasis was given on cities. The basics of using location quotients can be found in the first formula, where x_i^r and x^r denote gross output of sector i in region r. Total output of all sectors at national level, denotes n, i.e. $x_i^n$and x^n.(Miller & Blair, 1985, p. 349).

$$LQ_i^r = \frac{x_i^r/x^r}{x_i^n/x^n} \quad (1)$$

This formula express how much each of the sectors contributes to the regional output in its numerator and to the national output in its denominator. As a consequence: the more the LQ exceeds 1, the more is the sector concentrated in the region compared with nation. Region in the following analysis it will be a city. The quotient refers to the most concentrated industry. The implementation of this LQ would be appropriate to support with the Wald test as suggested in explanation using dartboard test. This test provides valuable information on the substance of decision making to localization, i.e. independency and randomness (Capone & Boix, 2008, pp. 209-224; Guimaraes, Figueiredo, & Woodward, 2009, pp. 360-364). This test was mentioned here to provide a limitation of the study that can be an impetus for new and deeper research. Another test were recommended such as Kolmogorov-Smirnov (K-S) test for normality (O’Donoghue & Gleave, 2004, pp. 419-427). It is because LQ values shall approximate normality, otherwise the logarithmic transformation is recommended. This was done in respect to the fact that aggregation error is continuously of importance in regional input – output models. (Lahr & Stevens, 2002, pp. 477-507). Later on we use this quotients for broader analysis (Hsieh & Kung, 2013). The overall usefulness of using LQs can be underpinned by regional input coefficient that can be estimated (Anthony T. Flegg & Tohmo, 2013, pp. 703-721; A. T. Flegg & Webber, 1997, pp. 795-805). The data used for analysis was found in Statistical Office SR and World city report (Habitat, 2016).

Cities of border regions in Slovak republic: Bratislava and Žilina

Both Bratislava and Žilina are cities on the river stream, Dunaj and Váh river respectively. Comparing the urban area: Žilina covers 8 003 hectares and Bratislava 36 763 hectares. Despite this fact Žilina is the fourth largest city in Slovak republic and was selected for the study because of its geographic location. Further description of border regions gives details on region of Bratislava city, which is located about 55 kilometers from Vienna in Austria, which is noticeably hosting almost one third of total labour force in its quarters. While in Bratislava it is around half of this proportion, as seen in table 1. Next comparison is related to the city of Žilina, which can be reached from Polish cities: Katowice (177 km), Kraków (127 km) and Czech city Ostrava (76 km). Out of all cities Kraków can refer to the lowest unemployment, in the region of 3%.

Table 1. Comparing labour market characteristics of cities neighbouring slovak region

Metropolitan areas	**Labour force of the metropolitan area as a share of national value (%)**				**Employment of the metropolitan area as a share of national value (%)**				**Unemployment of the metropolitan area as a share of national value (%)**			
	2000	**2010**	**2013**	**2014**	**2000**	**2010**	**2013**	**2014**	**2000**	**2010**	**2013**	**2014**
Bratislava	14,7	14,6	14,3	14,2	16,7	15,8	15,5	15,3	6,5	7	7,2	7,4
Brno	6,1	6,1	6,3	...	6,2	6,1	6,3	...	5,8	6,5	6,2	...
Katowice	5,4	6,5	6,8	6,6	5,3	6,6	6,9	6,6	6,2	6,2	6,5	6,3
Kraków	3,6	3,3	3,5	3,4	3,8	3,4	3,5	3,4	2,6	3,2	3,7	3,5
Ostrava	5,5	5,2	5,1	...	5,1	5	5	...	8,9	7,2	7,3	...
Vienna	31,8	32,2	32	...	31,8	31,8	31,4	...	32,4	40,2	42,2	...

Source: based on data of World Cities Report 2016.

In the following we have applied the simple location quotient (LQ) for employment in two towns thought all industries (see table 2, where NA stands for „not applicable”). Previously mentioned knowledge worker and their jobs are to be noticed in economic activities (J – Information and communication), Bratislava 2,87 whereas in Zilina less 1,53. This location points out that region of Bratislava provides output from Information and communication services from 13 811 job positions, similarly Žilina from 760 job positions.

Table 2. Employment in thousands of persons concerning the export jobs and location quotient (as of 2014)

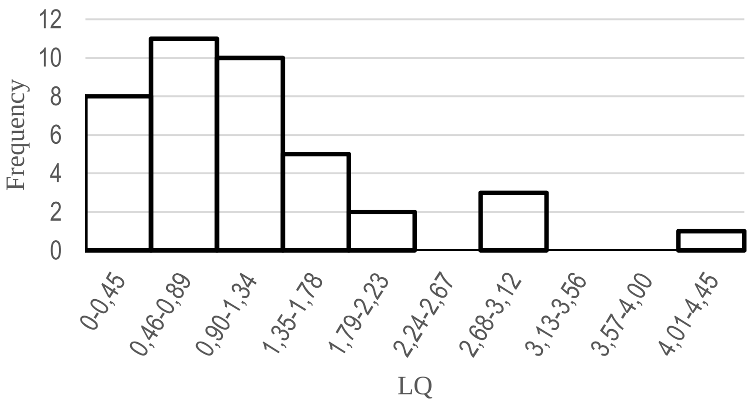
Of which: by economic activities of NACE Rev.2 (codes)			Bratislava LQ	Bratislava Export jobs	Žilina LQ	Žilina Export jobs
Agriculture		A	0,04	NA	0,21	NA
	Industry in total*	B,C,D,E	0,42	NA	0,91	NA
***Of which:**	Mining and quarrying	B	0,08	NA	1,06	17
	Manufacturing	C	0,41	NA	0,84	NA
	Electricity supply	D	0,29	NA	1,95	701
	Water supply, waste	E	0,36	NA	1,16	144
Construction		F	0,87	NA	2,04	2 424
Wholesale, retail trade		G	1,19	7 832	1,22	1 758
Transportation and storage		H	1,05	995	1,26	1 032
Accommodation, food services		I	1,31	1 433	0,33	NA
Information, communication		J	2,87	13 811	1,53	760
Financial, insurance activities		K	2,97	12 015	0,67	NA
Real estate activities		L	1,49	1 769	0,87	NA
Profession.,scient., techn. activit.		M	2,84	20 042	0,71	NA
Administrative services		N	1,61	6 111	0,84	NA
Public administration		O	0,98	NA	0,74	NA
Education		P	0,72	NA	1,26	1 367
Health		Q	0,83	NA	0,63	NA
Arts, entertaitment, recreation		R	1,52	2 121	1,07	57
Other service activities		S	1,50	1 356	0,75	NA

Source: Own elaboration, based on data of Statistical Office SR.

A services providing financial, insurance activities (K) is favorable for Bratislava, where 6 108 people work to provide for local demand and 12 015 provide for other regions. It is possible that these workers provide serves for demand in Žilina, because the location quotient for this economic activity there is 0,67. The opposite is true for industry of construction (F), where Bratislava `s location quotient is 0,87 and Zilina`s is 2,04. In Žilina there is 2 424 export jobs. The most favorable activities in Bratislava can be summarized as: Wholesale, retail trade; Transportation and storage; Accommodation, food services, Information, communication; Financial, insurance activities; Real estate activities; Administrative services; Arts, entertainment, recreation and other services. In Žilina the most favorable economic activities would be: Electricity supply; Water supply, waste, Construction; Wholesale, retail trade; Transportation and storage; Information, communication; Education and Arts, entertainment, recreation.

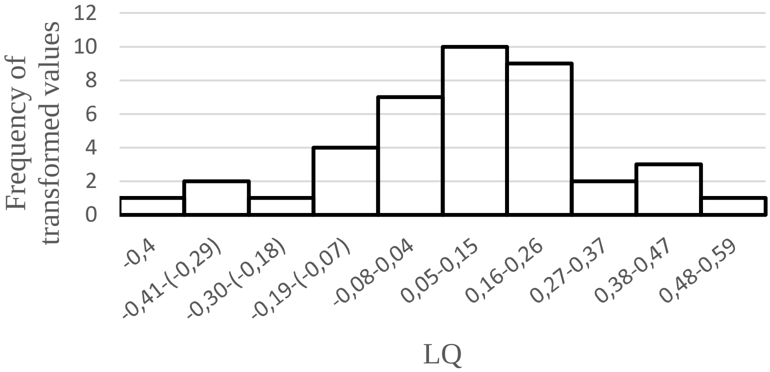
As seen in Figure 1 the skewness of location quotient is positive (1,7) and K-S test of normality approved that distribution is not normal (D(39)=2,14, p>0,05). Thus the Standardized Localization Quotient (SLQ) were obtained from logarithmic transformation (figure 2) using Box-Cox transformation (Freeman & Modarres, 2006, pp. 764-772), skewness of SLQ (-0,24). This way the outliers, statistically significant residuals could be identified. Statistically significant values of LQ were found in z-values (over 1,65) of the following activities and it is only in Bratislava for sectors: J (1,85), K (1,93), M (1,82). None sectors were identified in Žilina.

Figure 1 Measure of location quotient asymetry of the probability distribution



Source: Own elaboration, based on data of Statistical Office SR.

Figure 2 Standardized Location Quotient –after transfomation of data



Source: Own elaboration, based on data of Statistical Office SR.

Companies of border regions in Slovak republic: Bratislava and Žilina

The economic growth and improvement of competitiveness of national economy can be directly influenced either by small and medium enterprises (SME) in Slovakia within which were observed Bratislava and Žilina cities and its regions or by integration to network of companies and especially by integration to global value chains – GVC. These chains are coordinated by transnational corporations. The importance of this form of international labour division has risen significantly especially in the course of last two decades. This again is influencing economic position of national economy as well as competitiveness. In this context and upon the foreign experiences the paper took advantage of knowledge of the Slovak enterprises and large companies that were part of the GVC and global supply networks particularly in automobile industry. The automobile industry is a economic activity that had been using observably the international labour division since 90s of 20th century (Sturgeon & Van Biesebroeck, 2011). There were serious changes in intensity and architecture of such chains in reaction to global recession. At the same time the automobile industry is a flagship of the economic growth in Slovak Republic as noticeable from the presence of three large automobile companies in the country and two of them are situated in the regions in question, i.e.: Volskwagen SK, a.s. in Bratislava and Kia Motors Slovakia, s.r.o. in Teplička nad Váhom in Žilina region.

It is self-evident that automobile industry in Slovakia is not only the three large car producing companies, but also broad network of high quality suppliers that are both vertically included into global value chains and included to horizontal clusters.

According to data of Automotive Industry Association of the Slovak Republic (hereinafter „ZAP SR“) in 2016 there were 343 supplying companies to automobile industry. Out of this number it even 279 located in the western part of Slovakia, especially along the highway D1 from Bratislava (the capital) to Žilina and along the road R1 from Trnava to Banská Bystrica, 64 suppliers are located in eastern part of Slovakia. Among these are also large companies within foreign control. Such companies are suppliers of first haul (e.g. Continental, Johnson Controls, INA, Mobis, Magneti Marelli, Getrag Ford, Valeo, ZF, ArvinMeritor, Visteon, Faurecia, Lear, etc.) and suppliers of second haul (e.g. HBPO, Brose). This is true not only for automobile companies in Slovakia, i.e. they export its products. The most numerous group of the suppliers are suppliers of lower level, who supply components, parts of products, raw material such as metal parts, plastics, aluminum parts, textile and the like. This group also includes several foreign controlled companies together with domestic producers.

Business environment in Bratislava and Žilina region is relatively stable and friendly towards entrepreneurs. These regions were helped by FDI inflow, especially Volkswagen SK, Kia Motors Slovakia and subcontractors that are cooperating with local businesses. Direct consequence of FDIs and induced investments are reflected in statistics either employment ones or average wages. Employees praise opportunities of carrier promotions as well as educational opportunities, introducing newest technologies and social benefits.

The above description should illustrate the situation from qualitative point of view as an additional information to location quotient and employment data analysis.

Conclusions

Activities having higher value added could be fostered by the government policy focus especially on education, research and development and cooperation of universities (research institutions) with business sector. This policy in fostering cooperation shall bring about conditions for foreign investors to have an interest in establishing their economic activities with higher value added. This applies generally for joining of local enterprises to GVC. In praxis it is mostly SMEs, eventually also large companies that still are not included in GVC. SMEs need more attention in terms of information assistance (in order to provide knowledge on SMEs to foreign investors and vice versa in order to provide SMEs with information on opportunities of joining GVC available to them, as well as information on quality standards and other norms that such inclusion requires). Of key importance is also an financial support for SMEs.

There are main recommendations for government policies towards SMEs in GVC in the following theses:

- to provide information on market opportunities for subcontractors and potential foreign partners;
- to support expansion of domestic SMEs to abroad;
- by means of suitable tools support spreading of information among various chain parts of GVC, eventually motivate foreign investors to inform local companies on their intentions (while it is allowed or even required by their own global strategy)
- to support formation of companies` networks or clusters in local economy;
- to provide SMEs with workshops on the correct ways of the selection of the future cooperating partner; and so forth.

Given recommendation can contribute towards improvement in attractiveness (even taken into account by dartboard test) of local sector of SMEs to foreign investors. This also can in certain extant apply towards local business that they would achieve better position in the value chain. Still an unanswered question is how to secure financing such claims that are brought about with SMEs inclusion into GVC. Perhaps euro funds could be used here.

One can rephrase the result of tests that in Bratislava are outstanding the following sectors: Information, communication (J), Financial, insurance activities (K), Professional, scientific, technical activities (M). For Žilina the sector of Construction (F) can be mentioned. These sectors were influencing the growth and sprawl in its regions. As for the limitations: dartboard test suggested by Portuguese authors can contribute to better understanding of randomness of the localization process and at same time shad a light on urban sprawl.

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Testing European business cycles asymmetry

JEL Classification: *C12, C14, E32*

Keywords: *business cycle; asymmetry; Mills test; Mira test; Sichel test*

Abstract

Research background: One of business cycles stylized facts is that contractions are shorter than expansions, but less persistent, more volatile and therefore asymmetric. Investigating existence and type of business cycles asymmetry is important for analysis of economic policy and statistical modeling. Economic implication of business cycles asymmetry is that economic policy should be different in period of contractions than expansion. Statistical implication is that linear models of business cycles cannot capture this stylized fact.
Purpose of the article: The article has two objectives: extend the literature on the business cycles asymmetry by testing data from 36 European countries including countries never been analyzed before and test robustness of the results to extraction methods and asymmetry tests used.
Methodology/methods: Quarterly GDP series from Eurostat database covering period 2000q1-2016q3 were used. Series were prepared by removing seasonal component using X13-ARIMA procedure. To assess robustness of asymmetry tests results to alternative methods of detrending business cycles were extracted using two filters: Corbae-Ouliaris ideal band filter and double Hodrick-Prescott filter. For testing the deepness and steepness asymmetry three tests were used: Mills, Mira and Sichel tests.

Findings: Weaker evidence of deepness asymmetry was found in Cyprus, Montenegro and Turkey cycles where all three tests statistics for both filters have negative sign. However, only for one of the tests in each country the result was statistically significant. For two other countries, Germany and Sweden, four of six tests indicated deepness asymmetry, but only one of these tests results was statistically significant. Most of the cycles show steepness asymmetry, with exception of Ireland business cycles and to certain extent cycles of Poland, Malta, Montenegro and Spain.

Introduction

One of the business cycle stylised facts is that recessions are shorter than expansions, but less persistent, more volatile and therefore asymmetric. Investigating existence and type of business cycles asymmetry is important for analysis of economic policy and statistical modeling. Economic implication of business cycles asymmetry is that economic policy should be conditional on the stage of the cycle. Statistical implication is that linear models of business cycles cannot capture this stylised fact and therefore would be inefficient when applied. The main objective of this study is to explore whether European business cycles are asymmetric. More specifically the time series from the Eurostat database were used to achieve the following objectives:

– extend the literature on the business cycles asymmetry by testing data from 36 European countries including countries never been analysed before
– test robustness of the results to extraction methods and asymmetry tests used.

Research methodology

There are three methodological problems that have to be addresses when conducting research on business cycle asymmetry. They are related to preparation of time series, selection of cycle extraction methods and selection of asymmetry tests.

The quarterly time series of GDP at market prices (chain linked volumes, index 2010 = 100) seasonally unadjusted are extracted from the Eurostat Database. The sample period for most of the GDP series used in this study runs from 2000q1 to 2016q3. For Bosnia & Herzegovina and Montenegro quarterly GDP time series were not available, so the quarterly index of industrial production was used instead. Series were prepared by removing seasonal component using X13-ARIMA procedure. The logarithm of seasonally adjusted real GDP was used, so that the deviations around trend are expressed as percentages.

Cycle extraction methods

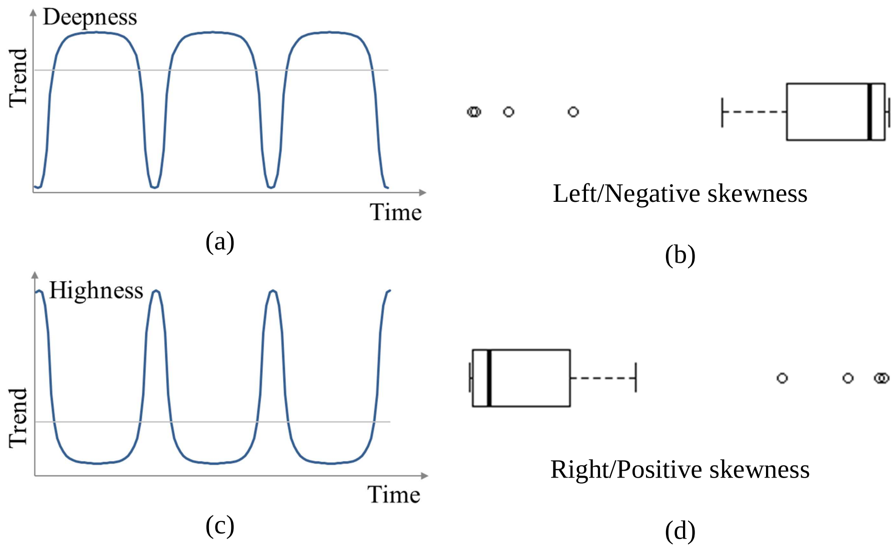
In order to assess how robust are the asymmetry tests results on using different extraction methods two filters were applied: Hodrick-Prescott (hereafter HP) and Corbae-Ouliaris (hereafter FD) filters. When applying HP filter the two-step procedure was used. For the smoothing parameter $\lambda = 1600$ was used. Since the extracted cycles still contain random component HP filter was applied for the second time. This time smoothing parameter $\lambda = 10$ was used. The other cycle extraction method used is FD filter (Corbae & Ouliaris, 2006). The advantage of FD filter over other filters is that it can handle series with nonstationarity (e.g. unit root and heteroscedasticity) without prior testing for type of nonstationarity.

Asymmetry tests

Sichel (1993) considers two different types of asymmetric patterns of cycle, i.e. deepness (business cycle troughs are deeper than peaks are tall) and steepness (business cycle contractions are shorter and sharper than expansions). Deepness asymmetry of business cycle is illustrated in Figure 1(a) and cycle highness on panel (c). Boxplots on panels (b) and (d) illustrate how asymmetric distributions are when there is deepness or highness in business cycles.

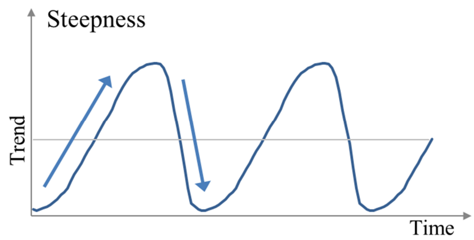
Steepness asymmetry is illustrated in Figure 2. The first difference of the cycle series would have the same graph as the graph in Figure 1(a). The null hypothesis in these tests is that a given distribution is symmetric about some unknown median, against a very broad class of asymmetric alternatives. More specifically, null hypothesis is that the business cycles have no deepness/steepness asymmetry against the alternative that cycles do have deepness/steepness asymmetry.

Figure 1. Deepness and Highness in business cycles



Source: own estimation.

Figure 2. Steepness in business cycles



Source: own estimation.

Sichel test

The asymmetry test proposed by Sichel (1993) is based on skewness of a cyclical series:

$$S = \frac{\frac{1}{N}\sum_{t=1}^{N}(c_t - \bar{c})^3}{\sigma(c)^3} = \frac{\mu_3}{\mu_2^{3/2}} \qquad (1)$$

where c_t is a cyclical component of time series; N is the length of time series; $\bar{c}$ and $\sigma(c)$ are mean value and standard deviation of a cyclical component c_t respectively and μ_j is j-th central moment of series c_t. When calculating the standard error of the test statistic (1) Sichel addressed the issue of possible autocorrelation and heteroscedasticity by using the following variable in the regression on a constant:

$$z_t = \frac{(c_t - \bar{c})^3}{\sigma(c)^3} \tag{2}$$

Estimated regression coefficient is identical to *S* statistic, and for testing its significance Newey-West standard error was used. Though, as pointed out by Mills (2001), this adjustment still does not adjust variance for non-normality. Such modified *t* statistic follows an asymptotic normal distribution.

Mills test

Mills (2001) suggested two corrections in the Sichel's test. The first correction addresses the problem of non-normality, and the variance of the test statistics is:

$$\sigma_S^2 = \frac{1}{N}\left(\frac{\mu_6}{\mu_2^3} - 6K + 9 + \frac{S^2}{4}(9k + 35) - \frac{3\mu_5\mu_3}{\mu_2^4}\right) \tag{3}$$

where *S* is the measure of skewness and $K = \frac{\mu_4}{\mu_2^{3/2}}$ is the measure of kurtosis. The second correction addresses the problem of autocorrelation by using the Newey-West adjustment. The variance of the test statistic *S* at lag l is:

$$\sigma_S^2(l) = \sigma_S^2\left(1 + \frac{2}{N}\sum_{j=1}^{l}\omega_j\rho_j\right) \tag{4}$$

where ρ_j is the j-th autocorrelation of series $\frac{c_t^3}{(\mu_2)^{3/2}}$ and ω_j is the weight $\omega_j = 1 - \frac{j}{l+1}$, with $l = 4\left(\frac{N}{100}\right)^{2/9}$. Statistic $Z_S = \frac{S}{\sigma_S(l)}$ has an asymptotic normal distribution. Statistically significant negative value of this statistic indicates deepness, while positive value indicates highness of the business cycle.

Mira test

Mira (1999) proposed the test based on the following statistic:

$$Z_g = \frac{g}{\sigma_g} \tag{5}$$

with $g = \bar{c} - c_{med}$, where $\bar{c}$ and c_{med} are mean and median respectively. Mira shown that Z_g statistic is asymptotically standard normal with $\sigma_g = \frac{(4\hat{\sigma}^2 + D^2 - 4DE)}{4N}$, with $\hat{\sigma}^2 = \frac{\sum_{t=1}^{N}(c_t - \bar{c})^2}{(N-1)}$, $E = \bar{c} - \frac{2}{N}\sum_{t=1}^{N} c_t I(c_t \leq c_{med})$ and $D = N^{1/5}\left(c_{1/2(N+N^{4/5})} - c_{1/2(N-N^{4/5}+2)}\right)$.

The first difference of business cycles would show negative skewness if the cycle shows steepness. So, the same three tests could be used to test the hypothesis of steepness asymmetry by simply replacing c_t with its first difference, i.e. Δc_t.

Results

Table 1 shows the results of the deepness asymmetry tests conducted for 36 European countries plus cycles of European Union (EU28) and Euro Area (EA19). Results vary across the tests and filters used. Negative values of the test statistics are in bold font. Only a few countries has all negative values for both filters and for all three tests. They are Cyprus, Montenegro and Turkey. For two other countries (Germany and Sweden), four of six tests indicated deepness asymmetry. However, as the *p*-values in parenthesis show, not all of these tests results are statistically significant. For instance, significant results were observed for the following countries: Cyprus (Mills test & HP filter), Germany (Mills & HP), Montenegro (Mira & FD), Portugal (Mills & HP) and Turkey (Mira & HP).

Overall, we can conclude that the business cycles for majority of European countries exhibit cycle symmetry and that the evidence of deepness asymmetry is very weak, depending on the tests and filters used.

Table 1. Deepness asymmetry tests of the business cycles (2000q1-2016q3)

	Mills test		Mira test		Sichel test	
Country	FD	HP	FD	HP	FD	HP
Austria	2.68 (0.00)	15.52 (0.00)	**-0.61** (0.54)	1.05 (0.30)	0.23 (0.89)	0.33 (0.91)
Belgium	15.40 (0.00)	5.05 (0.00)	1.13 (0.26)	1.78 (0.07)	0.34 (0.83)	0.35 (0.87)
Bosnia & Herz.	0.43 (0.33)	**-1.31** (0.10)	1.05 (0.29)	1.37 (0.17)	0.27 (0.79)	**-0.47** (0.51)
Bulgaria	2.73 (0.00)	52.18 (0.00)	3.20 (0.00)	2.64 (0.01)	0.77 (0.84)	1.31 (0.74)
Croatia	5.85 (0.00)	801.5 (0.00)	0.89 (0.37)	3.71 (0.00)	0.89 (0.78)	1.40 (0.76)
Cyprus	**-0.25** (0.40)	**-5.41** (0.00)	**-0.78** (0.44)	**-0.68** (0.50)	**-0.04** (0.97)	**-0.47** (0.93)
Czech Republic	2.32 (0.01)	6.85 (0.00)	3.72 (0.00)	0.58 (0.56)	0.66 (0.83)	0.71 (0.84)
Denmark	1.01 (0.16)	3.67 (0.00)	0.88 (0.38)	0.57 (0.57)	0.16 (0.93)	0.13 (0.96)
Estonia	0.06 (0.48)	0.12 (0.45)	0.89 (0.37)	0.87 (0.38)	0.09 (0.98)	0.13 (0.98)
Finland	1.11 (0.13)	2.90 (0.00)	0.60 (0.55)	1.97 (0.05)	0.32 (0.86)	0.41 (0.90)
France	0.54 (0.30)	0.26 (0.40)	0.79 (0.43)	1.55 (0.12)	0.00 (1.00)	0.02 (0.99)
Germany	**-0.55** (0.29)	**-1.68** (0.05)	1.06 (0.29)	0.37 (0.71)	**-0.09** (0.96)	**-0.07** (0.98)
Greece	0.12 (0.45)	**-0.91** (0.18)	0.72 (0.47)	1.38 (0.17)	0.05 (0.98)	**-0.22** (0.96)
Hungary	1.18 (0.12)	4.93 (0.00)	2.64 (0.01)	1.83 (0.07)	0.26 (0.85)	0.27 (0.92)
Iceland	1.08 (0.14)	2.54 (0.01)	1.26 (0.21)	0.95 (0.34)	0.73 (0.81)	0.87 (0.82)
Ireland	0.50 (0.31)	**-0.28** (0.39)	1.11 (0.27)	0.55 (0.58)	0.38 (0.83)	**-0.14** (0.97)
Italy	1.70 (0.04)	8.49 (0.00)	0.72 (0.47)	0.51 (0.61)	0.10 (0.95)	0.15 (0.94)
Latvia	0.33 (0.37)	0.51 (0.31)	2.44 (0.01)	2.05 (0.04)	0.47 (0.91)	0.53 (0.91)
Lithuania	0.44 (0.33)	0.78 (0.22)	0.42 (0.67)	0.50 (0.62)	0.49 (0.87)	0.57 (0.89)
Luxem-bourg	2.78 (0.00)	11.93 (0.00)	0.55 (0.58)	1.32 (0.19)	0.97 (0.74)	1.21 (0.77)
Macedonia, FRY	1.80 (0.04)	5.22 (0.00)	0.95 (0.34)	**-1.04** (0.30)	0.64 (0.62)	0.72 (0.20)
Malta	1.98 (0.02)	60.80 (0.00)	2.15 (0.03)	0.26 (0.79)	0.30 (0.82)	0.21 (0.93)
Montenegro	**-0.29** (0.38)	**-0.06** (0.48)	**-1.68** (0.09)	**-1.36** (0.17)	**-0.44** (0.72)	**-0.05** (0.95)
Netherlands	1.07 (0.14)	29.23 (0.00)	2.12 (0.03)	0.82 (0.41)	0.20 (0.90)	0.43 (0.83)
Norway	12.89 (0.00)	3.25 (0.00)	0.32 (0.75)	**-0.74** (0.46)	0.24 (0.92)	0.24 (0.94)
Poland	2.17 (0.02)	3.40 (0.00)	3.10 (0.00)	1.00 (0.32)	0.36 (0.86)	0.25 (0.90)
Portugal	0.66 (0.25)	**-38.26** (0.00)	0.39 (0.69)	**-0.44** (0.66)	0.09 (0.95)	**-0.26** (0.91)
Romania	0.77 (0.00)	43.74 (0.00)	1.41 (0.16)	1.92 (0.06)	0.51 (0.86)	1.47 (0.73)
Serbia	1.39 (0.08)	**-1.12** (0.13)	1.86 (0.06)	0.36 (0.72)	0.49 (0.92)	**-0.11** (0.92)
Slovakia	9.37 (0.00)	10.02 (0.00)	4.19 (0.00)	3.43 (0.00)	1.69 (0.68)	1.79 (0.73)
Slovenia	3.01 (0.00)	8.74 (0.00)	1.35 (0.18)	1.65 (0.10)	1.05 (0.74)	1.15 (0.77)
Spain	2.08 (0.02)	2.49 (0.01)	**-0.06** (0.95)	0.16 (0.88)	0.33 (0.90)	0.12 (0.99)
Sweden	**-0.60** (0.27)	**-0.84** (0.20)	2.01 (0.04)	0.65 (0.51)	**-0.15** (0.94)	**-0.07** (0.98)
Switzerland	3.57 (0.00)	26.31 (0.00)	1.38 (0.17)	1.36 (0.17)	0.33 (0.87)	0.34 (0.89)
Turkey	**-0.27** (0.39)	**-1.01** (0.16)	**-1.19** (0.23)	**-3.08** (0.00)	**-0.19** (0.91)	**-0.38** (0.88)
UK	4.06 (0.00)	11.35 (0.00)	2.10 (0.04)	2.69 (0.01)	0.49 (0.83)	0.40 (0.91)
EU28	8.71 (0.00)	20.83 (0.00)	0.60 (0.55)	1.03 (0.30)	0.63 (0.79)	0.55 (0.86)
EA19	6.19 (0.00)	28.55 (0.00)	0.76 (0.45)	0.61 (0.54)	0.48 (0.81)	0.47 (0.86)

Note: Negative values (bold font) indicate the deepness asymmetry. In case of Bosnia and Herzegovina and Montenegro industrial cycles were used in period 2006q1-2016q3 and 2010q1-2016q3 respectively. In case of Poland quarterly GDP series was available in period 2002q1-2016q3. Test results with *p*-values within parenthesis are based on cycles extracted using Corbae-Ouliaris (FD) and Hodrick-Prescott (HP) filters.
Source: own estimation.

Table 2 shows the results of the steepness asymmetry tests where negative values of the test statistics are in bold font. With a few exceptions (most prominent case is Ireland) a majority of European countries have a negative sign for all three tests and for both filters. That would strongly support the claim that European cycles exhibit steepness asymmetry. However, such claim should be made with caution because not all these negative values are indicating statistically significant result. For example, Sichel test for both filters shows that none of the results are significant. This could be a result of the test weakness and its sensitivity to outliers. As pointed out by Mills (2001) less evidence of asymmetries of Sichel test could be the result that the variance in the test statistic is not adjusted for non-normality.

Table 2. Steepness asymmetry tests of the business cycles (2000q1-2016q3)

	Mills test		Mira test		Sichel test	
Country	FD	HP	FD	HP	FD	HP
Austria	**-4.13** (0.00)	**-3.21** (0.00)	**-0.11** (0.91)	**-0.45** (0.65)	**-0.91** (0.66)	**-0.85** (0.76)
Belgium	**-3.39** (0.00)	**-3.31** (0.00)	**-1.42** (0.15)	**-1.48** (0.14)	**-0.71** (0.63)	**-0.80** (0.64)
Bosnia & Herz.	**-4.52** (0.00)	1.19 (0.12)	**-1.48** (0.14)	**-0.87** (0.38)	**-0.36** (0.71)	0.26 (0.72)
Bulgaria	**-14.0** (0.00)	**-17.3** (0.00)	**-1.94** (0.05)	**-1.55** (0.12)	**-1.41** (0.67)	**-1.45** (0.69)
Croatia	**-15.4** (0.00)	**-4.81** (0.00)	**-0.41** (0.68)	**-0.69** (0.49)	**-1.42** (0.58)	**-0.92** (0.74)
Cyprus	**-1.02** (0.15)	**-0.19** (0.42)	**-0.41** (0.68)	0.40 (0.69)	**-0.15** (0.92)	**-0.04** (1.00)
Czech Republic	**-15.3** (0.00)	**-6.41** (0.00)	**-2.01** (0.04)	**-2.84** (0.00)	**-1.28** (0.57)	**-0.98** (0.65)
Denmark	**-5.53** (0.00)	**-4.43** (0.00)	**-0.67** (0.50)	**-1.86** (0.06)	**-1.08** (0.69)	**-0.92** (0.74)
Estonia	**-36.5** (0.00)	**-161** (0.00)	**-1.14** (0.25)	0.54 (0.59)	**-1.65** (0.68)	**-1.15** (0.74)
Finland	**-7.09** (0.00)	**-5.33** (0.00)	**-0.94** (0.35)	**-0.57** (0.57)	**-0.91** (0.68)	**-0.97** (0.72)
France	**-4.16** (0.00)	**-3.43** (0.00)	0.16 (0.87)	**-2.16** (0.03)	**-0.94** (0.62)	**-0.88** (0.72)
Germany	**-6.03** (0.00)	**-2.89** (0.00)	**-0.29** (0.77)	**-0.40** (0.69)	**-1.14** (0.69)	**-0.74** (0.77)
Greece	**-2.29** (0.01)	**-3.93** (0.00)	**-1.19** (0.23)	**-0.60** (0.55)	**-0.15** (0.88)	**-0.52** (0.87)
Hungary	**-132** (0.00)	**-13.5** (0.00)	**-1.77** (0.08)	**-1.23** (0.22)	**-1.71** (0.59)	**-1.41** (0.57)
Iceland	**-15.2** (0.00)	**-5.65** (0.00)	**-0.91** (0.36)	**-1.64** (0.10)	**-0.42** (0.83)	**-0.76** (0.82)
Ireland	53.39 (0.00)	13.25 (0.00)	1.71 (0.09)	0.20 (0.84)	1.27 (0.59)	1.03 (0.67)
Italy	**-4.20** (0.00)	**-3.03** (0.00)	**-2.36** (0.02)	**-1.09** (0.28)	**-0.87** (0.64)	**-0.67** (0.75)
Latvia	**-152** (0.00)	**-46.9** (0.00)	**-1.76** (0.08)	0.25 (0.80)	**-1.50** (0.72)	**-1.06** (0.80)
Lithuania	**-5.0** (0.00)	**-45.5** (0.00)	**-2.19** (0.03)	**-1.28** (0.20)	**-2.27** (0.64)	**-1.64** (0.68)
Luxembourg	**-12.0** (0.00)	**-4.74** (0.00)	**-1.65** (0.10)	**-0.18** (0.86)	**-0.97** (0.71)	**-0.97** (0.75)
Macedonia, FRY	**-12.6** (0.00)	**-8.13** (0.00)	**-1.93** (0.05)	**-2.31** (0.02)	**-0.98** (0.65)	**-1.08** (0.47)
Malta	**-2.40** (0.01)	**-1.35** (0.09)	0.06 (0.95)	0.04 (0.97)	**-0.27** (0.77)	**-0.33** (0.83)
Montenegro	**-0.32** (0.38)	10.32 (0.00)	0.00 (1.00)	**-0.49** (0.63)	**-0.18** (0.86)	0.21 (0.85)
Netherlands	**-1.06** (0.14)	**-3.08** (0.00)	**-0.70** (0.48)	**-1.33** (0.18)	**-0.20** (0.89)	**-0.59** (0.72)
Norway	**-2.61** (0.00)	**-2.28** (0.01)	**-1.86** (0.06)	**-1.62** (0.11)	**-0.45** (0.96)	**-0.55** (0.78)
Poland	**-0.33** (0.37)	0.63 (0.26)	0.68 (0.50)	0.71 (0.48)	**-0.06** (0.97)	0.12 (0.94)
Portugal	**-1.10** (0.14)	**-3.42** (0.00)	**-0.83** (0.41)	**-1.97** (0.05)	**-0.14** (0.90)	**-0.51** (0.73)
Romania	**-29.5** (0.00)	**-9.86** (0.00)	**-0.48** (0.63)	**-1.36** (0.17)	**-1.19** (0.60)	**-1.38** (0.69)
Serbia	**-0.52** (0.30)	**-3.37** (0.00)	1.37 (0.17)	**-0.11** (0.92)	**-0.04** (0.97)	**-0.60** (0.78)
Slovakia	**-16.3** (0.00)	**-5.09** (0.00)	**-1.14** (0.26)	**-1.31** (0.19)	**-1.34** (0.60)	**-1.19** (0.65)
Slovenia	**-12.5** (0.00)	**-4.79** (0.00)	**-0.48** (0.63)	0.92 (0.36)	**-0.98** (0.62)	**-0.84** (0.74)
Spain	**-1.46** (0.07)	**-1.05** (0.15)	1.72 (0.09)	0.64 (0.52)	**-0.23** (0.83)	**-0.17** (0.92)
Sweden	**-3.22** (0.00)	**-2.12** (0.02)	**-0.83** (0.41)	**-2.15** (0.03)	**-0.79** (0.77)	**-0.57** (0.82)
Switzerland	**-4.81** (0.00)	**-4.08** (0.00)	**-0.47** (0.64)	**-1.72** (0.09)	**-0.84** (0.58)	**-0.80** (0.66)
Turkey	**-22.9** (0.00)	**-13.9** (0.00)	**-2.55** (0.01)	**-2.91** (0.00)	**-1.22** (0.39)	**-1.04** (0.63)
UK	**-8.28** (0.00)	**-15.2** (0.00)	**-1.63** (0.10)	**-1.54** (0.12)	**-2.15** (0.52)	**-1.85** (0.66)
EU28	**-14.3** (0.00)	**-5.05** (0.00)	**-2.23** (0.03)	**-0.88** (0.38)	**-1.43** (0.57)	**-1.05** (0.70)
EA19	**-6.35** (0.00)	**-3.79** (0.00)	**-2.05** (0.04)	**-0.75** (0.45)	**-1.12** (0.60)	**-0.85** (0.72)

Note: Negative values (bold font) indicate the deepness asymmetry. In case of Bosnia and Herzegovina and Montenegro industrial cycles were used in period 2006q1-2016q3 and 2010q1-2016q3 respectively. In case of Poland quarterly GDP series was available in period 2002q1-2016q3. Test results with *p*-values within parenthesis are based on cycles extracted using Corbae-Ouliaris (FD) and Hodrick-Prescott (HP) filters.
Source: own estimation.

Overall, Mills test does not reject the null hypothesis of symmetric distribution in 19% (FD filter) and 11% (HP filter) cases, while this percentages raise to 83% in case of Mira's test for both filters. Two tests (Mills and Mira) yielded for both filters statistically significant result indicating steepness asymmetry only for Czech Republic, Macedonia FRY and Turkey cycles.

Three tests results were significant for Bulgaria, France, Italy, Lithuania, Sweden, EU28 and EA19 indicating that for these countries the contraction period in the economic activities were generally faster and shorter than expansionary phases

When comparing our results with results in other studies it is evident that results even for the same country depend on the period covered, changing nature of asymmetry, series, filters and tests used. However, the overall results confirmed the results and main conclusion of Astolfi et al (2015), Chirila (2012) and Chirila & Chirila (2012) studies.

Conclusions

This paper analysis 36 European countries GDP data in order to detect the presence and type of asymmetries in their business cycles. Two cycle extraction methods were used: HP and FD filters, with three asymmetry tests to address the second objective of the study, i.e. robustness of the results. In spite of differences in the period covered and countries include between our study and other studies, our results confirm previous results that only a few European countries cycles show deepness asymmetry. At the same time most of the countries cycles show steepness asymmetry.

More specifically, weaker evidence of deepness asymmetry relative to trend was found in Cyprus, Montenegro and Turkey cycles where all three tests statistics for both filters have negative sign. However, only for one of the tests in each country the result was statistically significant. For two other countries, Germany and Sweden, four of the six tests indicated deepness asymmetry, but only one of these tests results was statistically significant. Most of the cycles show contractionary steepness relative to trend, with exception of Ireland business cycle and to certain extent cycles of Poland, Malta, Montenegro and Spain.

Variations in the test results across three tests and two filters indicated sensitivity of the test results suggesting that the results should be interpreted and used with great caution.

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Social convergence in Nordic NUTS-3 regions

JEL Classification: *C10,C43, I31, R12,*

Keywords: *social convergence, Nordic regions, standard of living, taxonomy spatial measure of development*

Abstract

Research background: Geographical proximity, common historical roots and collaboration within the Nordic Council make the Nordic countries, often wrongly treated as monoliths. However, in reality, Nordic regions differ in terms of broadly defined social and economic development. Issues concerning the standard of living are one of the priorities of the Helsinki Treaty signed by Nordic countries.
Purpose of the article: The main goal of this paper is to analyze the existence of the social convergence in the Nordic NUTS-3 regions over the 2000-2015 period. The social convergence refers to a reduction in the dispersion of the standard of living across regions. Result of this analysis may be helpful in evaluating the efficiency of the activities under third and fourth Nordic Strategy for Sustainable Development.
Methodology/methods: The spatial taxonomy measure of development proposed by Pietrzak was used as the standard of living approximation. Inclusion of spatial relationships in the construction of taxonomic measure of development is justified as regions are not isolated in space and can be affected by other units. The existence of beta-, sigma- and gamma convergence was tested for global spatial aggregate measure and as well for sub-groups of determinants forming the standard of living.
Findings: The analysis showed that the regions with the highest standard of living are those situated on the west coast of Norway. Regions with the lowest standard of living were regions located in central Finland. However the most important part of this research was to investigate the existence of beta-, sigma- and gamma- social

convergence. The results show that there is no convergence for global standard of living measure. However the convergence occurs in groups of determinants of education and health care.

Introduction

The main goal of this research is to analyze the social convergence in the Nordic NUTS-3 regions over the 2000-2015. In this article social convergence refers to a reduction in the dispersion of the standard of living across regions. In this paper the definition proposed by Bywalec and Wydmus (1992, pp. 669-687) has been used. It refers to the level of wealth, comfort, material goods and necessities available to a certain socioeconomic class in a certain geographic area.

The subjects of interest in this article are Nordic NUTS-3 regions. Nordic regions were chosen for several reasons. Firstly, Nordic countries stand out against the background of today's developed countries, not only in terms of a higher standard of living (OECD Better Life Index 2013, pp. 1-2; Human Development Report 2015, pp. 20-22; World Happiness Report 2017, pp. 22-27) but also the relatively better conditions of their economies. Secondly, in 1952, Nordic Council was formed and in 1962 the Nordic countries signed the so-called 'Helsinki Treaty' which regulates cooperation between them. Nordic Council implemented the fourth strategy for the sustainable development of the Nordic region (A Good Life in a Sustainable Nordic Region. Nordic Strategy for Sustainable Development 2013, pp. 5-32). In this strategy, the emphasis is on cooperation leading to higher employment, green economic growth and increasing the competitiveness of the economies but also the safe, healthy and decent life of inhabitants. Thirdly, it should be remembered that the good of society is deeply rooted in the traditions of the Nordic countries. Starting from the beginning of the twentieth century when *folkhemmet* concept was launched in Sweden until nowadays. Folkehemmet can be translated as 'a home for society' where everybody contributes and everybody counts, and an emphasis is on equality and mutual understanding. Finally, due to their geographical proximity and common historical roots, the Nordic countries are often wrongly treated as unity. However, in reality, different regions of the Nordic countries are diverse in terms of socio-economic development.

Research methodology

As it was mentioned in the introduction the social convergence in this article refers to the reduction of disparities in the standard of living among regions. To evaluate standard of living spatial taxonomy measure of development according Pietrzak (2014, pp. 181-201) was used as this approach allows the occurrence of different potential strength of interaction for each variable.. It is worth mentioning here that inclusion of spatial factor into socio-economic analysis getting popularity in contemporary researches (Antczak, 2013, pp. 37-53; Pietrzak, 2014, pp. 181-201; Pietrzak et al., 2014, pp. 135-144; Sobolewski et al., 2014, pp. 159-172; Vu et al, 2014, pp. 6400-6417; Pietrzak, 2016a, pp. 69-86; Pietrzak, 2016b, pp. 47-58).

The procedure of calculating spatial taxonomy measure of development (sTMD) according to Pietrzak is as follows:

1. Testing the presence of spatial autocorrelation using Moran's I statistics:

$$I = \frac{n}{\sum_i \sum_j w_{ij}} \cdot \frac{\sum_{i=1}^{n} \sum_{j=1}^{n} w_{ij} (x_i - \bar{x})(x_j - \bar{x})}{\sum_{i=1}^{n} (x_i - \bar{x})^2} \quad (i = 1,..,n;\ j = 1,...,n) \quad (1)$$

where:

I - the value of Moran's I statistics;

n - number of observations;

w_{ij} - spatial weight matrix;

x_i, x_j - the value of analysed variable in *i* and *j* objects;

$\bar{x}$ - the mean average of analysed variable.

The variables for which the value of Moran's I statistic are statistically significant are included in the group of 'spatial' variables and otherwise - in the group of variables having no spatial character. In this research, spatial contiguity weight matrix was used, since it is the most frequently used in the studies, taking into account the spatial relationship. These weights indicate whether regions share a common boundary or not.

$$w_{ij} = \begin{cases} 1, & bnd(i) \cap bnd(j) \neq \varnothing \\ 0, & bnd(i) \cap bnd(j) = \varnothing \\ 0, & i = j \end{cases} \tag{2}$$

Spatial weight matrix was row standardised.

2. Estimating the SAR model for each variable from ‘spatial’ group of variables (LeSage, 1999):

$$\mathrm{X}_{\mathrm{j}} = \rho \mathrm{W} \mathrm{X}_{\mathrm{j}} + \varepsilon \tag{3}$$

where:

X_{j} - the vector of analysed *j* variable;

ρ - the spatial autoregression parameter;

W - the spatial weight matrix;

ε - the spatially correlated residuals.

3. Preparing the set of diagnostic variables:

3.1. Adjusting the values of variables from ‘spatial’ group according to formula:

$$\mathrm{S}_{j} = (I - \rho \mathrm{W})^{-1} \mathrm{X}_{j} \tag{4}$$

where:

S_{j} - the vector of spatially adjusted *j* variable;

I - identity matrix;

ρ - the spatial autoregression parameter,

W - the spatial weight matrix.

3.2. Remaining unchained the values of variables from ‘non-spatial’ group.

4. Changing destimulants for stimulants and standardise variables according to Hellwig's formula:

$$z_{ij} = \frac{x_{ij} - \overline{x}_j}{s_j} \quad (i = 1,...,n;\ j = 1,...,m) \tag{5}$$

where:

z_{ij} - standardised value of *j* variable in *i* object;

x_{ij} - the value of *j* variable in *i* object;

$\overline{x}_j$ - the mean average of *j* variable;

s_j - the standard deviation of *j* variable.

5. Calculating the distance between the i object and 'ideal' object:

$$d_i = \sqrt{\sum_{j=1}^{m} \left(z_{ij} - \varphi_j\right)^2} \quad (i = 1,...,n;\ j = 1,...,m) \tag{6}$$

where:

z_{ij} - standardised value of *j* variable in *i* object;

φ_j - value of *j* variable in the 'ideal' object.

6. Calculating the spatial taxonomy measure of development (sTMD) according to formula:

$$sTMD_i = 1 - \frac{d_i}{d_{i-}} \quad (i = 1,...,n) \tag{7}$$

where:

$$d_{i-} = \overline{d} + 2s_d \quad (i = 1,...,n) \tag{8}$$

$sTMD_i$ - the taxonomy spatial measure of development for the county *i*;

d_i - the distance between object *i* and 'ideal' object;

$\bar{d}$ - the average value of *d* vector ($d = d_1,...,d_n$);
s_d - the standard deviation of *d* vector.

The higher the value of $sTMD_i$ the better from the point of view of analysed phenomena.

Values of sTMD were the basis for the beta-, sigma- and gamma-convergence analysis. Firstly the beta-convergence was tested, as the existence of beta-convergence is a necessary, but not sufficient, condition for existence of sigma- and gamma-convergence (Sala-i-Matin, 1996, pp. 1019-1036). In this research a growth equation model was used to examine the existence of beta-convergence:

$$g_i = \alpha + \beta sTMD_{i,0} + \varepsilon_t \tag{9}$$

where:
$sTMD_{i,0}$ - the value of spatial taxonomy measure of development in region *i* at the first year of analysis,
g_i - the average change of the value of spatial taxonomy measure of development over time, calculated as:

$$g_i = \frac{1}{T} \log \frac{sTMD_{i,T}}{sTMD_{i,0}} \tag{10}$$

where:
T - number of analyzed periods,
$sTMD_{i,T}$ - the value of spatial taxonomy measure of development in region *i* at the last year of analysis.

A negative relationship between the growth rate and the initial level of the standard of living (*β* must be negative and statistically significant) is evidence that the followers are catching up with the leaders (Barro & Sala-i-Matin, 1992, pp. 223-251).

For areas in which beta convergence occurs, the presence of sigma and gamma convergence was also tested. Sigma-convergence refers to a reduction of disparities among regions. In this research, the standard deviation of a log-transformed spatial taxonomy measure of development (sTMD) was used as a measure of sigma-convergence. To test if the sigma-convergence exists, a linear trend model was estimated:

$$S_{sTMD} = \alpha_0 + \alpha_1 t + \varepsilon_t \tag{11}$$

where:
S_{sTMD} - standard devotion of log-transformed sTMD.

Sigma convergence occurs when α_1 is negative and statistically significant.

At the last stage of analysis, gamma convergence was investigated. It is a concept proposed by Boyle and McCarthy (1999, pp. 343-347). Gamma convergence usually is based on comparison of linear ordering of analyzed regions. Simple measure that captures the change in rankings is Kendall's index of rank concordance calculated as:

$$\tau = \frac{C - D}{n(n-1)} \tag{12}$$

where:
C - the number of concordant pairs,
D - the number of discordant pairs,
n - the number of observations.

Empirical analysis

The main goal of this paper is to analyze the existence of the social convergence in the Nordic NUTS-3 regions over the 2000-2015 period. The subject of analysis are 67 NUTS-3 regions of Nordic countries in 2000-2015 period. The standard of living was calculated based on a set of 18 diagnostic variables, divided into 9 groups (Table 1).

Table 1. The set of diagnostic variables.

Domain	Variables
Population	x_1 - the net migration rate (S),
Labour market	x_2 - the unemployment rate (D), x_3 - the average income of household in euro (current prices) (S),
Health care	x_4 - the number of deaths due to tuberculosis per 100 000 inhabitants (D), x_5 - the number of deaths due to malignant neoplasm per 100 000 inhabitants (D), x_6 - the number of deaths due to heart diseases per 100 000 inhabitants (D), x_7 - the number of new AIDS cases per 100 000 inhabitants (D), x_8 - the number of physician per 100 000 inhabitants (S),
Education	x_9 - the number of students in tertiary education per 1000 inhabitants (S),
Leisure time	x_{10} - the number of hotels per 1000 inhabitants (S), x_{11} - the number of museums per 100 000 inhabitants (S),
Living conditions	x_{12} - the number of new dwellings completed per 1000 inhabitants (S),
Transport and communication	x_{13} - transport infrastructure in km per km2 of land area (S), x_{14} - the number of cars per 1000 inhabitants (S),
Social security	x_{15} - the number of suicides per 100 000 inhabitants (D), x_{16} - the number of divorces per 1000 marriages (D),
Natural environment	x_{17} - protected area as % of land area (S), x_{18} - the CO_2 emission in kg per capita per year (D).

Source: Author's own investigation. (S) – for stimulants, (D) – for destimulants.

At the first step of analysis the presence of spatial autocorrelation was tested using Moran's I statistics (1). Half of the used variables revealed spatial autocorrelation (x_1, x_2, x_3, x_4, x_7, x_9, x_{13}, x_{14}, x_{18}). Therefore, the inclusion of spatial factor in the construction of synthetic measure seems reasonable. For each variable that belongs to 'spatial' group in each period a SAR model (3) was estimated. Then sTMD was calculated according to (4)-(8). Obtained sTMD values for 2000 and 20015 are presented in Table 2.

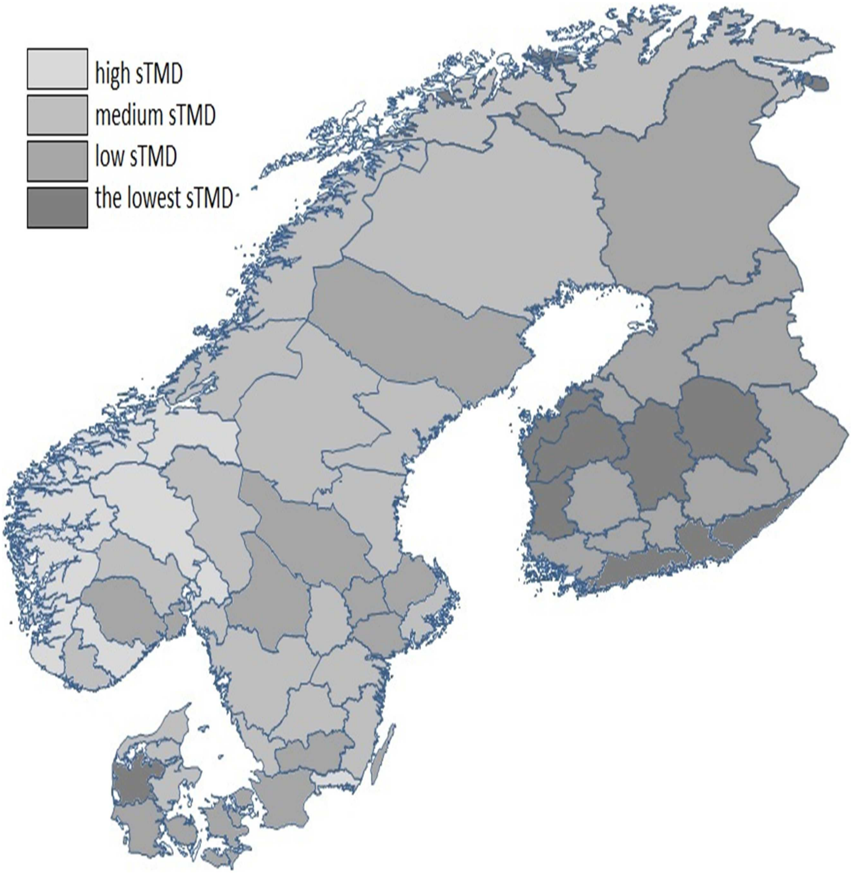
Analysing data presented in the table 2, one can see that regions with the highest standard of living in 2000 were: Oslo, Sør-Trøndelag, Rogaland, Møre og Romsdal and Blekinge. In 2015 the top 5 regions were: Sør-Trøndelag, Rogaland, Oslo, Møre og Romsdal and Hordaland. The highest standard of living was observed mostly at the west-coast of Norway, which is connected with well development industry, especially oil and petrochemical industry, affording high employment and relatively higher earnings, which have an impact on the material aspect of the inhabitants' standard of living. On the other hand, the lowest standard of living in 2000 was observed in following regions: Etelä-Pohjanmaa, Satakunta, Pohjois-Savo, Kymenlaakso and Keski-Suomi. In 2015 the bottom 5 regions were: Satakunta, Kymenlaakso, Pohjanmaa, Keski-Suomi and Etelä-Pohjanmaa. The regions with the lowest standard of living are forested regions of central Finland, with poorly developed industry, communications infrastructure and high unemployment. (see Figure 1 and 2).

Table 2. Values of sTMD in year 2000 and 2015

Region	sTMD		Region	sTMD		Region	sTMD	
	2000	2015		2000	2015		2000	2015
Byen København	0,436	0,494	Hordaland	0,497	0,582	Jämtland	0,415	0,402
Københavns omegn	0,382	0,403	Sogn og Fjordane	0,512	0,531	Västerbotten	0,347	0,385
Nordsjælland	0,371	0,366	Møre og Romsdal	0,542	0,652	Norrbotten	0,431	0,437
Østsjælland	0,315	0,358	Nordland	0,444	0,459	Pohjois-Savo	0,281	0,324
Vest- og Sydsjælland	0,362	0,370	Troms	0,424	0,461	Pohjois-Karjala	0,330	0,327
Fyn	0,352	0,354	Finnmark	0,403	0,453	Kainuu	0,324	0,319
Sydjylland	0,369	0,361	Stockholm	0,410	0,442	Uusimaa	0,304	0,373
Vestjylland	0,302	0,359	Uppsala	0,385	0,400	Itä-Uusimaa	0,375	0,398
Østjylland	0,421	0,422	Södermanland	0,343	0,382	Varsinais-Suomi	0,354	0,355
Nordjylland	0,405	0,408	Östergötland	0,329	0,381	Kanta-Häme	0,352	0,356
Oslo	0,757	0,693	Örebro	0,443	0,454	Päijät-Häme	0,332	0,350
Akershus	0,511	0,532	Västmanland	0,460	0,476	Kymenlaakso	0,283	0,253
Hedmark	0,428	0,435	Jönköping	0,407	0,440	Etelä-Karjala	0,299	0,322
Oppland	0,514	0,516	Kronoberg	0,357	0,385	Satakunta	0,241	0,219
Østfold	0,404	0,409	Kalmar	0,362	0,403	Pirkanmaa	0,352	0,341
Buskerud	0,457	0,490	Blekinge	0,529	0,554	Keski-Suomi	0,286	0,290
Vestfold	0,385	0,405	Skåne	0,432	0,457	Etelä-Pohjanmaa	0,239	0,296
Telemark	0,355	0,383	Halland	0,424	0,425	Pohjanmaa	0,301	0,284
Aust-Agder	0,507	0,550	Västra Götaland	0,420	0,451	Keski-Pohjanmaa	0,312	0,313
Vest-Agder	0,488	0,510	Värmland	0,390	0,388	Pohjois-Pohjanmaa	0,325	0,332
Rogaland	0,599	0,707	Dalarna	0,385	0,429	Lappi	0,339	0,340
Sør-Trøndelag	0,730	0,799	Gävleborg	0,416	0,427			
Nord-Trøndelag	0,453	0,493	Västernorrland	0,429	0,448			

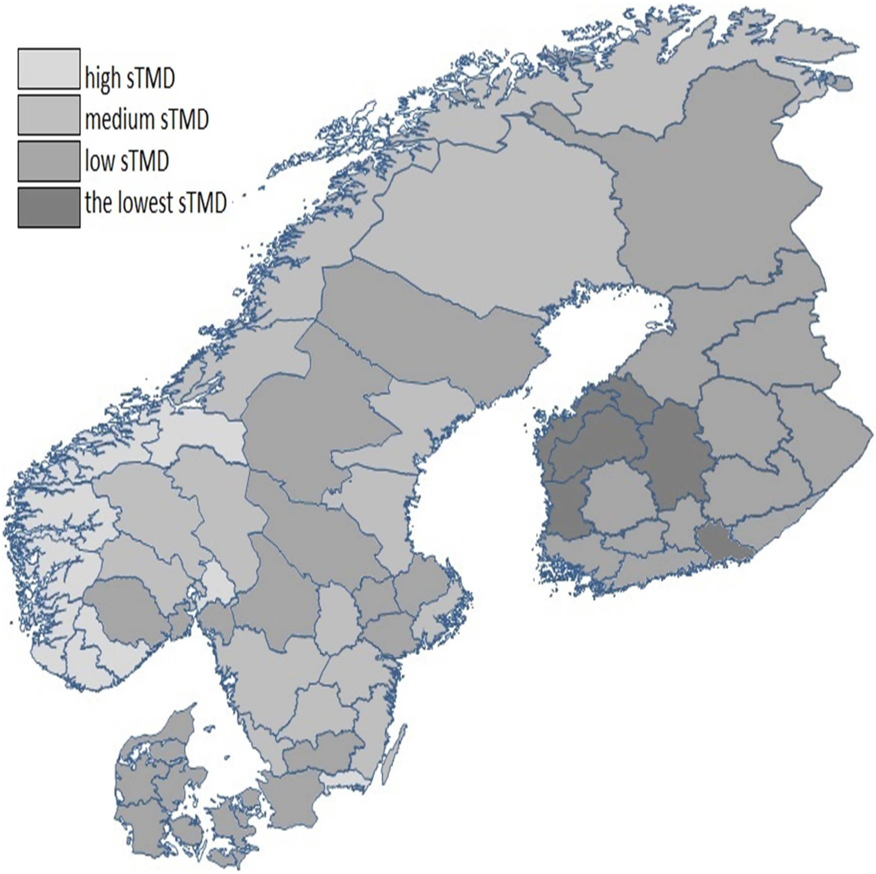
Source: Author's own investigation.

Figure 1. Similar group of Nordic NUTS-3 regions in terms spatial taxonomy measure o development value in 2000.



Source: Author's own investigation.

Figure 2. Similar group of Nordic NUTS-3 regions in terms spatial taxonomy measure o development value in 2015.



Source: Author's own investigation.

The main part of this research is to analyze the existence of beta-, sigma- and gamma- convergence among Nordic NUTS-3 regions. Analysis was conducted not only for standard of living measure but also for synthetic variables describing each domain of standard of living. The study was conducted this way because the occurrence (or absence) of convergence for the standard of living as a whole does not necessarily imply the existence (or absence) of convergence in its particular domain.

Firstly, the existence of beta-convergence was tested, according formula (9). Results of this analysis are presented in Table 3.

Table 3. Absolute beta-convergence in the standard of living domains.

Domain	α	β	R^2
Standard of living	0,0012	0,0003	0,0004
Population	0,0074	-0,0246	0,0098
Labour market	0,0080	-0,0083	0,0027
Health care	0,6181 ***	-1,4585 ***	0,2673
Education	0,0650 ***	-0,1087 ***	0,1429
Leisure time	0,0190 ***	-0,0282	0,0473
Living conditions	0,0135 ***	-0,0238	0,0393
Transport and communication	0,0296 ***	-0,0461	0,0855
Social security	0,0059	0,0047	0,0548
Natural environment	0,0120	-0,0018	0,2153

*** p<0,01; ** p<0,05; * p<0,01
Source: Author's own investigation.

As can be seen in Table 3, conditions for the existence of beta convergence are fulfilled only for two dimensions, i.e. health care and education. It can be therefore stated that regions with initially lower standard of living are not developing fast enough to catch up regions with initially higher standard of living. The same situation is taking place in most of the standard of living domains.

The analysis of sigma and gamma convergence is only possible for two standard of living dimensions, i.e. health care and education. As the occurrence of beta convergence is a necessary, but not sufficient condition for existence of sigma- and gamma-convergence. So in the next step of analysis the social sigma convergence was examined using formula (11). Results are presented in Table 4.

Table 4. Sigma-convergence in the standard of living domains.

Domain	α	α_1	R^2
Health care	0,0875 ***	-0,0023 ***	0,8526
Education	0,1030	0,0009	0,0951

*** p<0,01; ** p<0,05; * p<0,01
Source: Author's own investigation.

Analysing Table 4, it can be seen that sigma convergence occurs it the health care domain. It means that disproportions among regions in terms of health care are decreasing. In education area sigma convergence does not occur, so even though that weaker regions are developing faster than stronger one, the differences between them are still quite high.

At the last step of analysis the existence of gamma convergence was tested using formula 12. Once again only for domains in which beta-convergence occurred. Results are presented in table 5.

Table 5. Gamma-convergence in the standard of living domains.

Domain	τ	p-value
Health care	0,8436	<0,0500
Education	0,7349	<0,0500

*** p<0,01; ** p<0,05; * p<0,01
Source: Author's own investigation.

As can be seen in table 5, τ takes high, statistically significant values so there is a high rank concordance between 2000 and 2015. This is why it can be claimed that gamma-convergence does not occur neither in health care nor education domain.

Conclusions

Main goal of this paper was to analysis the existence of social convergence in the Nordic regions in period 2000-2015. Pietrzak's spatial taxonomy measure of development was used to determine inhabitants' standard of living in each region. The results of the analysis indicate that there is no social convergence in the standard of living and in most of its domain. The exception are the education sector for which beta convergence occurs, and the health care sector, where beta and sigma convergence have emerged.

Although the Nordic countries appear to be one strong monolith, it has been shown that the regions differ strongly among themselves. It should be not surprising that Nordic Council and Nordic Council of Ministers are implementing another strategy for sustainable development, as there is still much to do in terms of sustainability of Nordic region.

Future research will focus on the impact of immigration on the standard of living and social convergence in the Nordic regions.

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The most valuable global brands and condition of economies: a spatial approach

JEL Classification: *F63, M31*

Keywords: *GDP; brand value; spatial economics*

Abstract

Research background: Brands are considered to be the most valuable asset of a company. Some of them achieve spectacular global results. The significance of global brands is proved by the fact that their value is often greater than the sum of all company's net assets.
Purpose of the article: The aim of this article is to highlight that brand value does not only create company's value but also leverages economies. We claim that even though global brands are sold worldwide they more strongly contribute to the development of economies in the countries where these brands' owners are located.
Methodology/methods: Based on 500 Brandirectory, the most Valuable Global Brands ranking powered by Brand Finance, we have discovered a spatial-economic autocorrelation to illustrate the potential interdependency between GDP and brand value which constitutes a foundation for further construction of a spatial regression model. Because the ranking data was only available for the year 2014, the analyses were performed for 33 selected countries.
Findings: Our findings confirm the hypothesis that assumptive spatial dependencies matter for the investigated relationship between brand value and GDP. The evidence is based on the spatial error and the spatial lag model, although the former has a slightly better performance than the latter alternative.

Introduction

Brands are considered to be the most valuable asset of a company (Kamakura & Russel, 1993, pp. 9-22; Barwise et al., 1990, pp. 43-59). Some of these brands achieve spectacular global results. Referring to the 500 Brandirectory 2016, the most Valuable Global Brands ranking powered by Brand Finance, ex. the value of No 1: Apple, is: $145,918 m. The significance of global brands is proved by the fact that their value is often greater than the sum of all the company's net assets (Barwise et al., 1989, pp. 34). The meaning of brands for businesses, companies, and corporations is evident (Zéghal & Maaloul, 2011, pp. 262-274; Belo, Lin &Vitorino, 2014, pp. 150-169). Therefore, the research question is: do global brands only create company's value or also leverage countries' economies?

The knowledge-based 'network economy' has contributed greatly to economic growth in recent years (Malik, Ali & Khalid, 2014, pp. 32-48). According to Nakamura (2010, pp. 135–155), intangible investment expenditures have risen from roughly 4% of U.S. GDP in 1977 to 9–10% in 2006. Referring to World Bank estimates (Hamilton, et al., 2005, pp. 61-70), approximately 78% of the world's wealth is attributed to intangible capital. In developing nations, intangible capital accounts for 59% of the wealth, while in OECD countries this share is approximately 80%. Intangible capital is an important argument of a nation's wealth. The 'new economy' is underpinned by intangible capital (De, 2014, pp. 25-42) such as brands. Brand builders are the new primary producers in our so-called knowledge economy' (Klein, 2000, pp.196). Thus, we have decided to examine how global brands contribute to the development of economies of the countries where these brands' headquarters are located. We are going to start with the current literature review looking for the answer.

Only a few scientific articles correspond with our research question. Perhaps the reason is that the answer requires multidisciplinary research at the intersection of Management, Marketing, Economics and Statistics. Referring to Pike (2009, pp. 190-213; 2013, pp. 317-339) the conclusion about brands and branding geographies is that they have the potential to stimulate a novel approach to addressing spatial questions at the intersections of economic, social, cultural, political and ecological geographies. Particularly, referring to Pike (2015, pp. 40-53), one of the most important approaches of branding geographies is spatial circuits of brand value and meaning and uneven development. Referring to this field, one of the most interesting papers was written by Ferilli, et al. (2016, pp. 62-75) who examined the correlation between the Top 100 Most Valuable Global Brands positioning and positioning of the corresponding countries in terms of quality perceptions. Their findings suggest that although the correlation between positioning of a country and positioning of corporate brands exists, it strongly depends on particular categories and economy sectors which present different levels of representativeness of the country's most typical attributes. Although the presented results display a strong connection between the most valuable brands and their countries of origin, there is no evidence supporting the existence of a connection between brand value and a particular country's economic condition. Thus, we have decided to examine how global brands contribute to the development of economies. Referring to Wang, et al., (2015, pp. 93-102) Gross Domestic Product per capita (GDPpc) is widely accepted among several social-economic indicators as the most efficient indicator of per capita economic condition. This is why we have decided to choose the GDPpc as an indicator of the economy's condition. To our knowledge, our paper is the first study that examines the potential interdependency between brand values and GDPpc of the countries where these brands' headquarters are located. Next, it will constitute a foundation for construction of a spatial regression model.

Method of the research

The empirical analysis was performed in a few stages. In the first of them we made a preliminary assessment of statistical significance of the relationship and spatial autocorrelation for brand values, which constituted the basis for selecting the final form of regression model. Next, we estimated coefficients of the most appropriate form of spatial regression model. The brand value data was accepted on the basis of the yearly published ranking of brand value Branddirectory 500 top global brands 2014 ranking powered by Brand Finance (Brandirectory, 2014). The analyses were performed for 33 selected countries, which are not in every case reciprocal neighbours. Thus, it was necessary to construct a spatial weights matrix based on economic distances (Pietrzak, 2010, pp. 79-98). The value of real GDP (2014) was chosen for that measure. This kind of technical nests inside the spatial model an additional interpretation of coefficients.

In ordinary least squares (OLS) regression it is assumed that the modeled phenomena or processes are independent of their location, so there is no interaction between the two objects. This assumption is not always suited to the analysis of socio-economic phenomena in spatial terms. According to the so-called. the first law of geography formulated by Tobler (1970, pp. 234–240) all objects in space (observation units) interact, and spatial interactions are the greater, the smaller the distance between objects. Thus, in the analysis and modeling of data located we must take into account the spatial interactions, which may relate to both the dependent variable and the random component. In a situation where the value of the dependent variable in a given location affect the value of this variable from other locations, there is the so-called spatial autoregression.

The basis for the selection of the most accurate form of the regression model is the analysis of spatial autocorrelation. It is defined as „the degree of correlation of observed values of the variable at his different locations" (Suchecki & Olejnik, 2010, pp. 103). This means that the value of the modeled variable is related to values of the same variable in other locations, and the degree of relationship in accordance with Tobler's rule (closer objects are more relevant than distant) affect the relative position of objects and their geographical (or economic) distance. Specification of that matrix belongs to arbitrary decisions taken by a researcher and a choice of the alternative method of weighing is often due to the knowledge of the spatial structure of the phenomenon and links between units (Kossowski, 2010, pp. 9–26; Łaszkiewicz, 2014a, pp. 145–168). Spatial weights matrix is a structure whose elements we take the value 0 when the two objects i, j are not neighbors, and 1 otherwise.

Specification of spatial weight matrices is a prerequisite and the first step in the analysis of spatial autocorrelation. Among many measures used for spatial relationships testing the most commonly used is Moran's I statistic (Longley et al. 2005, pp. 86-107).

In this paper we proposed two basic models with spatial effects, although it should be mentioned, that these are only the most popular examples of the wide range of spatial models reported in the literature multiplied with their numerous extensions and modifications. Spatial regression models like SAR – spatial autoregressive models (also classified as spatial lag models – SLM) or spatial error models (SEM) are used in case of spatial autocorrelation (Rogerson, 2001, pp. 215-227; Kossowski, 2010, pp. 9–26).

Results

In the first stage of the analysis, the calculations of spatial autocorrelation Moran's measure for Brand Value were performed. When spatial autocorrelation statistics are computed for variables, such as GDP or Brand value, they are based on the assumption of constant variance. This is usually violated when the variables are for areas with greatly different populations. That is why we should implement here the Assuncao-Reis empirical Bayes standardization to correct it (Assunção & Reis, 1999, pp. 2147–2162). Both results are shown in Table 1.

Table 1. Spatial autocorrelation statistic for Brand Value

Spatial autocorrelation type	Moran's I	E(I)	$\sqrt{Var(I)}$	Z_I	p-value
Univariate	0.1766	-0.0312	0.0329	6.3229	0.0070
Univariate with empirical Bayes standardization	-0.1790	-0.0311	0.0565	-2.6176	0.0044

Source: Own calculations performed in GeoDa.

As shown in Table 1., the bayesian correction of the Moran's I measure of autocorrelation for brand values through the differences in scale of the GDP makes this statistic more accurate here and completely changes its character. Negative, statistically significant ($p<0.01$) spatial autocorrelation of the brand value is the basis to make the estimation of the structural parameters of spatial regression models in the next step of our analysis (Rogerson, 2001, pp. 215-227; Kossowski, 2010, pp. 9–26). In Table 2. the results of an estimation of linear regression models LM and regression models based on the matrix of spatial weights: SEM (spatial error model) and SLM (spatial lagged model) are presented.

Table 2. Estimation of linear and spatial regression functions for GDP (p-values in brackets)

Model	LM	SEM	SLM
constant	1.29283e+06 (0.001662)	394368 (0.00162)	173531 (0.32311)
Brand value	8822.05 (0.000000)	14944.9 (0.00000)	670.502 (0.13136)
λ / ρ		-0.939922 (0.00000)	0.937984 (0.000000)
R^2	0.55005	0.902002	0.960771
Log-likelihood	-534.824	-512.389	-498.84
Akaike criterion	1073.65	1028.78	1003.68

Source: Own calculations performed in GeoDa / R.

The obtained results (presented in Table 2.) have correct statistical properties (LR and BP tests, significance of coefficients, Akaike criterion, R2) and the correct economic interpretation only for LM and SEM models. The spatial lag model (SLM) showed no statistical significance of parameters and wrong (apparently poorly resistant to differences in the scale of the modeled variable) positive sign of ρ. Spatial error model (SEM) however, proved us the highest (96%) determination coefficient and high ($p<0,01$) statistical significance. The use of spatio-economic weight matrices gave us a very good fit of the model to the empirical data, which can be seen in the values of the logarithm of the likelihood function, values of the coefficient of determination and also Akaike criterion. The presented fit to the empirical data is mainly due to more complete description of the spatial autocorrelation of brand value. The choice of the final form of the regression model (SEM) caused a further significant improvement of explanatory abilities of the analysis.

Discussion and limitations

The results presented above corroborate the assumption made in the introduction regarding the relationship between best global brands and the condition of economies where brand owners are located. It may seem disputable however to what extent it is justifiable to analyze the influence of global brands on economies of countries where these brand owners' headquarters are located if we take into account their global reach. Thus, bearing in mind the fact that global brands are one of the most valuable assets of "global factories" and when global companies invest in brands (Buckeley, 2009, pp. 6) they perform constant spatial reorganisation, internationalization and integration of all processes connected with brand value creation which make it difficult to assign them to the one separate country. There is no question about globality of these processes. The question can be asked why the decision about examining the problem of spatial dependencies for the investigated relationship between brand value and GDP of the country where the brand owner's headquarters is located. Referring to Buckeley (2009, pp. 131-143), we claim that although "global factories" put a radical shift into generally all economies of all the locations of all their activities, the control or orchestration of these operations remains very firmly within the advanced countries (Buckley & Strange, 2015, pp. 237-249), where the headquarters of the owners of "global factories" are located.

Moreover, bearing in mind the presented results of our research, it is worth highlighting that the whole set of 500 cases of global brands' value data has been assigned to only 33 countries, whereof 38% of them to the US and 33% to the Europe. None of the European brands was assigned to the old ex Eastern Bloc. Taking into consideration all the above, let us summarize: global brands and economies are strongly related.

Conclusions

The spatial autocorrelation analysis of this paper confirms a positive association between the GDPpc of the country where the brand owner's headquarters is located and the brand value, as was emphasized in the introduction. The presented results lead to the conclusion that global brands can strongly leverage economies. However, in our study we did not compare global brands' influence on other drivers of countries' economies. It would be interesting to examine, and compare results of, the relationship of brand value with other economic indicators referring to the condition of economies. Correlation analysis of the dynamics in time of this relationship could also result in reaching a thought-provoking conclusion. The presented findings prove that having strong global brands is positive for economies thus governments should create favorable conditions for the development of global brands. It not only leverages economies but, referring to Ferilli et al. (2016, pp. 62-75), builds a positive image of the country where the brand originates.

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Hill-Climbing algorithm for robust emergency system design with return preventing constraints

JEL Classification: *C61; C63*

Keywords: *Emergency system design; robustness; iterative algorithm; convex combination; return preventing constraints*

Abstract

Research background: This paper deals with smart design of robust emergency service system. The robustness means here resistance of the system to various detrimental events, which can randomly occur in the associated transportation network. Consequences of the detrimental events are formalized by establishing a set of detrimental scenarios. A robust emergency service system is usually designed so that the deployment of given number of service centers minimizes the maximal value of objective functions corresponding with the specified scenarios. The original approach to the system design using means of mathematical programming faces computational difficulties caused by the link-up constraints.
Purpose of the article: The main purpose of our research is to overcome the computational burden of the branch-and-bound method caused by the min-max constraints in the model. We suggest an iterative hill climbing algorithm, which outperforms the original approach in both computational time and computer memory demand.
Methodology/methods: The methodology consists in approximation of the maximum of original objective functions by a suitable convex combination of the objective functions. The previously developed hill climbing algorithm is extended by return preventing constraints and their influence on computational effectiveness is studied within this paper. Especially, we focus on finding the most suitable form of the return preventing constraints and strategy of their implementation.

Findings: We present here a comparison of the suggested algorithm to the original approach and the Lagrangean relaxation of the original approach. We found that the suggested algorithm outperforms the original exact approach as concerns the computational time with maximal two percent deviation from the optimal solution. In addition, the algorithm outperforms the Lagrangean approach in both computational time and the deviation.

Introduction

Emergency service systems are established to provide users by necessary service in emergency cases like accidents, fire or similar severe events endangering life or property. As serviced population of users is spread over a geographical area comprising big number of dwelling places and the considered kind of service can be provided only from limited number of service centers, the center deployment in the given area represents the main part of the emergency system design. The optimal deployment of a given number of centers in a set of possible center locations is searched with the objective to minimize a sum of weighted time-distances from users to the nearest located center. The weight corresponds with population at the user location (Avella et al., 2007, pp. 89-114; Current et al., 2002, pp. 81-118; Marianov & Serra, 2002, pp. 119-150). Each designer's dream is to suggest such a system, which is resistant to randomly occurring events in the transportation network used for the service transport. To make the suggested system robust, a finite set of the most damaging scenarios is specified and the center deployment is designed so that the objective function value connected with the worst scenario is minimal (Correia & Saldanha da Gama, 2015, pp. 177-203; Janáček, 2015, pp. 595-606` Pan et al., 2014, pp. 164-172; Scaparra & Church, 2015, pp. 623-642). The associated linear programing model minimizes maximum of several objective functions and thus the model must contain so-called link-up constraints. The associated solving computational process is then very slow due to the link-up constraints and the size of the model. To overcome this drawback, we suggested an iterative algorithm based on processing a convex combination of the scenarios and iterative adjustment of the associated multipliers. The algorithm was designed in the form of "hill-climbing" algorithm. When testing its preliminary version we found that the computational process had been often locked in a short cycle formed by two or three solutions. Within this paper, we focus on such algorithm arrangement, which prevents the computational process from the deadlock. We present a study of the arrangement impact on computational efficiency and give a recommendation for a choice of solving tool for the robust emergency system design.

The remainder of the paper is organized as follows. The next section is devoted to a concise explanation of a radial formulation of the emergency system design problem (García et al., 2011, pp. 546-556; Janáček & Kvet, 2013, pp. 332 – 337). The third section introduces the approach to the robust emergency system design based on the convex combination of the detrimental scenarios. The fourth section comprises results of numerical experiments. The fifth section summarizes the achieved results and findings.

Radial formulation of emergency system design problem

To describe the emergency system design problem with p located centers in the radial form (García et al., 2011, pp. 546-556; Janáček & Kvet, 2013, pp. 332 – 337), we denote I a set of possible center locations and J the set of possible users' locations. The symbol b_j denotes population of users located at $j\in J$. The symbol d_{ij} denotes the integer distance between a user at j and the possible center location i. To model the decision on locating or not locating a center at the particular location $i\in I$, we introduce a zero-one variable $y_i \in \{0, 1\}$, which takes the value of 1, if a center should be located at the location i, and it takes the value of 0 otherwise. An integer time-distance between a user location j and the nearest located center is expressed by the sum $x_{j0} + x_{j1} + x_{j2} + \dots + x_{jv}$ of auxiliary zero-one variables x_{js} for $s = 0, \dots, v$. The variable x_{js} takes the value of 1, if the distance of the user at $j \in J$ from the nearest located center is greater than s and it takes the value of 0 otherwise. We assume that the maximal considered time distance between user and possible center locations is v+1. Further we introduce a zero-one constant a_{ij}^s for each $i\in I$, $j\in J$ and s= 0, …, v. The constant a_{ij}^s is equal to 1, if the time-distance d_{ij} between the user location j and the possible center location i is less than or equal to s, otherwise $a_{ij}^s = 0$. Then the radial model can be formulated as follows:

$$\text{Minimize} \qquad \sum_{j\in J} b_j \sum_{s=0}^{v} x_{js} \tag{1}$$

$$\text{Subject to}: \quad x_{js} + \sum_{i\in I} a_{ij}^s y_i \geq 1 \qquad j\in J, \quad s = 0,\dots,v \tag{2}$$

$$\sum_{i\in I} y_i \le p \tag{3}$$

$$x_{js} \ge 0 \quad j\in J,\; s=0,\dots,v \tag{4}$$

$$y_i \in \{0,1\} \quad i\in I \tag{5}$$

The objective function (1) gives the sum of weighted time-distance values. The constraints (2) ensure that the variables x_{js} are allowed to take the value of 0, if there is at least one center located in radius s from the user location j. The constraint (3) limits the number of located centers by the number p. Even if only zero-one values of variable x_{js} are meaningful in the above model, constraints (4) are sufficient to ensure it due to partial integrality property of the model.

An iterative approach to the robust emergency system design

The robust emergency system design problem is formulated with use of a set of possible failure scenarios denoted by U. The time distance between locations i and j under a specific scenario $u\in U$ is denoted by d_{iju}. The suggested approach is based on a convex combination of the objective functions associated with the individual scenarios. The objective function a solution $\boldsymbol{y}$ associated with a scenario u of is denoted as $f^{u}(\boldsymbol{y})$. We distinguish scenario $b\in U$, which is the basic scenario corresponding to the standard conditions. Let $\boldsymbol{y}^u$ minimize the objective function $f^{u}(\boldsymbol{y})$. The convex combination of the scenario objective function for the given set of nonnegative multipliers $\lambda_u \ge 0$ for $u\in U$ satisfying the condition that their sum equals to one can be defined using convex combination of considered matrices $\{d_{iju}\}$ for $u\in U$. The distance between i and j according to the convex combination is defined by (6).

$$d_{ij}(\lambda) = \sum_{u\in U} \lambda_u d_{iju} \quad i\in I, j\in J \tag{6}$$

If we define a zero-one constant $a_{ij}^{s}(\boldsymbol{\lambda})$ which is equal to 1 in the case that the time distance $d_{ij}(\boldsymbol{\lambda})$ is less or equal to s, otherwise $a_{ij}^{s}(\boldsymbol{\lambda})$ equals to 0, then we can easily obtain the optimal solution for the convex combination objective functions by solving problem (1)-(5). Here, the incidental coefficients $a_{ij}^{s}(\boldsymbol{\lambda})$ are used instead of the original coefficients a_{ij}^{s}. For a given current solution $\boldsymbol{y}$, values of $f^{u}(\boldsymbol{y})$ can be easily found. Then the multiplier values can be computed from a current solution $\boldsymbol{y}$ for a positive parameter β according to (7).

$$\lambda_u(\boldsymbol{y}) = \frac{(f^u(\boldsymbol{y}) - f^b(\boldsymbol{y}^b))^\beta}{\sum_{u\in U}(f^u(\boldsymbol{y}) - f^b(\boldsymbol{y}^b))^\beta} \qquad u \in U \tag{7}$$

The iterative process with the return preventing constraints is described by the following steps:

0) Compute the optimal solution y^b for the objective function f^b and the multipliers λ_u associated with $\boldsymbol{y}^b$. Set $\boldsymbol{y}=\boldsymbol{y}^b$. Initialize the best found solution $\boldsymbol{y}^*=\boldsymbol{y}^b$. Set noFails=0. Set k=0 and produce list $I(k)=\{i\in I, y_i^b=1\}$.
1) Solve the problem (1) - (5), (8) for the current $a_{ij}^s(\lambda)$ and obtain current solution $\boldsymbol{y}$. Set $k=k+1$ and produce list $I(k)=\{i\in I, y_i=1\}$.
2) If $f^r(\boldsymbol{y}) < f^r(\boldsymbol{y}^*)$, then update $\boldsymbol{y}^*$, otherwise set noFails= noFails +1.
3) Determine new values of λ_u for the current solution $\boldsymbol{y}$ according to (7).
4) If noFails >MaxFails, then terminate, otherwise go to 1).

We have to comment on β adjustment in the above algorithm. In the case of updating $\boldsymbol{y}^*$, we set β at the value of 1 and in the opposite case, we used the strategy of incrementing current value of β by 1.2, if the worst scenario was the same as in the previous step and we decremented the value of β by 0.2, when the worst scenarios differed.

The set of return preventing constraints applied at the k th run of the algorithm has the form of (8).

$$\sum_{i\in I(t)} y_i \le p - r \quad t = 0, ..., k-1 \tag{8}$$

The set of constraints (8) ensures that the current solution of the problem (1) - (5), (8) differs from the solutions obtained in the previous k runs of the algorithm at least in r locations.

Methodology of the associated research

Our effort in this field was focused on complying curse of dimensionality in robust emergency system design. This associated model contains multiply more decision variables than the model with only one scenario. The same situation occurs in the number of constraints and furthermore, the model of robust system design must be enlarged by link-up constraints. These min-max link-up constraints and the cardinality of the scenario set represent an undesirable burden in any solving proves used for design solution. To overcome these obstacles, we aimed our research at finding such properties of models and algorithms, which enable to reduce the problem size, to simplify its structure and to accelerate the associated computational process.

The methodology of our research can be divided into two parts. The first one consists of constituting a convex combination of the scenarios and studying the characteristics of the associated iterative hill-climbing process, which is performed with the problem, which size is considerably reduced in comparison with the original robust emergency system design problem. The associated synthesis has led to creating a solving iterative algorithm, which characteristics were obtained by performing numerical experiments and analyzing the results. As an accompanying phenomenon of the hill-climbing algorithm is the situation when the process gets locked in a short cycle formed by two or three solutions (see Figure 1).

The second part seeks for such a measure, which prevents the computational process from the deadlock. Research in this part was focused on construction of proper forms of return preventing constraints. We have suggested a general form of return preventing constraints and searched for a sufficient setting of constraint parameters.

Numerical experiments

This chapter is devoted to the results of numerical experiments. To get the results, the optimization software FICO Xpress 8.0 (64-bit, release 2016) was used and the experiments were run on a PC equipped with the Intel® Core™ i7 5500U processor with the parameters: 2.4 GHz and 16 GB RAM. The used benchmarks were derived from the road network of Slovakia for eight self-governing regions, i.e. Bratislava (BA), Banská Bystrica (BB), Košice (KE), Nitra (NR), Prešov (PO), Trenčín (TN), Trnava (TT) and Žilina (ZA). All cities and villages with corresponding number b_j of inhabitants were taken into account. The coefficients b_j were rounded to hundreds. In the benchmarks, the set of communities represents both the set J of users' locations and also the set I of possible service center locations. The cardinalities of these sets vary from 87 to 664. The number p of located centers was derived from real emergency health care system, which has been originally implemented in studied regions and it varies from 9 to 67.

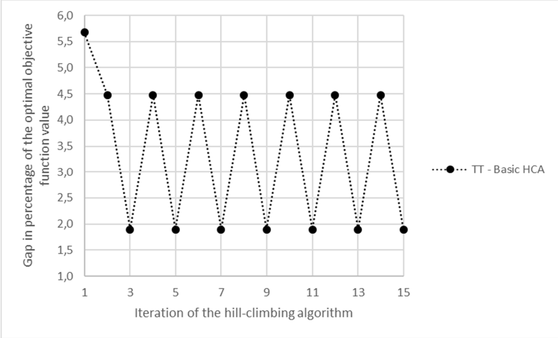
The matrix $\{d_{ij}\}$ of the time-distances from possible center locations to individual users' locations obtained from the associated road network represents so-called basic scenario in each solved instance. To study the suggested algorithm for robust emergency system design, several scenarios are needed. Due to the lack of common benchmarks for study of robustness, the scenarios used in our computational study were created in the following way. We selected 25 percent of matrix rows so that these rows correspond to the biggest cities concerning the number of system users. Then we chose randomly from 5 to 15 rows from the selected ones and the associated time-distances in the chosen rows were multiplied by the randomly chosen constant from the range 2, 3 and 4. The rows, which were not chosen by this random process, stay unchanged (they are multiplied by the value of 1). This way, 10 different scenarios were generated for each self-governing region. The scenarios represent the consequence of fatal detrimental events, when some time-distances are several times elongated.

An individual experiment was organized so that the optimal solution $\boldsymbol{y}$ of the robust emergency system design problem was obtained using the radial formulation. Here, the maximal objective function value over all scenarios is minimized. This criterion can be formulated as follows.

$$h = \max\{\sum_{j \in J} b_j \min\{d_{iju} : i \in I,\ \ y_i = 1\} : u \in U\} \tag{9}$$

After getting the optimal solution, the basic version of the hill-climbing algorithm with no return preventing constraints was applied on the same problem to evaluate its time demands and the results accuracy. For this computational study, the hill-climbing algorithm was restricted to 15 iterations. While analyzing the algorithm performance, it was found, that the iterative process might get stuck at a local minimum or alternate between two or three solutions. Such situation is demonstrated in the Figure 1, which reports the computational process of the hill-climbing algorithm for the self-governing region of Trnava (TT). In each iteration, the objective function (9) for the resulting vector $\boldsymbol{y}$ of location variables y_i was computed. Instead of its absolute value, the relative gap is depicted. Here, the gap is defined as the difference between the resulting objective function value (9) and the optimal objective function value in percentage of the optimal objective function value.

Figure 1. Analysis of the computational process of suggested hill-climbing algorithm for the self-governing region of Trnava with $|I|$ = 249 and p = 25.



Source: Own calculation based on performed numerical experiments.

Based on the observed obstacle consisting in possible computational process deadlock, the concept of return preventing constraints was introduced to prevent the algorithm from the above-mentioned drawback.

Table 1. Comparison of two versions of the hill-climbing algorithm suggested for robust emergency system design to the original approach.

Region	$\|I\|$	p	**Standard approach**		**Basic HCA (without RPC)**			**HCA with RPC**		
			CT	*h*	CT	*h*	*Dif*	CT	*h*	*Dif*
BA	87	9	28.7	25417	2.1	26102	2.7	13.1	25417	0.0
BB	515	52	1063.1	18549	50.3	19056	2.7	53.6	19056	2.7
KE	460	46	1284.2	21286	32.5	21756	2.2	36.5	21717	2.0
NR	350	35	2017.6	24193	22.4	24402	0.9	53.8	24372	0.7
PO	664	67	1180.4	21298	77.8	21607	1.5	123.2	21590	1.4
TN	276	28	264.1	17524	11.4	17605	0.5	28.1	17605	0.5
TT	249	25	433.8	20558	10.9	20947	1.9	29.2	20859	1.5
ZA	315	32	1229.7	23004	11.9	23224	1.0	39.5	23156	0.7

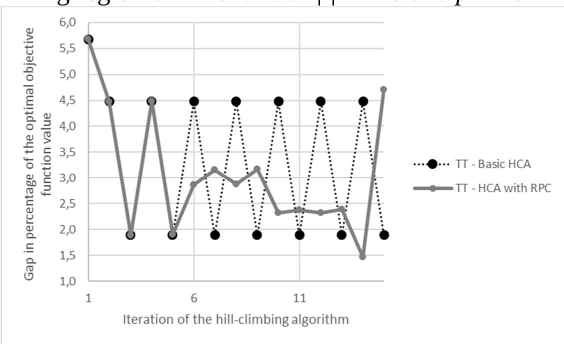
Source: The results of performed computational study.

The achieved results are summarized in the following Table 1, in which three different approaches to the robust emergency system design are compared. Each benchmark was solved by the exact approach to get the optimal objective function value. Then, the hill-climbing algorithm was applied and finally, the problem was solved by the hill-climbing algorithm with embedded return preventing constraints. For each approach, the computational time in seconds is reported in the columns denoted by CT. The columns denoted by *h* contain the objective function value computed according to (9) for particular resulting solution. To evaluate the accuracy of the suggested algorithm, the value of *Dif* is reported. It is defined as difference between the optimal and the resulting solution objective function value given in percentage of the optimal objective function value. We can observe that the resulting accuracy is very satisfactory.

The impact of the return preventing constraints on the algorithm performance is shown on the Figure 2, where the benchmark of Trnava (TT) was used. We can observe that the return preventing constraints may significantly change the computational process and bring better results than the original hill-climbing algorithm provided.

It must be noted that we have studied many other settings of the return preventing constraints, which differed in the parameter *r*. Its value defines the minimal number of located centers, in which the solutions must differ. Our research did not bring better results than reported above. Thus, the difference in at least one located service center is sufficient.

Figure 2. Impact of the return preventing constraints in the hill-climbing algorithm for the self-governing region of Trnava with $|I| = 249$ and $p = 25$



Source: Own calculation based on performed numerical experiments.

Conclusions

The main goal of this paper was to introduce an effective solving technique for robust emergency system design. The robustness follows the idea that the designed system should be resistant to various detrimental events occurring randomly. We have presented an iterative approach, which can considerably outperform the exact approach as concerns the computational time, whereas the resulting objective function value of the iterative approach does not differ from the exact value by more than two percent on average. Since the computational process may get locked in a short cycle, we have introduced the concept of return preventing constraints to avoid this obstacle. Based on achieved results we can conclude that we have constructed an efficient algorithm for robust emergency system designing.

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Short-run elasticity of substitution – error correction model

JEL Classification: *C13; E23; E24*

Keywords: *short-run and long-run elasticity of substitution, aggregate and sectoral estimations, vector error correction model, labour demand of the profit maximizing firm*

Abstract

Research background: The value of the elasticity of the substitution has been a subject of the research around the world in last decades. It affects the qualitative and quantitative answers to a host of economic questions.
Purpose of the article: We suggest the co-integration estimation form to estimate short-run elasticity of substitution. Using U.S. NIPA aggregate time series we estimate aggregate short-run elasticity of substitution. In comparison with estimations in economic literature, we confirm theoretical assumptions described in the research background.
Methodology/methods: Different econometric estimation forms are used to estimate elasticity of the substitution coefficient. One possibility is a constant elasticity of substitution production function linearization. Others come from the first-order conditions of a representative firm expressing factor demand functions. Error correction models are natural and elegant way to estimate the forms with non-stationary data. However, the use of error correction models in the factor demand econometric forms is useless for estimating a long-run elasticity of substitution coefficient. The co-integration relationship is given by the theoretical assumption of the labour share constancy in the long-run or by other underlying processes. Though, we can use this co-integration relationship to correct error term in the short-run estimation form. To estimate the short-run elasticity of substitution, we use Stock and Watson's estimation form. Stability, stationarity and serial correlation of residuals are tested by the relevant econometric tests.

Findings: The value of aggregate short-run elasticity of substitution is closed to one. In comparison with other relevant theoretical and empirical papers, our results incline to the Cobb-Douglas aggregate production function in U.S. economy

Introduction

There are many ways to estimate the elasticity of substitution. Chirinko (2008) and Klump, McAdam and Willman (2012) provide rich literature survey of elasticity of input substitution estimation problem. We focus to the co-integration analysis of the factor prices. Caballero (1994) measures long-run values by exploiting the co-integration relations between the capital/output ratio and the user cost of capital. As argued in Chirinko and Mallick (2011), this estimation strategy faces some econometric difficulties in recovering production function parameters. In this paper we use similar analysis of labour/output. We prefer labour demand analysis to the capital one, because there are large data series consisting of labour, output and prices in the U.S. NIPA data sources. The large observation set is needed for the co-integration analysis. We use Chirinko's and Mallick's (2011) suggestion to form and estimate a co-integration econometric specification suitable to quantify short-run values of the elasticity of substitution.

$$\begin{aligned}\Delta\left(y_t - l_t\right) = \alpha_0 + \beta_1 \Delta\left(w_t - p_t\right) + \\ + \lambda\left[\left(y_{t-1} - l_{t-1}\right) - \gamma_0 - \gamma_1\left(w_{t-1} - p_{t-1}\right)\right] + u_t\end{aligned} \tag{1}$$

where y_t, l_t, p_t and w_t are the natural logarithms of output y, labour l and their prices, u_t is a white-noise stochastic term. Coefficients β_1 and γ_1 are estimations (suggested by Caballero, 1994) of long-run and short-run elasticity of substitution and $-1 \leq \lambda \leq 0$ is a co-integration adjustment coefficient. Chirinko and Mallick (2011) argue that neoclassical growth theory assumes the constancy of the factor share $w_t + l_t - p_t - y_t$.

However, after substituting the factor share to the co-integration form (1), "the constancy holds if and only if the influence of relative prices is eliminated. In this case coefficient γ_1 must equal 1" (Chirinko and Mallick, 2011, p. 206) and the coefficient is not a measure of the long-run elasticity of substitution. We argue that the estimation form (1) is suitable for estimating the short-run elasticity of substitution β_1.

According to Chirinko and Mallick (2011), three cases consistent with a general economic knowledge may exhibit the co-integration form (1). Firstly, co-integration relation holds. This may be reasonable according to the neoclassical growth theory, if labour is the factor. Then $\gamma_1 = 1$. Secondly, co-integration relation does not hold. This may be reasonable according to the theory, if capital is the factor. Finally, co-integration relation does not hold, but variables are driven by different underlying co-integration processes. Considering labour demand estimation form, we can estimate co-integration form with $\gamma_1 = 1$. To estimate all coefficients in one step we rewrite the co-integration relation into the form suggested by Stock and Watson (1993).

$$\Delta(y_t - l_t) = \beta_0 + \beta_1 \Delta(w_t - p_t) + \lambda(y_{t-1} - l_{t-1}) + \delta_1(w_{t-1} - p_{t-1}) + u_t \quad (2)$$

where $\delta_1 = -\lambda\gamma_1$. Considering the mentioned restriction $\gamma_1 = 1$, we gain a specification:

$$\Delta(y_t - l_t) = \alpha_0 + \beta_1 \Delta(w_t - p_t) + \lambda\left[(y_{t-1} - l_{t-1}) - (w_{t-1} - p_{t-1})\right] + u_t \quad (3)$$

Szomolányi, Lukáčik and Lukáčiková (2015) showed that the both co-integration form (2) and (3) are consistent with the normalised constant elasticity of substitution production function suggested by De La Grandville (1989) and Klump, McAdam and Willman (2012).

The purpose of the article is to verify the suggested co-integration estimation forms for labour demand and estimate the short-run elasticity of substitution using U.S. aggregate data.

Data and method of the research

To estimate the coefficients of the forms (2) and (3) we use yearly data of logarithms of average labour product in constant prices, $y_t - l_t$, and its price, $w_t - p_t$, in the period 1929 – 2015 obtained from NIPA tables of U.S. Bureau of Economic Analysis portal[1]. Deriving the data we follow Gollin (2002) and Klump, McAdam and Willman (2007).

Gollin (2002) refers an inconsistency between a theory and observed values of labour share. This inconsistency comes from incorrect calculation of labour share. Compensation to employees is not suitable indicator for labour income because they exclude proprietors (self-employed) labour

[1] https://www.bea.gov/

income. It is unclear how the income of self-employed workers should be categorized in the labour-capital dichotomy.

We consider two approaches. Following Krueger (1999) and Antràs (2004) we add two thirds of self-employed workers' income to the compensations of employees. We denote this approach by the symbol (*a*).

Blanchard's Nordhaus's and Phelps's (1997), Gollin's (2002) and Bentolila's and Saint-Paul's (2003) approach (*b*) is to use compensation per employee as a shadow price of labor of self-employed workers, i.e. labour income in extensive form, $l_t w_t$, is:

$$labour\ income = \left(1 + \frac{self\ employed}{total\ employment}\right) \cdot compensation\ to\ employees \qquad (4)$$

Gollin (2002) also introduced two more ways to modify data for correct labour share calculation, but as he stated, these two ways are not suitable for the U.S. economy.

We consider *GDP* for output. We can use employment or number of hours worked as a labour indicator. For a long-run analysis, we consider the employment to be satisfactory measure of the labour.

In the first look on data we focus to the stationarity tests. Both augmented Dickey-Fuller and Phillips-Perron tests (see Lukáčik and Lukáčiková, 2008) imply stationarity in the data series of the average product and its price measured by both ways (*a*) and (*b*), if trend and intercept are not included in the test specification. However, the correlogram of the all data series imply unit roots. The first-order serial correlation is closed to one and autocorrelation values are slowly decreasing with time. Differencing the data series both test procedures as well as correlograms imply non-stationarity. Therefore we need to use their first differences in the estimation forms. Both (2) and (3) forms use the first differences of average factor products. The least square method is used to estimate the coefficients. The autocorrelation of residuals is tested by the Breusch-Godfrey serial correlation LM test.

Using the (*b*) measure of labour, the price residuals are serial correlated. In the case of serial correlation, we compute the standard errors with procedure of Newey and West (1994). The stationarity of residuals is tested using the same procedure as the data series. The normality of residuals is tested using the Jarque-Bera test. For testing of the co-integration adjustment coefficients λ, tables suggested by Banerjee, Dolado and Mestre (1998) are used. The coefficient restriction tests used χ^2 distributed Wald statistics which is preferred when the restriction is not linear as in our case.

Results

The estimations of (2) specification coefficients are in the Table 1. Using the (*a*) measure of the labour price, the estimated value of the short-run elasticity of substitution is 0.91. Using the Banerjee, Dolado and Mestre (1998) tables, the co-integration adjustment coefficient λ is statistically significant at 5 % significance level. We computed the coefficient by $\gamma_1 = -\delta_1/\lambda$. The estimation of the coefficient is closed to 1 (precisely 0.932), however we do reject the hypothesis $\gamma_1 = 1$ using χ^2 distributed statistics.

The standard errors of estimated coefficients of (2) using the (*b*) measure of the labour price (in the last column) are computed with the Newey-West (1994) procedure. The corresponding elasticity of substitution estimation is 1.074. The co-integration adjustment coefficient λ is statistically significant at 5 % significance level. The estimation of the γ_1 coefficient is 1.005 and we do not reject the hypothesis $\gamma_1 = 1$ using χ^2 distributed statistics.

Table 1. The estimations of the (2) specification coefficients

	Data Set (a)		***Data Set (b)***	
Coefficient	**Value**	**Standard Error**	**Value**	**Standard Error**
β_1	0.910	0.018	1.074	0.061
λ	-0.248	0.065	-0.412	0.095
δ_1	0.231	0.060	0.414	0.100

Source: own processing

Even if we reject the unity of the γ_1 coefficient in the (*a*) case, both estimations are closed to 1, confirming the theory. Using both datasets, we estimated the restricted estimation form (3) implying $\gamma_1 = 1$. The results are in the Table 2. The short-run elasticity of substitution estimations are consistent with the estimations corresponding to the (2) specification in the Table 1. Using the (*a*) measure of the labour price, the estimated value of the short-run elasticity of substitution is 0.906. However, using the Banerjee, Dolado and Mestre (1998) tables, the co-integration adjustment coefficient λ is not statistically significant.

The standard errors of estimated coefficients of (2) using the (*b*) measure of the labour price (in the last column) are computed with the Newey-West (1994) procedure. The corresponding elasticity of substitution estimation is 1.072. The co-integration adjustment coefficient λ is statistically significant at 1 % significance level.

Table 2. The estimations of the (3) specification coefficients

	Data Set (a)		***Data Set (b)***	
Coefficient	**Value**	**Standard Error**	**Value**	**Standard Error**
β_1	0.906	0.019	1.072	0.059
λ	-0.105	0.044	-0.405	0.087

Source: own processing

Our short-run elasticity of substitution estimation is closed to 1 in all cases, implying the Cobb-Douglas production function. Therefore we tested Cobb-Douglas restriction hypothesis $\beta_1 = 1$. Using χ^2 distributed Wald statistics, we reject the hypothesis with the estimations based on the (*a*) dataset, but we do not reject the hypothesis with the estimations based on the (*b*) dataset. Note that estimations based on (*a*) dataset do not fit the considered theory. Non-unity of γ_1 coefficient implies the non-constancy of the labour share or other underlying co-integration processes.

Conclusions

The most recent studies of Chirinko and Mallick (2014) or Klump, McAdam and Willman (2007) suggest the elasticity of substitution markedly lower than 1. The co-integration analysis of the average labour and its relative price relationship, estimating the long-run elasticity of substitution suggested by Caballero (1994), has been criticised by Chirinko and Mallick (2011). The neoclassical growth theory that comes from the long-run constancy of the factor share implies the studied relationship independent on the elasticity of substation. Our study return to the co-integration analysis and it considers the Chirinko’s and Mallick’s (2011) suggestions. Using co-integration form suggested by Stock and Watson (1993), estimating the short-run and long-run coefficients in one step, we estimate the short-run elasticity of substitution closed to 1.

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Two-part models of income distributions in Poland

JEL Classification: *C51; C52; D31*

Keywords: *income distribution; incomes models; Pareto model; power law*

Abstract

Research background: studies of structures of incomes distributions have been performer for about 15 years. They indicate that there is no one model which describes the distributions in their whole range. This effect is explained by the existence of different mechanisms yielding to low-medium and high incomes. While more than 97% of the distributions can be described by models with two or three parameter, high incomes (about 3% or less) is in agreement with power law.
Purpose of the article: the aim of this paper is an analysis of the structure of distributions of households' incomes in Poland. By using various models we verify the hypothesis about two-part structure of those distributions.
Methodology/methods: the studies are based on the households' budgets microdata for years 2004 – 2012. The two-component models were used to describe the incomes distributions. The major parts of the distributions have been described by the two or three parametric models: lognormal, Dagum, and Singha-Madalla. The highest incomes were described by the Pareto model.
Findings: one has showed that two or three parametric models explain from about 95% to more than 99% of ranges of income distributions. The poorest agreement with data is for lognormal model, while the best agreement has been obtained for Dagum model. Regarding the highest incomes the Pareto model describe the data very well only for the selected years. For the remaining years the results are not so obvious. The tails of the income distributions seems to have more complex structure.

Introduction

The studies of structures of the income distributions have been performer for about 15 years. They indicate that there is no one model which describes the distributions in their whole ranges. This effect has been observed for the distributions of incomes in U.S., United Kingdom, Germany and Japan. In the majority of studies incomes are described the best by lognormal model with power law tail. Suoma (2001, pp. 463-470) studied Japanese income distributions for years 1887 – 1998. He showed that two-part model, lognormal with power law tail is the universal structure describing distributions of personal incomes in Japan. In the paper (Nirei & Souma, 2004, pp. 161-168) the authors continue researches and propose dynamic stochastic model explaining power low tails. Dragulescu & Yakovenko (2001, pp. 213–221) study the income distributions in United Kingdom (1994-1999) and in individual U.S. states (1998). They describe income distributions by two-part model: exponential and power law. Nirei & Souma (2007, pp. 440-459) studied income distributions in Japan and the U.S. for years from 1960 to 1999. They confirmed the hypothesis about two-part structure of income distributions. They described the left-central part of the distributions by the exponential model and the top 1% of incomes – by the power law. Clementi & Gallegati (2005, pp. 3-14) investigated income distributions of households in the U.S. (1980-2001), United Kingdom (1990-2001) and Germany (1990-2002). A low-middle income group was approximated by lognormal function and a high income group by power law function.

The motivation to take the studies presented in this paper was small number of similar studies for the new countries of European Union. In this paper we conducted such a study of income distributions in Poland. This subject was investigated by Jagielski & Kutner (2010, pp. 615-618). They analyzed incomes from Household's Budgets Survey but the highest incomes data were extracted from rank of the 100 richest Poles. They showed that Polish income distributions may have three-part structure.

The aim of this paper is analysis of the structure of the income distributions. We verify the hypothesis about two-part structure of the income distributions. In the first step we fit well-known models of incomes: lognormal, Dagum, and Singh-Maddala to the whole income distributions. As expected none of the above models describe data for the highest incomes. In the second step we fit power law (Pareto model) to the tails of the income distributions.

Data and data selection

Data from the Household Budget Survey (HBS) project from 2004 to 2012 have been used in this work. One selected subset of data containing micro-data about available monthly incomes in the households. Household's available income is a sum of household's gross incomes from various sources reduced by all income taxes as well as by social security and health insurance taxes.

The zero or negative incomes (about 0.6% – 0.7%) have been removed from data. Income of each household has been recalculated into the annual income in thousands PLN and expressed as the income per person. The number of data records varied from about 32,000 to 37,000 depending on year. One constructed empirical cumulative distributions based on the detailed data to evaluate power models and to present the results. The empirical cumulative distribution is defined:

$$F_{emp}(x_i) = \frac{k_i}{N}$$

where data x_i, $i = 1, ..., N$ are sorted ascending, k_i is rank of income x_i.

Methodology

We take into account three commonly used models: lognormal, Dagum, and Singh-Maddala. Probability density function (pdf) of lognormal distribution is

$$f_{LN}(x) = \frac{1}{x\sigma\sqrt{2\pi}} \exp\left(-\frac{(\ln x - \mu)^2}{2\sigma^2}\right), \tag{1}$$

where $x > 0$, while the σ parameter fulfills the condition $\sigma > 0$. The μ and σ parameters are interpreted as mean value and standard deviation of incomes logarithms respectively. Cumulative density function (cdf) of lognormal distribution can be expressed by the cdf Φ of the standard normal distribution

$$F_{LN}(x) = \Phi\left(\frac{\ln x - \mu}{\sigma}\right). \tag{2}$$

Lognormal distribution has been often used to describe distributions of wages and incomes. Pdf of Dagum distribution (Dagum, 2008, pp. 3-25) is described by the equation:

$$f_D(x) = \frac{\alpha\beta\delta}{x^{\beta+1}(1+\alpha x^{-\beta})^{\delta+1}}, \tag{3}$$

where $x > 0$, while the parameters fulfill the conditions: $\alpha > 1$ and $\beta, \delta > 0$. The pdf of Singh-Manddala distribution (Singh & Manddala, 1976, pp. 963-970) can be expressed by the formula:

$$f_{SM}(x) = \frac{\alpha\beta\delta}{x^{-\beta+1}(1+\alpha x^{\beta})^{\delta+1}}, \tag{4}$$

where $x > 0$ and $\alpha, \beta, \delta > 0, \ \beta\delta > 1$. Cumulative density functions of the above models are described by the equations:

$$F_D(x) = (1+\alpha x^{-\beta})^{-\delta} \tag{5}$$

$$F_{SM}(x) = 1-(1+\alpha x^{\beta})^{-\delta}. \tag{6}$$

Studies performed in various countries show that models (3) and (4) exhibit high conformance with empirical distributions of incomes (Bandourian, *et al.*, 2002, p. 47; Dagum, & Lemmi, 1988, pp. 123-157; Kleiber, 1996, pp. 265-268). They are universal, they may describe zero- as well as one-modal distributions (see Łukasiewicz, *et al.*, 2012, pp. B82-B85). Dagum model is used very often in studies of incomes (see i.e. Łukasiewicz, & Orłowski, 2003, pp. 122-130; Łukasiewicz, & Orłowski, 2004, pp. 146-151; Quintano, & D'Agostino, 2006, pp. 525-546).

The Pareto model Type I has been used to describe the highest incomes (tails of the distributions). The model, known also as a power law, contains one parameter and the functions pdf and cdf are of the forms:

$$f_P(x) = \alpha x_m^{\alpha} x^{-\alpha-1}, \tag{7}$$

$$F_P(x) = 1 - x_m^{\alpha} x^{-\alpha}, \tag{8}$$

where $x \geq x_m$ and parameter $\alpha > 0$. A limit value of income is indicated by x_m. The pdf and cdf are equal to 0 for $x < x_m$.

All the models have been evaluated by means of the nonlinear least square method utilizing Levenberg-Marquardt algorithm. Thus, the coefficients of the models are estimated by a minimization of the function:

$$SSE(\theta) = \sum_{i=1}^{n} (y_i - f(x_i;\theta))^2 , \qquad (9)$$

where θ is a vector of the model's parameters.

The models (1) – (3) were evaluated based on the grouped data. In the case of the model (7) obtained results were unstable because of the small number of counts for the highest incomes. The Pareto model's parameter α has been evaluated based on the cumulative data using the function (8).

The limit values of x_m were evaluated for each model and year after estimating the functions (1) – (3). The x_m was determined as the income above which the model's residuals start rising.

Analysis and results

The lognormal, Dagum, and Singh-Maddala models of incomes were fitted to the empirical distributions. The results are listed in Table 1. The columns contain: parameters' estimators, coefficients of determination $R^2 = 1 - SSE$, limits x_m and values of the theoretical cdf: $F(x_m)$. The latter is a percentage of the income distribution (percentage of households) explained by the model.

Table 1. Estimations of the lognormal (*LN*), Dagum (*D*), and Singh-Maddala (*SM*) models. There are standard errors of the parameters' estimators in the brackets. The symbols μ, σ are the parameters of the lognormal model

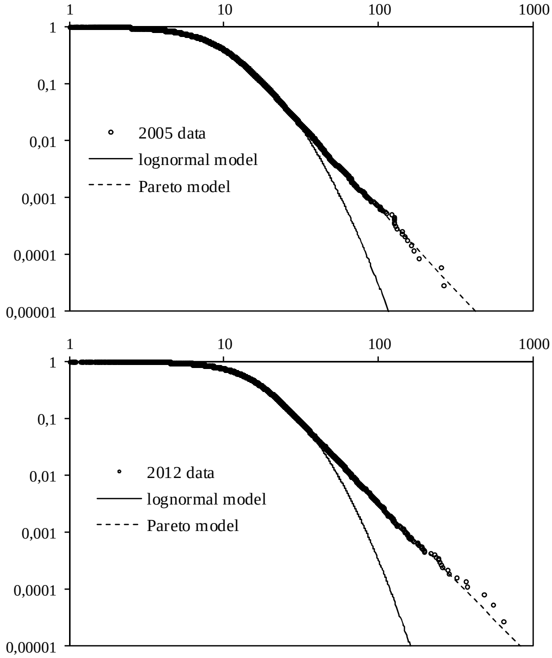
Year	**Model**	$\alpha(\mu)$	$\beta(\sigma)$	δ	R^2	x_m	$F(x_m)$
2004	*LN*	2.149 (0.004)	0.612 (0.003)		0.995	31.59	0.983
	D	838.0 (76.1)	2.995 (0.030)	0.787 (0.016)	0.998	59.04	0.997
	SM	0.003 (< 0.0001)	2.502 (0.016)	1.421 (0.041)	0.998	36.16	0.989

Table 1. Continued

Year	Model	$\alpha(\mu)$	$\beta(\sigma)$	δ	R^2	x_m	$F(x_m)$
2005	*LN*	2.166 (0.003)	0.608 (0.002)		0.995	29.83	0.979
	D	1285.0 (112.8)	3.124 (0.029)	0.735 (0.014)	0.996	72.26	0.999
	SM	0.0028 (< 0.0001)	2.531 (0.015)	1.378 (0.036)	0.997	34.88	0.986
2006	*LN*	2.250 (0.002)	0.593 (0.002)		0.996	33.10	0.981
	D	1220.0 (113.4)	3.045 (0.031)	0.810 (0.016)	0.997	102.40	> 0.999
	SM	0.0020 (< 0.0001)	2.609 (0.015)	1.327 (0.034)	0.998	42.55	0,991
2007	*LN*	2.349 (0.002)	0.562 (0.002)		0.996	27.47	0.956
	D	1884.0 (109.3)	3.132 (0.019)	0.851 (0.010)	0.998	42.11	0.987
	SM	0.0011 (< 0.0001)	2.784 (0.010)	1.241 (0.019)	0.998	32.35	0.972
2008	*LN*	2.479 (0.002)	0.556 (0.001)		0.996	32.36	0.962
	D	2060 (73.0)	3.050 (0.011)	0.927 (0.007)	0.999	103.10	0.999
	SM	0.0007 (< 0.0001)	2.860 (0.007)	1.155 (0.010)	0.999	54.93	0.992
2009	*LN*	2.562 (0.002)	0.559 (0.002)		0.995	33.35	0.954
	D	2649.0 (168.3)	3.041 (0.019)	0.916 (0.012)	0.998	95.81	0.998
	SM	0.0006 (< 0.0001)	2.776 (0.010)	1.298 (0.020)	0.999	37.59	0.968
2010	*LN*	2.616 (0.001)	0.559 (0.001)		0.996	34.64	0.949
	D	2611.0 (96.0)	2.995 (0.011)	0.955 (0.007)	0.999	73.30	0.995
	SM	0.0005 (< 0.0001)	2.831 (0.006)	1.186 (0.011)	0.999	57.74	0.989
2011	*LN*	2.660 (0.002)	0.555 (0.002)		0.994	36.75	0.952
	D	5603.0 (261.5)	3.176 (0.013)	0.850 (0.008)	0.999	80.34	0.996
	SM	0.0004 (< 0.0001)	2.836 (0.009)	1.217 (0.016)	0.999	42.98	0.969
2012	*LN*	2.707 (0.003)	0.557 (0.002)		0.992	40.27	0.959
	D	7823.0 (567.3)	3.222 (0.022)	0.814 (0.010)	0.998	47.70	0.976
	SM	0.0004 (< 0.0001)	2.753 (0.012)	1.386 (0.026)	0.998	40.27	0.959

Source: own calculation based on the HBS microdata.

Figure 1. Complementary cumulative density functions of the lognormal (solid line) and Pareto (dashed line) models for years: 2005 and 2012 in log-log scale. The horizontal axis: annual income in thousands PLN, the vertical axis: percentage of the households



Source: own preparation based on the HBS data.

All the evaluated models describe empirical data very well. They are characterized by the high coefficients of determination and very small errors of their parameters. The values of R^2 are similar to each other for all the models. The smallest values of R^2 are observed for the lognormal model, which describes the smallest part of the incomes distributions: from 94.9% to 98.3%, depending on year. On the other hand, lognormal model doesn't explain from 1.7% (2004) to 5.1% (2010) of incomes, Singh-Maddala: from 0.8% (2008) to 4.1% (2012), and Dagum: from 0.1% (2006) to 2.4% (2012). Models' functions of incomes are plotted in Fig. 1 for years: 2007, 2009 and 2012. There are complementary cumulative density functions in the figure. They are given by the equations:

$$\overline{F}_{emp}(x_i) = 1 - F_{emp}(x_i) \text{ and } \overline{F}(x) = 1 - F(x) .$$

In order to emphasize differences between the empirical and theoretical distributions the plots are on the log-log scale.

In the next step, tails of the empirical distributions have been approximated by the Pareto model. The tails have been defined in this work as incomes satisfying the inequality $x \geq x_m$. Further on, we will take into account and discus two cases: when the limit values x_m have been determined for: (i) lognormal model and (ii) Dagum model. For those two models one obtained the minimum and the maximum values of x_m respectively (see Table 1). In the case of Singh-Maddala model values of x_m are slightly bigger than in (i) and values of estimation parameters for Pareto model are similar to those in (i). Because of that, these results are omitted in this paper. Results of the estimations of Pareto model are presented in Table 2. The plots of the Pareto functions are in Fig. 2.

In the case (i) the quality of the Pareto model's fits is very high. We also observe very small errors of the α parameter. In the first year (2004) the Pareto exponent has value of 3.04, and in the following years has values $2.65 \div 2.93$. The power law exponent is very stable in time, it's changes are small and values around 2.80. For comparison, Clementi & Gallegati (2005, pp. 3-14) obtained the Pareto exponents: $1.10 \div 3.34$ for the U.S. (1980–2001); $3.47 \div 5.76$ for the UK (1991–2001) and $1.63 \div 2.14$ for Germany (1990–2002). In the case (ii) the results are more dispersed than in the case (i). Dagum model does not explain only below 0.5% of incomes for most of the year. The range of incomes which could be regarded as tail is very narrow. Such a good agreement of this model with income data is emphasized in the empirical studies (Bandourian, *et al.*, 2002, p. 47; Kleiber, 1996, pp. 265–268). However, analysis of the residuals and *SSE* shows that Dagum model overestimates income distributions in their central part for most of the analyzed years. In other words, Dagum model fits well in the tail of the distribution at the expense of quality of the fit in the middle part.

This effect is also visible in Table 1: Singh-Maddala model explains smaller parts of income distributions than Dagum model, whereas is characterized by the same or even greater goodness of fits. In the case (ii) the models of tails (Table 2) are characterized by lower qualities of fits and greater errors than in the case (i). Pareto exponent is $1.76 \div 3.21$. The results are more dispersed than in the case (i).

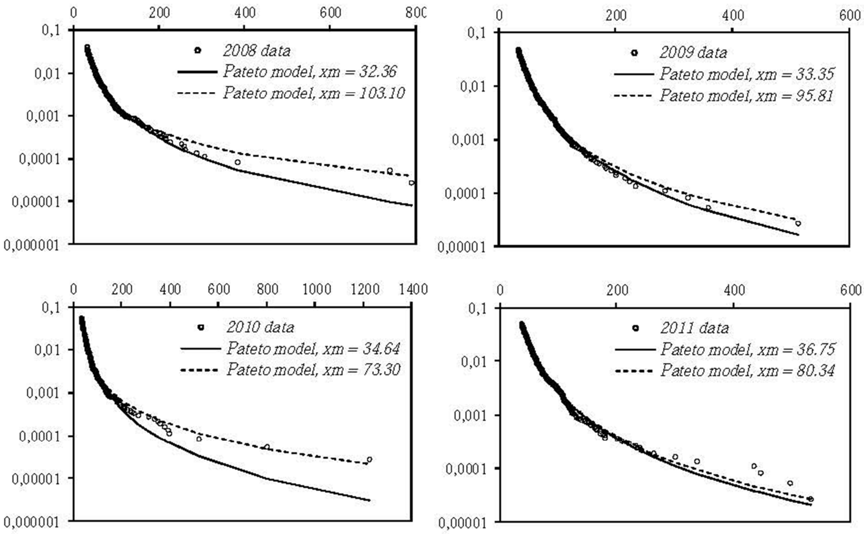
Table 2. Estimations of the Pareto model. Values of limits x_m have been set for lognormal (*LN*) and Dagum (*D*) models. Values s_α indicate standard errors of parameters' estimators α

Year	Model	x_m	α	s_α	R^2
2004	*LN*	31.59	3.036	0.008	0.996
	D	59.04	3.205	0.043	0.983
2005	*LN*	29.83	2.887	0.006	0.996
	D	72.26	2.542	0.046	0.984
2006	*LN*	33.10	2.865	0.004	0.998
	D	102.40	2.252	0.060	0.986
2007	*LN*	27.47	2.669	0.003	0.998
	D	42.11	2.567	0.085	0.994
2008	*LN*	32.36	2.649	0.007	0.989
	D	103.10	1.756	0.050	0.960
2009	*LN*	33.35	2.928	0.003	0.998
	D	95.81	2.438	0.040	0.979
2010	*LN*	34.64	2.732	0.008	0.983
	D	73.30	1.902	0.026	0.963
2011	*LN*	36.75	2.911	0.005	0.994
	D	80.34	2.747	0.036	0.969
2012	*LN*	40.27	2.761	0.005	0.996
	D	47.70	2.714	0.007	0.994

Source: own calculations based on the HBS data.

The lognormal models with power law tails are stable through the years: σ parameter is about 0.56 since 2007 and the Pareto exponent has values close to 2.8. The μ parameter increases with average income. The biggest discrepancies are observed in right tail-ends of the distributions. The tails are described by Pareto model very well for the majority of years. There are some deviations of the model from empirical data in the far ends of the distributions for years: 2008, 2010, 2011 (see Fig. 2). However, errors of the data points in those regions of the distributions are relatively large. Those differences seems to be assigned to the statistical fluctuations. Further detailed studied should provide knowledge about the size of such fluctuations and their influence on the model's parameters.

Figure 2. Tails of income distributions and Pareto model fits for 2008, 2009, 2010 and 2011 in semi-log scale. Values of limits x_m have been set for lognormal model (solid line) and Dagum (dashed line). The horizontal axis: annual income in thousands PLN, the vertical axis: percentage of the households



Source: own preparation based on the HBS data.

Conclusions

The income distributions of Polish households in 2004 – 2012 were studied in this paper. One evaluated an agreement with data of three models of incomes: lognormal, Dagum, and Singh-Maddala. The lowest goodness-of-fits were observed for lognormal model, while the best fits were for Dagum. None of the analyzed models were able to describe the distributions in their whole ranges with sufficiently high precision. The biggest discrepancies were observed in right tail-ends of the distributions.

Dagum model describes almost the whole range of the income distributions in the majority of years, unexplained tails are short. That's why the tails cannot be described with sufficiently high precision by Pareto model. The Power law exponents are not stable in time and have relatively big errors. At the same time Dagum model overestimates data in the middle of income distributions. In the case of Singh-Maddala model the results were similar to those obtained using lognormal model.

The lognormal models with power law tails are stable through all years. This two-part model will be used in future studies. The discrepancies between the model and data will be further investigated. Incomes of individuals in the households will be analyzed using this model.

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Decomposition of inter-regional inequality in average personal incomes by income sources: the Russia case study

JEL Classification: *D31; I31; R13*

Keywords: *personal income, sources, inter-regional inequality, decomposition*

Abstract

Research background: This paper is dedicated to inter-regional disparities in personal incomes and their composing by sources. We suggest that income sources contribute differently to overall inequality. Some of them, e.g. property incomes, amplify inequality, while others, e.g. social transfers, should mitigate it.
Purpose of the article: The aim of this article is to determine the character, direction and strength of influence of different sources, i.e. wages and salaries, property incomes, social transfers, entrepreneurship incomes and revenues from informal activities on inter-regional differences in overall incomes per capita and their dynamics based on Russian regional statistics in 2001-2014.
Methodology/methods: We used the method of relative deflating of regional incomes based on the fixed consumer basket cost, the population-weighted Theil index to measure inequality and technique of its decomposition to evaluate the contribution of various sources to regions' convergence in real incomes per capita.
Findings: For Russian regions in 2001-2014 we revealed different paths of inter-regional inequality for various sources of incomes. Decomposition of inter-regional income inequality demonstrated the largest and growing contribution made to it by wages and salaries. Informal incomes demonstrated declining influence on inequality and provided more than half of total inter-regional convergence. The contribution of entrepreneurship incomes to inter-regional disparities occurred the third and slightly decreasing, but their share in total incomes has declined. Social transfers per capita demonstrated the largest smoothing effect, but their contribution to convergence is mostly depleted. The property incomes proved to have the greatest

enhancing impact on inequality especially in the period of economic growth, albeit not large by value because of small share in total income. Ultimately we revealed the substituting role of informal incomes in respect of formal incomes and existence of self-perpetuating mechanisms of reducing inequality in Russian economy.

Introduction

Earlier researchers dedicated their studies to assessment and analysis of inter-regional inequality in personal incomes in Russian economy. In general, they found growing regional disparities in average personal incomes in Russia during the transition period of 1990-2000 (Yemtsov, 2005, pp. 348–408). This tendency changed to opposite, i.e. convergence in regional personal incomes per capita, in the first decade of the 21st century (Guriev & Vakulenko, 2012, pp. 1-81). In this period, especially during 2005-2008, favorable market conditions in the oil and gas industry allowed to accumulate and redistribute mining rent, to increase pensions and other social benefits, salaries and wages in the public sector (Zubarevich, 2013, p. 52-56).

Researchers of Russian regional convergence revealed some particular features attributed to it. Firstly, they discovered its gravity effects, i.e. influence of the geographic proximity of regions on the speed of convergence (Ivanova, 2014, pp. 100-119). Secondly, they revealed impact of the development similarities on convergence, the most evident in the group of reach regions (Kholodilin *et al*., 2009, pp. 5-27). In addition, (Lehmann & Silvagni, 2013, pp. 1-46) established high sensitivity of the level of incomes' inequality in Russia to performance of Moscow city and Tyumen Oblast and mining industry.

Decomposition of inter-regional inequality may shed light on formation and change in regional disparities in personal incomes. Modern scholars apply a range of methods of inequality decomposition: the covariance method (Shorrocks, 1982, pp. 193-212), the Gini coefficient additive decomposition (Lerman & Yitzhaki, 1989, pp. 43-47), the L. Shapley value method (Shorrocks, 2013, pp. 99-126), the Theil index decomposition (Chongvilaivan & Kim, 2016, pp. 79-98), etc. Now these techniques are employed for one, two and multi-dimensional decomposition of inequality in various spheres (Jedrzejczak, 2010, pp. 109-123; García-Peñalosa & Orgiazzi, 2013, pp. 689-727).

Unfortunately, these techniques are rarely used for incomes inequality decomposition in Russian economy. Thus, (Guriev & Vakulenko, 2012, pp. 1-81) applying the A. Shorrosks technique to the Gini coefficient disaggregated personal incomes inequality in 1995-2010 into those originated from wages, transfers and other incomes. Other researchers (Ovcharova *et al.*, 2016, pp. 170-185) applying the entropy indices and the regression technique by Morduch and Sicular found that the educational factor made the largest contribution to income inequality in Russia.

Our current study is aimed at detailed decomposition of interregional inequality in average personal incomes by sources based on more recent data of Russian regions in 2001-2014. According to our research hypothesis, different sources make different relative contributions to regional disparities in total incomes, and impact of some of them is due to state management actions, while others are induced by adaptive practices of population within the specific institutional environment.

Research methodology

Our study is based on the official data on 80 Russian regions in 2001-2014 provided by the Federal State Statistics Service of Russian Federation (FSSS) embracing personal incomes per capita, the structure of total incomes of population, number of population and the cost of the minimum fixed consumer basket. The personal incomes are grouped by sources, including: 1) business activities (entrepreneurship) incomes; 2) wages and salaries of employees reduced by arrears; 3) social transfers (pensions, benefits, scholarships, insurance compensations, etc.); 4) property incomes (interest on deposits, securities, dividends, etc.); 5) other incomes (proceeds from the sale of foreign currency, remittances, informal incomes).

First of all, we eliminate influence of regional inflation on nominal incomes through dividing them by indices of relative cost of living in the regions. These indices are calculated as the ratio of the cost of minimum consumer basket in the regions to the average cost of the same basket nation-wide (Malkina, 2015, pp. 99-100).

Secondly, we use the he population-weighted Theil index for assessment of inequality, which is one of the measures of generalized entropy. Based on the logarithmic scale, it embeds the principle of diminishing marginal utility of relative incomes.

$$Th = \sum_{i=1}^{m} \rho_i \cdot \left(y_i / \bar{y} \right) \cdot \ln\left(y_i / \bar{y} \right). \tag{1}$$

where $i = \overrightarrow{1, m}$ - serial number of the region; ρ_i – share of the i-th region in total population of country; y_i - average personal income in the i-th region; $\bar{y} = \sum_{i=1}^{n} \rho_i \cdot y_i$ – average personal income in the country.

Thirdly, we apply relevant technique of the Theil index decomposition by K sources:

$$Th = \sum_{k=1}^{K} Th_k \ , \tag{2}$$

$$Th_k = \sum_{i=1}^{m} \rho_i \cdot \left(y_{ki} / \bar{y} \right) \cdot \ln\left(y_i / \bar{y} \right), \tag{3}$$

where y_{ik} – average personal income coming from the k-th source in the i-th region.

Next, we compare the shares of various sources in inequality with their shares in overall personal incomes to reveal which income sources are relatively enhancing and which are rather smoothing inequality.

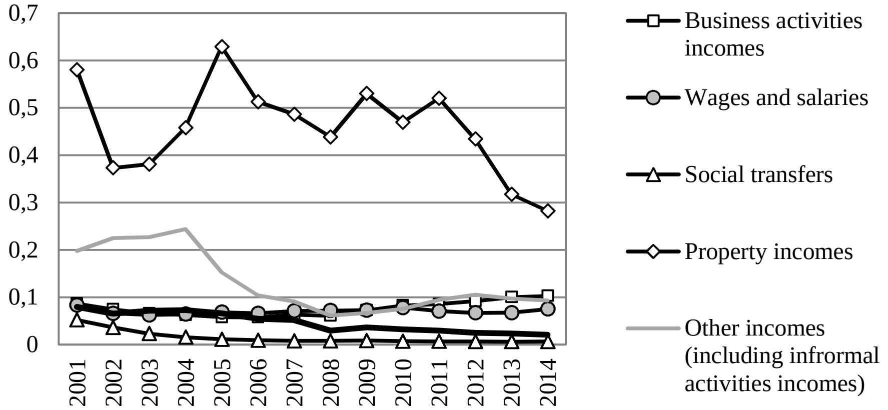
Finally, we employ the proportional method of factor analysis to evaluate contributions of various sources to total convergence/divergence of Russian regions in personal incomes across the years in connection with changing economic conditions.

The results of assessment of inter-regional inequality in average personal incomes and their components

The figure 1 demonstrates the level of inter-regional inequality in personal incomes and their components calculated by formula 1.

The property incomes appeared the most unevenly distributed component of personal incomes among Russian regions. Besides, their inequality shows large fluctuations across time, however, finally reduces by more than half.

Figure 1. Dynamics of the inter-regional Theil coefficient for average personal incomes and their components in Russian Federation in years 2001-2014



Source: own calculations based on FSSS of RF (2017).

The social transfers, on the contrary, demonstrate the lowest level of inter-regional inequality. This is quite reasonable, because social payments are designed as automatic stabilizers in economy aimed at smoothing the differences in personal incomes. Moreover, they demonstrate the most intensive regional convergence amounting to 87.6%.

Inter-regional inequality in wages and salaries is observed in the medium zone of our figures and outline cyclical waves over time embedded in narrow hallway. The Theil index indicates decrease in regional disparities in average wages by only 9.6% over the period considered.

Inter-regional inequality in business activities incomes as well appears medium among other types of income and demonstrates upward tendency after the crisis of 2009. Eventually, regional differences in this type of income enlarged by 18.7% over 2001-2014.

Unlikely the formal business incomes, inequality in informal incomes decreased noticeably, more than 2 times over the period considered. It was permanently decreasing in the period of economic recovery of 2004-2008 and showed opposite ascending tendency in the following crisis likewise business activities incomes.

Meanwhile, separate evaluation of inequality of various income sources does not specify their interaction with overall inequality. Apparently, some sources of inequality may reinforce the general inequality (when act in the same direction with it), while others may weaken it (when act in the opposite direction). This necessitates the analysis of their cointegrated influence on overall inequality in personal incomes.

The results of decomposition of inter-regional inequality in personal incomes by sources

Contributions of various sources to total income inequality assessed by formulas 2-3 in comparison with their contributions to total personal income are represented in the table 1.

Table 1. The results of decomposition of the inter-regional personal incomes inequality by sources based on the Theil coefficient (share, %)*

	Business activities incomes		Wages and salaries		Social transfers		Property incomes		Other incomes		Total incomes	
	s_{Thk}	s_{Yk}	s_{Thk}	s_{Yk}	s_{Thk}	s_{Yk}	s_{Thk}	s_{Yk}	s_{Thk}	s_{Yk}	s_{Thk}	s_{Yk}
2001	4.7	13.0	19.3	39.5	3.2	15.6	21.4	5.0	51.4	26.9	100	100
2002	4.0	12.2	18.7	41.8	1.0	15.7	16.1	4.8	60.2	25.4	100	100
2003	2.4	12.4	17.4	40.1	-3.0	14.7	23.9	7.2	59.3	25.6	100	100
2004	0.7	12.2	16.8	41.1	-5.3	13.5	29.0	7.5	58.8	25.7	100	100
2005	0.6	11.8	25.3	39.8	-9.1	13.4	44.9	9.0	38.3	26.0	100	100
2006	0.7	11.5	31.8	39.5	-9.6	12.7	42.6	8.8	34.5	27.6	100	100
2007	-1.6	10.5	40.7	41.1	-10.4	12.2	39.0	7.9	32.3	28.3	100	100
2008	0.1	10.6	71.8	43.5	-9.2	13.6	31.8	5.5	5.5	26.9	100	100
2009	-0.5	9.9	54.9	40.3	-9.1	15.4	36.1	5.8	18.6	28.7	100	100
2010	-3.2	9.2	60.9	39.4	-15.2	18.3	34.3	5.6	23.2	27.7	100	100
2011	-4.0	9.3	53.3	39.2	-17.0	18.8	32.4	4.6	35.3	28.1	100	100
2012	-3.0	9.7	57.6	40.3	-17.5	18.8	30.2	4.6	32.7	26.5	100	100
2013	-2.2	8.9	63.1	40.4	-19.3	19.1	27.9	5.0	30.5	26.5	100	100
2014	-1.2	8.6	77.4	40.4	-16.5	18.4	27.5	5.4	12.8	27.2	100	100

* *Note:* s_{Thk} *- share of the k-th type of income in total inequality (by the Theil index);* s_{Yk} *- share of the k-th type of income in total income*

Source: own calculations based on data provided by (Russian Federation Federal State Statistics Service, 2017).

The obtained results evidence that the structure of inter-regional inequality in personal incomes has changed significantly over 14 years. The share of wages and salaries in total inequality has increased more than 4 times, while their share in total personal income was persistently about 39-41%.

The property incomes had the greatest relative impact on inter-regional inequality. Their share in regional disparities surpassed their share in personal incomes 3.3-7 times in different years. These shares ratio was sharply growing during 2003-2011. After that we can observe a small drop in the property incomes relative contribution to inequality, which is probably caused by the recession in economy, primarily deteriorating the condition of affluent regions.

Social transfers proved to have the greatest leveling effect on inter-regional inequality only enhancing over time. At the same time, the share of social transfers in personal incomes in Russia has increased from 15.6% to 18.4%, which indicates the growing paternalism in Russian economy.

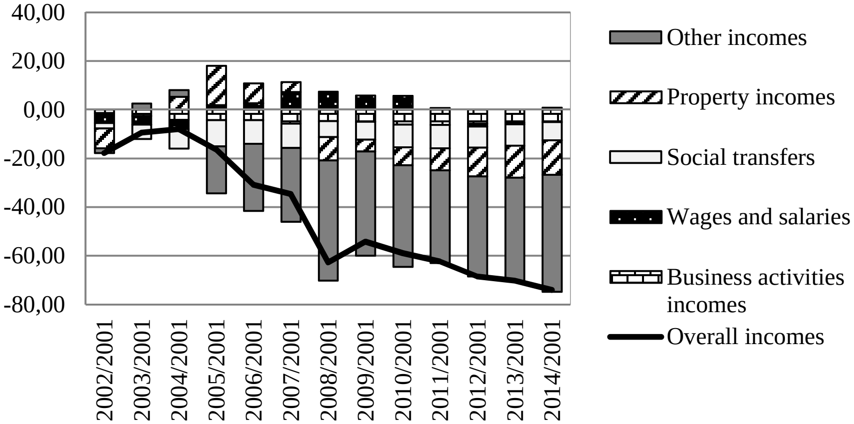
Generally we can ascertain the positive influence of business activities incomes on reduction in regional disparities in personal incomes in Russia, although their smoothing impact on inequality reduced during the 2011-2014 recession. However, permanent decrease in the share of business activities incomes in total incomes of Russian population did not allow their equalizing effect to manifest.

Informal incomes used to be the greatest source of spatial inequality in Russia in the first half of the 2000s. After that their impact on inter-regional inequality in personal incomes dropped, while their contribution to personal incomes almost did not change. This process was accompanied by relocation of informal activity towards the less affluent southern regions. Noticeable reduction in relative impact of informal incomes on inequality observed in 2008-2010 and 2014 is probably caused by launch of self-perpetuating mechanisms of population adaptation to deteriorating environment during the crisis.

Contribution of income sources to the regional convergence in personal incomes per capita

The figure 2 illustrates cumulative contributions of various sources to Russian regions convergence in personal incomes assessed by means of the proportional method of factor analysis.

Figure 2. The contribution of different sources to the Russian regions convergence in personal incomes per capita presented on an accrual basis since 2001 (according to the Thei decomposition)



Source: own calculations based on data of FSSS of RF (2017).

According to our calculations, about 65% of regional convergence in personal incomes was attained due to smoothing effect of the informal incomes, whose influence was only amplifying in course of time. This really surprising result cannot be estimated unconditionally positive because most part of this revenue is involved in tax evasion.

Property incomes contributed to growth in inequality until 2008, and then demonstrated moderate contribution to regions convergence in personal incomes (finally providing 19.2% of it). Social transfers and business activities incomes altogether provided additionally 16.9% of total convergence. The ultimate contribution of wages and salaries to regional convergence proved to be almost nil. Moreover, it was not steady, altering by direction and even more provoking divergence in 2007-2008 and in 2014.

Conclusions

In this research we employed the Theil index and technique of its decomposition for assessment of contribution of various income sources to inter-regional inequality in average personal incomes in Russia. It allowed us to explain the earlier revealed phenomenon of reducing regional disparities in the level of personal incomes in Russian economy in 2001-2014 and to disclose its qualitative nature.

We found that contribution of various types of incomes to spatial inequality in overall personal incomes depends not only on their own inequality but also on their correlation with over incomes. Thus, social transfers proved to be the most mitigating type of incomes, which inter-regional differences dropped most of all. But their contribution to regional convergence in total incomes appeared moderate. The property incomes are mostly enhancing source of inequality, reacting to crisis, but their share in incomes is small. They tend to contribute to convergence during crisis.

Business activities incomes appeared the second ranked equalizing component of regional incomes inequality, after social transfers, but their share in personal incomes dropped. The main correcting role in spatial inequality was conveyed to informal incomes. Their contribution to inter-regional convergence in personal incomes occurred the largest mostly because of their permanently significant share in total personal incomes and spatial relocation in favor of less advantaged regions. This result corresponds to the study by (Amarante, 2016, pp. S4–S21) observed the same phenomenon in Latin America.

Finally, wages and salaries have gradually turned from the source mitigating spatial inequality to one enhancing it. They did not really have any perceptible relation to the regions convergence in terms of personal incomes.

We confirm the existence of self-perpetuating forces in economy preventing growth in inequality and ensuring catching-up effect. Except for social transfers specifically constructed as automatic stabilizers, we can mention legal and illegal business activities' incomes which may partially compensate for differences in income in periods of ups and down, respectively.

Finally, we have to make a reservation for the national statistical peculiarities not explaining in details the origin of 26% of household incomes called “other incomes”. This problem is also emphasized by (Zubarevich, 2013, p. 49) who points out the shortcomings of the Russian household statistics, such as a rough estimate of shadow incomes, inadequate sample household survey, the complexity of the measurement of natural receipts, etc., hindering a meaningful analysis. Finding ways to overcome these obstacles would allow more precise analysis of participation of various personal income sources in formation of inter-regional disparities in Russia. It may be the subject of further analysis and future discussions.

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Property tax autonomy and tax mimicking in major metropolitan areas in Poland

JEL Classification: *H2; H71; R5*

Keywords: *tax autonomy; property taxation; tax mimicking; spatial interdependence; Poland*

Abstract

Research background: Real estate and urban economics literature is abundant in studies discussing various types of property taxes and their characteristics. Growing area of research focused on tax equity, tax competition, and tax mimicking. Recently, due to substantial developments in spatial and regional economics more attention was drawn to spatial effects. Empirical results are focused on spatial interaction and diffusion effects, hierarchies of place and spatial spillovers.
Property tax system in Poland differs from those utilized in the majority of developed countries. As a consequence, property tax policy at local government level (including tax competition and tax mimicking effects) in Poland can differ substantially from those found in previous research in US and other European countries. There are few studies addressing the problem of tax competition and tax mimicking in Poland from empirical perspective.
Purpose of the article: In the article we explore spatial dependences in property taxation. We identify clustering or dispersion of high and low values of the tax rates within major metropolitan areas in Poland. The effects can indicate presence of tax mimicking among municipalities in given metropolitan areas.
Methodology/methods: We analyze the panel data from 304 municipalities in 10 metropolitan areas in Poland from year 2007 to 2016. The data covers four property tax rates: (1) on residential buildings (2) on buildings used for business purpose (3) on land used for business purpose (4) on land for other uses. To explore spatial

distribution of rates we used global and local spatial autocorrelation indicators (Moran's I statistic and LISA).
Findings: The results suggest the presence of spatial correlation within metropolitan areas. We also found significant differences between metropolitan areas. The results of the study fill the gap in empirical research concerning property tax mimicking in Poland.

Introduction

Property tax autonomy is closely related to general financial autonomy of municipalities, which may be discussed with regard to the income and/or expenditure aspects. Usually more attention is focused on income issue as a criterion determining financial autonomy of municipalities rather than the local governments' independence in public expenditure. Like in many other countries worldwide, a property tax is the most important public levy in Poland with reference to income autonomy of local governments. It comes from a few circumstances: a property tax is a stable and quite profitable source of local income, municipal authority possesses some ability to shape its own fiscal policy within the limits set by the legislation.

The scope of tax autonomy in Poland is restricted by legal construction of property tax system and contains primarily: setting tax rates up to the level of statutory ones fixed on a yearly basis by central government, differentiation of tax rates, application of tax preferences in the form of exemptions.

It's worth to mention that the property tax system in Poland differs significantly from those utilized in the major of developed countries. In contrary to the framework of property taxation adopted in many other European countries, tax burden in Poland is based on the size of an area of real estate instead of the value. A common feature of both taxation systems – in relation to the area or the property value - is the usage of property tax as an instrument to support local socio-economic development. (Helms, 1985, pp. 574-582; Bartik, 1992, pp. 102-111; Wassmer, 1994, pp. 1251–1278; Buss, 2001, pp. 90-105; Małkowska & Głuszak, 2016, pp. 269-283).

Growing theoretical and empirical literature is focused on different aspects of real estate taxation. One of the current and important issue connected with fiscal autonomy is the strategic interaction among the tax solutions set by neighbouring municipality. Scholars have noticed that policies (e.g. tax policies) adopted by one jurisdiction frequently have economic effects on the others in geographically proximate neighbours. Economic consequences of policy decisions taken by one municipality for its neighbours constitute a strategic game among local governments in which every government competes with those in geographic proximity (Baybeck, Berry & Siegel, 2011, pp. 232-247).

Local governments' decisions in property taxation may have the impact on attracting new capital. Thus, setting tax rates is a sort of economic competition between proximity jurisdictions for mobile factors and residents. Next cause of spatial interactions between public entities may have political background such as electoral accountability, political trends and vote-seeking (e.g. Besley & Case, 1995, pp. 25-45; Sole-Olle, 2003, pp. 685-713; Santolini, 2008, pp. 431-451). This interactions leads to the situation, that local policymakers consider the tax solutions of neighbouring jurisdictions when setting their own tax rates (Santolini, 2008), what leads to the phenomenon of tax mimicking.

First researches on fiscal policy interdependence were conducted on the base of the data from the United States (e.g. Ladd, 1992, 450-467; Case, 1993, pp. 136-148). Further studies verified the existence of tax mimicking in a few European countries (e.g. Heyndels & Vuchelen, 1998, pp. 89-101; Allers & Elhorst, 2005, pp. 493–513; Santolini, 2008, pp. 431-451, Delgado & Mayor-Fernandez, 2011, pp. 149-164). In Polish literature there are only few papers devoted to tax competition and tax mimicking (e.g. Walasik, 2014, pp. 200-210; Łukomska & Swianiewicz, 2015). However, current research based on Polish data has not explored the problem of spatial interdependency in property tax policy in an exhaustive. In comparison to the other foreign empirical works, there is a significant difference between mechanisms appropriate to ad valorem tax and those based on the area size of real estate. For this reason, empirical studies focused on the other than ad valorem taxation system are notable.

In order to fill the gap in empirical evidence Authors have examined municipalities located in major metropolitan areas in Poland from year 2007 to 2016 in the context of property tax rate settings. We collected the panel data included 304 public entities in 10 metropolitan areas.

The main purpose of this research was to find out whether it is a spatial interdependence in property taxation among neighbouring municipalities within metropolitan areas. For answer this question we have identified clustering or dispersion of high and low values of the tax rates within analysed territories. We established two hypotheses: (1) there is spatial correlation between property tax rates set by municipalities incorporated into metropolitan areas, which can suggest property tax mimicking phenomenon; (2) there are significant differences in spatial patterns of property tax rates values between metropolitan areas.

To indicate this spatial arrangement due to an assumption of policy interdependence we used global and local spatial autocorrelation indicators (Moran's I statistic and LISA).

Method of the research

In order to verified whether it is a spatial interdependence in property tax rate setting among neighboring municipalities within metropolitan areas in Poland we gathered the panel data from 304 municipalities in 10 metropolitan areas concentrated around the following central cities in Poland: Bydgoszcz-Toruń (*Bydgoszcz-Torun Metropolitan Area – BTOM*), Gdańsk-Gdynia-Sopot (*Tricity Metropolitan Area – TOM*), Katowice (*Upper Silesia Metropolitan Area – GOM*), Kraków (*Krakow Metropolitan Area – KOM*), Lublin (*Lublin Metropolitan Area – LUBOM*), Łódź (*Lodz Metropolitan Area – LOM*), Poznań (*Poznan Metropolitan Area – POM*), Szczecin (*Szczecin Metropolitan Area – SZOM*), Warszawa (*Warsaw Metropolitan Area – WOM*), Wrocław (*Wroclaw Metropolitan Area – WROM*).

The time range of data covers the period from 2007 to 2016. The substantive scope of gathered information contains four property tax rates: (1) on residential buildings (2) on buildings used for business purpose (3) on land used for business purpose (4) on land for other uses.

Analysis of policy interdependence in tax rate setting between neighboring municipalities was conducted by global and local spatial autocorrelation metrics (Moran's I statistic and LISA).

Exploratory analysis

We investigated the dynamics of major tax rates on land and buildings. To account for autonomy, and to compare different rates we calculated *relative* tax rates. We define *relative* tax rate based on the ratio between actual tax rate set by municipality and maximum allowable tax rate announced by Ministry of Finance in a given year. To analyze the changes in distribution of relative tax rates within metropolitan areas we calculated descriptive statistics. A brief summary of the results is presented in a table (Table 2).

Table 2. Relative major tax rates on land and buildings in selected metropolitan areas in Poland from 2007 to 2016

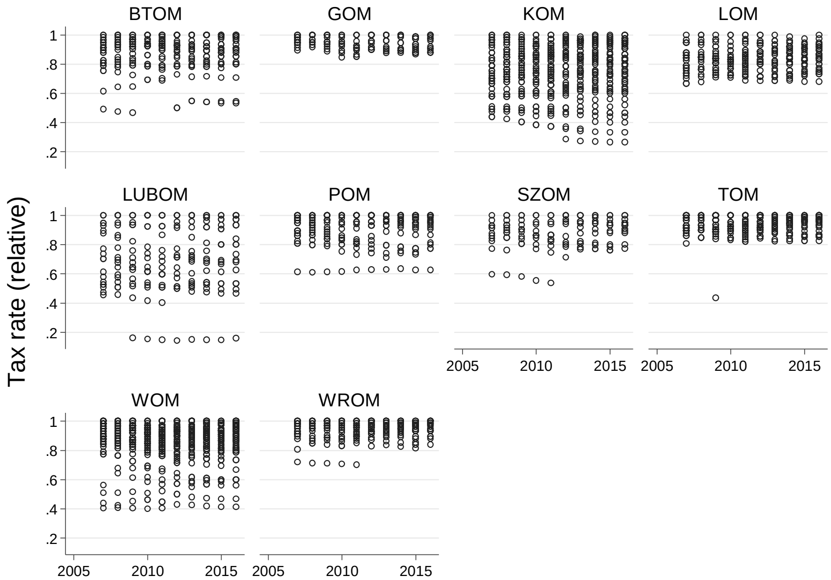
Tax rates /		2007		2010		2013		2016	
Metropolitan Areas		Mean	SD	Mean	SD	Mean	SD	Mean	SD
Land used for business purpose	BTOM	0.87	0.10	0.89	0.09	0.88	0.07	0.90	0.08
	GOM	0.96	0.03	0.95	0.03	0.95	0.05	0.95	0.04
	TOM	0.83	0.13	0.84	0.12	0.84	0.12	0.86	0.12
	KOM	0.89	0.08	0.89	0.07	0.89	0.07	0.91	0.07
	LUBOM	0.80	0.14	0.81	0.14	0.82	0.13	0.86	0.13
	LOM	0.93	0.06	0.93	0.07	0.94	0.08	0.95	0.07
	POM	0.90	0.09	0.89	0.10	0.91	0.07	0.94	0.07
	SZOM	0.94	0.05	0.95	0.05	0.95	0.05	0.96	0.04
	WOM	0.92	0.07	0.91	0.07	0.90	0.08	0.91	0.07
	WROM	0.95	0.05	0.95	0.06	0.96	0.04	0.98	0.03
Other land	BTOM	0.46	0.21	0.57	0.23	0.65	0.21	0.68	0.21
	GOM	0.71	0.16	0.81	0.14	0.88	0.13	0.87	0.14
	TOM	0.47	0.24	0.49	0.23	0.55	0.22	0.56	0.24
	KOM	0.53	0.24	0.58	0.22	0.59	0.21	0.61	0.20
	LUBOM	0.56	0.29	0.63	0.27	0.70	0.28	0.73	0.25
	LOM	0.61	0.20	0.69	0.18	0.76	0.20	0.77	0.19
	POM	0.52	0.24	0.65	0.23	0.74	0.17	0.79	0.19
	SZOM	0.68	0.17	0.76	0.16	0.80	0.16	0.85	0.16
	WOM	0.63	0.20	0.68	0.19	0.73	0.19	0.74	0.19
	WROM	0.72	0.16	0.79	0.17	0.89	0.13	0.89	0.13
Buildings used for business purpose	BTOM	0.85	0.07	0.87	0.07	0.88	0.07	0.89	0.07
	GOM	0.97	0.02	0.96	0.03	0.97	0.03	0.98	0.03
	TOM	0.79	0.15	0.81	0.10	0.82	0.10	0.83	0.11
	KOM	0.85	0.08	0.85	0.07	0.85	0.07	0.88	0.07
	LUBOM	0.83	0.08	0.83	0.07	0.83	0.07	0.86	0.07
	LOM	0.89	0.09	0.89	0.09	0.89	0.10	0.91	0.10
	POM	0.90	0.07	0.88	0.08	0.89	0.09	0.92	0.07
	SZOM	0.89	0.08	0.89	0.08	0.90	0.08	0.92	0.08
	WOM	0.92	0.07	0.90	0.07	0.90	0.07	0.91	0.07
	WROM	0.96	0.03	0.95	0.05	0.95	0.04	0.97	0.04
Residential buildings	BTOM	0.86	0.11	0.90	0.09	0.87	0.12	0.88	0.12
	GOM	0.96	0.03	0.94	0.05	0.95	0.05	0.94	0.05
	TOM	0.75	0.16	0.76	0.16	0.77	0.18	0.77	0.19
	KOM	0.83	0.09	0.83	0.08	0.84	0.09	0.85	0.08
	LUBOM	0.72	0.19	0.70	0.23	0.72	0.23	0.75	0.23
	LOM	0.91	0.09	0.91	0.10	0.92	0.11	0.92	0.10
	POM	0.87	0.10	0.86	0.11	0.90	0.09	0.92	0.07
	SZOM	0.94	0.05	0.94	0.06	0.95	0.05	0.95	0.05
	WOM	0.90	0.12	0.86	0.13	0.87	0.13	0.88	0.13
	WROM	0.95	0.06	0.94	0.07	0.96	0.04	0.96	0.04

Source: own calculations.

The results reveals significant between-group differences in mean tax rates on land and buildings set by municipalities. In case of tax on land for building purpose, relative rates were very high (close to the maximum annual levels set by Ministry of Finance). On average, relative tax rates on land used for business purpose were the highest in Wroclaw Metropolitan

Area (WROM), where it reached 96% of maximum rate in 2016 set by Ministry of Science, and the lowest in Lublin Metropolitan Area (LOM) and Tricity Metropolitan Area (TOM). In latter two it averaged approximately 86% of maximum rate in 2016. On average, lower relative tax rates and significantly larger differences (higher standard deviations) were observed in case of tax rates for other land. In 2016, average relative rates for other land ranged from 56% (TOM) to 89% (WROM). The rates for building were more uniform, with the exception of Lublin Metropolitan Area (LUBOM), were average values were significantly lower than in other metropolitan areas. The dispersion of relative tax rates on buildings in metropolitan areas during the study period is presented in more detail in the figure (Figure 1 and 2).

Figure 1. Tax rate on residential buildings from 2007 to 2016 (relative to annual Maximum Rate set by Ministry of Finance, in %)

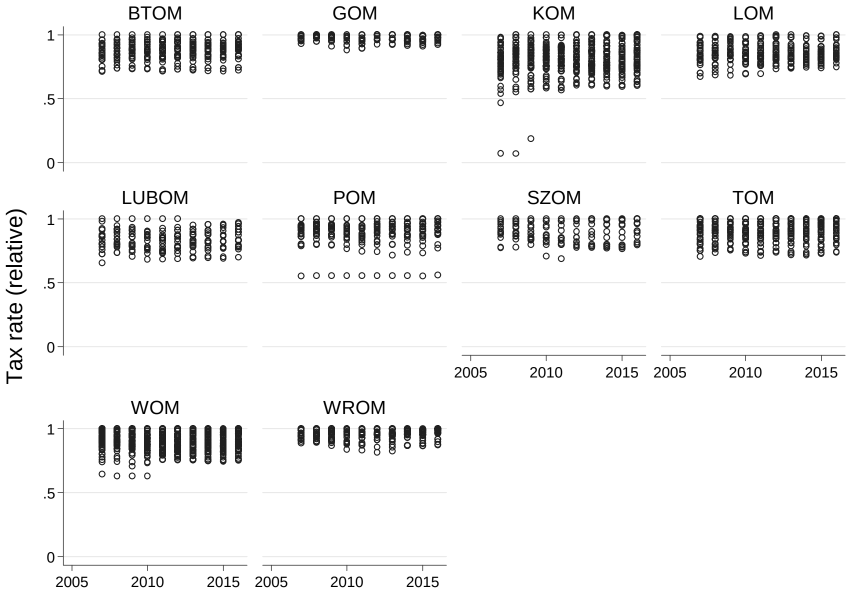


Source: own calculations.

The analysis reveals the presence of outliers, where tax rates differed significantly from typically set in given metropolitan areas. The best examples are Krakow Metropolitan Area (KOM) and Poznan Metropolitan Area

(POM). There are considerable differences in variance of the rates – the graph reveals huge disparity in KOM and low dispersion in Upper Silesia Metropolitan Area (GOM) and WROM – where municipalities applied relatively similar relative tax rates on buildings used for business purpose during the study period.

Figure 1. Tax rate on buildings used for business purpose from 2007 to 2016 (relative to Maximum Rate set by Ministry of Finance, in %)



Source: own calculations.

Tax rates on residential buildings were less centered around mean in most metropolitan areas. Huge variation of tax rates was observed within WOM, KOM, and LUBOM. Also in case of tax on residential buildings rates were considerably uniform in GOM.

Spatial analysis

We examined the spatial autocorrelation for four different real estate tax rates in ten metropolitan areas during ten year period. The adjacency matrix used for calculations had queen criterion of contiguity, which means that a unit (municipality) which share a border or even one corner with another unit is considered as "neighbour". Spatial computations were performed in GeoDa (version 1.8.16.4) software (Anselin, 2006). Table 1 presents Moran I spatial autocorrelation measures.

Table 2. Moran I statistics, p-value = 0,001

Tax type	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Tax1	0,252	0,248	0,250	0,228	0,239	0,239	0,240	0,240	0,187	0,215
Tax2	0,072	0,101	0,281	0,031	0,029	0,027	0,267	0,022	0,265	0,059
Tax3	0,299	0,283	0,285	0,290	0,287	0,285	0,278	0,284	0,273	0,272
Tax4	0,374	0,370	0,338	0,340	0,348	0,265	0,329	0,047	0,304	0,295

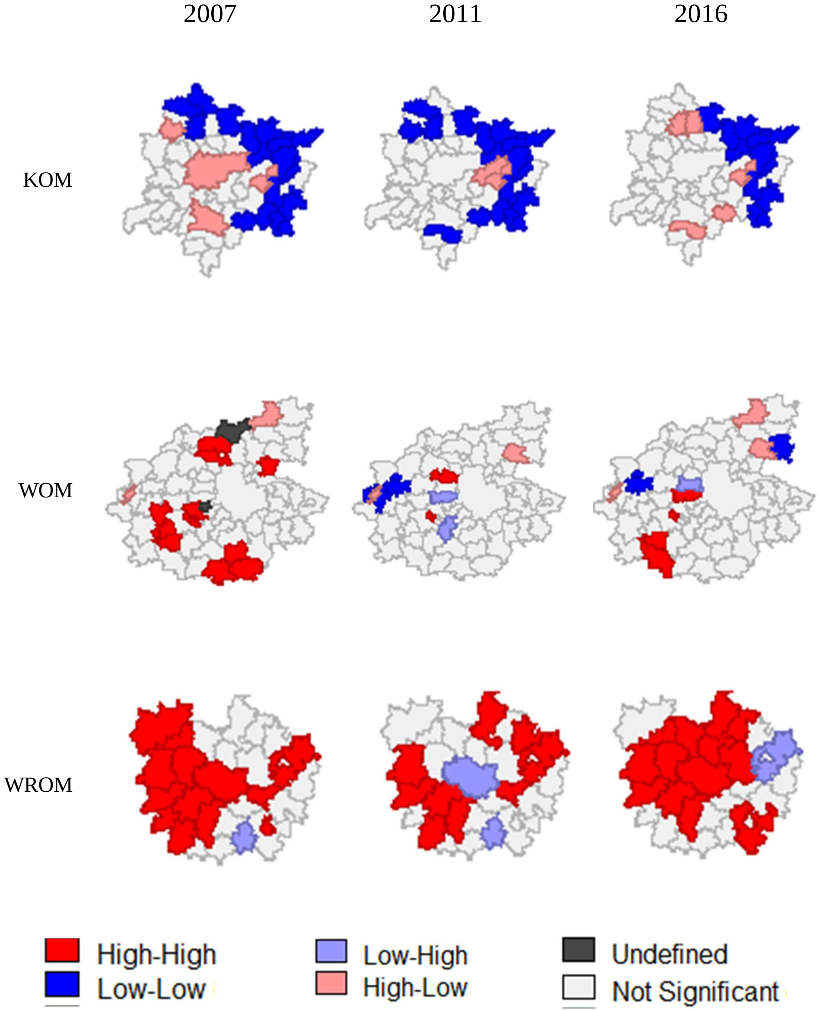
Source: own studies.

Results shows that the highest Moran I measure, which indicate the occurrence of low or high value clusters, were calculated for tax 4 (Moran I from 0,29 to 0,37), in turn the lowest Moran I statistics – for tax2 (Moran I from 0,02 to 0,1) and indicates no spatial autocorrelation. Global statistics for all other tax rates (tax1, tax3) were on average about 0,25. Note that despite constant tendencies to clustering, during the analysed period, several exceptions occurred. Tax1 for example, in 2015 had very low Moran I statistic, and for tax2, which didn't indicated any clustering trend, in 2009, 2013 and 2015 global statistic raised to 0,25. Similarly, Moran I statistics for tax4, with strong autocorrelation, in 2014 deflected to 0,047. Certainly, this requires further analysis and political factors should be considered, as an initiator of changes in tax rate policy.

Further analysis consisted of calculating local measures, to test metropolitan areas in terms of which units create "hot" and "cold" clusters. Subsequently we generated LISA cluster map to depict statistical significant locations by the type of association and the results indicate geographical tendencies. Local statistics in three out of ten metropolitan areas were not statistically significant (SZOM, LOM and BTOM) for all tax rates during the analysed time period.

Figure 3 and 4 present the most interesting cases (metropolitan units KOM, WOM and WROM) respectively for tax3 and tax4 over three analysed years (2007, 2011 and 2016). Colours on the map present the following relationships: (1) the dark red locations indicate high tax rates surrounded by high tax rates; (2) the dark blue locations show low tax rates surrounded by low rates. Spatial outlier are marked with lighter colours as followed: (1) light red municipalities are those where are high tax rates surrounded by low; (2) light blue covers locations of high tax rates surrounded by low, (3) light grey depict statistical insignificant areas, and finally (4) dark grey are locations with no data available.

Figure 3. LISA Cluster Map of tax rates on residential buildings (tax3)

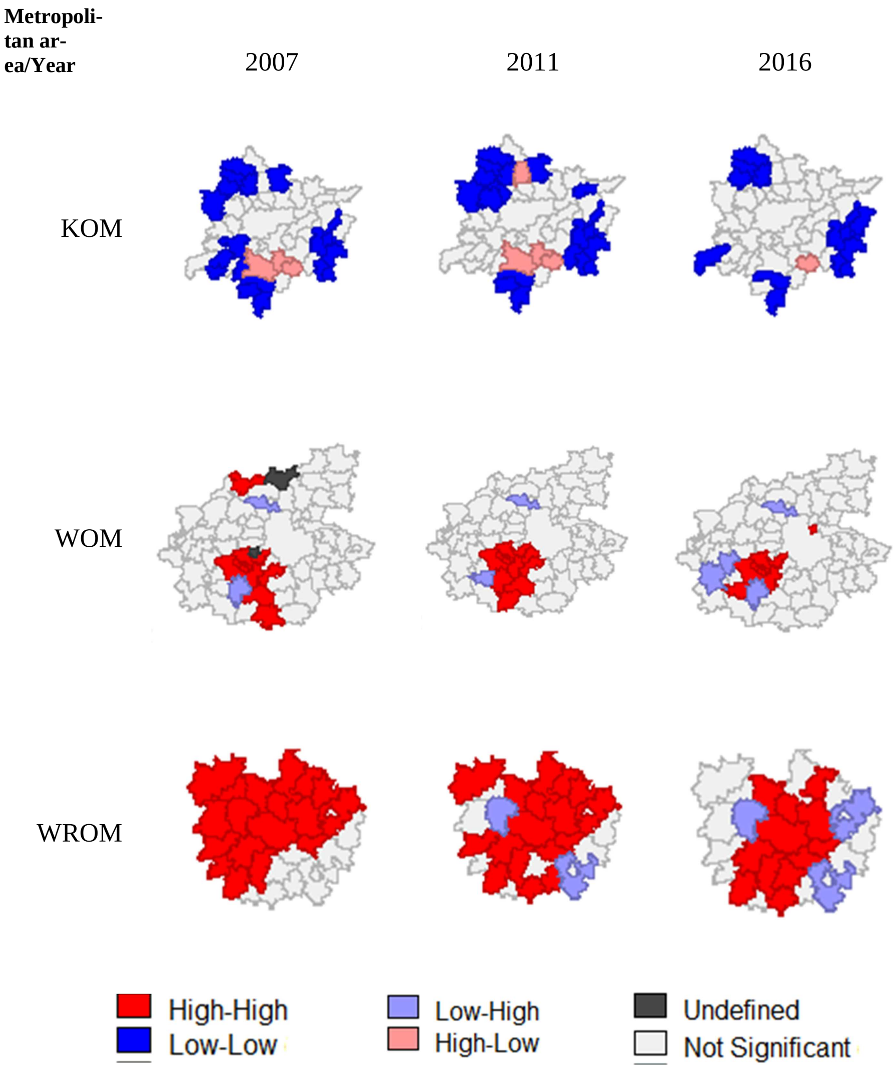


Source: own studies.

In case of tax on residential buildings (tax3) and buildings used for business purposes(tax4), similar to tax1, can be seen the tendencies to clustering of high values in western metropolitan areas, whereas cluster of low values were found in eastern areas. In KOM during the following years low values were concentrated in the eastern part of the area, while in the centre appeared "outliers" – units with high values, surrounded by low values. In WOM area basically didn't stand out any clear trend, but in WROM we observed strong clustering of high tax rates.

Figure 4 presents LISA Cluster Map of tax on building used for business purposes for three metropolitan areas (KOM, WOM, WROM) in 2007, 2011 and 2016.

Figure 4. LISA Cluster Map of tax rates on building used for business purposes (tax4)



Source: own studies.

Analysis reveals that Moran I statistics calculated for tax4 (tax on buildings used for business purposes) was the highest. LISA statistics indicate that clusters of high values appears in WROM, TOM and GOM areas, and low value clusters – in KOM and LUBOM and clustering process weakens over time. Local statistic for WOM seems to be an interesting case, because of its randomness, on first sight and slight tendency to clustering in the centre of the area. The Authors suppose, that the reason for that may be connected with an investment activity of municipalities and these are clustered in the centre which are considered to have the greatest economic potential.

Conclusions

In the paper we investigated the problem of fiscal autonomy of local government, exploring property tax rates used by municipalities in Poland. In the empirical part, analyzed the panel data from 304 municipalities in 10 metropolitan areas in Poland from 2007 to 2016. The results suggests that many municipalities used maximum allowable rates set by Ministry of Finance, thus level of effective autonomy is partially reduced by existing caps. Furthermore, we observed significant differences in property tax policies between metropolitan areas, as well as presence of spatial correlation. We found that municipalities form spatial clusters in relation to tax rates used. This clusters tend to be relatively stable over time. We also identified presence of spatial outliers, municipalities that used different rates than neighbour counterparts. We conclude that this result may indicate property tax mimicking.

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Duration model of enterprises – analysis of territorial groups

JEL Classification: *C10; C14; C41*

Keywords: *model of enterprises duration; Kaplan-Meier estimator; hazard function; cohort tables of enterprises survival*

Abstract

Research background: The popular term of business demography or demography of the firm denotes a relatively young area of science which focuses on the structures of cohorts of firms and the changes that undergo within these structures. As both the terms suggest, the studies use research methods traditionally applied in demographic studies. Survival analysis is increasingly used in business demography.
Purpose of the article: The purpose of the present study was to build the enterprises survival models for territorial groups in Zachodniopomorskie (Poland). In the first stage the Kaplan-Meier estimator was calculated and the test to verify the similarity of the survival function for poviats was conducted. Poviats were classified into groups. Next, the tables of enterprises survival were built and the business liquidation intensity was analysed in individual groups.
Methodology/methods: In this study the continuous-time non-parametric models were used: Kaplan-Meier estimator, Gehan test and duration table. Those methods were employed to model the survival time and find differences in the survival of firms in the poviats of the Zachodniopomorskie. In keeping with the above scheme five territorial groups with similar enterprises survival time models were distinguished.
Findings: The study results presented in this article reveal the differentiation of enterprises survival models in the territorial groups. Five groups of poviats were distinguished. These groups, as a result of the study, have been characterized.

Introduction

Survival analysis is increasingly used in business demography. In the literature on the subject, one may come across papers presenting the results of analysis of enterprises based on phenomena modelling methods. For instance, López-Garcia and Puente (2006) adopt procedures for phenomena analysis to examine firms operating in Spain. The results of many studies (Hannan & Freeman, 1989; Carroll & Hannan, 2000; Caves, 1998) suggest that age, size, growth and mortality of enterprises are interrelated. Santarelli (2000) presented using Cox regression model for analysing the duration of new firms. The analysis is aimed at identifying the relationship between the duration and size of newly established enterprises offering financial intermediation in Italy. In his research on the bankruptcy of quoted companies functioning in Great Britain throughout the period 1965–2002, Bhattacharjee (2005) suggests taking account of initial and current size of firms in the risk model. He has proven that the effect of initial size of a given company on its lifespan is subject to change as the enterprise "grows older". Geroski, Mata and Portugal (2007) conducted survival analysis with reference to new firms established in Portugal. It was based on data collected by Portuguese Ministry of Labour for the period 1982–1995. On the basis of estimated semi-parametric models, it was stated that large enterprises operated longer. Kaniovski and Peneder (2008) used parametric analysis for determining the lifespan of Austrian firms during the period 1975–2004. The researchers proved that the risk of exit was greater in the case of enterprises operating in service sector (compared to production sector) and that larger enterprises were more likely to survive. Nunes and de Morais Sarmento (2012) determined survival function for firms founded in Portugal during the period 1987–2005. 86% of enterprises survived the first year, and only 22% had operated for 18 years.

For the purpose of the survival analysis the parametric, semi-parametric and non-parametric models are used. The construction of the parametric models requires the adoption of a theoretical distribution of the examined variable (Bieszk-Stolorz & Markowicz, 2015a), which is difficult in the case of studies on the duration of enterprises (Markowicz, 2012a; Markowicz, 2014). Therefore, in this study the continuous-time non-parametric models were used: Kaplan-Meier (K-M) estimator, Gehan test and duration table. Those methods were employed to model the survival time and find differences in the survival of enterprises in the poviats of the Zachodniopomorskie voivodeship.

The purpose of the present study was to build the business survival models for territorial groups. In the first stage the K-M estimator was calculated and the test to verify the similarity of the survival function for poviats was conducted. Poviats were classified into groups. Next, the tables of enterprises survival were built and the business liquidation intensity was analysed in individual groups.

This study used data from the registry of REGON, related to enterprises established in 2009-2011. These entities were observed to the end of 2013.

Research methodology

The present paper presents the findings of studies into duration of enterprise. The initial event is the act of setting up a enterprise (registering it), while the final event is its de-registration. The episode is the time between the initial and the final events, or the duration of enterprise. In the survival analysis the random variable is the time between the events. It is a continuous variable, but it can be occasionally treated as a discrete variable if the observed time series are fixed.

In retrospective research the data can be censored (Bednarski, 2014). The researcher is interested in the probability of the event ending the observation of a given subject in the subsequent time units. If the event has failed to take place by the end of the observation, we call such an observation incomplete or censored (Markowicz & Stolorz, 2009). The main reasons for incomplete data to occur are our inability to continue the observation to the end, i.e. until all the subjects finish the process and the unavailability of some subjects in a fixed period of time. The former reason takes place when the observed process lasts for too long for the research capacity, while the latter – when the subjects have not been observed at the beginning of the process, escape the observation or are eliminated from the sample. The subject's duration can be left-, right- or bilaterally censored. Censoring which is most common in empirical studies is the right-censoring, hence such is the case in the present study (Markowicz, 2012b; Markowicz, 2015).

Random censoring takes place when individual subjects enter the observation at different calendar dates and the observation ends at a fixed date. Such censoring type is the best for the studies on the enterprise survival time. The period of observation is limited by dates. In the present study the observation took place during the period 2009-2011. The observed enterprises were set up and closed down at different moments. In research, Author used the methods of the survival analysis: Kaplan-Meier estimator and survival tables.

A non-parametric model of enterprises survival can be built by means of the K-M method, provided that we assume the presence of censored observations. In contrast to the survival tables, this method does not require grouping the observation times in class intervals.

The K-M estimator is a function that is non-increasing, periodically constant, with leaps at random time points determined by complete observations. The estimator adopts the values (Kaplan & Meier, 1958; Markowicz, 2012b; Bieszk-Stolorz & Markowicz, 2015b):

$$\hat{S}(t_i) = \begin{cases} 1 & \text{for} \quad t_0 \\ \prod_{t \le t_i} \left(1 - \frac{z_i}{n_i}\right) & \text{for} \quad t_1 \le t \le t_k \\ 0 & \text{for} \quad t > t_k \quad \text{when} \quad \delta_n = 1 \\ \text{undefined} & \text{for} \quad t > t_k \quad \text{when} \quad \delta_n = 0 \end{cases} \tag{1}$$

where:

t_i – moment in which there was at least one event,

z_i – number of events in time t_i,

n_i – number of units of observation at time t_i.

The initial value of the survival function is 1 and it decreases at subsequent points of time t_i, at which at least one analysed event, has occurred. When using the K-M estimator, the probability of survival can be estimated at any time. The statistical relevance of the differences in survival models built for groups can be measured with an adequate non-parametric statistical test, taking into consideration the presence of censored data. The hypothesis that the survival functions for groups are equal (Gehan, 1965; Klainbaum & Klein, 2012) is verified by means of the Gehan test (Namboodiri & Suchindran, 1987; Domański *et al.*, 2014).

The next stage of the analysis was the construction of cohort tables of enterprises survival (actuarial method) in individual groups. The tabular model has been built for the three-month models (Markowicz, 2015). The enterprises that did not go into liquidation by the end of 2013 are considered censored.

The number of enterprises that survived (n_t) was given at the beginning of the interval and calculated as $n_t = n_{t-1} - (z_{t-1} + c_{t-1})$, wherein (n_t) for $t = 0\,(n_0)$ denotes the initial number of enterprises in the cohort; z_t marks the number of enterprises liquidated in the interval $\langle t, t+1)$, c_t denotes the number of enterprises which did not experience that event by the end of the cohort observation time.

The paper presents duration tables in actuarial version. Therefore, in next column there is the number of units at risk (at risk of liquidation). This value is represented by means of the formula: $n_t^* = n_t - c_t / 2$.

The next two values in the cohort table of survival were estimated according to the discrete approach because they can be calculated only for the time interval. First of them means the probability of a enterprise to be liquidated in the time interval $\hat{f}_t^*$. The distribution of the business survival cannot be assigned to any known type of probability distribution. This is why the functions describing the process of the enterprises survival are not known, and the tables of survival contain them their estimates calculated on the basis on empirical data. The probability estimator of business liquidation in the time interval $\hat{f}_t^*$ is a ratio of the number of liquidated economic entities in a given interval of time z_t to the number of enterprises at risk of liquidation by the interval n_t^*. Opposite to the probability of business liquidation in the time interval is the probability of business survival in the time interval:

$$\hat{p}_t^* = 1 - f_t^* = \frac{n_t^* - z_t}{n_t^*} \tag{2}$$

The probability of survival and the hazard intensity are functions continuous in their nature, but in the tables they are presented in a discrete approach. The probability of survival when calculated for interval $\langle t, t+1)$, is the probability that the enterprise will be liquidated after the time $t+1$:

$$\hat{S}_t^* = \prod_{k=1}^{t} p_k^* \tag{3}$$

In the moment $t = 0$ (in moment of setting up a economic entity) $S_t = 1$ and this function is decreasing over time. The rate at which the survival function is decreasing depends on the value of *t* and is defined as a hazard function (a_t – length of time interval):

$$\hat{h}_t^* = \frac{z_t}{\left(n_t^* - \frac{z_t}{2}\right)a_t} \tag{4}$$

Statistical data

The article presents the results of the cohort analysis. The cohorts comprise the enterprises set up in the poviats of Zachodniopomorskie voivodeship in 2009-2011 that were observed to the end of 2013. Throughout 2009–2011 59587 enterprises were established. By the end of 2013 the number of liquidated enterprises reached 22234 (37%). In that study, data comes from a database REGON (National Official Business Register).

Territorial groups with similar survival functions

With a purpose to distinguish the territorial groups with similar firm survival times, the relevance of differences in the survival times of firms established in 2009-2011 in 21 poviats was examined. K-M estimators were calculated for each poviat and compared pair-wise. The groups were separated in such a way as to ensure that each of them contains poviats where the differences among survival time models were not statistically significant. For each pair of poviats the hypothesis $H_0 : S_1(t) = S_2(t)$ was tested. The differences were considered significant when $p \leq 0.05$. Therefore, each group contained only the poviats with similar survival functions. The groups were ordered according to the decreasing probability of the enterprises survival with time. On the other hand, poviats within the groups are ordered depending on the increasing number of similarities to poviats in other groups. The territorial groups are shown in Table 1. In keeping with the above scheme five territorial groups with similar enterprises survival time models were distinguished. The first group consisted of the poviats: Koszalin (city), Szczecin (city) and policki (adjacent to the Szczecin) where the probability of the enterprises survival in the successive months was the highest. Another group comprised a single poviat – drawski. The tests indicated the similarity of the survival function to some poviats in the groups 1 and 3. The remaining groups were characterised with increasingly faster declining survival functions. It needs to be noted that the last group (gryficki) had the lowest probabilities of survival in the successive months. The last column in Table 1 shows the values test for many samples designated for groups of multi-poviat. The results reveal the lack of significant differences in the survival function within the groups.

Table 1. Groups of poviats with similar of enterprises duration model (the Gehan test)

Poviat	Numbers of similarities outside the group	Group	Test (*p*-value)
Koszalin (city)	0	1	1.9565 (0.3760)
Szczecin (city)	1		
policki	2		
drawski	8	2	
wałecki	1	3	6.4037 (0.6021)
kołobrzeski	2		
myśliborski	2		
szczecinecki	2		
świdwiński	2		
goleniowski	3		
gryfiński	3		
Świnoujście (city)	3		
kamieński	5		
sławieński	0	4	4.5315 (0.6051)
łobeski	0		
stargardzki	1		
pyrzycki	2		
choszczeński	4		
białogardzki	7		
koszaliński	8		
gryficki	0	5	

Source: own study.

The cohorts tables of enterprises – actuarial version

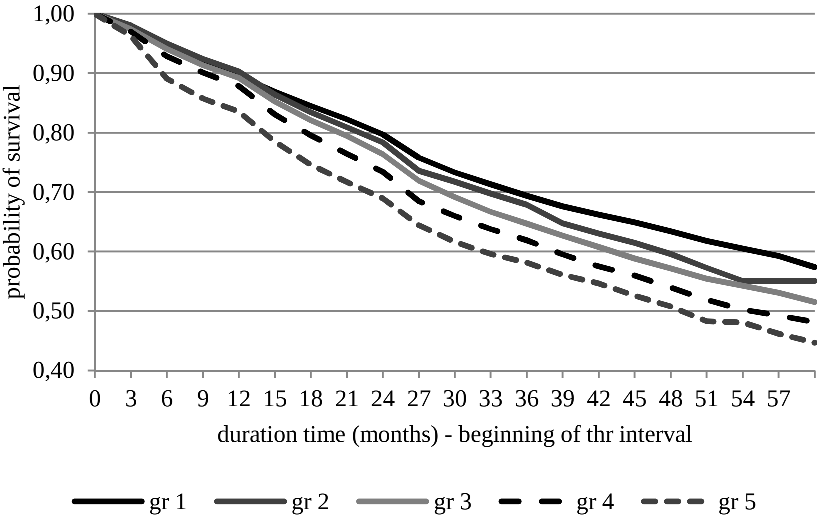
The next stage of the analysis was the construction of cohort tables of enterprises survival in individual groups. Out of the elements of the table, the survival function and the intensity function of enterprises liquidation (hazard function) was analysed.

Figure 1 shows the survival function of enterprises for five territorial groups. The functions of individual groups take a characteristic shape. Having analysed the shape of the survival function in individual groups, the following observations have been made:

– passing from group 1 to group 5 we can observe lower and lower values of survival function in a given period of time,
– the survival functions for individual groups reached the first quartile of the following times: $27.63; 25.48; 24.61; 22.60; 17.56$ months,

– only for groups 4 and 5 function survival reaches a value of median (51.27 and 47.36 months) .

Figure 1. Estimation the probability of enterprises survival (groups 1–5)



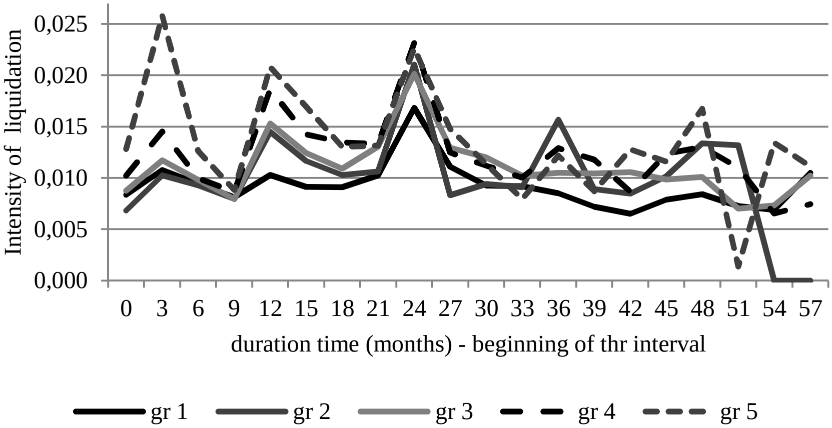
Source: own study

Many studies have confirmed that the intensity function of enterprises liquidation adopts the inverted *U*-shape with a fixed maximum, which is in keeping with the theoretical learning model (Wagner, 1994; Audretsch, Santarelli & Vivarelli, 1999; Bartelsmann, Scarpetta & Schivardi, 2005; Markowicz, 2013).

Figure 2 shows the intensity function for five territorial groups. Having analysed the shape of the intensity function in individual groups built according to the survival models, the following observations have been made:

– the intensity function of liquidation (hazard function) for group 1 takes a typical inverted *U*-shape with the maximum marked within 24-27 months; it adopts low values,
– passing from group 1 to 5 we can observe less and less distinct shape of the intensity function in a form of inverted *U*-shape, increasingly higher intensities of liquidation and increasingly stronger fluctuations of this intensity over time.

Figure 2. Estimation the intensity of enterprises survival (groups 1–5)



Source: own study

Conclusions

The study results presented in this article reveal the differentiation of enterprises survival models in the poviats of the Zachodniopomorskie Voivodeship. Five groups of poviats were distinguished. The groups (for 1 to 5) were characterised by:

– decreasing time to firms liquidation (decreasing survival functions),
– less and less distinct shape of the intensity function (inverted *U*-shape),
– growing intensity of enterprises liquidation,
– increasingly stronger fluctuations of intensity in time,
– increasingly higher percentage of enterprise liquidated during two years of activity.

The research has shown that a critical moment is the 24th month of operation. One of the reasons for the enterprises liquidation may be the period of subsidized social security contributions. Since 2005 the start-up owners can pay significantly lower social security contributions for the first 24 months of operation, which definitely helps enterprises to survive. However, the failure of businesses after the period of subsidized contributions comes to an end suggests their weakness.

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Development of innovative financial products in Europe: Case of exchange-traded products in Germany

JEL Classification: *G11; G12; G23; O16*

Keywords: *exchange-traded funds; exchange-traded products; financial innovations; stock exchange; Germany*

Abstract

Research background: Exchange-traded products (ETPs) are one of the most rapidly growing categories of financial products. Their fast development has been boosted by innovative features. Three main categories of ETPs are exchange-traded funds (ETFs), exchange-traded commodities (ETCs) and exchange-traded notes (ETNs). ETCs and ETNs remain least known, even though their number on some stock exchanges is high. In Europe, Germany is one of the largest and most active ETPs markets. ETCs and ETNs are debt instruments, in contrast with the most popular ETFs, which are equity securities. Therefore, they offer investors different advantages but also expose them to other types of risks.
Purpose of the article: The key aim of the article is to present the features of ETPs and to provide in-depth insight into the issues linked with the development of ETPs market in Germany, with the special emphasis on the ETCs and ETNs.
Methodology/methods: German ETPs market is analyzed using descriptive statistics and technological substitution framework (employed for the analysis of innovations in order to evaluate the changing market shares of ETFs, ETCs and ETNs). Main period of the analysis is 2010-2016 and monthly data are used.
Findings: Share of ETPs other than ETFs in the total market in Germany remains low. Even though market position of the leading products, i.e. ETFs, is still very strong, some substitution has been observed, especially after 2015. Predictions

made using technological substitution model indicate that this trend (growing market share of ETCs and ETNs) will continue in the upcoming years.

Introduction

Exchange-traded products (ETPs) are one of the most rapidly growing categories of innovative financial products. Three main categories of ETPs are the most popular exchange-traded funds (ETFs), exchange-traded commodities (ETCs) and exchange-traded notes (ETNs). ETCs and ETNs remain relatively least known among participants of financial markets, even though their number on some stock exchanges is high. In Europe, German Xetra trading system (part of the Deutsche Börse group) is one of the largest and most active ETPs trading venues, where a significant share of European ETCs and ETNs transactions is conducted. **The key purpose of the article is to present the most important features of three main categories of ETPs and to provide the in-depth insight into the issues linked with the development of ETPs market in Germany, with the special emphasis on the role of ETCs and ETNs.** To the best of our knowledge, it is one of the few articles to address the issue of transforming ETPs market structure and the first one in which the structure of the ETPs market has been analyzed using not only descriptive statistics but also with the technological substitution model, adapted to analysis of the financial markets.

Method of the research

German ETPs market is analyzed preliminarily using descriptive statistics. In order to more accurately and reliably evaluate the occurrence and degree of substitution between the three types of ETPs on the German market, the technological substitution framework is applied.

The technological substitution model is used to explain the changing market shares of technologies (Kucharavy & De Guio, 2011, pp. 408-413; Lechman, 2015, p. 46) but it may be also applied to financial products. It is based on the assumption that the total sum of market participants using two competing products is fixed. In this research, a three-parameter logistic substitution model has been applied, following the methodology of Marchetti & Nakicenovic (1979, pp. 1-8). In case of two different products, which replace each other, N_i represents the number of users of each product. Share of market participants using certain product i at time t can be stated as (Lechman, 2015, p. 47):

$$f_i(t) = \frac{N_i(t)}{N} \tag{1}$$

Diffusion of the innovative products is expected to follow three stages: a logistic growth stage, (growth rate is initially slow); an exponential growth stage (of rapid diffusion); and the saturation stage (product reaches maximum market share). Therefore, as Kwaśnicki (2013, pp. 50-60) shows, innovative products follow a logistic growth trajectory. It is very important to identify the times when substitution stages start and finish. According to Meyer et al. (1999, pp. 247-257), the estimate of the time when the saturation stage stops is given by:

$$\frac{y_i''(t)}{y_i'(t)} \to \min. \tag{2}$$

where $y_i(t)$ is the market share of product i according to Fisher-Pry transformation (Fisher & Pry, 1972, pp. 75-88):

$$y_i(t) = \ln\left[\frac{f_i(t)}{1-f_i(t)}\right] \tag{3}$$

After estimating y_i and y_i', it is thus possible to estimate the two crucial parameters of the logistic curve for product i, which can be expressed as (Meyer et al., 1999, pp. 247-257):

$$\Delta t_i = \frac{\ln(81)}{y_i'(t)} \tag{4}$$

And

$$T_{m_i} = \ln\left[\frac{\left(y_i(t) - \frac{\ln(81)}{\Delta t}\right)}{\frac{\ln(81)}{\Delta t}}\right]. \tag{5}$$

Δt_i shows the time needed for product i to increase its share in the combined market for two products from 0.1 to 0.9 (i.e. from 10% to 90%) and T_{m_i} represents the mid-point, i.e. point in time when the substitution process is half complete (market shares of both products are equal to 50%).

Monthly Xetra transaction reports have been used to construct unique database which contains data on the German ETPs. Indicators used to reach the stated aim are the values of turnover of ETFs, ETCs and ETNs (in EUR millions), and, additionally, the values of assets under management (in

EUR millions). Structure of the ETPs market is evaluated through the analysis of market shares.

Exchange-traded products: features, comparisons, advantages and disadvantages of various categories

Exchange-traded products are one of the most significant groups of financial innovations introduced in the recent decades, with quickly growing size of the market and increasing impact on the financial system (Lechman & Marszk, 2015). Three major groups of ETPs are ETFs, ETCs and ETNs. ETFs are the oldest (first ETFs had been launched in the late 1980s) and largest category of ETPs. ETFs are equity instruments, parallel in their trading mechanisms to stocks of listed companies. ETCs are a group of ETPs which offer users rates of return linked to commodities (single or baskets of such assets) or, much less frequently, to currencies (Deutsche Bank, 2015, p. 71). ETCs are debt instruments, similar to bonds issued by banks, backed by the issuer's credit. Despite some initial differences in the details of their construction (e.g. legal structures or status of the debt holder (Deutsche Bank, 2010, pp. 19-30)), currently structures of ETNs are very similar to ETCs - they are both debt instruments (very similar to undated zero-coupon bonds). One of the very few remaining technical differences is the method of replication: ETCs use both physical and synthetic replication (first is based on the purchase of tracked assets, second on swaps or other derivatives) while ETNs use synthetic only. The biggest difference refers to the covered type of assets: ETNs track returns of indices other than commodities markets, for instance, volatility indices, stock indices (short or long, with or without leverage), interest rate futures. and currencies (last category depends on the exchange – in some countries such products are categorized as ETCs). Distinction between ETNs and ETCs based on the tracked asset classes has also been applied on the German market, including Xetra platform, which will be analyzed in the empirical section. In some publications these two names (ETCs and ETNs) are used interchangeably and describe debt ETPs tracking all types of assets.

Table 1. Types of exchange-traded products: comparison of key features

	ETFs	ETCs and ETNs
type of instrument	equity	debt
similarity of assets in the portfolio to the benchmark	high (physical) or none (synthetic)	high (physical ETCs) or none (synthetic ETCs and ETNs)
replication method	physical or synthetic	physical (ETCs) or synthetic (ETCs and ETNs)
tracking error	low	very low or none
credit risk of issuer	no	yes
counterparty risk	very low or none	usually low but may be substantial in some rare cases

Source: own elaboration based on Deutsche Bank (2010, p. 20).

In order to understand the reasons why market participants may switch from ETFs to ETCs or ETNs, the advantages and disadvantages of all three categories should be discussed in comparative perspective (see table 1). Relative benefits of ETCs or ETNs include (Ferri, 2009, p. 54; Hill et al., 2015, pp. 39-40):

- lower tracking error;
- broader and more flexible access to unique markets or strategies;
- cheaper hedging applications;
- favorable taxation in some countries.

Using ETC or ETNs exposes investors to some types of risks which are very uncommon or even not present in case of ETFs:

- credit risk of the issuer;
- counterparty risk.

It should be stressed that occurrence of the above-mentioned events is very improbable and in most cases they should not be treated as substantial threats of using ETCs or ETNs.

Evaluation of the benefits and risks of ETCs and ETNs compared to ETFs shows that both broad categories offer certain relative advantages. It seems, though, the strengths of ETCs and ETNs have not yet been fully appreciated by market participants. In relation to their, mostly negligible, relative weaknesses they seem more advantageous and flexible products than ETFs. Consequently, their share in the total ETPs market could be expected to grow at the expense of ETFs.

Development and structure of the German ETPs market

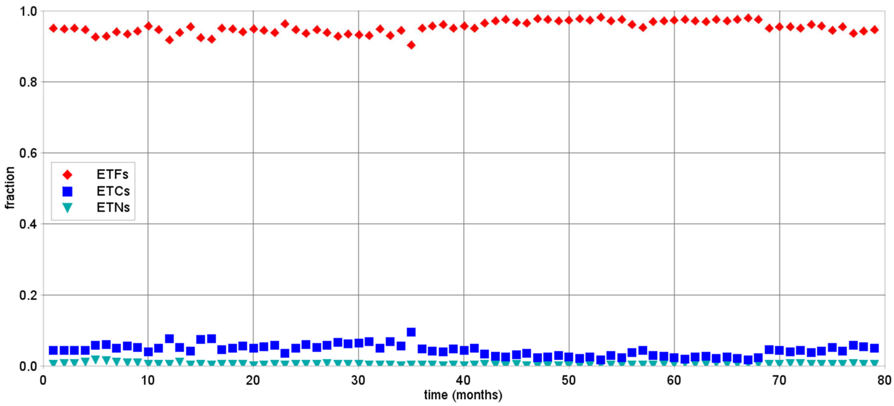
Total assets under management of the ETPs listed in Germany reached at the end of 2016 the record-high level of almost 430 bln EUR (all data in the remaining part of this section have been extracted from the monthly cash market reports published by Deutsche Börse on the exchange's website (Xetra, 2017)). In comparison with the end of first half of 2010 it meant an increase of more than 200%. ETFs were the largest category over the whole period, with ca. 94.5% share of total ETPs' assets at the 2016 year-end (share of ETCs amounted to ca. 5.4% and share of ETNs was extremely low, below 0.1%). However, assets of ETNs have grown most significantly, by 700%. First ETFs had been launched on Deutsche Börse in the early 2000s, ETCs in 2006 and ETNs in 2009.

Value of the total monthly ETPs' turnover was very similar at the beginning and end of the analyzed time period – it was at ca. 14 bln EUR, which shows that the market development in this perspective has been almost non-existent (despite the considerable increase in the total assets mentioned above). Lack of development measured using the turnover indicators is also proven by the mean ETPs turnover value which was at ca. 13.26 bln EUR (lower than the initial value). Maximum turnover has been observed in the second half of 2011 which may be regarded as the period of the highest ETPs market development in Germany.

Structure of the German ETPs market has been evolving in the analyzed time period (see figure 1) but it is difficult to determine the exact trends (detailed discussion of substitution will be presented in the next paragraphs). ETFs were the most actively traded category of ETPs in Germany over the whole period, with the maximum share in the total ETPs turnover of 98.1% which was reached in October, 2014. The minimum market share of ETFs was observed several months earlier, in April, 2013 (90.4%) which shows the high dynamics. Only in case of ETCs the value of turnover has increased which also led to stronger position in the total market. Despite significant growth of the ETNs' assets, their turnover remained at a very low level.

In order to more accurately describe changes occurring in the structure of the German ETPs market, and, even more importantly, to evaluate the observed and potential substitution, total market has been divided into two categories: first - ETFs (as more established, equity products), second - ETCs and ETNs (as newer, more innovative, debt products). Substitution between those two categories has been analyzed. It should be added that substitution between ETCs and ETNs may regarded as negligible because, according to the classification applied by Xetra, they offer different types of exposure (ETCs to commodities markets, ETNs to other types of markets and assets) – they are thus products which may be perceived as complimentary.

Figure 1. Market shares of exchange-traded funds, exchange-traded commodities and exchange-traded notes in Germany (share in the total turnover of exchange-traded products, monthly data for 2010-2016)



Source: own calculations. Month no. 1 = June, 2010; month no. 79 = December, 2016.

In the first half of the discussed time period the share of ETFs has been at rather stable level between ca. 93.5 and 94.5%. It started increasing in the second half of 2013, reaching the highest level in the late 2014 and 2015 (at ca. 97.5 %). However, since the end of 2015 it has started to decrease quickly which means that, at the same time, market share of ETCs and ETNs has begun to grow – at the end of 2016 it amounted to almost 5.3% (the highest level since 2013). Therefore, it seems that over 2010-2016 there were three stages: first – stability between 2010 and 2013; second – strengthening position of ETFs between 2013 and 2015; and, finally, third – growing share of debt ETPs since late 2015.

Substitution model has been used to estimate the parameters T_{m_i} and Δt_i for combined ETCs and ETNs versus ETFs (see table 2). If the full sample period is taken into account, no conclusions can be stated – the process is not definite and the estimated parameters are insignificant. Nevertheless, based on the preliminary analysis discussed in the previous paragraphs, full sample has been divided into sub-sample periods 1, 2 and 3. In the first sub-sample period no substitution has been observed – estimated parameters are negative and insignificant (the insignificance has been caused by lack of clear trends of increasing or decreasing market shares). In the second period values of parameters are still negative (proving growing market share of ETFs) and high (yet much lower than in case of first period) –

it has been the sub-sample period of growing ETFs market share but this process was not definite as shown by the reversal in the next period.

Table 2. Estimated substitution models

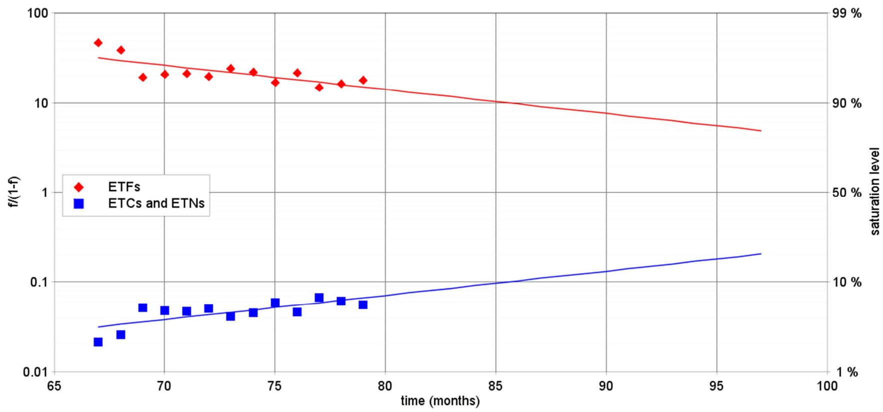
ETCs and ETNs *versus* ETFs	
Full sample	
-293.262	Substitution process not definite.
-474.623	
Sub-samples	
2010m6 to 2013m9 (no. 1)	Substitution process not definite.
-1589.961	
-2524.883	
2013m10 to 2015m11 (no. 2)	Substitution process not definite.
-513.199	
-707.467	
2015m12 to 2016m12 (no. 3)	Substitution reported.
122.453	
70.409	

Source: own elaboration in the IIASA software. Italics: misspecifications; T_{m_i}: estimated midpoint (market shares equal to 50%); Δt_i: estimated takeover time (time needed for ETCs and ETNs to increase their share in the combined ETPs market from 10% to 90%).

Period no. 3, December, 2015 – December, 2016 (see table 2 and figure 2; month no. 67 = December, 2015), is the only sub-sample period for which the estimated parameters are statistically significant. From December, 2015 ETCs and ETNs have gradually increased their market position (from ca. 2% to more than 5%) – it proves that they have potential to win some market share. According to the estimates for the third sub-sample period, T_{m_i} = 122.453 months which means that estimated time when ETCs and ETNs will reach 50% market share (in the total ETPs market) is at ca. 122 month, i.e. in July, 2020 (if further market development will follow path predicted by logistic substitution model, typical for innovations, such as financial). Estimated takeover time, Δt_i, time needed for the market share of ETCs and ETNs to grow from 10 to 90% (i.e. in the stage of rapid diffusion), is ca. 70 months. It applies to predicted development as the empirical market share was below 10%. Such market share is expected to be reached at ca. month no. 85, i.e. in June, 2017.

It should be stated, though, that due to various factors (such as much higher awareness of their features among investors) ETFs are expected to remain the dominant ETPs in the upcoming years. ETCs and ETNs are still relatively new products but they may gradually increase their market share due to their innovative features (which, taking into account absolute values means turnover of hundreds of millions EUR). This change will be caused mostly by ETCs as ETNs remain a marginal product. Most factors (including legal and regulatory environment) are rather similar for all types of ETPs, similarly the group of users or applications – the exact determinants of substitution remain to be identified.

Figure 2. Exchange-traded products observed and predicted substitution patterns in Germany. December, 2015 – June, 2018



Source: own elaboration in the IIASA software (logistic-fit, Fisher-Pry transformation).

Conclusions

Empirical findings indicate that share of ETCs and ETNs in the total ETPs market in Germany remains rather low, despite the quickly growing assets and turnover of some products. Even though market position of ETCs and ETNs is much weaker than the leading products, some substitution (yet still rather weak and of uncertain sustainability) between ETCs and ETNs has been observed, especially since 2015. It proves that diffusion of financial innovations (i.e. development of their markets) is a complicated process and its trajectory is difficult to predict.

Potential future research directions could include the analysis of the factors influencing the development of ETPs markets in various countries or regions, including Germany, particularly the determinants of their structures, explaining why some categories of ETPs, like ETNs, have not diffused in the rate similar to other types.

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Productivity effects of the ownership concentration in employee–owned companies

JEL Classification: *D24; G32; L33*

Keywords: *privatisation process; direct privatisation; employee–owned company; productivity; ownership structure*

Abstract

Research background: Empirical research on the influence of the degree of ownership concentration in the employee–owned companies on their sales revenues thematically fits into the issue of efficiency of the direct privatisation method, in particular giving a state–owned enterprise for use against payment.
Purpose of the article: The main goal of this article is to verify the research hypothesis stating that in employee–owned companies an increase in the degree of ownership concentration leads to an increase in sales revenues.
Methodology/methods: In conducted empirical studies parameters of a Cobb–Douglas production function were estimated by Ordinary Least Squares method for two variants, differing in the way of measuring the degree of ownership concentration.
Findings: The research hypothesis formulated in this paper was verified negatively as the increase in the degree of ownership concentration in employee–owned companies caused the decrease in their sales revenues.

Introduction

The main aim of this article is to verify the research hypothesis stated that in investigated employee–owned companies an increase in the degree of ownership concentration leads to an increase in sales revenues.

The employee–owned company is a joint stock company established by employees of the directly privatised state–owned enterprise to take its assets in the use against payment (compare Jawłowski, 2001, p. 55; Kozarzewski, 1998, pp. 25-26; Leksykon, 1998, p. 195). The strong employee nature of a company using a state–owned enterprise against payment is a result of the need to meet capital-ownership statutory conditions (see Błaszczyk, 2002, p. 193) which create a possibility to establish a joint stock company, even with a full participation of employees, but with dispersed ownership.

Empirical studies on the influence of employee ownership on the efficiency of a company carried out so far show that the entities, in which the share of employee ownership exceeded 5% of the share capital, revealed relatively poor performance (see Faleye *et al.*, 2006, p. 509; Kruse & Freeman, 2012, pp. 23). However, it seems that the increase in ownership concentration in the hands of outside or inside shareholders (compare Fazlzadeh *et al.*, 2011, pp. 255-256; Kapopoulos & Lazaretou, 2006, p. 18; Schanchez–Ballesta & Garcia-Meca, 2007, 885-886) and the implementation of managerial equity ownership (compare Daraghma & Alsinawi, 2010, p. 124; Jelinek & Stuerke, 2009, p. 173) may improve performance of this type of entities.

The essence of employee–owned companies

Giving a directly privatised state–owned enterprise for use against payment as a rule, takes place to a joint stock company that meets conditions connected with a required value of the share capital as well as a participation of employees and outside investors in it (see Ustawa z dnia 30 sierpnia 1996 r., Article 51 (1, 2)).

The fulfilment of these conditions, with limited financial resources of employees and negligible interest of outside investors in joining the company with their capital participation makes that the ownership of relatively low value share capital is usually significantly dispersed (see Jarosz & Kozak, 1995, pp. 115-125). However, due to the disposal of shares belonging to ordinary employees to managers, the ownership that was initially dispersed among employees is gradually concentrated in the hands of managerial elites (compare Błaszczyk & Woodward, 2001, p. 17). The reason for the transfer of shares by employees is mostly a weak economic and financial standing of the employee–owned company, resulting from the need to meet not only capital-ownership statutory conditions of its creation, but also the obligations under the agreement on giving a state–owned enterprise for use against payment concluded for a fixed period (see Ustawa z dnia 30 sierpnia 1996 r., Article 52 (1)).

The most important obligation of the employee–owned company is the necessity to repay the debt for the use of a state–owned enterprise. This commitment cannot be lower than the sum of (compare Rozporządzenie Rady Ministrów z dnia 16 października 1997 r., §3) the value of the state–owned enterprise paid in capital instalments and the sum of additional fees for the entire duration of the agreement debited in financial costs (see Kozarzewski, 1998, p. 25).

Beside price liabilities, i.e. related to the value of a state–owned enterprise, the employee–owned company is obliged to comply with the so-called, non-price commitments. Non-price commitments primarily consist of investment commitments requiring from the employee–owned company to pay a set amount of capital expenditure on tangible fixed assets (compare Bojar *et al.*, 2003, s. 110-111; Wrońska, 2004, pp. 125-127; Matuszewska–Pierzynka, 2014, pp. 45-47) and social guarantees including a need to keep agreed employment and quite frequently, even to increase wages (see Matuszewska–Pierzynka, 2016, pp. 101-103; Matuszewska–Pierzynka, 2016b, pp.114-115; Ustawa z dnia 30 sierpnia 1996 r., Article 44).

The small share capital with slight prospects for its increase in the future, difficulties in gaining a positive financial result, being the effect of significant financial and remuneration costs, as well as the lack of property rights of a state–owned enterprise in the duration of the agreement with the State Treasury (see Ustawa z dnia 30 sierpnia 1996 r., Article 5 (2)) negatively affect the credit capacity of the employee–owned company. Limited possibility of obtaining funds from a bank loan for the implementation of obligatory investments means that a primary source of their financing becomes the net profit (compare Matuszewska–Pierzynka, 2015a: pp. 388-389; Matuszewska–Pierzynka, 2015b, p. 103). Therefore, due to retaining the whole of a minuscule net profit for investment purposes, workers-shareholders seeking to maximize total current incomes (compare Faleye *et al.*, 2006, p. 509; Harbaugh, 2005, p. 566; Kim & Ouimet, 2010, pp. 9, 36), which mainly consist of salaries and dividends, are likely not only to exert some wage pressure, but also to sell shares (compare Błaszczyk, 2002, p. 197; Kozarzewski & Woodward, 2001, p. 22).

Research methodology

The verification of the formulated research hypothesis was conducted among fifteen employee–owned companies from Mazowieckie Province, which concluded the agreement of giving a state–owned enterprise for use against payment in between years 2000–2004, basing on the data from financial statements submitted by them to the National Court Register for ten–year period after the privatization year.

Bearing in mind previous empirical research that analysed productivity effects of the employee participation (see Conte & Svejnar, 1988, pp. 144-145; Estrin *et al.*, 1987; pp. 51-52; Jones, 1993, pp. 478-479; Kozarzewski & Woodward, 2001, p. 31), empirical studies on the relation between ownership concentration and productivity of employee–owned companies are based on a Cobb–Douglas production function that in a logarithm form looks as follows:

$$lnV = lnA + \alpha_1 lnK + \alpha_2 lnL + \beta X + \gamma Z$$

From collected data, three operating variables (values are deflated by CPI $_{2000=0}$ – Consumer Price Index (basic year = 2000)) are constructed:

- V (output) – sales revenues instead of value added, which was impossible to calculate because of the lack of data measuring capital cost (compare Christev & FitzRoy, 2002, p. 261; Grosfeld & Nivet, 1999, p. 1141),
- K (capital input) – tangible fixed assets (one period lagged variable) being the object of obligatory investments and
- L (labour input) – salaries covering employment and wages commitments.

The X vector contains dummies for the number of years after privatisation year treated as 0 period (AGE – values from 1 to 10), the year of production (YEAR – values from 0 for 2001 to 13 for 2014) and the location of company headquarters (CITY – values 1 and 0) as well as the construction (CONST – values 1 and 0) and transportation and storage (TRANS – values 1 and 0) sectors. The vector Z comprises three proxies for the ownership concentration: DOC (degree of ownership concentration) measured by the value of Herfindahl–Hirschman Index (compare Sosnowski, 2015, p. 351; Fazlzadeh et al., 2011, p. 254) that forms the basis for the construction of two other dummy variables, namely SOC (strong ownership concentration – the value of Herfindahl–Hirschman Index is above the third quartile from a set of index values) and WOC (weak ownership concentration – the value of Herfindahl–Hirschman Index is below the first quartile from a set of index values).

The estimation of a Cobb–Douglas production function is carried out with the use of Ordinary Least Squares method for two variants – main and additional – that differ in terms of the vector Z structure. Taking into account constructed variables as well as denoting enterprises by *i*, the time period in years by *t* (*t* = 1, 2, …) and residual by μ, the estimated Cobb–Douglas production function in discussed variants is as follows, respectively:

$$lnV_{it} = \alpha_0 + \alpha_1 lnK_{it-1} + \alpha_2 lnL_{it} + \beta_1 AGE_{it} + \beta_2 YEAR_{it} + \beta_3 CITY_{it} + \beta_4 CONST_{it} + \beta_5 TRANS_{it} + \gamma DOC_{it}$$

and

$$lnV_{it} = \alpha_0 + \alpha_1 lnK_{it-1} + \alpha_2 lnL_{it} + \beta_1 AGE_{it} + \beta_2 YEAR_{it} + \beta_3 CITY_{it} + \beta_4 CONST_{it} + \beta_5 TRANS_{it} + \gamma_1 SOC_{it} + \gamma_2 WOC_{it}$$

The relation between ownership concentration and productivity of employee–owned companies – the results of empirical research

Analysing the results of the estimation of a Cobb–Douglas production function for employee–owned companies qualified for the research sample, the positive relationship between sales revenues and tangible fixed assets as well as salaries, whose coefficients are statistically significant at the significance level $\alpha = 0.01$ can be noticed.

The positive coefficient of AGE variable in both considered variants of the estimation, although not statistically significant is slight support for assertions advocating the existence of a positive relationship between the company's performance and its life cycle. The coefficient of YEAR variable, which is negative in the main variant of the estimation and positive in the additional one, as well as statistically insignificant in both of these variants, does not allow to formulate the request for the direction of impact of technological changes on company's performance.According to the conducted empirical research, the location of company headquarters in Warsaw negatively influenced on sales revenues of studied employee–owned companies – the coefficient for CITY variable is statistically significant in the main variant of the estimation at the significance level $\alpha = 0.05$ and in the additional variant with the probability close to 90%. What is more, sales revenues are on average lower for employee–owned company operating in the transportation and storage sector, and higher for those operating in the construction sector. It is worth noting that the coefficient of CONST variable may be considered statistically significant with the probability close to 95% only in the additional variant of the estimation, and the coefficient of TRANS variable is statistically significant in both of them at the significance level α = 0.01.

Table 1. Production function estimates of productivity effects

Variable	Main variant		Additional variant	
	Parameter estimate	*p*-value	Parameter estimate	*p*-value
LnA	2.4624	0.0024	2.4222	0.0062
LnL	0.2537	0.0000	0.2530	0.0000
LnK	0.7079	0.0000	0.7047	0.0000
AGE	0.0123	0.7691	0.0028	0.9481
YEAR	-0.0042	0.9141	0.0013	0.9745
CITY	-0.2031	0.0414	-0.1614	0.1069
CONST	0.1867	0.1493	0.2419	0.0679
TRANS	-0.5549	0.0005	-0.4876	0.0028
DOC	-0.4003	0.0243	-	-
SOC	-	-	-0.1470	0.1765
WOC	-	-	0.0307	0.7425
N	146		146	
Adj R^2	0.8988		0.8961	
F statistics	161.91		139.91	

Source: own calculations based on the data of the National Court Register.

The conducted empirical research in relation to variables associated with the ownership concentration revealed in the main variant of the estimation the existence of the negative relation between the degree of ownership concentration and sales revenues that is statistically significant with the probability close to 99%. The occurrence of the negative influence of ownership concentration on sales revenues of the investigated employee–owned companies seem to confirm the results of the estimation of a Cobb–Douglas production function in the additional variant, in which the coefficient of SOC variable is negative and of WOC variable is positive. However, it should be noted that both of these coefficients are not statistically significant, even at the significance level $\alpha = 0.1$ (see Table 4).

Conclusions

The conducted empirical research on the effects of the degree of ownership concentration on sales revenues of employee–owned companies showed that the increase in the degree of ownership concentration leads to the decline in sales revenues, which means that the formulated research hypothesis was verified negatively. In addition, sales revenues within the strong ownership concentration are on average lower and within the weak ownership concentration are on average higher than in other cases, which suggests that to some extent the increase in the degree of ownership concentration in examined employee–owned companies causes the increase in their sales revenues and to some extent it causes the decrease (compare Akimowa & Schwödiauer, 2004, p. 41; Lee, 2008, p. 22).

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Density forecasts of Polish industrial production: a probabilistic perspective on business cycle fluctuations

JEL Classification: *E37; C53*

Keywords: *density forecasts; Bayesian inference; business cycle; Dynamic Conditional Score models; Generalized t distribution.*

Abstract

Research background: Current approaches used in empirical macroeconomic analyses use the probabilistic setup and focus on evaluation of uncertainties and risks, also with respect to future business cycle fluctuations. Therefore, forecast-based business conditions indicators should be constructed using not just point forecasts, but rather density forecasts. The latter represent whole predictive distribution and provide relevant description of forecast uncertainty.
Purpose of the article: We discuss a problem of model-based probabilistic inference on business cycle conditions in Poland. In particular we consider a model choice problem for density forecasts of Polish monthly industrial production index and its selected sub-indices. Based on the results we develop indicators of future economic conditions constructed using probabilistic information on future values of the index.
Methodology/methods: In order to develop a relevant model class we make use of univariate Dynamic Conditional Score models with Bayesian inference methods. We assume that the conditional distribution is of the generalized t form in order to allow for heavy tails. Another group of models under consideration relies on the idea of business cycle modelling using the Flexible Fourier Form. We compare performance of alternative models based on ex-post evaluation of density forecasting accuracy using such criteria as Log-Predictive Score (LPS) and Continuous Ranked Probability Score (CRPS).

Findings: The assessment of density forecasting performance for Polish industrial production index turns out to be difficult since it depends on the choice of verification window. The pre-2013 data supports the deterministic cycle model whereas more recent observations can be explained by a very simple mean-reverting Gaussian AR(4) process. This provides an indirect evidence indicating the change of pattern of Polish business cycle fluctuations after 2013. A probabilistic indicator of business conditions is also sensitive to details of its construction. The results suggest application of forecast pooling strategies as a goal for further research.

Introduction

The purpose of the paper is to set up a methodology that allows for practical predictive business cycle analysis based on an industrial production index. Inference about future evolution of business cycle conditions should be model-based and take into account the estimation and the prediction uncertainty. In the paper we make an effort to present such a model and apply it to Polish data on industrial production. In order to do so we consider a menu of alternative specifications and discuss their properties as well as out-of-sample predictive performance. We make use of the models to construct a probabilistic index describing future prospects as to the growth rate of the industrial production index.

The shift in attention from point forecasts to probabilistic (or density) forecasts is quite widespread in the recent econometric literature (see e.g. Clark & Ravazzolo (2015). An influential paper summarizing the state-of-the-art as to formal, statistical evaluation of density forecasts was given by of Gneiting and Raftery (2007). The paper contains references to so-called proper scoring rules and strictly proper scoring rules that should be used for *ex-post* evaluation of density forecasts. Such criteria are log-predictive score (LPS) and continuous ranked probability score (CRPS) which are used in the empirical part of the paper.

Another related issue is that of structural change. It is not impossible that the underlying economic process driving the business cycle fluctuations is not time-homogenous. Hence it is necessary to consider the problem of possible changes in adequacy of the competing models. In the case of Polish economy there is a number of reasons that support the view that some sort of structural change might underlie the economic growth. For example it is not obvious that the pattern of business cycle fluctuations that has been identified for the Polish economy before say 2013 can be still considered adequate afterwards.

Method of the research

The methodological part of the paper deals with the following problems. Firstly, the model classes under consideration are introduced. The models can be divided into two groups: the ones that explicitly account for the cyclical properties of the data and the ones that rely on more sophisticated stochastic properties. The first group of models make use of so-called Flexible Fourier Form in order to represent the business cycle fluctuations. However, the models have rather simple stochastic properties, relying on the autoregressive formula with conditionally Gaussian observations. The other group of models make use of the idea of Dynamic Conditional Score (DCS) approach of Harvey (2013) and make use of more flexible conditional distribution, being the generalized t distribution. The basic structure of the models is recalled and references are given for more detailed description.

The Bayesian model for analysis of deterministic cycle used here is described by Lenart & Mazur (2016) and its application for in-sample business cycle analysis is considered by Lenart et. al. (2016). The underlying idea is close to that of cyclostationarity. It is assumed that short-term deviations from the time-varying mean μ_t are represented by a Gaussian autoregressive process denoted by v_t:

$$y_t = \mu_t + v_t,\ v_t = \psi_1 v_{t-1} + \cdots + \psi_p v_{t-p} + \varepsilon_t, \varepsilon_t \sim iiN(0, \sigma^2)$$

where y_t represents the observed series of year-on-year growth rates. The Flexible Fourier time-varying mean is given by:

$$\mu_t = \sum_{f=1}^{F} \left(\alpha_{1,f} \sin(t\phi_f) + \alpha_{2,f} \cos(t\phi_f)\right).$$

The parameters denoted by $\phi_f \in (\phi_L, \phi_U) \subseteq (0, \pi)$ represent frequencies of the fluctuations and the fixed lower and upper bounds (denoted by ϕ_L and ϕ_U) can be used in order to restrict attention to cyclical fluctuations of specific period length (i.e. to exclude fluctuations with a period that is either too long or too short). The flexibility of the cyclical part of the model depends on the number of the Fourier components denoted by F. An interesting feature of the model is that it allows for F>1 which implies that the business cycle fluctuations are driven by components with just more than one empirically important frequency. In practical applications we restrict F not to exceed 3 as higher values might lead to overfitting issues. Statistical inference in such a model within the Bayesian setup is rather complicated – it is described in detail by Lenart & Mazur (2016).

The generalized t distribution used here is described by Theodossiou (1998), see also the discussion by Harvey & Lange, 2016. Its probability density function has the following form:

$$p(y) = \frac{1}{\sigma} K(\nu, \gamma) \left[1 + \frac{1}{\nu} \left(\frac{y - \mu}{\sigma} \right)^{\gamma} \right]^{-\frac{(1+\nu)}{\gamma}}$$

with:

$$K(\nu, \gamma) = \frac{\gamma}{2\nu^{1/\gamma}} \frac{1}{B\left(\frac{\nu}{\gamma}, \frac{1}{\gamma}\right)}$$

The distribution given above has location parameter μ, scale parameter σ and two shape parameters: ν and γ. An interesting feature of this symmetric probability distribution is that it allows for heavy tails and nests a number of known distributions as nested or limiting cases. For example as γ =2, it becomes Student-*t* with ν degrees of freedom. On the other hand, with $\nu \to \infty$, the limiting case is GED(γ), denoting the generalized error distribution, see e.g. Harvey & Lange (2016) for more detailed discussion. Such a distribution is quite flexible and therefore capable of capturing many empirically relevant situations, especially related with occurrence of rare events.

The class of Dynamic Conditional Score (DCS) models have been presented in detail by Harvey (2013). The model class is closely related to Generalized Autoregressive Score models of Creal et. al. (2013). In the paper we follow the formulation by Harvey. However, our contribution is in developing a methods of Bayesian inference for the models.

The structure of Dynamic Conditional Score modelling reflects the idea that for the given conditional distribution of the data some of its features can be dynamically updated. In the case of DCS models the updating mechanism explicitly depends on the score of the conditional distribution (i.e. partial derivative of the log-density w.r.t. to the parameter under consideration). In other words, properties of the updating mechanism depend on properties of the conditional distribution, which is a very appealing concept. The general idea together with a number of application is described by Harvey (2013). Here we assume that the following formulation holds:

$$g_t = \eta_1 g_{t-1} + \cdots + \eta_p g_{t-p} + \phi_1 s_{t-1} + \cdots + \phi_q s_{t-q}$$

where g_t represents the deviation of the feature under consideration from its average (or seasonally changing) state: $g_t = f_t - \delta_t$, with δ_t being either time invariant ($\delta_t = \delta$) or seasonal ($\delta_t = \delta_s$) with the initial conditions described by $g_0 \ldots g_{-p+1}$. Moreover, s_t is the value of the score at the point corresponding to the realized observation ad time t.

We assume that the feature being updated (f_t) corresponds to the conditional location or the conditional scale. These represent the respective parameters of the Generalized *t* distribution introduced above. Consequently, the model is not formulated in terms of conditional moments, though due to symmetry of the distribution the relationship between scale and variance is not that complicated. For the scale parameter it is necessary to add so-called linking function that maps it values into the real line. When more than one feature is being updated, it is possible to consider a matrix version of the dynamic equation. However, the path is not pursued here. We assume that the updating mechanism is diagonal, i.e. works separately for each feature (however, there exists a relationship between the expression for score for the scale and the location parameters, see Harvey & Lange, 2016).

The standard criteria for *ex-post* evaluation of the forecasts include RMSFE and MAE. However, the quantities apply to the point forecasts only and hence convey some information about adequacy of the location of the forecast, but completely ignore its dispersion (or other features of the distribution). However, from the decision-making point of view it is quite obvious, that such a strong information reduction might be innocuous under very special conditions only. Here we assume that it is necessary to include other criteria for forecast evaluation as well.

Finally, we propose an index of future business conditions that relies on full predictive distribution of the year-on-year growth rates. The index is intended to be evaluated using monthly data (in order to keep the inflow of new information). However, the y-on-y growth rates at monthly frequency often display considerable short-term variation (even in the case of calendar-adjusted data). We therefore assume that the index represents the probability that the average growth rate for the period covering *t*+4, *t*+5, *t*+6 is greater than the average growth rate for *t*+1, *t*+2 and *t*+3. In other words it measures the probability of the tendency for the growth rates to increase during the next six months (on average). Alternatively, it could be computed with 6M or 12M base period (instead of 3M). However, it must be emphasized that the index does not convey information as to the magnitude of the growth, dealing just with the direction of change in the growth rate dynamics. However, it might be interpreted as reflecting future prospects as to the growth cycle, taking into account prediction uncertainty and dynamic dependence between forecasts for various horizons.

Empirical analysis of Polish industrial production data

The dataset under consideration i.e. year-to-year growth rates of Polish industrial production (in per-cents, monthly data, adjusted for calendar effects, not seasonally adjusted, 1997M01-2016M12, T = 240) is depicted in Figure 1.

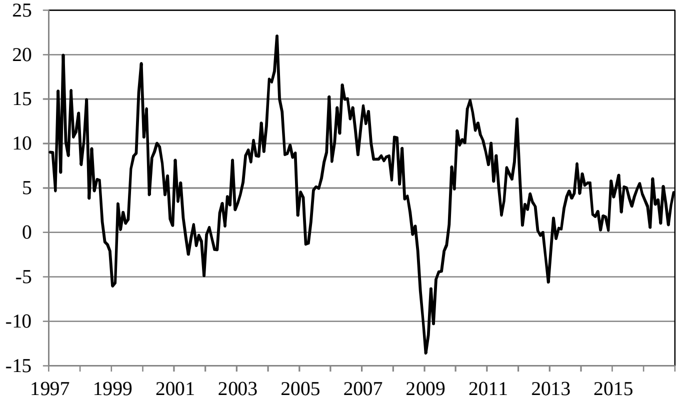
We treat the first 120 observations (10 years) as a training sample and verify the out-of-sample predictive performance of alternative models on the remaining 120 data points. The forecasts are generated within the expanding-window setup. No effort is made to mimic real-time data flow – the most recent readouts available are used.

We consider only the direct forecasts of y-o-y growth rates. This is because a preliminary analysis using various DCS models indicates that such specifications are unable to deliver non-trivial forecasts for horizons greater than 12 months (for higher horizons the sequence of point forecasts implied y-o-y forecast is practically flat, which is obviously inadequate).

Consequently, in what follows we consider the models estimated on y-o-y data only and use the direct approach for the sake of prediction. We make use of two Gaussian autoregressive models, one with 4 lags and one with 22 lags (labeled AR(4) and AR(22)).

The models are chosen to represent complicated and simple structures of the autocorrelation function. Moreover, we consider a deterministic cycle model, with F=3, frequency parameters restricted to the (0.052, 0.52) interval and 22 lags in the autoregressive part (labeled AR(22)-F(3)). The last specification under consideration is a DCS model with $p = q = 6$ for the location parameter and $p = q = 2$ for the log-scale parameter. The model allows for asymmetric response to the score (following Harvey & Lange, 2016) and its conditional distribution is of the generalized t form (asy-Gt-DCS(6,6;2,2), labeled DCS for short).

Figure 1. Growth rates of Polish industrial production index (y-o-y, in [%]).



Source: Eurostat.

Table 1 contains basic summary characteristics for *ex-post* evaluation of point and density forecasts obtained from the models mentioned above. The results are reported for horizons of 12, 18 and 24 months ahead. Moreover, the results are also calculated using the last 36 realized forecasts only (the last observation used for the purpose of evaluation is that representing 2017M01).

Table 1. *Ex-post* evaluation of point and density forecasts for 12, 18 and 24 months ahead. LPS is computed using natural logs (cumulated), CRPS is in positive orientation (the lower the better, averaged)

		h = 12			*h* = 18			*h* = 24	
	RMSE	LPS	CRPS	RMSE	LPS	CRPS	RMSE	LPS	CRPS
				full sample analysis					
AR(4)	6.46	-359.47	3.52	6.5	-340.84	3.58	5.58	-314.52	3.3
AR(22)	5.83	-351.57	3.3	5.87	-332.48	3.32	5.12	-308.72	3.1
AR(22)-F(3)	6.72	-363.96	3.96	6.8	-347.25	3.97	6.36	-325.44	3.79
DCS	6.77	-370	3.82	6.83	-350.14	3.85	6.13	-323.79	3.61
				last 36 observations					
AR(4)	2.67	-103.44	1.94	2.48	-104.77	1.95	2.73	-106.05	2.06
AR(22)	4.79	-109.62	2.82	4.53	-109	2.69	3.81	-107.66	2.39
AR(22)-F(3)	8.14	-131.54	5.02	7.81	-130.48	4.73	7.08	-128.48	4.21
DCS	6.08	-114.43	3.57	5.93	-113.68	3.35	4.93	-110.7	2.85

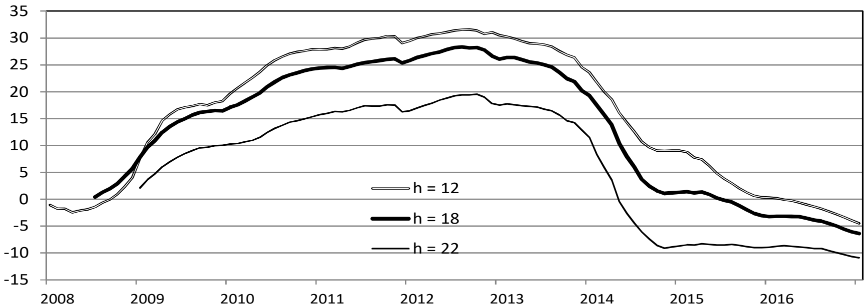
Source: own computations.

Analysis of Table 1 seems to lead to a very simple conclusion. The overall predictive performance is dominated by the Gaussian AR(22) model and if one restricts attention to the last 3 years, the results are dominated by a simple AR(4) model. In particular neither the stochastically sophisticated

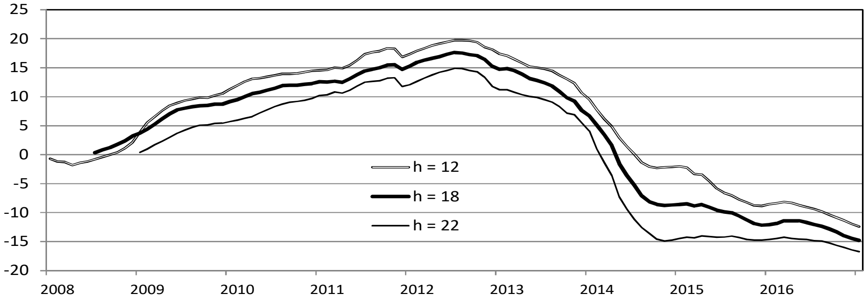
DCS specification nor the business-cycle oriented AR(22)-F(3) lead to satisfactory results. The conclusion is unanimously supported by point and density criteria.

One might want to conduct more detailed analysis and to decompose the e.g. the difference in cumulated LPS between certain models into the contribution of individual observation. Such a decomposition for the two winning models (AR(22) and AR(4)) against the AR(22)-F(3) specification is presented in Figure 2A and 2B (with positive values supporting AR(22)-F(3)). The figures reveal the fact that throughout most of the verification window the data provide strong and systematic support in favor of the business-cycle-oriented model AR(22)-F(3).

Figure 2. Differences in cumulated LPS between AR(22)-F(3) and other models evolving in time (positive values in favor of AR(22)-F(3))



A: differences vs. AR(4)



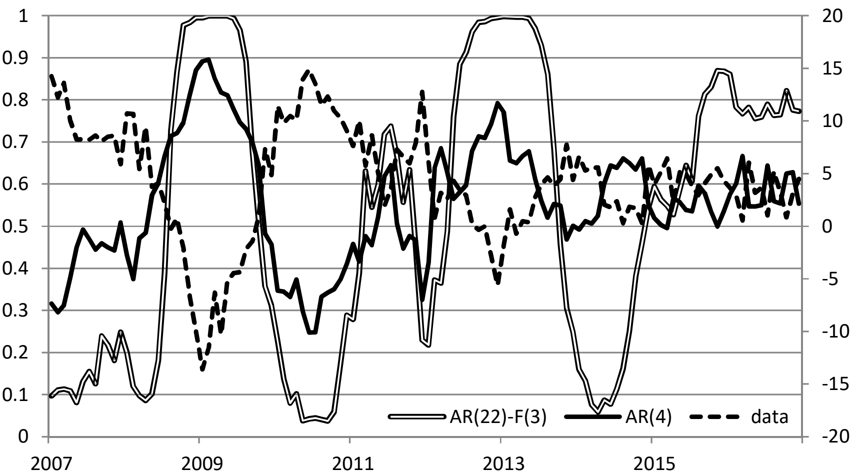
B: differences vs. AR(22)

Source: own calculations.

However, in 2013 the pattern breaks down and the performance of the model deteriorates quickly. As a consequence, the last three years of the data bring strong evidence against the model, and the empirical support shifts towards the AR(4) specification. The abrupt change might suggest that that the business cycle properties of the Polish industrial production growth rates have changed after 2013 in such way that the previously observed pattern seems no longer valid. Importantly, the model with the best forecasting performance in the recent period, namely the AR(4), generates quite trivial forecasts with quick mean reversion.

Finally in Figure 3 we present values of the probabilistic indicator of future economic conditions. Based on the results of the predictive comparison we pick the results for AR(4) and AR(22)-F(3). Moreover, the version presented refers to one-year-ahead forecast. At each point in time the value of the indicator represents the probability that the average growth rate for the period t+7…t+12 will exceed its counterpart compared for the period t+1…t+6.

Figure 3. Probabilistic index of future economic conditions (6/6 months ahead) – left axis (obtained from two models, AR(22)-F(3) and AR(4) and the data (right axis).



Source: own computations.

One might notice that for most of the time the probabilistic index obtained from AR(22)-F(3) provides clear-cut signals, being close to either 0 or 1. Moreover, it seems to provide adequate information (i.e. it leads actual changes), at least in the first part of the sample. Closer to the sample end the fluctuations of industrial production growth rates dampen, so the adequacy is not easy to verify.

Conclusions

In the paper we compare density predictive performance of alternative model specification with application to y-on-y growth rates of Polish industrial production. In particular we consider two kinds of models. Models of the first kind focus on business cycle fluctuations using the deterministic approach based on Flexible Fourier Form (see Lenart & Mazur, 2016). Models of the second kind are more general in terms of stochastic specification. The models belong to the Dynamic Conditional Score class and allow for heavy tailed conditional distribution (of the generalized *t* class) and time-varying conditional scale. We generate density forecasts for horizons up to 24 months ahead. Evaluation of the forecasts (based on CRPS and LPS criteria) seems to indicate that the DCS-type models do not generate additional predictive power despite their sophistication. Closer examination reveals the fact that up to approximately 2013 the best preforming model was that of deterministic cycle, while in the more recent period the evidence shifts toward a trivial AR(4) specification with quick mean reversion. It might suggest that there was a change in the process underlying Polish business cycle fluctuations. A practical suggestion (and a direction for future research) is the use of dynamic prediction pools of density forecasts for the sake of probabilistic forecasting of Polish industrial production series.

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Efficiency analysis of ERDF and CF co-financed programmes focusing on the transport in member states of the European Union

JEL Classification: *C67; O11; O52; R11; R12*

Keywords: *DEA; Efficiency; European Regional Development Fund, Ex-post evaluation; Cohesion Fund*

Abstract

Research background: European Union provides financial support to the Member States through various financial tools currently from European Structural and Investment Funds that represent the main instrument of EU Cohesion Policy to sustain territorial development, to increase competitiveness and to eliminate regional disparities. The overall impact of EU Funds depends on the structure of funding and absorption capacity of the country.
Purpose of the article: Efficiency of funding across EU Member States is a fundamental issue for the EU development as a whole. The author considers determining the efficiency of EU Funds as an issue of high importance and therefore this study provides a contribution to the debate on the role of the EU Cohesion Policy in EU Member States. The paper focuses on the territorial effects of selected EU Funds in programming period 2007–2013 in theme of infrastructure through transport efficiency analysis.
Methodology/methods: Efficiency analysis is based on data at country level originating from ex-post evaluation of Cohesion Policy programmes 2007–2013 representing the input and output variables to analyse whether the goal of fostering growth in the target countries have been achieved with the funds provided and whether or not more resources generated stronger growth effects in transport accessibility. Study deals with comparative cross-country analysis, descriptive data analysis and multicriteria approach to Data Envelopment Analysis (DEA) in the form of output oriented BCC VRS model.

Findings: The study aims at testing several factors in form of two inputs and five outputs, trying to elucidate the differences obtained by the EU Member States in efficient using of the European Regional Development Fund and the Cohesion Fund in transport sector. Paper determines if the countries have been more efficient in increasing their levels of competitive advantages linked with transport. Preliminary results reveals that mostly countries with lower amount of funding achieve higher efficiency, especially from the group of EU15.

Introduction

The establishment of the EU marked at the beginning of new area; the European Union (EU) Member States currently enjoy many benefits in this respect: a free market, effective trading, enhanced security, economic cohesion, sustainable development, the protection of human rights, the creation of jobs etc. The European Structural and Investment Funds (ESIF) are basic instruments of the EU Cohesion Policy to promote the overall harmonious development of the EU, to reduce disparities between the levels of development of the various regions, and to strengthen its economic, social and territorial cohesion. ESIF consist of the following five funds, i.e. European regional development fund (ERDF), European social fund (ESF), Cohesion fund (CF), European agricultural fund for rural development (EAFRD) and European maritime and fisheries fund (EMFF). The EU devotes an important part of its resources to financing regional development projects through ESIF which provide subsidy aid to Member States and their regions based on their economic situation, mainly based on the particular region's GDP. How efficiently the Member States apply the funds is a fundamental issue for the development and continuity of the EU Cohesion Policy, and especially so in the context of the economic crisis and the growing number of regions with low levels of development that the incorporation of so called new countries into the EU has supposed. Such circumstances have forced the EU to make huge economic efforts to maintain and increase the resources for the funds, and so it is vital for European authorities to know how efficiently these are being applied (Enguix et al., 2012).

As the key EU objective is deeper market integration among Member States, the construction of efficient and big transport infrastructures was seen as a necessary step toward this goal, i.e. in form of the Trans European Network (TEN) investments. Development of the transport networks causes economic growth and trade, higher employment rate and an increase in the quality of life of the population and other favourable economic aspects. Transport networks are a very important part of the supply chain, because they are a basic influence for the economy in all countries and enable an effective movement of people and flow of goods. The attractiveness of the area can be increased by upgrading the equipment in transport infrastructure. Areas which can be characterized as those with highly developed transport infrastructure, are more attractive for investors (see Górniak, 2016; Sucháček, 2013). Moreover development of transport infrastructure and decrease of efficiency in that branch are one of the important factors of economic growth. Convenient road, railway, air and water connections result in constant movement of people and goods and they tend to improve the quality of life.

The study focuses on the territorial effects of the EU Funds in programming period 2007–2013 in theme of infrastructure through transport efficiency analysis. Efficiency analysis is based on national data originating from ex-post evaluation of Cohesion Policy programmes 2007–2013 representing the input and output variables to analyse whether the goal of fostering growth in the target countries have been achieved with the funds provided and whether or not more resources generated stronger growth effects in transport accessibility. By analysing the amounts granted to each Member State, efficiency level of using funds is observed based on multicriteria approach of Data Envelopment Analysis (DEA) in the form of output oriented BCC VRS model. Paper determines if the countries have been more efficient in increasing their levels of competitive advantages linked with transport.

Research methodology

Efficiency of the EU Cohesion Policy policies is an issue of high relevance, although studies on the efficiency of the EU Cohesion Policy through funds have not provided conclusive findings (see overview in Mohl and Hagen, 2010), it is useful to determine whether the huge amounts of resources employed could have given better results. The EU Cohesion Policy should be effective, as is the case of transport policy. Currently, the trend in efficiency studies revolves around the application of non-parametric models, since they allow to consider a multiplicity of outputs and inputs in the analysis, and thus make less severe demands on the whole and the frontier of production. Efficiency measurement has been the challenge of many subjects which have interest to improve their productivity. In 1957, Farrell investigated the question how to measure efficiency and highlighted its relevance for economic policy makers (Farrell, 1957). Since that time techniques to measure efficiency have become more frequent and improved.

Among the non-parametric techniques, Data Envelopment Analysis (DEA) is the most accepted method. DEA is data oriented approach for providing a relative efficiency assessment and evaluating the performance of a set of peer entities called Decision Making Units (DMUs). DEA provides a single measure and easily deals with multiple inputs and multiple outputs; and its aim is to examine DMU if they are efficient of inefficient by the size and quantity of consumed resources and by the produced outputs. In recent years, we have seen a great variety of applications of DEA for evaluating the performances of many different kinds of entities engaged in many different activities (such as banks, hospitals, universities, cities, courts, business firms, and others, including the performance of countries, regions, etc.); and evaluation of territorial units is topic of interest in this study (for more DEA works about national or regional efficiency see e.g. Staníčková, 2014).

Used DEA model can be distinguished by the scale and orientation of the model. If in order to achieve better efficiency, governments' priorities are to adjust their outputs (before inputs), then an output oriented (OO) DEA model, rather than an input oriented (IO) model, is appropriate in this study. Next step is Returns to Scale (RTS) estimation and based on classifications of countries into RTS, then DEA model choice is characterized, i.e. in most of countries variable returns to scale (VRS) were estimated. For calculations of efficiency it is used output oriented BCC (Banker-Charnes-Cooper) model with variable returns to scale (VRS), see model (1) (Cook and Seiford, 2009):

$$\max\ g = \phi_q + \varepsilon(\mathbf{e}^{\mathbf{T}}\mathbf{s}^{+} + \mathbf{e}^{\mathbf{T}}\mathbf{s}^{-}),$$

subject to

$$\begin{aligned} \mathbf{X}\boldsymbol{\lambda} + \mathbf{s}^{-} &= \mathbf{x}_q, \\ \mathbf{Y}\boldsymbol{\lambda} - \mathbf{s}^{+} &= \phi_q \mathbf{y}_q, \\ \mathbf{e}^{\mathbf{T}}\boldsymbol{\lambda} &= 1, \\ \boldsymbol{\lambda}, \mathbf{s}^{+}, \mathbf{s}^{-} &\geq \mathbf{0}, \end{aligned}$$

where g is the coefficient of efficiency of unit U_q; ϕ_q is radial variable indicates required rate of increase of output; ε is infinitesimal constant; $e^T\lambda$ is convexity condition; s^+, and s^- are vectors of slack variables for inputs and outputs; λ represent vector of weights assigned to individual units; x_q means vector of input of unit U_q; y_q means vector of output of unit U_q; X is input matrix; Y is output matrix. In BCC model aimed at outputs the efficiency coefficient of efficient DMU equals 1, but the efficiency coefficient of inefficient DMU is greater than 1.

In BCC model, efficiency coefficients of efficient units equal to 1. Depending on chosen model, but also on relationship between number of units and number of inputs and outputs, number of efficient units can be relatively large. Due to the possibility of efficient units' classification, it is used Andersen-Petersen's model (APM) of super-efficiency. Following VRS model is output oriented dual version of APM (2) (Andersen and Petersen, 1993):

$$\max \ \mathrm{g} = \phi_{\mathrm{q}} + \varepsilon(\mathbf{e}^{\mathbf{T}}\mathbf{s}_{\mathrm{i}}^{+} + \mathbf{e}^{\mathbf{T}}\mathbf{s}_{\mathrm{i}}^{-}),$$

subject to

$$\sum_{j=1}^{n} x_{ij}\lambda_j + s_i^- = x_{iq},$$

$$\sum_{j=1}^{n} y_{kj}\lambda_j - s_i^+ = \phi_q y_{kq},$$

$$\mathbf{e}^{\mathbf{T}}\boldsymbol{\lambda} = 1,$$

$$\lambda_q = 0,$$

$$\lambda_j, s_k^+, s_i^- \geq 0,$$

$$j = 1, 2, \ldots, n, \ j \neq q; k = 1, 2, \ldots, r; i = 1, 2, \ldots, m.$$

where x_{ij} and y_{rj} are i-th inputs and r-th outputs of DMUj; ϕ_k is efficiency coefficient of observed DMU$_k$; λ_j is dual weight which show DMU$_j$ significance in definition of input-output mix of hypothetical composite unit, DMU$_k$ directly comparing with. Rate of efficiency of inefficient units (ϕ_k >1) is identical to model (1); for units identified as efficient in model (1), provides OO APM (2) rate of super-efficiency lower than 1, i.e. $\phi_k \leq 1$.

This study covered 27 Member States of the EU drawing money from the EU during the programming period 2007–2013. Efficiency analysis is based on data at country level originating from ex-post evaluation of the EU Cohesion Policy programmes 2007–2013 (European Commission, 2016). Data represent input and output variables (see Table 1) to analysing whether the goal of fostering growth in the target countries have been achieved with the funds provided and whether or not more resources generated stronger growth effects in transport accessibility. In Table 1 in Annex, data for 27 Member States (DMUs) with two inputs and five outputs are demonstrated in numerical example. With respect to data availability and need for relevancy of gained results, data for 23 Member States come into efficiency analysis through DEA method, i.e. without AT, DK and LU with zero values of indicators, and also without BE only with one-known value of indicators. For other countries, the values are available for all of the indicators, or some indicators show missing data and therefore report zero values. DEA Frontier software tool is used in the study.

Table 1. Input and output indicators for DEA analysis

Inputs
I-1: Road (mld. EUR)
I-2: Rail (mld. EUR)
Outputs
O-1: km of new roads
O-2: km of new TEN roads
O-3: km of reconstructed roads
O-4: km of TEN railroads
O-5: km of reconstructed railroads

Source: European Commission (2016); own elaboration (2017).

Results and discussion

In the first step, OO BCC VRS model of efficiency should be solved for the EU23 Member States. So, efficient and inefficient countries can be determined. In the second step, OO APM model of super-efficiency should be solved for all the EU23 Member States. Based on results of Andersen-Petersen's model, efficient and inefficient countries can be determined and ranked. Output oriented BCC VRS model of efficiency and OO Andersen-Petersen's model of super-efficiency singled out productive units which are efficient; to the group of these countries belong Bulgaria (BG), Spain (ES), France (FR), Italy (IT), Cyprus (CY), Malta (MT), Netherlands (NL), Poland (PL), Portugal (PT), Romani (RO), Finland (FI) and Sweden (SE). Efficient countries are highlighted by bold in Table 2. In this case, the efficiency boundary is a straight line cutting through these DMUs. All other units are inefficient, i.e. they fall short of the efficiency curve. Inefficient countries are Czech Republic (CZ), Germany (DE), Estonia (EE), Ireland (IE), Greece (EL), Latvia (LV), Lithuania (LT), Hungary (HU), Slovenia (SI), Slovakia (SK) and United Kingdom (UK). Inefficient countries are highlighted by italics in Table 2. DEA allows to determine how DMU should change its behaviour to become efficient and rise to the efficiency curve. In the case of inefficient countries, optimal values of inputs and out-

Table 2. Relative the EU countries' DEA efficiency

EU	OO BCC VRS	OO APM VRS	Efficient input-output target							Rank of countries		
			I1	I2	O1	O2	O3	O4	O5	No.	EU	OO APM VRS
BG	**1,000**	**0,347**	1078,845	341,391	175,000	173,000	1040,480	234,000	234,000	1	FI	0,007
CZ	*1,267*	*1,267*	3796,887	2199,226	519,539	256,480	2557,546	372,628	698,245	2	SE	0,008
DE	*1,143*	*1,143*	2082,771	766,349	335,564	223,901	2049,805	181,547	313,335	3	NL	0,015
EE	*1,842*	*1,842*	290,406	138,908	128,464	48,335	1057,030	16,628	187,483	4	CY	0,214
IE	*4,112*	*4,112*	63,500	16,750	15,600	8,477	135,700	2,111	17,113	5	PL	0,223
EL	*1,159*	*1,159*	1282,721	530,576	345,060	167,330	3066,051	55,554	383,837	6	IT	0,254
ES	**1,000**	**0,895**	2296,862	4139,081	509,750	124,720	2458,100	0,000	1,210	7	MT	0,257
FR	**1,000**	**0,335**	171,837	202,326	28,000	0,000	0,000	57,000	549,870	8	FR	0,335
IT	**1,000**	**0,254**	835,378	2185,181	94,270	0,000	188,070	733,190	1034,960	9	PT	0,345
CY	**1,000**	**0,214**	33,209	0,000	2,900	3,000	3,420	0,000	0,000	10	BG	0,347
LV	*2,783*	*2,783*	483,041	226,137	191,820	81,455	1771,721	28,022	260,446	11	ES	0,895
LT	*1,702*	*1,702*	681,253	315,890	257,011	115,533	2507,102	39,745	335,521	12	RO	0,988
HU	*1,131*	*1,131*	3276,672	1720,107	567,569	271,710	3535,631	51,334	339,480	13	HU	1,131
MT	**1,000**	**0,257**	103,432	0,000	0,000	0,000	13,290	0,000	0,000	14	DE	1,143
NL	**1,000**	**0,015**	8,450	0,424	0,000	0,000	0,000	0,000	0,000	15	SI	1,148
PL	**1,000**	**0,223**	15910,622	5479,094	1886,270	1056,010	7216,230	123,650	482,060	16	EL	1,159
PT	**1,000**	**0,345**	813,206	375,641	300,410	138,220	2996,660	47,550	385,500	17	CZ	1,267
RO	**1,000**	**0,988**	3377,417	1692,047	367,900	313,600	1892,820	21,800	122,260	18	LT	1,702
SI	*1,148*	*1,148*	404,809	184,079	68,835	60,159	369,320	102,668	123,229	19	EE	1,842
SK	*1,860*	*1,860*	1888,527	914,309	393,099	190,023	3023,583	119,609	455,496	20	SK	1,860
FI	**1,000**	**0,007**	9,169	10,198	31,469	0,000	12,238	0,000	70,806	21	LV	2,783
SE	**1,000**	**0,008**	9,272	11,605	36,000	0,000	14,000	0,000	81,000	22	IE	4,112
UK	*4,214*	*4,214*	192,377	65,432	54,778	29,496	185,078	39,334	95,493	23	UK	4,214

Source: own elaboration (2017).

puts are calculated, i.e. targets for inefficient countries as an instruction for improving their input-output ratio to become efficient (compare Table 2 and Table 1 in Annex with efficient and initial values of indicators).

Conclusions

Development of transport network is a very important element for effective functioning of the EU Members States. The increasing demand for goods and movement of people is the reason of successful expansion and modernization of transport infrastructure. Generally it is very important to connect all the EU countries into a functioning system of transportation network. It will promote to movement of people and flow of goods (with consideration of distance). Differences in the levels of accessibility are significant in the new EU countries. They have good prospects for growth of transport infrastructure with regard to the amount of allocations from the European funds and according to the theory of growth due to the effect of catching up of the less developed countries to more developed ones, and there are several reasons for it: (1) the new EU Member States constantly fall into the category of less developed countries based on GDP per head in PPS; (2) threshold defining the level of GDP as a percentage of the EU average was taken as a reference, as it is the criterion for identifying countries that are eligible for funding under the established criteria of the EU Cohesion Policy. The EU funds are an important tool for reducing economic, social and territorial disparities among European countries. Of the total EU budget allocated to the Cohesion Policy, a substantial part is allocated just to the new EU countries, thus significantly supporting their development; (3) the new EU Member States are often significantly dependent on exports to old EU Member States and on the flow of money for this exchange shift, thus freight transport needs adequate transportation network, which is important for these countries in terms of trade relations.

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Title factors influencing the formation of autopoietic economic structures in the Baltic States

JEL Classification: *D21; L22*

Keywords: *autopoiesis; formation of a firm; Baltic States*

Abstract

Research background: The concept of autopoiesis was initially developed in the field of biology and it was used to explain the behavior of biological systems. However it has been successfully applied in other fields of science, including economics and management. Although researches on economic entities using autopoietic systems' theory are performed in Western Europe and USA, this scientific approach still is not developed in Baltic countries. This paper addresses to this vacuum of scientific researches on autopoiesis of economic structures in small open markets.
Purpose of the article: The paper aims to identify and evaluate factors that turn on self-organization mechanisms of autopoietic economic structures in Baltic States, in particular in Latvia.
Methodology/methods: Expert survey was used to identify the most important factors affecting the formation of meso-economic entities in the Baltic States. Analytic Hierarchy Process (AHP) with fuzzy numbers was employed to process the data. Two different scales of evaluation (inverse linear and balanced) were used.

Findings: The factors influencing the process of formation of business groups were evaluated by experts. Research results allow making conclusions regarding the causes of the business integration, and impact of diversified integrated business structures on the country's business system in Central Europe.

Introduction

The concept of autopoiesis was initially developed by Humberto Maturana and Francisco Varela (1980) in the field of biology and it was used to explain the behavior of biological systems. However it has been successfully applied in other fields of science, including economics and management.

The goal of the given research is to identify and evaluate factors that turn on self-organization mechanisms of autopoietic economic structures in Baltic States. The pilot study, conducted by Morkunas in Lithuania (2017), has been prolonged, and the results are reflected in the current paper.

Based on the results from the pilot study, the following hypothesis was stated by the authors:

H1: The most important factor influencing formation of meso-economic entities in the Baltic States is the “big market entry barriers”.

To achieve the research goal and to test the stated hypothesis, experts – top-executives of international companies or their separate business units' managers, as well as academicians with the expertise in management theories and international management – were surveyed. The authors used their own developed research instrument.

Respondents were offered to make a pairwise comparison of six factors, influencing the self-formation of large entities. Nine-point scale was suggested to the experts for completing individual comparison matrices. To identify the most important factors, procedures within AHP (Analytic Hierarchy Process) method were performed. AHP consensus index was estimated to evaluate the level of consistency between experts' viewpoint.

Concept of autopoiesis and factors influencing the formation of autopoietic structures

Now concept of autopoiesis is being frequently studied within the framework of management science (Alaa, 2009, pp. 19-34; Dittus & Vásquez, 2016, pp. 136-146; Vásquez & Benavente, 2015, pp. 269-274).

Autopoietic systems theory postulates, that autopoietic systems should have the following features: 1) ability to create the elements of which are composed by themselves, 2) be self-organizing, e.g. can independently define the boundaries of the system and generate an internal system architecture, 3) be self-sufficient, and 4) at least for a short period of time they can become closed. Such characteristics of the sophisticated autonomy were epistemologically discussed by Mirazo and Moreno (2004, pp. 235-259) and Bich (2012, pp. 215-232).

Investigation of factors affecting formation of integrated diversified business structures was made by Khanna & Riwkin (2001, pp. 45–74), Morck et al. (2005, pp. 655-720) and others.

For the research purposes, the authors selected six main factors, described further. The choice was substantiated by the results of the previous research made by Morkunas (2017), which yielded these factors as the most important ones in Lithuania.

Big market entry barriers (Mahmood & Lee, 2004, pp. 513-531). In some business sectors, economic activity can be characterized as requiring large scientific and / or economic resources, being of high dependence on economies of scale or specific commercial activity. If acting individually, for some companies such barriers can be insurmountable.

Risks related to production specialization (Knudsen, 2007, pp. 117-138). The opposite side of economies of scale in production is its increasing degree of specialization, dependence on specific skills. This leads to caution among companies regarding formation of specific competencies / deepening specialization or the adoption of liabilities of such kind, reducing the company's economic activity compared with the situation when risk sharing is of consolidative nature that is a characteristic of a business group owned enterprises.

The ability to more efficiently allocate resources (Khanna & Yafeh, 2007, pp. 331-372). This factor is being understood as the efficiency of internal business group's capital (loans to group's companies), production (purchases from group companies), human resources (rotation of the best managers / specialists) markets and maneuvering them within the business group, due to the high coordination level from one (or several) center.

The necessity of adapting to weak market regulatory institutions by reducing transaction costs (Meyer et al. 2009, pp. 61-80). With market institutes being under development a relatively high level of transaction costs is due to low level of trust between the parties, frequent breaking of agreements or even disregard to property rights. This results that making supply contracts with the unfamiliar or firms that are in distrust is quite expensive, but in some cases it is necessary, for what the company believes that it makes sense to include suppliers into their structure and by such mean at least partially control them.

Bargaining power in the development of relations with the state for state orders. When merged into large economic entities, companies become more attractive partner not only for other companies, but also to public authorities in its economic policy. Often the governance structures initiates and /or promotes such integration with the hope that such an integrated structure will help to achieve the objectives of the state for countries economy. This factor has much more significance in emerging markets (Claessens, 2008, pp. 554-580; Cooper et al., 2010, pp. 687-724).

Bargaining power in the development of relations with the state for more favorable legislation (Guriev & Rachinsky, 2005, pp. 131-150). Indirect impact on inter-enterprise integration makes public institution's policy, when influential politicians tend not to interact with many, but only with some of the strongest / most influential businessmen. As a result of these heads' of state actions, is the desire of companies to have direct contact with the decisive for determining state's policy politicians, what makes to bond into large economic entities in order to gain more power and access to decision-makers, which is converted into even greater economic benefits and market power.

Research methodology

For research purposes the authors developed an original research instrument that was offered to experts in the field - representatives of the academic environment (professors with the background or research interest in finance, economics, management and / or business administration) and representatives of business environment (top-executives of national business units of large diversified business groups).

Selected factors (see Table 1) were inserted into the evaluation matrix, combined in pairs.

According to AHP (Analytic Hierarchy Process) method experts compare alternatives with each other by filling pairwise comparison matrices.

For completing individual comparison matrices experts were suggested to use nine-point scale, where "1" means that factors are equally important and "9" means that one factor is extremely important over another. Every expert had to evaluate $(n(n-1)\,/\,2)$ pairs (n – number of alternatives). For the purpose of data processing balanced scale (Salo, Hämäläinen, 1997, pp. 309-319) and inverse linear scale (Ma, Zheng, 1991, pp. 197-202) were used.

Table 1. Labels of factors

No.	Factor	Factor's label
F1	Big market entry barriers	Entry barriers
F2	Risks related to production specialization	Risks
F3	The ability to more efficiently allocate resources	Resource allocation
F4	The necessity of adaptation to weak market regulatory institutions by reducing transaction costs	Cost reduction
F5	Bargaining power in the development of relations with the state for state orders	Bargaining power I
F6	Bargaining power in the development of relations with the state for more favourable legislation	Bargaining power II

Source: designed by the authors.

Scales, which characteristics are presented in Table 2, were chosen as they provide higher consistency level of the pairwise comparison matrices (Franek and Kresta, 2014, pp. 164-173).

After experts complete pairwise comparison of the factors, all the assessments have to be written in standardised matrix form and arithmetic mean of each line is calculated. In this way, the main factor is identified. However, if the level of inconsistency is higher than the set limit, the matrix has to be modified into consistent one or should be eliminated from the further calculations as consistency of the matrices shows whether experts' factors evaluations were logical and reliable.

In order to determine consistency index, eigenvalue λ_{max} of pairwise comparison matrix ought to be calculated. After the value of λ_{max} is computed, consistency ratio *CR* could be calculated (Zhang et al. 2017, pp. 1-13). For experts' pairwise comparison matrices that fulfil the consistency condition ($CR < 0,2$), the aggregated experts' assessment was calculated. Aggregated experts' assessment was calculated using geometric mean.

Besides, consensus index introduced by Goepel (2013, pp. 1-10) was calculated. AHP consensus index compares experts' numerical estimations of criteria. The results vary from 0 to 100 percent and show the level of agreement between the experts.

Research results

Experts' individual comparison matrices were analyzed to rank the factors according to the are presented in the Appendix. Analysing experts' individual comparison matrices it was found that the matrix constructed by expert Nr. 5 appeared to be inconsistent; hence, it was eliminated from further analysis. The results of the factors' assessments are presented in the Table 2.

Table 2. Factors' assessment

	Normalized eigenvector, w_j		Rank	
	Balanced	Inverse Linear	Balanced	Inverse Linear
F1	0.146	0.152	2	2
F2	0.135	0.139	5	5
F3	0.307	0.282	1	1
F4	0.137	0.142	4	4
F5	0.129	0.136	6	6
F6	0.145	0.149	3	3

Source: authors' estimation.

Testing for consistency yielded values of the consistency ratio (CR = 0.015 and 0.009 for balanced scale and inverse linear scale, respectively), lambda (λ = 6.093 and 6.054 for balanced scale and inverse linear scale, respectively) and consensus index (S* = 77.1% and 81.5% for balanced scale and inverse linear scale, respectively), which met the stated requirements. Consequently, experts' aggregated assessments could be used for obtaining general results.

Based on the results provided in Table 2, the highest rank was assigned to the ability to more efficiently allocate resources. In fact, this factor's weight is more significant than the other factors' weights and exceeds 28 percent limit according to balanced and inverse linear scales. This, in turn, corresponds to the statements of the common theory on large business entities for developed markets. It is also an evidence of maturity of the Baltic market.

The experts ranked big market entry barriers at the second position. The weight of the factor is 0.146 according to balanced scale and 0.152 according to inverse linear scale. Such a high ranking of this factor points to the globalization effect onto small open markets, such as Baltic States market.

Bargaining power in the development of relations with the state for more favourable legislation was ranked at the third position by the experts. Hence, high ranking of this factor, when determining the formation of large autopoietic economic entities in Baltic countries, shows a clear contradiction to a factor that was positioned at the first place. The reason is that in mature developed markets there are almost no possibilities to affect politicians in order to get a more favourable legislation, which is being converted to economic benefits at the expense of other market players. Therefore, the results indicated some weaknesses in market regulation institutes, especially those, which are ensuring equal rights to all market players, or lack of transparency of State's decision markets.

Experts ranked the necessity of adaptation to weak market regulatory institutions by reducing transaction costs at the fourth position. In developed markets this factor should not be so important. However, some business groups in the Baltic States were formed in 1990s or at the beginning of the 2000s. At that time a market regulation was relatively weak.

Risks related to production specialization is the factor that was ranked to the fifth position. Such a low position can be explained by the fact, that Baltic States economies are dominated by a service sector, so there are very few large scale mass production companies, which would require some specific parts for its production.

Based on the experts' evaluation, bargaining power in the development of relations with the state for state orders was at the last place. The weight of this factor is 0.129 according to balanced scale and 0.136 according to inverse linear scale.

Conclusions

The current paper reflects the results of the authors' conducted survey on investigation of the factors influencing the formation of large diversified economic systems in the Baltic States.

The results of the experts' survey allowed identifying the most important factor influencing the formation of meso-economic entities in the Baltic States - the ability to more efficiently allocate resources within the business group. In the pilot study this factor was also highly ranked – it took the third place. Thus, the research hypothesis is partially rejected, since the factor regarding market entry barriers was evaluated as the second most important by the experts.

The ranking of other factors, mainly, corresponds to the theory and the results of the previously conducted pilot study in Lithuania. The only contradiction with the previous results is related to the last positioned factor "bargaining power in the development of relations with the state for state orders". In a pilot study, conducted only in Lithuania, this factor was factor was placed at a much higher place than the "bargaining power in the development of relations with the state for more favourable legislation". It can be explained by the fact, that in this survey the participants from all three Baltic countries, and as Estonian market is being considered more mature, transparent and developed than Lithuanian, so there are almost no possibilities for companies in Estonia to achieve its' economic goals of winning government contracts by infringing other market players. This finding also offers a new ground for researches aimed at finding differences in factors influencing the formation of large autopoietic economic structures in Estonian and Lithuanian markets.

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Local determinants of foreign direct investment in Poland

JEL Classification: *F23, F23, R12.*

Keywords: *foreign direct investments (FDIs), location determinants, regional and spatial distribution of FDI, LAU 1, Poland*

Abstract

Research background: The internationalisation of economies, which foreign direct investments significantly contribute to, affects the growth of regional and local economies. Their choice of location is the topic of frequent debates among scholars, politicians and regional/local authorities.
Purpose of the article: Given the scarcity of empirical evidence on the locational determinants of foreign direct investments at the local level of analysis (LAU 1) in Poland, and the time that has passed since similar analyses were run on a regional scale, we conduct a study investigating the locational determinants of FDIs in Poland between 2011 and 2015.
Methodology/methods: We use a unique dataset comprising data available in public statistics and information gathered from computations run using GIS software indicating the average distances of districts to selected points of interest (such as the border, motorway/express road, airport, railway line, special economic zone, etc.). The utilisation of GIS-based data is a significant improvement to the past research, which tended to use dummy variables in this regard. To identify the key locational determinants, we run a series of negative binomial regressions, due to the count character of the dependent variable.
Findings: The results prove that a significant part of the spatial distribution of FDIs in Poland can be attributed to factors originating from New Economic Geography, whereas the rest stems from the heterogeneity of local areas. The lower and more detailed scale of the analysis brings to light new facts on the choice of loca-

tion as compared to previous studies, especially regarding the role of SEZs or proximity to agglomerations.

Introduction

The increased internationalisation of individual countries' economies has a significant impact on the development of cities and regions of these economies, especially the processes of locating and concentrating economic activity taking place in their area. According to Cieślik (2005a), international businesses are playing an increasingly greater role in these processes. By their presence in many countries and easy access to global markets as well as global knowledge resources, they are viewed as stimulants of changes taking place in countries which host foreign investors.

In Polish literature, the analysis of the location of FDIs was most often carried out at relatively high data aggregation on - the national economy (Aleksandruk & Forte, 2016; Torrisi, Delaunay, Kocia, & Lubieniecka, 2009; Walkenhorst & Peter, 2001; Wojciechowski, 2013) or provinces (NUTS 2) (Ablov, 2015; Chidlow, Salciuviene, & Young, 2009; Cieślik, 2005a, 2005c, 2005b, 2013; Cieślik & Ryan, 2005; Domański, 2001). However, the high internal diversification of Polish regions (Bogdański, 2012; Nazarczuk, 2015), as well as the suggestions of new economic geography along with the experiences of a new, new trade theory, indicate the need for more detailed analyses in this scope, covering analyses on less aggregated units.

Therefore, the aim of the article is the identification of locational determinants of business entities with foreign capital share in Polish districts (*powiat*). Using data taken from the Central Statistical Office (GUS), information obtained from calculations on maps as well as negative binomial regression, the most important determinants of the location of companies with foreign capital were identified, referring to the structural characteristics of the districts as well as localization factors resulting from the teachings of new economic geography.

Research methodology

Compared to earlier studies on the determinants of FDIs in Poland (Cieślik, 2005a, 2005c, 2005b, 2007; Cieślik & Ryan, 2005), we carry out the analysis on the lower level of aggregation, i.e. districts (LAU 1), falling more in line with the teachings of new economic geography and the concept of heterogeneity. In addition to the structural features of districts, we also account for their average distances (communes in individual districts) from select points in space (first and second nature factors), including national borders. We do not use dummy variables for this purpose as was the case in previous studies, but introduce continuous variables, thanks to which we are better able to show the border effect or account for the potential impact zone of select places.

The work uses data obtained from the local data bank for districts on the location of companies with foreign capital share in Poland and select structural characteristics of local economies. The remaining data covering the average distances of communes in individual districts from select places in space (in accordance with the teachings of new economic geography), i.e. the border, airport, express road/motorway, national road, railway line, SEZ, and province capital, were obtained using the Quantum GIS program and expressed in km.

The most frequently used approach to the empirical study of the choice of location by companies with foreign capital in literature on the subject is the logistic regression model (McFadden, 1974). An alternative approach is based on econometric models based on count data, which do not assume constant values. Two of the most popular approaches to estimating the above dependencies are Poisson regression and negative binomial regression (Cieślik, 2005c, 2013; Cieślik & Ryan, 2005). Thus, a similar approach to the analysis of the determinants of FDI location in Poland was applied in the present work.

The general form of Poisson models being the subject of estimation was expressed by the following formula:

$$Pr(y_i) = \frac{\mathrm{e}^{-\lambda_i}\lambda^{y_i}}{\mathrm{y}_i!}, y_{i=0,1,2,\dots} \tag{1}$$

where: parameter λ_i signifies the expected value of the number of companies with foreign capital in the ith district. Independent variables describing the local characteristics of districts were also introduced to the model, described by the formula:

$$ln\lambda_i = \beta' x_i \tag{2}$$

In which the vector of parameters estimated over the course of modelling, found near independent variables, was marked by β.

However, due to the frequently occurring case of excessive dispersion in the case of analysing count data, i.e. when variation is higher than the average value, negative binomial regression is a better choice, while in the case of variation and average value being equal – Poisson regression is more appropriate (Cieślik, 2007). Since we are dealing with the first case, the work presents the results of estimations using negative binomial regression, carried out using the Stata 14.2 application. This choice was confirmed by the results of the likelihood ratio test, which unanimously preferred the negative binomial model to the Poisson's, further confirmed by the significance of the α parameter (table 2). Moreover, in order for it to become possible to compare the quality of the assessed models between individual specifications, we use two information criteria – AIC (Akaike Information Criterion) as well as BIC (Bayesian Information Criterion).

Estimation results of local determinants of foreign direct investment in Poland

Table 1 contains the results of estimations regarding the expected number of FDIs in the Polish districts in the years 2011-2015 using negative binomial regression according to different specifications. In Column 1, Table 2, only variables related to geographical features were used, indicating the distance from selected points in space as well as the border. Among all of the above-mentioned factors – mainly second nature factors, in accordance with the teachings of new economic geography, the proximity of the location in relation to the province capital, special economic zone, airport, port or national border is of key importance. The nearness of a border and province capital ensure high accessibility to national and foreign markets and, especially in the case of the later, facilitate access to well-educated labour resources. They also point to the importance of perceiving the importance of an agglomeration by foreign investors.

SEZs, by means of tax breaks, make it possible to, above all, gain a cost advantage and increased productivity as compared to entities outside of the zone. They are also, more and more frequently, an integrative element attracting FDIs, increasing the chances of a FDI being located in the given area when accompanied by other favourable conditions (the fulfilment of other location criteria). The short distance from an airport and port indicate the significance of good transport infrastructure. The two variables describing the proximity of road infrastructure were not significant in the logarithmic specification of the model, both the distance to: (1) a national road, and (2) an express road or motorway were not statistically significant.

Table 1. Results of estimates of local FDI determinants in Poland

Variables	(1)	(2)	(3)	(4)	(5)
dist_reg_cap	-0.530***	-0.528***	-0.191***	-0.213***	-0.158***
	(0.117)	(0.118)	(0.0484)	(0.0494)	(0.0465)
dist_SEZ	-0.453***	-0.451***	-0.230***	-0.171***	-0.171***
	(0.0854)	(0.0868)	(0.0605)	(0.0527)	(0.0540)
dist_mway	0.0580	0.0996	-0.0402	0.0124	0.00623
	(0.0732)	(0.0728)	(0.0348)	(0.0318)	(0.0310)
dist_nroad	-0.0665	-0.131	-0.0824	-0.0885*	-0.0905*
	(0.104)	(0.109)	(0.0579)	(0.0498)	(0.0514)
dist_railway	-0.159	-0.0875	-0.205***	0.0235	0.0148
	(0.102)	(0.0985)	(0.0589)	(0.0566)	(0.0542)
dist_airport	-0.554***	-0.628***	-0.154**	-0.0578	-0.134**
	(0.123)	(0.143)	(0.0603)	(0.0597)	(0.0632)
dist_port	-0.219***	-0.0798	-0.0473	0.0417	0.0577
	(0.0772)	(0.125)	(0.0510)	(0.0472)	(0.0820)
dist_border	-0.158***		-0.146***	-0.0944***	
	(0.0603)		(0.0365)	(0.0338)	
comp10k			2.604***	1.500***	1.239***
			(0.200)	(0.227)	(0.247)
remun			0.747**	0.288	0.309
			(0.346)	(0.344)	(0.365)
unemp_rate			-0.300***	-0.464***	-0.489***
			(0.0878)	(0.0930)	(0.0915)
roads			0.645***	0.800***	0.813***
			(0.0639)	(0.0642)	(0.0646)
industry_sh				0.0279***	0.0281***
				(0.00356)	(0.00391)
services_sh				0.0385***	0.0415***
				(0.00462)	(0.00444)
higher_educ					1.920**
					(0.929)
dist_pl_de		-0.362***			-0.218***
		(0.0949)			(0.0660)
dist_pl_cz		0.0319			0.0663
		(0.108)			(0.0560)
dist_pl_sk		-0.0727			-0.0843
		(0.113)			(0.0722)
dist_pl_ru		0.133			-0.101
		(0.143)			(0.130)
dist_pl_by		0.278			0.117
		(0.170)			(0.149)
dist_pl_ua		-0.151			-0.255**
		(0.128)			(0.103)
dist_pl_lt		-0.198			0.148
		(0.246)			(0.224)

Table 1. Continued

Variables	(1)	(2)	(3)	(4)	(5)
Constant	10.73***	11.35***	-21.10***	-15.32***	-13.15***
	(0.727)	(2.227)	(3.078)	(3.078)	(3.736)
Observations	1,890	1,890	1,890	1,890	1,890
Year FE	NO	NO	YES	YES	YES
Year FE (p-val)			0.000	0.000	0.000
No. of clusters	378	378	378	378	378
Pseudo R2	0.129	0.140	0.218	0.242	0.250
LogPseudoLik	-8185	-8086	-7350	-7130	-7052
LR	163.8	338.2	954.9	1438	1627
LR(p-val)	0.000	0.000	0.000	0.000	0.000
Alfa	0.781	0.713	0.308	0.235	0.215
Alfa (p-val)	0.000	0.000	0.000	0.000	0.000
AIC	16391	16204	14736	14299	14157
BIC	16446	16292	14836	14410	14307

Information: The individual Year Fixed Effect is not presented due to limited space. The joint significance of the aggregate time effects is embraced in Year FE (p-val). Clustered standard errors in parentheses, *** $p<0.01$, ** $p<0.05$, * $p<0.1$.
Source: own compilation.

Despite the fact that the relative nearness to the border was an important factor encouraging the location of FDIs, the actual effect of the proximity of the border was heterogeneous (Column 2) in Table 1, and depended on the geographical direction or country bordering Poland. Only in the case of Germany did the location near the border work to the advantage of locating companies with foreign capital. The remaining geographic directions were characterized by insignificant estimates. The obtained result shows one of the key locational determinants to be the proximity of markets and focus of companies with foreign capital on export-oriented activity, which determines their location decisions in the context of future directions of sales.

In Column 3, Table 1, selected features of individual districts, i.e.: the level of agglomeration of businesses, remuneration, unemployment rate, and quality of road infrastructure measured by the length of roads with a hard surface are added to the factors of economic geography (from Column 1). All of these location criteria in this specification of the model were statistically significant, indicating the role of both the agglomeration of businesses and situation on the job market, as well as the road infrastructure. Interestingly, higher remunerations were not a deterring factor for FDIs and, on the contrary, attracted them.

Other factors which are significant as far as the location of FDIs is concerned, and falling into the diversification of districts, were those connected with the structure of the local economy (Column 4 in Table 1). Companies with a share of foreign capital locate themselves in areas with a higher share of the second and third sector in the employment structure. Moreover, in this model, the variable describing the nearness to national roads became statistically important.

In specification 5 of the model, in Table 1, we include the measure of the quality of human capital and the distance from individual borders. Results obtained in such a way, found in the last column, are characterized by the lowest AIC and BIC criterion and highest pseudo R^2 of all those presented in Table 2. Their analysis confirms the role of the agglomeration, proximity to SEZs, nearness of transport infrastructure (national road, airport), and also the border (especially with Germany and additionally - Ukraine). Among the features of districts, important localization factors besides the agglomeration of businesses, good access to people with a higher education, and a good situation on the labour market was also the economic structure of the district.

The specification of the model with the dependent variable delayed by one period was also additionally tested. However, despite the desirable sign, it was characterized by the lack of statistical significance, thus was not included in Table 1.

Conclusions

The main aim of the study was the assessment of location determinants of foreign direct investments in the districts of Poland using negative binomial regression. The obtained results indicate the role of both geographic factors, associated with the proximity of location in regard to selected points in the economic space, as well as certain structural features. Generally speaking, FDIs were more frequently located in districts with a higher level of development (also infrastructure), located closer to large urban centres, characterized by a relatively good situation on the job market, and with wide access to people with a higher education. Therefore, the location of FDIs by the selection of places with a relatively high level of development leads rather to the strengthening of existing regional/local differences than overcoming them.

One ought to keep in mind that the carried out analyses pertained to general FDI determinants, without distinguishing their sectoral structure, due to the lack of accessibility to such data. In actuality, the obtained estimates for companies in individual sectors could indicate the various significance of individual factors, due to the dissimilar preferences stemming from the specification of the business activity carried out.

As compared to previous studies carried out on a higher level of data aggregation (Cieślik, 2005a, 2005c, 2005b, 2007; Cieślik & Ryan, 2005) (16 NUTS 2 provinces and 49 old provinces), as well as a varied period of time (the 90s and middle of the 2000s), thanks to increasing the precision of data as well as introducing variables of a continuous nature instead of dummy variables, we positively assess: (1) the proximity of SEZs as a location factor, and (2) the distance from the province capital, as a potential growth pole initiating agglomeration processes in space. It is, however, difficult to state whether SEZs alone can be a factor attracting FDIs and overcoming at least some of the observed local development barriers, or if they are rather treated as a kind of starting package for discussions regarding the future location of a company.

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Autocorrelation of spatial allocation of funds at the municipality level of Slaskie Voivodship

JEL Classification: *C19;H76; R12*

Keywords: *investment funds, municipality, spatial autocorrelation, GIS, Moran's I statistics*

Abstract

Research background: Local development is a harmonized and systematic activity of the local community, local authorities and other entities operating in a municipality, aimed at creating and improving the usability of existing municipalities. The primary factor in the local development is investments undertaken by the municipality. The financial reflection of these activities is the amount of investment expenditure. The amount of a municipality's income, its development strategy and the expectations of the local communities influence both the level of investment expenditure and structure, which is diversified both in terms of time and space.
Purpose of the article: The aim of the study was to determine the spatial distribution of total funds allocated for investment, and investments in transport and communications in the municipalities of Slaskie Voivodship. Spatial relationship was also determined with the *Moran's I* statistic. The scope of work included creating a spatial database of the examined region at the level of basic local government units, i.e. 167 municipalities. The data were obtained from the studies of official statistics for the years 2008, 2011 and 2014.
Methodology/methods: Based on information contained in attribute data sheets, along with the postal codes of municipalities, a spatial database was created in the program ArcView. The analyzed maps were prepared in the GIS program ArcView. For better illustration and reading of detailed data from the prepared maps, the attribute variables were divided into groups using the Jenks method.

With it, classes could be determined by comparing the sum of the squares of the differences. The developed classes can also be called a natural border of the division. Based on the prepared spatial database, an analysis was performed with the program R-cran, using Moran's *I* statistics. Moran's *I* statistic determines the differences and similarities between the two objects, and allows analyzing the researched area.
Findings: With relation to the analysis of the total funds allocated for investment, the least among the investment periods studied was the year 2008. Noticeable in this period is the largest number of municipalities included in class I (142 municipalities), with the investment range 0 - 6,510,016.26 zloty. The developed spatial distribution shows that municipalities concentrated in the central part of the voivodship make up an island of high investment funds. These communes are located in the Upper Silesia Agglomeration, with a high population density. High values are also noticeable in large urban centers such as Czestochowa in the north of the voivodship, and Bielsko-Biala in the south.

Introduction

Space is one of fundamental properties of matter since every physical phenomenon takes place in a specific area. Therefore, often space is the subject of many scientific studies in various life spheres: mathematics, biology and even humanities. Economics is a field of science that has sceptically treated the concept of including space in research. It usually ascribes the role of spatial relations analysis to economic geography specialists. It results from a belief which economists shared on the universality of the economic rights regardless the investigated region but also from the lack of methods indispensable to analyse these phenomena. Recognition of a region as an economic space is also essential (Behrens &Thisse, 2007, pp. 457-465, Rey & Janikas, 2006, pp. 67-86). A turning point in economy, the so-called "silent revolution" begun along with the New Economic Geography. The economic geography law suggested by Tobler in 1979 shattered the way of perceiving economy as an independent object which does not interact spatially with neighbours, which was strengthened in the theory of economics. This turning point resulted in formation of spatial development models along with the analysis of spatial distribution of economic activity analysis on the example of activity concentration in agglomerations, transport costs, patterns of localization of companies and the perspective potential of regions (Bosker et al., 2007, pp. 152-169, Sikora et al., 2014, pp. 1317-1326, Szeląg-Sikora, 2009, pp. 39-48).

Autocorrelation is a field of statistics which analyses spatial data, and then deals with description and investigation of spatial phenomena. All

phenomena which take place in space are mutually related. Each element influences more or less another neighbouring element. However, one should notice that this phenomenon is reversely proportional to the distance between them. A multi-dimensional nature of the spatial autocorrelation, the so-called need of searching in all directions contrary to the single-direction time trend, is a complicating factor. A wide range of units which may be used in the spatial autocorrelation is another one (distance, neighbours, connections, etc.) (Getis, 2007, pp. 491-496, Anselin, 2007, pp. 450-456). The objective of the paper was to determine spatial distribution of funds designed for all investments and investments concerning transport and communication by the municipalities from Śląskie Voivodeship. Moreover, spatial relations were determined with the use of Moran's *I* statistics.
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Methodology of research

A database in the form of a calculation sheet was prepared for the purpose of this paper. Data were obtained from the studies prepared by the Main Statistical Office and 167 municipalities of Śląskie Voivodeship were analysed. A municipality was assumed as a reference unit due to a small area of research (voivodeship) and great significance of actions carried out on local levels.

The research concerned expenditures incurred by municipalities on all investments and expenditures on investments incurred for transport and communication. The obtained data refer to 2008, 2011 and 2014. Due to the fact that economy is still developing and that data similar to the present situation in a given municipality must be analysed, selection of years close to each other was justified.

Based on the information included in the prepared numerical database with codes of municipalities a spatial database was prepared in ArcView program. Three various file extensions describe the spatial database:

- extension *.shp due to which we define the investigated area,
- extension *.shx which serves for ascribing suitable identifiers and combining surrounding data,
- extension *.dbf which presents spatial database with the list of previously accepted variables.

The analysed maps were prepared in GIS ArcView program and for a better preview and readout of particular data from the prepared maps Jenk's method was applied (table 1).

Table 1. Classes of natural borders of division according to Jenk's method

Class	Value	Shade
I	very low	the brightest
II	low	bright
III	average	medium
IV	high	dark
V	the highest	the darkest

Source: Sikora et al., 2014, pp. 1317-1326

Global Moran's *I* statistics

Moran's *I* statistics is used for testing global spatial relations and gives a possibility of determination whether there is a spatial effect of agglomeration. Values of Moran's I statistics are within -1 to 1.

The described statistics may be determined with the two following formulas:

$$I = \frac{\sum_i \sum_j w_{ij}(x_1 - \bar{x})(x_1 - \bar{x})}{S^2 \sum_i \sum_j w_{ij}} \tag{1}$$

$$\frac{1}{n} \sum_i (x_1 - \bar{x})^2 \tag{2}$$

where:
x_1 – observation in i region,
$\bar{x}$ - average from all investigated regions,
n - number of regions,
w_{ij} – element of the spatial matrix of weights W.

Characteristic of the obtained results of global Moran's *I* statistics:

- if the value of Moran's *I* statistics is within (0.1>, namely I>0 then a positive spatial autocorrelation takes place, values of close observations are similar,
- if the value of Moran's *I* statistics is within (-1.0, <-1.0), namely I<0 then a positive spatial autocorrelation takes place, values of close observations are similar,
- if the value of Moran's *I* statistics is zero, namely *I*=0, then in the investigated space values of observations are randomly distributed (Sikora, 2009, pp.217-227).

Matrices of spatial weights

Matrices of spatial weights are a basic element of spatial analyses. For the research the most often applied type of matrix was assumed, namely a matrix of neighbourhood constructed based on the criteria of a common border. Thanks to this analysis, we are able to obtain the best reflection of the closeness of the analysed objects in the investigated space. Matrices of neighbourhood weights may be divided into the following types:

– B type matrix - basic binar zero-one matrix,
– W type matrix - of the first row standardized with rows,
– C type matrix - generally standardized,
– U type matrix - divided into the number of neighbours,
– S type matrix - stabilizing variations.

Elements of weight matrix assume the following values:

– $w_{ij} = 1$, when i object neighbours with j object,
– $w_{ij} = 0$, when i object does not neighbour with j object,
– $w_{ij} = 0$ diagonal elements of the matrix.

Results and discussion

167 municipalities from Śląskie Voivodeship were analysed with division into two categories of variables. Figure 1, 2 and 3 present a spatial distribution of expenses on all investments in the years 2008, 2011 and 2013 and figure 4, 5 and 6 present a spatial distribution of means designated for the transport and communication investments also in the above-mentioned years.

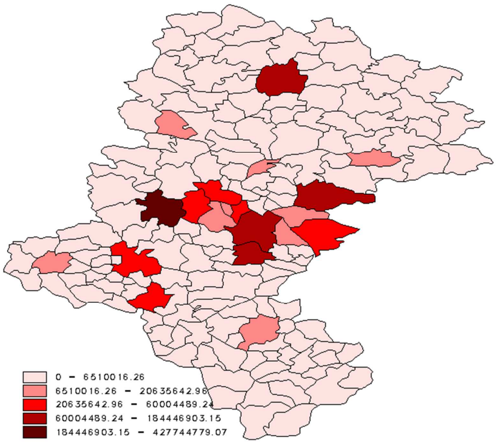
Means designated for all investments

147 municipalities were marked with a colour, which is 88% of the total investigated area. The measure of development of the first class is within PLN 0 – 6510016.26. While observing figure 7 we may also notice that along with the increase of the class, the number of municipalities in a given class drops. In particular classes we respectively have:

– in class I - 147 municipalities, which is 88%,
– in class II - 9 municipalities, which is 5.39%,
– in class III - 6 municipalities, which is 3.59%,

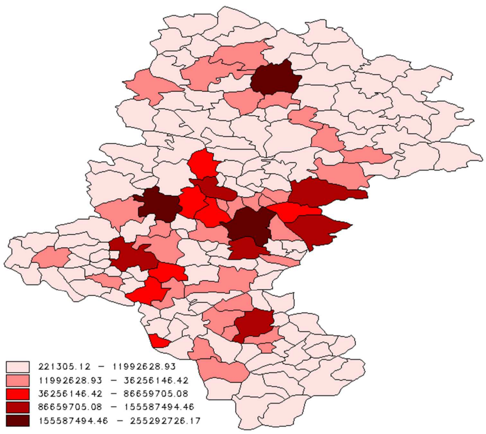
- in class IV - 4 municipalities, which is 2.40%,
- in class V - 1 municipality, which is 0.60%.

Figure 1. Spatial distribution of expenses designated for investments in 2008 in municipalities of Śląskie Voivodeships



Source: Author's own study.

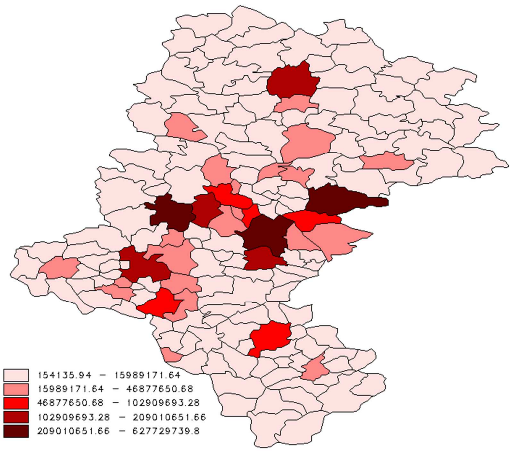
Figure 2. Spatial distribution of expenses designated for investments in 2011 at the level of municipalities of Śląskie Voivodeship



Source: Author's own study.

In 2011 we may observe a decisive raising trend of the funds allotted for investments by municipalities in comparison to 2008. A disproportion between municipalities which are in the lowest class and those in the highest classes has decreased. In the lowest class, there were 120 municipalities which constittues 71% of the investigated area with PLN 221305.12 – 11992628.93 The highest increase in the number of municipalities (over 10%) in comparison to 2008 was reported in class II.

Figure 3. Spatial distribution of expenses designated for investments in 2014 at the level of municipalities of Śląskie Voivodeship



Source: Author's own study.

The spatial analysis of data for 2014 shows that still there is the highest number of municipalities which allot the lowest amounts of funds for investments. These are precisely 134 municipalities and their aggregate measure was within PLN 154135.94 – 15989171.64. The number of municipalities from the I class is visible. We may notice a clear decrease of funds designated on the investments in the municipalities of Częstochowa and Bielsko-Biała provinces. Investments in the municipalities of Śląsk agglomeration: Katowice, Gliwice and Dąbrowa Górnicza were at a constant high level.

Table 2. Characteristics of investigated municipalities on account of indicator of funds allotted to all investments in municipalities of Śląskie Voivodeship

Classes	Number of poviats in a given class			Participation of poviats (%)		
	2008	2011	2014	2008	2011	2014
I	147	120	134	88	71.85	80.24
II	9	31	21	5.39	18.56	12.57
III	6	7	5	3.59	4.19	2.99
IV	4	6	4	2.40	3.59	2.40
V	1	3	3	0.60	1.80	1.80

Source: Author's own study

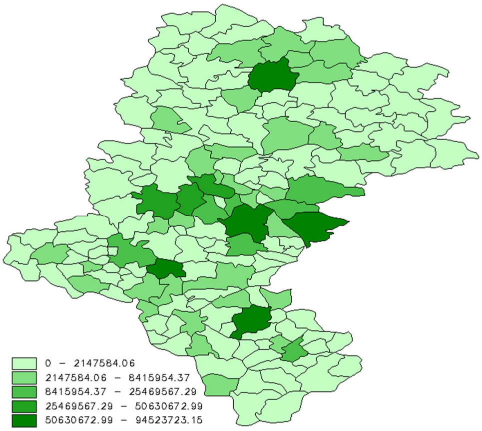
To sum up, the spatial distribution shows that municipalities located in the central part of the voivodeship allot the highest amount of funds on investments. It results mainly from high urbanization, which we may observe in the Upper Silsesia conurbation.

Funds designated for transport and communication investments

Spatial analysis of funds allotted for transport and communication investments in 2008 allows a statement that there are high discrepancies between the investigated municipalities. It is confirmed by the fact that municipalities which have the highest inputs on the investments are represented only by 5 companies and in the class I (the lowest) and their value is as much as 120 municipalities. The highest expenditures for transport and communication were reported in the following municipalities: Bielsko-Biała, Częstochowa, Katowice, Żory and Jaworzno.

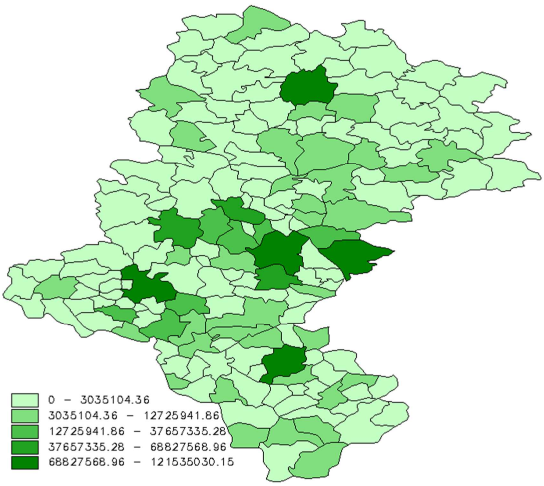
On the presented map we can also notice that the second class was left by the municipalities located to the north of Częstochowa, namely: Kłobuck, Mykanów, Rędziny, Kłomnice and Mstów. On the south of the voivodeship, the spatial analysis proved the increase of expenses in the following municipalities: Milówka, Węgierska Górka and Ujsoły.

Figure 4. Spatial distribution of funds designated for transport and communication investments in 2008 in Śląskie Voivodeships



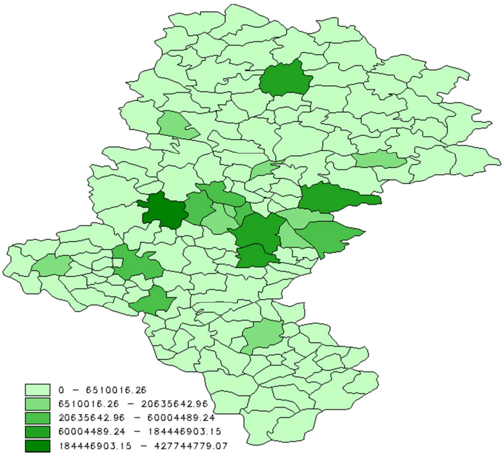
Source: Author's own study.

Figure 5. Spatial distribution of funds designated for transport and communication investments in 2011 in municipalities of Śląskie Voivodeships



Source: Author's own study.

Figure 6. Spatial distribution of funds designated for transport and communication investments in 2014 at the level of municipalities of Śląskie Voivodeships



Source: Author's own study.

In 2014 we may observe a considerable increase of municipalities which are in class I. In the analysed period in the group of municipalities with the biggest expenses on the transport and communication investments there were 147 municipalities which constitutes as much as 88% of the investigated group. The biggest changes of the spatial distribution in comparison to 2008 and 2011 may be observed in municipalities which previously were in the second class. Undoubtedly, the increase of the scope for the second class has a great impact on the state of affairs.

Table 3. Characteristics of the investigated municipalities on account of the indicator of funds allotted for transport and communication investments in the municipalities of Śląskie Voivodeship

Classes	Number of poviats in a given class			Participation of poviats (%)		
	2008	2011	2014	2008	2011	2014
I	120	117	147	71.86	70.06	88.02
II	32	35	9	19.16	20.96	5.39
III	7	7	6	4.19	4.19	3.59
IV	3	3	4	1.79	1.79	2.40
V	5	5	1	2.99	2.99	0.60

Source: Author's own study.

From the spatial analysis of the funds allotted for the transport and communication investments in Śląskie Voivoideship in 2008, 2011 and 2014 we may conclude that between the first two investigated periods there were no considerable differences. However, 2014 presents completely different values. In 2014 in comparison to the previous year, a decisive decrease of municipalities of the II and IV class was reported. However, attention should be paid to the fact that in 2014, measures of scopes of particular classes increased largely and it resulted from great financial inputs in Gliwice municipality. In 2008 and 2011 transport and communication investments were distributed into a greater number of municipalities mainly on account of the construction of A4 highway and many transportation hubs and access roads on the territory of Śląskie Voivodeship.

Spatial relations based on Moran's I global statistics

Formulation of analysis was initiated from the matrix of weights of the basic which uses a relation of closeness of objects by means of a common border. Results of relations were presented in table 7. 10 groups of relations were separated from the space of Śląskie Voivodeship. One object had only one neighbour and it was a municipality with the identification number 142 (Koszarawa), it is a municipality of Beskid Żywiecki the most protruding to the south east of the voivodeship and cutting into the area of Małopolskie Voivodeship. The number of relations in the so defined matrix was 892 and it was 3.2 % of all possible interactions.

Characteristic of the first row matrices type "B" for the set of 167 municipalities of Śląskie Voivodeship:

– number of regions: 167,
– number of non-zero relations: 892,
– interest of non-zero relations: 3,19,
– average number of relations: 5,35,
– object with only one neighbour: 142,
– object with the highest number of relations; 85.

Tabela 4. Number of relations of spatial objects

Number of neighbours	1	2	3	4	5	6	7	8	9	11
Number of objects	1	2	17	42	30	34	24	9	7	1

Source: Author's own study.

Results based on the matrix of weights with the criterion of mutual border for the set of municipalities of Śląskie Voivodeship were placed in table 8. Results of the spatial analysis based on Moran's *I* statistics confirm that the biggest number of funds allotted for all investments and in the transport and communication department in the municipalities of Śląskie Voivodeship can be observed in 2011. The increase of the value of the index of Moran's *I* statistics between 2008 and 2011 informs on the convergence process which takes place. In case of the period between 2011 and 2014 the divergence process is noticeable.

Table 5. Spatial analysis for synthetic indicator determined for allotted funds for all investments and for transport and communication based on Moran's I global statistics of the set ($\Omega_{Ś}$)

Type of weights	Year 2008		Year 2011		Year 2014	
	I	level of significance	*I*	level of significance	*I*	level of significance
Funds for all investments in municipalities						
Weights of neighbourhood according to joint border type B	0.278	$p < 0.05$	0.464	$p < 0.05$	0.333	$p < 0.05$
Funds allotted for investments in transport and communication department						
Weights of neighbourhood according to joint border type B	0.451	$p < 0.05$	0.493	$p < 0.05$	0.207	$p < 0.05$

Source: Author's own study.

In case of variables describing funds allotted to all investments and the transport and communication investments there is a spatial autocorrelation in all time intervals. Autocorrelation has a positive nature. It means that objects with similar values of measure of funds allotted for investments tend to group together.

Conclusions

Spatial analyses were made based on two variables - funds allotted for all investments and funds for transport and communication investments. Data from 2008, 2011 and 2014 were accepted for the research. The research area covered all 167 municipalities of Śląskie Voivodeship. The tests which

were carried out enabled observation of considerable discrepancies between the municipalities which are on rural areas and urban municipalities.
The spatial distribution shows that municipalities grouped in the central part of the voivodeship form an island of high values of funds allotted for investments. These municipalities are in Górny Śląsk agglomeration with a high population density. High values are also notable in big urban centres such as Częstochowa in the north of the voivodeship and Bielko-Biała in the south. The analysis which was carried out unanimously states that there is a great disproportion in the funds allotted to investments between municipalities which are in rural areas and city municipalities. Of course, there are exceptions, which occur mainly in rural municipalities which neighbour with big urban centres. Municipalities focused around Częstochowa and Żory are an example in the research concerning transport and communication investments for 2008.

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Determinants of net exports in Polish and Czech manufacturing: a sectoral approach with error correction model

JEL Classification: *F40; C23; F14; O14; L60*

Keywords: *CEE economies; net exports; international competitiveness; manufacturing; error correction mode*

Abstract

Research background: Growth model in CEE countries has based on a massive inflow of direct foreign investments, especially in manufacturing, from the onset of the transformation. This resulted in a substantial share of manufacturing goods in total exports and a high ranking position of some CEE countries among the most industrialized economies in the world.
Purpose of the article: The main objective of this paper is to compare the determinants of the international competitiveness, measured by the net exports of the manufacturing sectors in the Czech and Polish economies, by using the database of 13 manufacturing sub-sectors in 1995-2011. The authors research the question of how much foreign and domestic demand, the level of labour costs, the level of sector innovation intensity, the level of sector openness to foreign markets as well as sectoral labour productivity influence the changes in trade balance.
Methodology/methods: Our approach is based on employing an error correction model and SURE model to disaggregated sectoral manufacturing data.
Findings: The results of the analysis conducted show substantial differences in the roles particular variables play in explaining the net exports in individual sectors. For the majority of Polish and Czech manufacturing sub-sectors, generation of positive trade balance is determined by relative demand growth. An increasing labour productivity influences heavily a positive trade balance of Polish goods in majority of sub-sectors, however, a key factor in Czech sub-sectors is decreasing unit labour costs. The results of the analysis indicate mostly a greater impact of the

researched factors on net exports in long rather than short term and the better capacity of the Czech economy to correct deviations from the equilibrium.

Introduction

CEE exports represent a major source of growth, so positive net exports is a sign of a high level of international competitiveness. Therefore, knowledge about the main determinants of net exports, especially at the level of individual sectors, seems to be crucial for creating an appropriate export-led growth strategy.

The researches identifying the determinants of manufacturing trade balance of CEE countries are scarce. For this reason authors want to fill the gap in the empirical literature on the determinants of CEE net exports, based on Poland and the Czech Republic, two leading economies among Central and East-European. The empirical part of the article concentrates on 13 manufacturing sub-sectors and covers the period 1995-2011.

The structure of the paper is as follows. The next section presents both data used in the analysis and the methodology of the research. In the subsequent part the authors present the results of the empirical analysis. The last part of the paper contains conclusions drawn from the conducted research.

Research methodology and data description

Before evaluating the international competitiveness of the manufacturing sector in the Czech Republic and Poland, first we test non-stationarity of the variables using the Breitung test (Breitung, 2000), the Im-Pesaran-Shin test (Im et al., 2003) and Pesaran test (2007). Second, we verify the cointegration between variables by using two Pedroni test statistics – panel-t statistic and group-t statistic (Pedroni, 1999).

If the cointegration between variables is confirmed, according to Granger's representation theorem, analysed regressions can be presented as an error correction model (ECM).

In the light of current research on estimators which are appropriate for non-stationary panel data and in the context of our sample size, in the first step cointegration vector parameters are obtained with a DOLS estimator (Kao and Chiang, 2000). The starting point in Kao and Chiang's approach is a fixed effects model:

$$y_{it} = \alpha_i + x_{it}'\beta + \varepsilon_{it}, \tag{1}$$

where x_{it} is integrated of order one:

$$x_{it} = x_{i,t-1} + \xi_{it} . \tag{2}$$

If all Kao and Chiang's additional assumptions are met, then ε_{it} is expressed as follows:

$$\varepsilon_{it} = \sum_{-\infty}^{\infty} c_{ij} \xi_{i,t+j} + \nu_{it} . \tag{3}$$

The error terms ξ_{it} and ν_{it} are not correlated simultaneously and are not correlated for all lags and leads either. The lags and leads are usually limited to $\langle -q, q \rangle$ due to the assumption of c_{ij} being absolutely summable. Combining (1), (2) and (3), we obtain the DOLS regression, which allows endogeneity to be removed by using the lag and lead values of Δx_{it} as additional regressors of y:

$$y_{it} = \alpha_i + x'_{it}\beta + \sum_{j=-q}^{q} c_{ij} \Delta x_{i,t+j} + \nu_{it} . \tag{4}$$

In the next step DOLS residuals are used to estimate error correction models.

From the point of view of this analysis, SUR estimation seems to be an interesting approach. It allows heterogeneous coefficients for each subsector to be obtained. In the case of non-stationary data, Mark et al (2005) propose a DSUR estimator. Its construction is similar to the DOLS estimator with endogeneity controlled by introducing the lags and leads of Δx_{it} which come from the whole system. Starting with regression (1) and x_{it} described as (2) we assume that:

$$z'_{qit} = \left(\Delta x'_{i,t-q}, \ldots, \Delta x'_{i,t+q}\right), \qquad z'_{qt} = (z'_{q1t}, \ldots, z'_{qNt}). \tag{5}$$

Then, the DSUR regression looks as follows:

$$y_{it} = x'_{it}\beta_i + z'_{qt}\delta_{qi} + \nu_{it} . \tag{6}$$

Introducing additional factors into the equation substantially reduces the degrees of freedom, which is why the DSUR estimator is recommended for panels with large T. Our sample size forces us to abandon DSUR and to focus on the ordinary SUR approach, remembering that in such a case standard errors are biased.

The data are taken from the STAN OECD database and the WIOD database (Timmer, 2015). We divide the whole manufacturing sector into subsectors according to NACE 1.1. Due to lack of available data for all 14 subsectors, we combine subsector DB (manufacture of textiles and textile products) and subsector DC (manufacture of leather and leather products). Finally, we examine 13 manufacturing subsectors using balanced panel data for the period 1995 – 2011. The details of the dataset are presented in Table 1.

Table 1 Details of the dataset

Variable Name	Variable Description	Source of the Data
L_NEX	logarithm of ratio of export goods value (million USD) to import goods value (million USD)	STAN OECD
L_FD	logarithm of unweighted sum of the final consumption expenditure of households, non-profit organizations serving households and government, fixed capital formation and changes in inventories and valuables from 39 countries* (million USD)	WIOD
L_DD	logarithm of sum of the final consumption expenditure of households, non-profit organizations serving households and government, fixed capital formation and changes in inventories and valuables (million USD)	WIOD
L_RULC	logarithm of ratio of national unit labour cost to unit labour cost in Germany – unit labour cost is the ratio of the sum of wages and salaries (million USD) to gross value added (USD)	WIOD
L_OPEN	logarithm of ratio of export goods value (million USD) to gross value added (million USD)	STAN OECD WIOD
L_INNO	logarithm of R&D expenditure (million USD)	STAN OECD
L_LPRO	logarithm of ratio of production (million USD) to total hours worked	WIOD

Note: to calculate FD for Poland date from 40 WIOD countries excluding Poland are taken. To calculate FD for the Czech Republic we take the same group of countries excluding the Czech Republic.
Source: own elaboration.

Empirical results

According to the methodology described in the previous section, our empirical analysis begins with assessment of the panel unit root for all the variables and the cointegration analysis.[1] All the results allow us to estimate ECM. We apply a two-step Engle-Granger procedure. In the first step, we use the DOLS estimator. The number of leads and lags is chosen on the basis of SIC. All the regressions contain individual effects and a deterministic trend. In the second step, DOLS residuals are used to estimate ECM.

The results of estimated shared models for the Czech Republic and Poland are reported in Table 2. Because of the explanatory variable, which is the export and import quotient, relative demand (FDDD) is included in the model. This is the relationship between foreign demand mainly influencing exports and domestic demand influencing imports.

Table 2. Czech and Polish shared model (with relative demand variable) – ECM results

	short-run elasticities			long-run elasticities	
	Czech Republic	Poland		Czech Republic	Poland
Δ L_FDDD	0.001	0.089***	L_FDDD	0.073***	0.109***
	(0.018)	(0.032)		(0.020)	(0.039)
Δ L_RULC	-0.103***	-0.059*	L_RULC	-0.123***	-0.261**
	(0.026)	(0.031)		(0.016)	(0.104)
Δ L_OPEN	0.284***	0.355***	L_OPEN	0.177***	0.337***
	(0.054)	(0.060)		(0.025)	(0.061)
Δ L_INNO	0.001	0.009[1)]	L_INNO	0.021**	-
	(0.013)	(0.016)		(0.008)	
Δ L_LPRO	0.170***	0.141**	L_LPRO	0.089***	0.207**
	(0.048)	(0.054)		(0.026)	(0.103)
λ	-0.771***	-0.548***			
	(0.221)	(0.078)			
R^2_{ECM}	0.44	0.44			

Note: Standard errors in parenthesis; 1) in the ECM for Poland the logarithm of R&D expenditure (L_INNO) is considered as the I(0) variable.
* - significant at the 0.1 level, **- significant at the 0.05 level, ***- significant at the 0.01 level.
Source: own calculations.

[1] The results are obtainable upon request. The results confirm non-stationarity of all the variables apart from R&D expenditure (INNO) and cointegration between variables.

In the model, all the explanatory variables are statistically important in explaining the variation of the net exports of the manufacturing sector in both economies, both for the short term (except for FDDD in the Czech Republic) and the long term. The impact of the variables used is substantially greater for the long term. The influence of demand factors measured by relative demand is similar in both economies for the long term. The key elements which are decisive in generating a positive trade balance in Polish and Czech industry are: trade openness, unit labour costs and labour productivity. The estimated size of the parameter λ, which determines the pace of adaptation of the variables to long-term equilibrium, indicates that the Czech economy has a better capacity to correct these deviations.

It may be interesting to see how the trade balance, divided into different manufacturing sub-sectors, reacts to its determinants. To see this, we propose a model which allows heterogeneous parameters for each sub-sectors to be obtained. On account of the fact that R&D investment turns out to be insignificant in the joint model for Poland and because of its low level of variation, it is omitted in the sector model for Poland. The results of estimation are shown in Table 3 for Poland and in Table 4 for the Czech Republic. In these tables the sectors are sorted in diminishing order, according to sector's share of the entire exports of manufacturing commodities in 2011.

The results in Table 3 and Table 4 show substantial differences in the roles particular variables play in explaining the net exports. In both economies and in majority of sub-sectors generation of a positive trade balance is determined by an increase in relative demand. However, some sub-sectors are capable of positive net export generation when relative demand is decreasing. Increasing productivity strongly influences a positive trade balance in the majority of the Polish sub-sectors, while in the Czech sub-sectors a key role is played by decreasing unit labour costs. Trade openness significantly helps the generation of positive net exports in a large number of both Polish and Czech sub-sectors, but in the key export sectors its influence is stronger in the Czech Republic. Investment in R&D turns out to be important both in the short and long term in sectors with high levels of investment in R&D (chemical and transport) only in the model used for the Czech economy.

Table 3 ECM results for Polish net exports decomposed by manufacturing sectors

	short-run elasticities					long-run elasticities			
	Δ L_FDDD	Δ L_RULC	Δ L_OPEN	Δ L_LPRO	λ	L_FDDD	L_RULC	L_OPEN	L_LPRO
DM	0.098**	0.154	0.715***	-0.169	-0.762***	0.086*	0.196	0.355***	0.272**
	(0.042)	(0.133)	(0.149)	(0.266)	(0.126)	(0.049)	(0.181)	(0.117)	(0.126)
DL	0.139***	-0.080	0.173**	0.237**	-0.189	0.132**	0.018	0.238***	0.292**
	(0.043)	(0.083)	(0.071)	(0.109)	(0.201)	(0.066)	(0.082)	(0.080)	(0.145)
DJ	0.352***	-0.061	-0.226***	0.315***	-0.997***	0.683***	0.092	-0.582***	0.514***
	(0.051)	(0.077)	(0.082)	(0.073)	(0.099)	(0.099)	(0.092)	(0.116)	(0.098)
DA	0.036	0.249**	0.556***	-0.074	-0.901***	-0.230***	-0.096*	0.384***	-0.025
	(0.050)	(0.099)	(0.057)	(0.085)	(0.126)	(0.051)	(0.058)	(0.050)	(0.041)
DG	0.555***	0.252***	0.735***	0.144***	-1.020***	0.644***	0.465***	0.683***	-0.096***
	(0.032)	(0.042)	(0.034)	(0.045)	(0.106)	(0.026)	(0.046)	(0.041)	(0.036)
DK	0.209***	-0.149	-0.052	0.486***	-0.933***	0.169***	-0.172**	0.076	0.597***
	(0.063)	(0.097)	(0.146)	(0.135)	(0.174)	(0.052)	(0.080)	(0.094)	(0.081)
DH	0.179***	-0.010	0.515***	0.197**	-0.720***	0.120***	-0.060	0.585***	0.297***
	(0.018)	(0.062)	(0.052)	(0.076)	(0.124)	(0.012)	(0.040)	(0.029)	(0.030)
DN	-0.047	-0.446***	0.164	-0.107	-0.654***	0.082	-0.257*	0.163	-0.037
	(0.055)	(0.130)	(0.122)	(0.085)	(0.137)	(0.085)	(0.137)	(0.117)	(0.082)
DF	-0.222	-0.055	0.247**	0.258***	-0.916***	-0.644***	-0.103**	-0.178	-0.026
	(0.174)	(0.043)	(0.107)	(0.080)	(0.105)	(0.210)	(0.052)	(0.159)	(0.070)
DB.DC	0.064**	-0.014	-0.156	-0.151*	-0.563***	0.090***	-0.017	-0.710***	-0.342***
	(0.027)	(0.059)	(0.106)	(0.080)	(0.141)	(0.027)	(0.062)	(0.079)	(0.024)
DE	0.458***	-0.213***	0.296***	0.502***	-0.533***	0.197**	-0.323***	0.442***	0.533***
	(0.096)	(0.076)	(0.090)	(0.114)	(0.135)	(0.079)	(0.077)	(0.057)	(0.087)

Table 3. Continued

	short-run elasticities					long-run elasticities			
	Δ L_FDDD	Δ L_RULC	Δ L_OPEN	Δ L_LPRO	λ	L_FDDD	L_RULC	L_OPEN	L_LPRO
DI	0.204***	-0.412***	0.743***	0.437**	-0.964***	0.189***	-0.315***	1.062***	0.191**
	(0.050)	(0.134)	(0.103)	(0.193)	(0.195)	(0.046)	(0.083)	(0.095)	(0.081)
DD	0.417***	-0.250***	0.171	0.395***	-0.691***	0.649***	0.133	-0.153	0.396***
	(0.055)	(0.071)	(0.116)	(0.082)	(0.120)	(0.090)	(0.127)	(0.142)	(0.127)

Note: Standard errors in parenthesis, * - significant at the 0.1 level, **- significant at the 0.05 level, ***- significant at the 0.01 level.
Source: own calculations.

Table 4 ECM results for Czech net exports decomposed by manufacturing sectors

	short-run elasticities						long-run elasticities				
	Δ L_FDDD	Δ L_RULC	Δ L_OPEN	Δ L_LPRO	Δ L_INNO	λ	L_FDDD	L_RULC	L_OPEN	L_LPRO	L_INNO
DL	0.044**	-0.050	0.561***	0.334***	-0.089***	-0.439***	-0.058	-0.040	0.705***	0.019	-0.073
	(0.021)	(0.082)	(0.061)	(0.083)	(0.031)	(0.077)	(0.035)	(0.157)	(0.055)	(0.072)	(0.057)
DM	0.005	-0.262***	0.595***	-0.0003	0.067*	-0.703***	-0.137***	-0.250***	0.503***	0.070***	0.154***
	(0.054)	(0.037)	(0.062)	(0.051)	(0.040)	(0.169)	(0.036)	(0.042)	(0.058)	(0.026)	(0.041)
DK	-0.143***	-0.406***	0.749***	-0.030	0.033	-1.061***	-0.143***	-0.156*	0.728***	0.146**	0.040
	(0.033)	(0.109)	(0.128)	(0.129)	(0.048)	(0.169)	(0.031)	(0.090)	(0.098)	(0.072)	(0.050)
DJ	0.161***	-0.146***	-0.341***	-0.089	0.160***	-1.220***	0.108***	-0.169***	-0.243***	-0.024	0.075
	(0.128)	(0.041)	(0.067)	(0.063)	(0.037)	(0.169)	(0.038)	(0.062)	(0.056)	(0.080)	(0.049)
DG	-0.073***	-0.214**	0.353***	-0.153	0.145*	-0.753***	-0.050*	-0.373***	0.336***	-0.145	0.330***
	(0.016)	(0.097)	(0.108)	(0.095)	(0.075)	(0.158)	(0.027)	(0.056)	(0.109)	(0.107)	(0.103)
DH	0.032**	-0212***	0.200***	0.188***	-0.001	-1.066***	-0.020	-0.187***	0.181***	0.211***	0.018
	(0.015)	(0.048)	(0.066)	(0.062)	(0.012)	(0.118)	(0.023)	(0.050)	(0.064)	(0.030)	(0.016)
DN	-0.037*	-0.018	-0.110*	-0.052	-0.106***	-0.916***	-0.027	-0.140**	0.249***	-0.036	-0.100***
	(0.021)	(0.038)	(0.060)	(0.064)	(0.009)	(0.082)	(0.036)	(0.064)	(0.046)	(0.036)	(0.017)

Table 4. Continued

	short-run elasticities						long-run elasticities				
	Δ L_FDDD	Δ L_RULC	Δ L_OPEN	Δ L_LPRO	Δ L_INNO	λ	L_FDDD	L_RULC	L_OPEN	L_LPRO	L_INNO
DB,DC	-0.028	-0.435***	0.055	0.208*	0.158***	-0.900***	0.071*	-0.143	-0.664***	-0.245***	0.175***
	(0.035)	(0.103)	(0.175)	(0.122)	(0.024)	(0.142)	(0.040)	(0.093)	(0.104)	(0.041)	(0.035)
DA	-0.178**	-0.152***	0.116	-0.118	0.076***	-1.323***	-0.219***	-0.082	0.218***	-0.258***	0.031
	(0.069)	(0.053)	(0.089)	(0.110)	(0.022)	(0.218)	(0.074)	(0.052)	(0.075)	(0.042)	(0.024)
DE	0.148***	0.085	0.149	-0.024	0.023***	-1.111***	0.208***	0.130***	0.210***	0.216***	0.029***
	(0.050)	(0.052)	(0.093)	(0.072)	(0.008)	(0.176)	(0.042)	(0.045)	(0.054)	(0.033)	(0.006)
DI	-0.007	-0.124	0.574***	0.070	-0.036	-0.280	0.050*	0.015	0.486***	-0.075	-0.095***
	(0.022)	(0.108)	(0.129)	(0.122)	(0.028)	(0.190)	(0.028)	(0.107)	(0.138)	(0.060)	(0.033)
DF	-0.789***	-0.197***	0.245***	0.200***	0.195***	-1.194***	-0.774***	-0.190***	0.051*	0.030	0.118**
	(0.073)	(0.016)	(0.061)	(0.050)	(0.043)	(0.146)	(0.127)	(0.024)	(0.031)	(0.045)	(0.057)
DD	-0.009	-0.113**	0.422***	0.197**	-0.031***	-0.433***	-0.063	-0.067	0.188	-0.187	-0.0005
	(0.013)	(0.047)	(0.098)	(0.083)	(0.010)	(0.069)	(0.046)	(0.120)	(0.230)	(0.117)	(0.036)

Note: Standard errors in parenthesis, * - significant at the 0.1 level, **- significant at the 0.05 level, ***- significant at the 0.01 level.
Source: own calculations.

Conclusions

For many CEE countries export represents a major source of growth, so positive net exports could be a measure of their level of international competitiveness. Therefore, knowledge about the main determinants of net exports, especially at the level of individual sectors, seems to be crucial for creating an appropriate export-led growth strategy.

The aim of this study has been to fill the gap in the empirical literature on the determinants of CEE's net exports. This paper has added to the few existing empirical works by specifying the net export performance equation not only as a function of foreign demand and price or cost factors, as is done traditionally, but also of the size of domestic demand, the level of innovation intensity, the level of openness to foreign markets and labour productivity. Our new approach is also based on employing an error correction model to disaggregated sectoral manufacturing data.

The results of the estimation help confirm an influence of increasing relative demand, increasing productivity and trade openness on the generation of a positive trade balance both in Polish and Czech manufacturing. Moreover, in both countries positive net exports are vulnerable to unit labour cost decreases. They also contribute to the better capacity of the Czech economy to correct deviations from the equilibrium in one period of time. The results show also substantial differences in the roles particular variables play in explaining the net exports in majority of sub-sectors generation of a positive trade balance.

The results of this research should be regarded as a basis for subsequent studies and should undergo further verification. We hope, however, that the results of the estimations will contribute to discussion of the instruments which can help enhance the competitiveness of particular sub-sectors of manufacturing. The analysis conducted has shown that the influence of particular factors is different in each sub-sector, and, more importantly, that there are different key factors fostering the generation of a positive trade balance. The fact that positive trade balance generation in manufacturing is a key priority in the Czech strategy for export growth for 2012-2020 shows its importance.

For further research, due to our a priori knowledge of how the relationships between the phenomenon investigated and the determining factors chosen are formed, together with the sample size, the use of Bayesian estimation for the analysis is worth considering. Once the data is available, further estimation of the models for a longer time series would be desirable.

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An attempt to optimise the number of pupils in comprehensive secondary schools based on their learning outcomes

JEL Classification: *A20; A21; A29*

Keywords: *number of pupils in a school; educational value added (EVA); comprehensive secondary school; socio-cultural capital*

Abstract

Research background: There may be a significant correlation between the number of pupils in a school and their learning performance. Some studies point to the negative impact of schools with a large number of pupils on the educational results achieved. At the same time, the demographic crisis that has been deepening steadily for several years now represents an important motivation for rationalising the existing network of schools.
Purpose of the article: The aim of the study was to determine the optimum size of schools based on the criterion of examination results expressed through educational value added.
Methodology/methods: The analysis covered all comprehensive secondary schools in Poland over the2013 to 2015 period (a total of 1,943 schools). It determined the correlation between the size of a school expressed through the average number of graduates, and the results of the matura examination (the secondary school leaving exam in Poland) expressed through educational value added. Data for the analysis was obtained from the Section of Educational Value Added of the Educational Research Institute in Warsaw. The comprehensive secondary schools under study were divided into 5 classes, according to the criterion of the average annual number of graduates. The following analytical classes were distinguished: class A - up to 50 graduates, class B - 51-100 graduates, class C - 101-150 graduates, class D - 151 -200 graduates, class E - above 201 graduates.

Findings: The analyses conducted in this study showed that the comprehensive secondary schools with over 600 pupils had the highest learning outcomes as expressed through educational value added. The lowest educational effectiveness was found in schools with less than 150 pupils. A dependency was discovered whereby the effectiveness of education increases as the number of pupils grows. Due to the lack of data concerning examination results in schools with more than 1,000 pupils (value indicated in American studies as the threshold value for positive learning outcomes), it was not possible to determine the maximum number of pupils that guarantees satisfactory learning outcomes.

Introduction

The key question to be asked when evaluating the effectiveness of educational facilities concerns the learning outcomes. Moreover, the public spending on education in Poland amounts to about 6% GDP. Such an amount of spending provides a particularly strong argument for seeking the ways to rationalise the expenditure allocated to this area of public activity.

The question seems even more relevant in view of the deepening demographic crisis. This is directly related to the issue of the optimum school size that would ensure the desirable learning environment and simultaneously minimise the administrative costs of running an educational facility.

The problem of school size should be considered in relation to the educational stage, since the negative impact of school size on learning outcomes may be linked to a particular stage of education.

In view of those considerations, the question should be asked: How big should a school be in order to ensure the optimum learning outcomes? Based on that question, the research objectives of this article were formulated. Thus, the purpose of the study was to determine the optimum size of a school based on the criterion of examination results expressed through educational value added.

The priority goal of educational activity should be to achieve the highest quality of education possible in a given situation. This objective was also confirmed by the report of the Polish Supreme Audit Office: "*The Supreme Audit Office regards the quality of school education as one of the most important long-term factors affecting the development of the state and the living standard of its citizens*" (NIK, 2014, p.7). Bearing this in mind, any measures aimed at rationalising the network of education facilities should take into account the effect of that rationalisation on learning outcomes.

Method of the research

The data in this study was analysed on the basis of the 3-year (2013-2015) educational value added indicator for all comprehensive secondary schools in Poland (N=1,943). Data for the analysis was obtained from the Section of Educational Value Added of the Educational Research Institute in Warsaw.

The comprehensive secondary schools under study were grouped into 5 classes according to the average number of graduates per each year of analysis: class A (up to 50 graduates), class B (51-100 graduates), class C (101-150 graduates), class D (151-200 graduates), and class E (above 250 graduates). Based on the quantitative analysis of educational value added in comprehensive secondary schools, the percentage of schools with a positive and negative educational value added indicator was determined for the examined population. Moreover, the mean educational value added indicator was calculated for each class of comprehensive secondary schools defined by the average annual number of graduates.

The impact of pupil number in a school on learning outcomes

The structure and quality of school environment is generally considered to be vital for creating favourable learning conditions and encouraging parental involvement. It is believed that large, impersonal and highly bureaucratised schools create many barriers to effective learning (Meier, 1997, pp. 194-208). Case studies investigating the effectiveness of schools point to the importance of school size (Hunt, 1990, pp. 252-254). At the same time, an improvement in pupils' educational attainment was observed in small comprehensive secondary schools (Darling-Hammond et al., 2002, pp. 639-673).

It is a popular belief that pupils attending smaller schools achieve better learning outcomes. In particular, attention is drawn to better learning conditions in those schools. A study conducted in New York took into account interpersonal relationships, educational outcomes, social attitudes and the level of safety. The results of the study suggest that the pupils attending a small school perceive it as a better learning environment needed for the accomplishment of their own objectives. However, the studies cited above did not substantiate the thesis that small schools provide a better learning environment than large ones. The findings represent a challenge for the widespread belief that better conditions offered by small schools contribute to higher learning outcomes(Schwartz et al., 2016, pp. 272-290)

The research on the optimum size of schools yields varied results. A study on educational value added conducted in North Carolina pointed to the lack of cause/effect relationship between school size and the learning outcomes achieved by the pupils. It was noted, however, that school size plays an important role for disabled pupils (Gershenson & Langbein, 2015, pp.135S-155S).

Some research findings suggest that the proper pupil/teacher ratio is an important factor reducing the level of crime. However, those parameters are not linked to school size. The level of crime amongst pupils is to a greater degree determined by the social capital derived from their family background than by the actual school size (Gottfredson & DiPietro, 2011, pp. 69-89).

The studies discussed above refer to a completely different part of the world. However, similar studies were also conducted in Ukraine, a country that is geographically close to Poland. The Ukrainian studies highlight the need to rationalise the school network due to demographic decline. In this context, a question arises. Should we maintain smaller schools and expect better exam results? Independent tests revealed that school size has a relatively small impact on the learning outcomes in secondary schools. This observation provides an argument in favour of rationalising the network of schools (Coupe et al., 2016, pp. 329-351).

The US government recommended the consolidation of schools, especially in rural areas, in order to improve school effectiveness. However, this policy was criticised. It was argued that school consolidation would result in the deterioration of learning conditions. Moreover, such situations usually raise questions concerning the economies of scales. One of the arguments in favour of school consolidation are the savings resulting from reduced costs of administration due to the transfer of schools with less than 500 pupils to the districts that provide schooling for about 3,000 to 4,000 pupils. This solution, however, goes contrary to the conclusions of studies on educational production function. The studies advocate maintaining primary schools with 300-500 pupils and secondary schools with 500-900 pupils. The authors of those studies believe that such school sizes could balance the advantages arising from the school size with the potential negative effects of large schools(Andrews et al., 2002, pp.245-262).

In Chicago, research on the size of comprehensive secondary schools was conducted over four years in order to assess the impact of transformation of large, traditional schools into small, autonomous ones. It was shown that the analysed schools had a lower drop-out rate. The authors of the study did not find any strong arguments to justify school size reduction, which implies there is no correlation between school size and learning outcomes(Kahne et al., 2008, pp. 281-315).

An examination of 57 results of empirical school size research carried out in the USA after 1990 reveals that primary schools for pupils from socially and economically disadvantaged backgrounds should ideally be limited in size to 300 pupils. Primary schools for pupils from advantaged backgrounds should be limited in size to 500 pupils. The size of middle schools should be limited to 600 pupils, whereas secondary school serving youth from socially and economically diverse backgrounds and relatively advantaged backgrounds should not exceed 1,000 pupils(Leithwood & Jantzi, 2009, pp. 464-490).

Other studies investigating the relationship between school size and learning achievements show that a comprehensive secondary school should ideally serve between 600-900 pupils. Pupils in smaller schools demonstrated lower academic performance; a similar situation was observed in schools serving over 2,100 pupils. It should be noted that the educational process was found to be more equitable in very small schools where it was linked to the pupil's socio-economic status (Lee & Smith, 1997, pp. 205-227).

The size of comprehensive secondary schools in Poland and learning outcomes

The mean educational value added provides an objective measure of school effectiveness. It is calculated for each pupil separately and the sum of scores of that indicator can be used to evaluate a school's effectiveness. The desired score of that indicator should be a positive value (neutral value is expressed through zero). A negative educational value added means that the teaching process does not make the proper use of the pupils' educational level. The assumptions concerning educational value added were used to estimate the effectiveness of schools depending on the school size which, in the present study, was expressed through the average annual number of graduates during the research period.

Table 1. Synthetic summary of matura exam results in comprehensive secondary schools from 2013-to 2015

	Polish language			Humanities		
Number of pupils taking matura exam (Class)	Number of schools with negative EVA	Number of schools with negative EVA	Mean EVA	Number of schools with positive EVA	Number of schools with negative EVA	Mean EVA
≤ 50 (A)	250 (30.34%)	574 (69.66%)	-2.09229	237 (28.76%)	587 (71.24%)	-2.29663
51-100 (B)	128 (32.24%)	269 (67.75%)	-1.32224	114 (28.72%)	283 (71.28%)	-1.52058
101-150 (C)	154 (49.68%)	156 (50.32%)	-0.07465	153 (49.35%)	157 (50.65%)	-0.05903
151-200 (D)	**170 (65.63%)**	**89 (34.36%)**	**0.79297**	**174 (67.18%)**	**85 (32.82%)**	**0.93170**
≥201 (E)	**111 (72.55%)**	**42 (27.45%)**	**1.53915**	**115 (75.16%)**	**38 (24.84%)**	**1.68386**
	Mathematics			Mathematical and natural sciences		
Number of pupils taking matura exam (Class)	Number of schools with positive EVA	Number of schools with negative EVA	Mean EVA	Number of schools with positive EVA	Number of schools with negative EVA	Mean EVA
≤ 50 (A)	150 (18.20%)	674 (81.79%)	-3.49010	149 (18.08%)	675 (81.92%)	-3.87027
51-100 (B)	110 (22.71%)	287 (72.29%)	-2.02076	103 (25.94%)	294 (74.06%)	-2.33627
101-150 (C)	164 (52.90%)	146 (47.10%)	0.07616	168 (54.19%)	142 (45.81%)	0.05806
151-200 (D)	**189 (72.97%)**	**70 (27.03%)**	**1.54958**	**202 (77.99%)**	**57 (22.01%)**	**1.70452**
≥201 (E)	**124 (81.05%)**	**29 (18.95%)**	**1.91778**	**131 (85.62%)**	**22 (14.38%)**	**2.25196**

Source: own work based on the data from the Educational Research Institute.

An evaluation of school effectiveness on the basis of educational value added indicator shows that the schools with the smallest number of graduates (class A and B) have an undesired level of learning outcomes. This is evidenced by the relatively high percentage of schools with negative educational value added and negative mean educational value added. In class A, about 70% to approximately 82% schools had a negative value added score. In class B, there were about 68% to74% such schools. A similar correlation was found with respect to mean educational value added which oscillated between -3.49010 and -1.32224 in the two classes mentioned above (Table 1).

The data given in Table 1 suggests that a school's effectiveness increases as the number of pupils in the school increases. A limit of 101-150 graduates represents the threshold value between ineffective and effective educational process. An analysis of final examination results in schools with such a number of graduates reveals that 50% of schools from that group (class C) have positive educational value added score. Moreover, mean educational value added has a positive score for examination results in mathematics, and mathematical and natural sciences (Table 1).

The vast majority of schools in the next two classes, i.e.class D (151 graduates) and class E (above 201 graduates), achieved a positive educational value added score. About 65% of schools in class D had a positive educational value added for Polish language exams, and over 85% of schools achieved a positive value added for mathematical and natural sciences exams (Table 1). Moreover, both those classes of schools recorded a regular increase in mean educational value added. The increase was from 0.79297 for Polish language exams in class D to 2.25196 for mathematical and natural sciences exams in class E (Table 1).

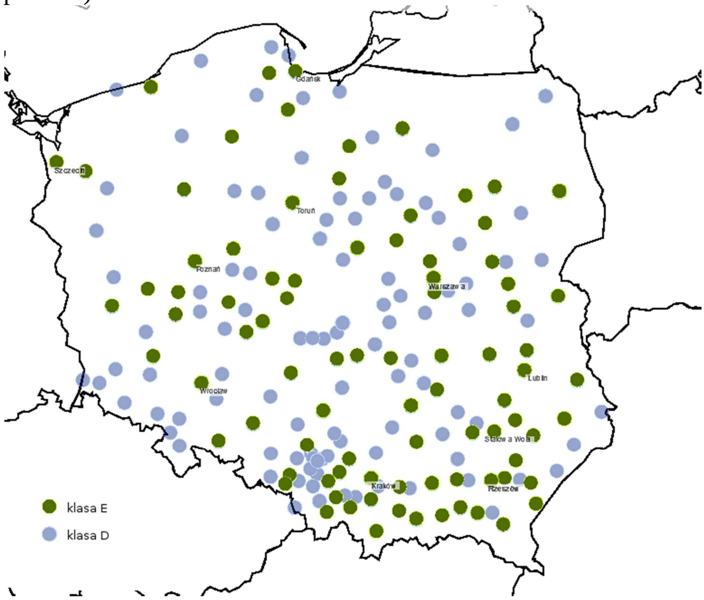
The three-year education cycle in Polish comprehensive secondary schools permits the following estimation of the number of pupils in a school: up to 150 in class A, from 151 to 300 in class B, from 301 to 450 in class C, from 451 to 600 in class D, and above 600 in class E. Under Polish conditions, it should be assumed that an effective learning environment is provided by schools serving a minimum of 450 pupils. However, schools with more than 600 pupils achieve even better learning outcomes. The proposed school sizes are in line with the results of the American studies quoted above (Leithwood & Jantzi, 2009, pp.464-490; Lee & Smith, 1997, pp. 205-227; Andrews et al., 2002, pp. 245-262).

A spatial analysis of the distribution of classes with the highest learning outcomes (D and E) shows that the schools belonging to those classes are usually located in large agglomerations, or cities. Such a correlation may indicate the presence of additional factors that strongly affect the quality of educational processes and have a particularly beneficial effect on those processes in large urban centres.

In this context, one cannot overlook the importance of what social scientists refer to as reproduction processes. Those processes are related to the phenomenon of *habitus* which is understood as a set of trends, dispositions, perceptions of values, and attitudes reflected in human habits (Bourdieu & Passeron, 2006, p. 13).

Special attention is given to the process of educational selections and the associated membership in the social class of origin which determines the living standards, the ethos as well as the hereditary social and cultural capital(Bourdieu & Passeron, 2006, p. 25).

Figure 1. Distribution of schools belonging to class D and E (the most effective teaching process)



Source: own work based on the analysed data.

Problems that may be attributable to young people's social and cultural capital were also confirmed by the report drawn up by the Supreme Audit Office, according to which *"pupils in middle and secondary-school show low motivation for participation in school activities which, alongside behavioural issues, leads to deterioration in pupils' learning outcomes. The pupils surveyed by the Supreme Audit Office reported that they would achieve better learning results if the teachers could get them interested in their subject"*(NIK, 2014, .9).

Conclusions

The analyses conducted in this study showed that the comprehensive secondary schools with over 600 pupils were characterised by the highest learning outcomes as expressed through educational value added. Those findings have also been confirmed by the American studies quoted above.

The dependencies discovered in this study may provide guidance to local government bodies (poviats) concerning the development of school network, especially in the context of demographic decline. It should be remembered, however, that the effectiveness of teaching does not solely depend on the number of pupils in school, but is also affected by other factors belonging to the sphere of sociocultural capital and economic capital.

Nonetheless, the analyses investigating all comprehensive secondary schools in Poland over a 3-year research period revealed that the school size has no negative impact on the quality of teaching (on the contrary, positive impact was identified), which is a sufficiently strong conclusion to be considered when undertaking the modification of the existing school network.

Due to the lack of data concerning examination results in schools with more than 1,000 pupils (number indicated in American studies as the threshold value for positive learning outcomes), it was not possible to determine the maximum number of pupils in a school that would guarantee satisfactory learning outcomes (Leithwood & Jantzi, 2009, pp. 464-490).

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Application of the PROperty FITting method (PROFIT) to classification of EU countries based on their innovation level

JEL Classification: *A11; A14; B16*

Keywords: multidimensional *scaling (MDS), property fitting method (PROFIT), innovation intensity, EU member countries, synthetic measures of innovativeness*

Abstract

Research background: As it is known, innovativeness can be measured by using many known indices, such as the Global Innovation Index, the Summary Innovation Index, etc. and often these indices are based on different methodologies and take into consideration different sets of diagnostic variables. As a consequence, the final evaluation of innovativeness may strongly depend on the innovation index used. Obviously, some groups of indices lead to similar ranks of the EU countries. Nevertheless, if there are at least two groups of indices which provide different ranks of these countries, a problem with the proper evaluation of their real innovativeness arises. One of the solutions is to select the most valuable indices by observing the impact of all indices on forming distances between innovativeness levels of the EU countries. Following this option, the main aim of this paper is classification of the EU countries with respect to their innovativeness and the evaluation of international index influences on the classification obtained.
Purpose of the article: The aim of the paper is to conduct the research on differences in innovation intensity across the EU member countries.
Methodology/methods: For the purpose of the article, the PROFIT (PROperty FITting) method, an extension of multidimensional scaling (MDS), was applied. The ultimate goal of MDS techniques is to produce a geometric map that illustrates the underlying structure of complex phenomena, for instance, innovativeness of the EU countries. It is a widely used method which collects attribute ratings for each object (country) and then finds the best correspondence of each attribute to

the derived perceptual space. Applying the PROFIT method needs linear regression techniques and provides some additional information, i.e. the impact of the considered set of diagnostic variables on the shape of the perception map.
Findings: The final result is a two-dimensional map of the EU countries which reflects distances among their innovativeness levels along with vectors presenting the influence of international indices of innovativeness on the structure of this map. The nature of the results and the ways in which they are interpreted are subsequently reviewed. The main conclusion drawn from the perception map created concerns the interpretation of the above-mentioned vectors, i.e. the information about the role of each international innovation index in clustering the EU countries with respect to their innovation intensity is obtained.

Introduction

As it is known, innovativeness can be measured by using many known indices, such as the *Global Innovation Index* (Dutta *et al.*, 2015), the *Summary Innovation Index* (European commission, 2015), and also the *Innovation Output Indicator* recently added by the European Commission (European Commission 2013; Vertesy & Deiss, 2016), as well as many others. Often these indices are based on different methodologies and take into consideration different sets of diagnostic variables. As a consequence, the final evaluation of innovativeness may strongly depend on the innovation index used.

Sources of public statistical data play an important role in (1) the process of development of a proper national policy aimed at ensuring economic and social progress, and (2) the measurement and evaluation of phenomena occurring in the modern world. In the last few decades, the role and importance of statistics, especially indices of measurement, have significantly increased (Giovannini & Uysal, 2006). Public interest in information is based on current needs and is directly connected with people's active participation in various decision-making processes, both in the public and private domain (Hahn & Doganaksoy, 2008). This particular explosion of information often, instead of facilitating, becomes a considerable obstacle. Questions are raised about the quality and form of the information provided, its validity and reliability, thus further dilemmas are born (Goldsmith & Foxall, 2003, pp. 321-330; Hollanders, Van Cruysen, 2008). One of the solutions is to select the most valuable indices by observing the impact of all indices on forming distances between innovativeness levels of the EU countries. Following this option, the main aim of this paper is classification of the EU countries with respect to their innovativeness and the evaluation of international index influences on the classification obtained. In reference to the aim of the paper, a research hypothesis has been formulated stating that the degree of specialisation of an innovation index has a significant influence on the location/position of the EU Member States on a perceptual map. For the purpose of the analysis conducted, it has been assumed that the type and number of variables and the number of partial aggregates (sub-indices) included in the construction of the final innovation index determine the degree of index specialisation.

For the purpose of the article, the PROFIT (PROperty FITting) method, an extension of multidimensional scaling (MDS), was applied. Multidimensional scaling is used in many different fields, including economics (e.g.: Black 1991), sociology (e.g: Beardsworth & Keil 1992) and political science, as well as many other disciplines. Multidimensional scaling is widely used to assess various socioeconomic events, ranging from social/human views (Wish, Deutsch, & Biener 1971) to perceptions of visual patterns (Hirschberg, Jones, & Haggerty, 1978).

Methodology

The concept of the analysis

The research procedure was carried out according to the following steps: Step 1) Due to the varying range of variation of the innovation indices – *SII*, *IOI* and *GII* – selected for the analysis, first the standardisation of the variables according to the scheme corresponding to the zero unitarisation method was carried out. Step 2) Then multidimensional scaling was performed using the Euclidean distance, thus reducing the number of dimensions to two. Step 3) The last stage was the estimation of regression model parameters according to the PROFIT concept.

As a result of activities carried out within the framework of the above-described statistical procedure, a perceptual map was obtained illustrating similarities of the EU countries in terms their level of innovativeness and showing how individual innovation indices have contributed to the position of the individual countries on the map (Fig. 1).

Research method

PROFIT (PROperty FITting) is a kind of external vector analysis of preference mapping. The standard reason for using this method is testing hypotheses about attributes that influence people’s judgement of similarities among a set of items. Nevertheless, there are no technical objections to using PROFIT for other cases, not related only to human preferences. The PROFIT method is a two-step procedure which is a combination of multi-dimensional scaling and multiple regression analysis. To understand the idea of PROFIT, it is advisable to start from the description of multidimensional scaling (MDS). Multidimensional scaling (MDS) is a means of visualising the level of similarity of individual cases of a dataset. It refers to a set of related ordination techniques used in information visualisation, in particular, to display the information contained in a distance matrix. It is a form of non-linear dimensionality reduction (Kruskal & Wish, 1978), Young & Hamer, 1987). An MDS algorithm aims to place each object in N-dimensional space so that the between-object distances are preserved as well as possible. Each object is then assigned coordinates in each of the N-dimensions. The number of dimensions of an MDS plot N can exceed 2 and is specified a priori. Choosing N=2 optimises the object locations for a two-dimensional scatterplot. MDS can have a metric or non-metric form and, as a rule, the non-metric MDS is used before the PROFIT analysis (Kruskal, 1964, Takane et al., 1977). In such a case, the method finds both a non-parametric monotonic relationship between the dissimilarities in the item-item matrix and the Euclidean distances between items, and the location of each item in the low-dimensional space. The relationship is typically found using isotonic regression: let denote the vector of proximities, – a monotonic transformation of and the point distances; then coordinates have to be found that minimise the so-called stress defined as follows (Kruskal, 1964):

$$stress = \sqrt{\frac{\sum_{i,j}(d_{ij} - f(x_{ij})^2}{\sum_{i,j} d_{ij}^2}} \tag{1}$$

where lower indexes denote the i – th and the j – th point on MDS map.

A PROFIT analysis evaluates the correspondence between one or more item attributes and the location of items in a multidimensional space. As it was above-mentioned, PROFIT, which is a combination of multidimensional scaling and multiple regression analysis, consists of two phases. After the first step (MDS), we obtain a configuration of n points $x = (x_1, x_2, \ldots, x_n)^T$ in r – dimensional space (r is usually 2 or 3). In the second phase, PROFIT takes as input both a configuration of points x and a set of attribute preferences data $p_k = (p_{k1}, p_{k2}, ..., p_{kn})^T$, where $k = 1,2, ..., m$, is a number of attributes (Zaborski & Pełka, 2013). Then a multiple regression analysis is performed using the coordinates of as independent variables and the attributes as dependent variables. The procedure provides a separate regression for each attribute with "classical" regression coefficients:

$$a_k = (x^T x)^{-1} x^T p_k \quad . \tag{2}$$

Results and discussion

Research data

In this section, selected synthetic indices of innovativeness will be presented. The analysis conducted was limited to three major indices, i.e. the Global Innovation Index, the Summary Innovation Index and the Innovation Output Indicator. Differences in the approach to the measurement of innovativeness in each of these indices have a significant impact on the final results of the ranking of countries. One of the fundamental differences that can be observed is the degree of specialisation of the innovation indices selected for the analysis. The comparative summary of these three innovation indices presents the table below.

Table 1. Comparative summary of selected indices

No.	Name of the indicator	Source	Number of variables	Number of countries	Data of publication
1.	Global Innovation Index	Business School of the World, the World Intellectual Property	79	141	Since 2007, annually
2.	Innovation Output Indicator	European Commission	5	38	Since 2010, 4-year time frame
3.	Summary Innovaiton Index	European Commission	25	34	Since 2001, annually

Source: own elaboration based on: European Commission (2013), European Commission (2015), Vertesy & Deiss (2016), Dutta *et al.*, (2015).

The Global Innovation Index is characterised by the broadest coverage of variables. The eighth edition of the report presented 141 economies, the study covered 95.1% of the population living worldwide and 98.6% of global GDP (US $). In the construction of the ranking, 79 individual indicators that characterised innovativeness were included (Dutta et al., 2015).

It is followed by the Summary Innovation Index. As with GII, sub-indices, made up of a specific number of variables, are also created for this index. Over the years, the methodology of calculating the SII has evolved, now 25 indicators, which have been assigned to one of the five categories, are used. The first three sets of indicators are variables from the input layer, and the last two from the output layer. The input layer is described by: a) factors stimulating innovativeness (enablers), b) firm activities which show innovative activities implemented at the company level. The output layer is described by effects which reflect the results of innovative activities carried out in the sphere of business (European Commission, 2015; Majerova, 2015, pp. 230-231).

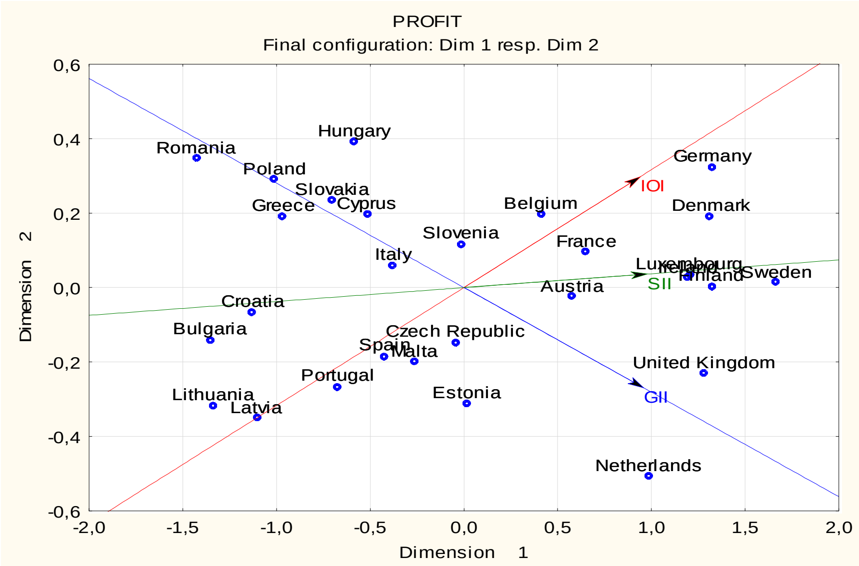
The Innovation Output Indicator is undoubtedly the index characterised by the narrowest specialisation among the ones chosen for the comparative analysis. Only five variables can be isolated in the index, and only in one case, at a lower level of analysis, an aggregate variable is generated. This applies to competitiveness of knowledge-intensive industries (with a high demand for specialist knowledge). The COMP component is defined as the arithmetic average (with equal weights) of two indicators: GOOD – the total value of exports of a country and SERV – the share of knowledge-intensive services in total services exports (European Commission, 2013, pp. 1-2).

Research results

In the paper, the PROFIT analysis is used to show how an input set of attributes (the values of the individual innovation indices) of the objects (the EU Member States) is visualised on the multidimensional scaling axes. Coordinates assigned to the individual objects (countries) are considered as explanatory (independent) variables, while the values of individual attributes (innovation indices) of the objects are response (dependent) variables.

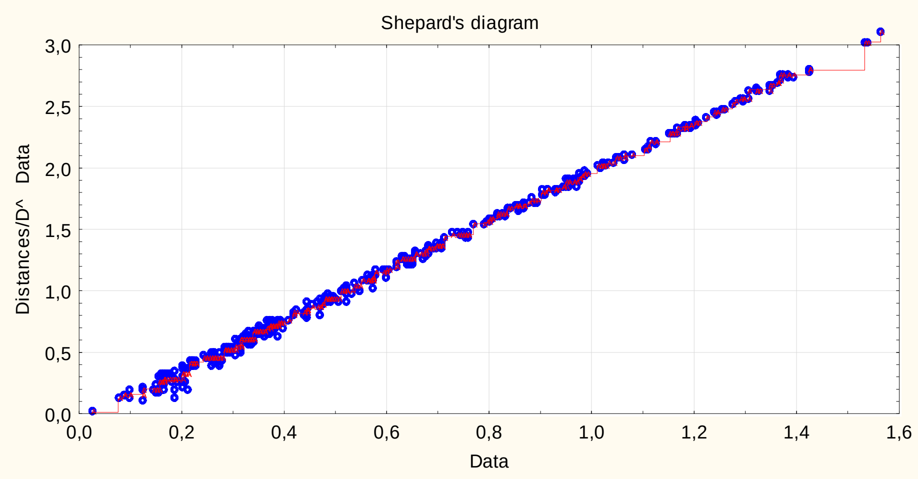
In the presented example, three regression analyses were performed as three attributes (variables) – SII, GII, IOI – were included in multidimensional scaling. The coordinates of the individual attributes (variables) were determined with the use of standardised regression coefficients corresponding to each of the multidimensional scaling axes. After conducting the regression analyses for all the three innovation indices, the PROFIT analysis algorithm provides directional correlation coefficients determining the vector direction and sense that corresponds to each of the attributes selected to describe the dimensions. Thus three points with the following coordinates were determined on the MDS map: SII (Dim 1 – (0.978); Dim 2 – (0.036)), GII (Dim 1 – (0.959); Dim 2 – (-0.269)), and IOI (Dim 1 – (0.941); Dim 2 – (0.298)); detailed results are presented in Table 2. The determined coordinates for the individual attributes allow to show how the EU member countries are arranged according to the intensity of a given attribute.

Figure 1. The perceptual map with vectors describing the individual dimensions of the plane



Note: The calculations were made with the use of Statistica 12.5 software Plus Suite – specialist analytical package.
Source: own elaboration based on: European Commission (2013), European Commission (2015), Vertesy & Deiss (2016), Dutta *et al.*, (2015).

Figure 2. Shepard diagram illustrating the distances derived from the original data sources versus the distances reproduced in the MDS analysis



Note: The calculations were made with the use of Statistica 12.5 software Plus Suite – specialist analytical package.
Source: own elaboration based on: European Commission (2013), European Commission (2015), Vertesy & Deiss (2016), Dutta *et al.*, (2015).

The Shepard diagram, which confronts distances based on the original data source with distances visualised in the MDS analysis (Fig. 2), and the low value of *stress* = 0.0188 indicate high efficiency of multidimensional scaling. In turn, the relevance of almost all the regression coefficients determined in the second stage of the PROFIT method and very high match rates of regression models (Tab. 2) indicate that the interpretation of the vectors determined on the perceptual map (Fig. 1) is probably reflected in reality.

The analysis of the position of each country on the perceptual map (see: Fig. 1 and Tab. 3) allows to draw some detailed conclusions about similarities and differences between the EU countries from the point of view of the indications of the 3 analysed indices of innovativeness. A clear advantage of the PROFIT method is the fact that, despite a fairly complex calculation procedure, it enables an easy and clear interpretation of the results presented graphically. When analysing the results obtained, it should be noted that the position of the EU country described by coordinates on the perceptual map is influenced by all the variables included in the analysis, i.e. all the three innovation indices combined. It can therefore be seen that, for example, Germany and Denmark are characterised by the highest intensity of *IOI* value. The reproduction of the coordinates for Lithuania and Latvia on the line where the IOI vector lies indicates that these countries have the worst results in terms of the variable in question. On the other hand, the Netherlands, the United Kingdom, and Sweden achieve the highest results according to the *Global Innovation Index*. In relation to *SII*, the ranking of the Member States shows that Sweden, Germany, Denmark, and Finland are characterised by the highest intensity of innovation index values, while Lithuania, Bulgaria, Latvia, and Romania by the lowest intensity.

Table 2. Regression analysis for all the variables/dimensions of the evaluation

N = 28	**Regression results for *IOI*:** R^2= 0.9738; corrected R2= 0.9717					
	F(2.25)=465.24 p<0.0000 Estimation error: 0.04774					
	b*	**std.error b***	**b**	**std.error b**	**t(25)**	**p**
free coeff.			0.498151	0.009021	55.21899	0.000000
Dim 1	0.949745	0.032351	0.269757	0.009277	29.07926	0.000000
Dim 2	0.298052	0.032351	0.356765	0.038724	9.21304	0.000000
N = 28	**Regression results for *SII*:** R^2= 0.9584; corrected R^2= 0.9551					
	F(2.25)=288.19 p<0.00000 Estimation error: 0.06366					
	b*	**std.error b***	**b**	**std.error b**	**t(25)**	**p**
free coeff.			0.513552	0.012031	42.68748	0.000000
Dim 1	0.978316	0.040778	0.296794	0.012371	23.99132	0.000000
Dim 2	0.036412	0.040778	0.046112	0.051641	0.89295	0.380402
N = 28	**Regression results for *GII*:** R^2= 0.9928; corrected R^2= 0.9923					
	F(2.25)=1746.5 p<0.0000 Estimation error: 0.02753					
	b*	**std.error b***	**b**	**std.error b**	**t(25)**	**p**
free coeff.			0.491315	0.005202	94.4393	0.000000
Dim 1	0.959316	0.016860	0.304392	0.005350	56.8995	0.000000
Dim 2	-0.269457	0.016860	-0.356904	-15.9822	0.89295	0.000000

Note: The calculations were made with the use of Statistica 12.5 software Plus Suite – specialist analytical package.
Source: own elaboration based on: European Commission (2013), European Commission (2015), Vertesy & Deiss (2016), Dutta *et al*., (2015).

Table 3. The results of the PROFIT analysis along with the coordinates that determine the location of each country on the perceptual map

	Final configuration: Stress = 0.018				
	GII	***IOI***	***SII***	**Dim 1**	**Dim 2**
Austria	0.655	0.636	0.711	0.577	-0.025
Belgium	0.525	0.556	0.775	0.411	0.199
Bulgaria	0.164	0.112	0.046	-1.356	-0.138
Croatia	0.145	0.154	0.203	-1.127	-0.065
Cyprus	0.219	0.375	0.449	-0.517	0.198
Czech Republic	0.542	0.480	0.453	-0.043	-0.146
Denmark	0.805	0.855	0.993	1.314	0.193
Estonia	0.603	0.359	0.531	0.014	-0.311
Finland	0.899	0.871	0.881	1.319	0.005
France	0.635	0.719	0.721	0.654	0.096
Germany	0.778	1.000	0.881	1.323	0.325
Greece	0.086	0.277	0.299	-0.963	0.193
Hungary	0.198	0.515	0.308	-0.590	0.394
Ireland	0.864	0.884	0.791	1.194	0.026
Italy	0.339	0.398	0.438	-0.380	0.062
Latvia	0.302	0.089	0.127	-1.108	-0.350
Lithuania	0.168	0.000	0.146	-1.338	-0.315
Luxembourg	0.860	0.882	0.817	1.201	0.035
Malta	0.507	0.406	0.359	-0.264	-0.199
Netherlands	0.965	0.566	0.827	0.987	-0.507
Poland	0.081	0.355	0.202	-1.011	0.290
Portugal	0.347	0.184	0.371	-0.673	-0.264
Romania	0.000	0.304	0.000	-1.428	0.347
Slovakia	0.198	0.419	0.291	-0.704	0.236
Slovenia	0.425	0.445	0.615	-0.017	0.119
Spain	0.449	0.345	0.338	-0.423	-0.182
Sweden	0.999	0.973	1.000	1.667	0.013
United Kingdom	1.000	0.791	0.807	1.282	-0.230

Note: The calculations were made with the use of Statistica 12.5 software Plus Suite - specialist analytical package.

Source: own elaboration based on: European Commission (2013), European Commission (2015), Vertesy & Deiss (2016), Dutta *et al.*, (2015).

Conclusions

The quality and reliability of the results obtained can be deemed as high, which may arise from the fact that dimensionality reduction was not too drastic and meant the transition from 3 dimensions (3 innovation indices) to 2 dimensions which are easy to interpret on the Cartesian perceptual map. The PROFIT analysis brings additional benefits beyond the ranking, as it allows to specify the clusters of countries with a similar level of innovativeness (e.g.: Poland on the MDS map is close to Slovakia, Hungary, Greece, and Romania, which means that unfortunately it is closer to the countries with a lower level of innovativeness, while the leaders, the Scandinavian countries, are naturally in the same cluster). The results of the conducted research confirmed earlier stated hypothesis that the degree of specialisation of an innovation index has a significant influence on the location/position of the EU Member States on a perceptual map. Moreover, observing the inclination angle of the vectors determined on the basis of the analysed innovation indices in relation to the axes connected with the dimensions (Dim 1 and Dim 2), it can be concluded that the SII index seems to be something of a resultant of measurements made with the IOI and GII indices. In turn, the latter two indices differ in terms of the direction of changes of the coordinate related to the second dimension, which may indicate that although they both measure innovativeness, their methodological differences will lead to noticeable differences in the assessment of the EU economies.

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Labour market institutions and employment in the OECD countries

JEL Classification: *J01; J08; J38*

Keywords: *minimum wage; union density; tax wedge; employment; unemployment*

Abstract

Research background: Despite the large number of studies concerning the impact of labour market institutions and macroeconomic policy on the labour market situation it is difficult to find studies using the same methods and the same set of data showing the analyzed phenomena. The panel methods (mainly FE and RE estimators) are very often used in empirical analyzes of this issue and thus it is assumed that the sensitivity of the labour market to institutions is the same in individual economies.
Purpose of the article: The aim of the study is a statistical analysis of the impact of labour market institutions on employment in the OECD countries. Particularly, we are interested if the aforementioned institutions affect different groups (by sex, age and education level).
Methodology/methods: To analyze the relationship between the institutions and the labour market outcomes the equations explaining the employment rates were estimated. Additionally, other key macroeconomic variables were taken into account. The parameters of mentioned equations were estimated using panel GLS assuming heteroscedastic and autocorrelated error term. Due to data availability our sample covers period 1991-2014.
Findings: The main conclusions of the analysis are as follow. The impact of minimum wages on the overall employment rate is statistically significant. The impact of minimum wages on the youth employment rate was not confirmed. The hypothesis that the minimum wage harms those with the lowest levels of education was not rejected. The tax wedge affect all analyzed employment rates, but the

impact of tax progressivity is not obvious. We cannot reject the hypothesis about the impact of employment protection legislation on the employment rates – the impact is the strongest in the group of the youngest and low educated.

Introduction

Labour market institutions have great impact on labour market outcomes and very often are included in the labour market analysis. Their impact on the labour market situation is generally measured by the impact of institutions on the level of equilibrium unemployment. That equilibrium level depends on (Layard, 1986; Gianella et al., 2008) following measures.

Labour market situation usually measured by the unemployment rate. The efficiency of the labor market means higher efficiency, lower time of job search and lower wage level. Compensation rate matters (the increase in the compensation rate means the lower intensity of the job search by the unemployed, the longer the search period and the higher the pressure on the increase in wages). Union strength and level of unionization, the generosity of the social assistance system play also important role. Eployment protection and tax burdens on employees also can affect emplyment.

The data availability and the number of variables used to describe the labor market situation allow include for analyses of the the following variables (Nickell et al., 2005; Schreiber, 2012): tax wedge, minimum wage, trade union density.

In most empirical studies, the hypothesis about the negative impact of labour market institutions on the emplyment level is verified and if the verified positive justifies the need to reduce level of analyses institutions. The importance of the institutions varies for different groups of employees. Employees characterized by higher flexibility of labor supply are particularly sensitive to their impact. Studies on economic groups, such as the EU and the OECD, were conducted by, for example, Daveri and Tabellini (2000), who analyzed economies in 14 OECD countries between 1965-1991. According to them, labor taxation has a greater negative impact on unemployment in countries with strong trade unions. They also showed that decentralized and centralized countries have better results in terms of functioning of the labor markets than those in which solutions are indirect. Blanchard and Wolfers (2000) used data for 20 OECD countries and divided the eight five-year periods from 1960 to 1995. They tested the effects of economic shocks interactively with labor market institutions. It turned out that shocks have a greater positive impact on unemployment at high replacement rates, longer duration of benefits, relatively restrictive legal protection of employment, high degree of unionization and low coordination of contracts. A similar research problem was made by Nickell et al. (2005). They argue that much of the change in unemployment in the OECD countries in 1961-1992 can be explained by changes in labor market institutions. Apart from estimating the direct impact of labor market institutions, they have introduced interactions between institutions and economic shocks (like Blanchard, Wolfers, 2000), but these interactions do not make much of an explanation for unemployment.

Unemployment was also analyzed by Jimeno and Rodriguez-Palenzuela (2002), who showed that rigid labor market institutions and the lack of detailed youth remuneratory rules mean that younger workers are less involved in the market. Their panel for 19 OECD countries in 1968-1996 allowed the conclusion that the variation in unemployment rates in OECD countries could be explained by the volatility of youth unemployment rates. Belot and van Ours (2004) analyzing the labor market institutions in the 1960-1999 period in 17 OECD countries showed that some kind of combination of selected labor market institutions are relevant for low unemployment rates in the analyzed countries. In particular, in many countries, the interaction between tax rates and replacement rates is significant - if financial incentives were enforced, unemployment fell and, in the case of weakening, increased. In turn, Dolenc, Laporšek (2010) investigated the impact of the tax wedge on employment dynamics in the 27 EU countries between 1999 and 2008. They distinguished low and high tax wedge countries and showed that in each of the groups the tax wedge influenced negatively on employment changes. Similar conclusions were reached by Góra et al. (2006) analyzing the OECD countries between 1996 and 2003, but additionally showed that the tax wedge influenced the employment rates of the low-skilled. Lehmann et al. (2016), analyzing a panel of 21 OECD economies in the period 1998-2008, examined the impact not only of the level of taxation but also of the progression to the labor market.

The aim of this article is to analyze the impact of employment taxation on OECD employment by age, sex and education level. The study covers data from 1991-2014 period and the OECD countries.

Method of the research

The statistical analysis of the relationship between labour market institutions and employment rates in OECD countries covers period from 1991 to 2014. The panel used in the study is unbalanced. In order to analyze the above mentioned relationship we estimate the parameters of the employment rate equation (see Neumark, Wascher, 2008; Lehman et al., 2016):

$$e_{it} = \sum_m \alpha_m Y_{mit} + \sum_n \alpha_n X_{nit} + \varepsilon_{it} \qquad (1)$$

where:
X vector covers labour market institutions and consists of (see Griffith et al. 2007; Bassanini, Duval 2009):

– atw67, atw100, atw167 – the average tax wedge for single person without children receiving salaries at 67%, 100% and 167% of average salary respectively,
– w_min – minimum wage to median wage,
– union – union density measure,
– EPL – emplyment protection legislation index,

Y vector includes the main determinants of employment and the labor market situation. They included labor productivity (y) and labor productivity growth rate as a measure of economic growth (gy), long-term unemployed (u_12m), labor force with higher education (edu_tert) as a measure of human capital, and trade (total exports And imports) to GDP also interpreted as an indicator of trade restrictions (Asiedu, 2002).

The parameters of equation (1) were estimated by the GLS method with the assumption of heteroscedasticity of the error term and its autocorrelation. Adoption of such assumptions results from the lack of homogeneity of relations between the analyzed variables in OECD countries and the presence of lagged adjustments on the labor market.

Empirical results

Tables below contain main results. The following conclusions can be drawn from the estimates of functions (1) for the employment rates as a whole and by gender (see table 1). Statutory taxation has a significant impact on all analyzed employment rates. It is expected that the increase in labor taxation will cause a decrease in employment rates, both in total and by sex. The estimated impact of labor taxation is concerned, it is significantly higher for men than for women. It turns out that tax progression is important only in case of women. In addition, employment rates are significantly affected by the legal protection of employment and the degree of unionization.

An analysis of the impact of labor taxation on the employment rate by age (Table) indicates that taxation affects mainly the employment of young people. Among adults (25+, er_adult) the impact of labor taxation is negligible if the atw100 is taken into account and the differences in taxation are the best and the least earners. The disaggregation of progression allows to find a statistically significant relationship. In addition, tax progression affects the employment rates of younger people aged 15-19 and 20-24, with the first degree of progression (atw100/atw67) only affecting the youngest. Other labor market institutions also affect employment by age, while protection of employment affects only the employment rates of people aged 20-24 and the impact of unionization is significant across all age groups except 25-29.

Table 1. Estimation results for emplyment by sex and tax wedge

	er	er_women	er_men	er	er_women	er_men
atw100(-1)	-0.196***	-0.053	-0.243***	-0.199***	-0.073*	-0.255***
	(-6.88)	(-1.48)	(-9.06)	(-6.65)	(-1.80)	(-9.34)
atw167/atw67 (-1)	-0.935	-5.638***	0.245			
	(-1.00)	(-5.32)	(0.17)			
atw167/atw100 (-1)				-3.188	-10.249***	-3.473
				(-1.31)	(-3.66)	(-1.20)
atw100/atw67(-1)				-0.332	-5.787***	1.957
				(-0.19)	(-3.18)	(0.87)
EPL(-1)	-2.205***	-2.554***	0.879**	-2.107***	-2.560***	1.139***
	(-6.72)	(-6.43)	(2.32)	(-6.86)	(-6.38)	(2.90)
union(-1)	0.077***	0.216***	0.071***	0.065***	0.212***	0.078***
	(7.43)	(12.68)	(6.83)	(6.54)	(12.80)	(7.42)
Obs	311	306	306	311	306	306

p<0.10, ** p<0.05, *** p<0.01
Source: own estimation.

Table 2. Estimation results for emplyment by age and tax wedge

	er_adult	er15_19	er20_24	er25_29	er_adult	er15_19	er20_24	er25_29
atw100(-1)	-0.037	-0.665***	-0.491***	-0.133***	-0.087***	-0.750***	-0.530***	-0.121**
	(-1.29)	(-8.59)	(-6.76)	(-2.63)	(-2.65)	(-8.88)	(-6.48)	(-2.18)
atw167/atw67 (-1)	-1.451	-10.584***	-7.070**	-0.079				
	(-1.60)	(-3.67)	(-2.31)	(-0.03)				
atw167/atw100 (-1)					-7.441***	-21.796***	-15.701**	1.639
					(-3.01)	(-2.82)	(-1.99)	(0.26)
atw100/atw67(-1)					0.502	-9.589**	-6.085	0.875
					(0.31)	(-2.12)	(-1.22)	(0.26)
EPL(-1)	0.143	-0.904	-3.389***	0.623	0.103	-0.695	-3.211***	0.222
	(0.36)	(-1.37)	(-4.11)	(1.22)	(0.26)	(-1.04)	(-3.87)	(0.46)
union(-1)	0.130***	0.218***	0.093***	0.005	0.137***	0.201***	0.108***	-0.007
	(9.04)	(6.57)	(3.71)	(0.39)	(10.00)	(5.92)	(3.94)	(-0.47)
Obs	306	260	260	260	306	260	260	260

p<0.10, ** p<0.05, *** p<0.01
Source: own estimation.

The labour taxation also significantly influences the analyzed employment rates by education, both by the impact of the level of taxation and by the progression. Tax progression is primarily for people with middle and higher qualification levels. These groups also have a first degree of progression. Analysis of the size of the estimated parameters makes it possible to conclude that labor taxation is more influenced by rates of employment of people with lower education levels, and that these rates do not in turn affect the prudential protection of employment. Moreover, the degree of unionization affects employment regardless of the level of education.

Table 3. Estimation results for employment by education level and tax wedge

	er_low	er_med	er_high	er_low	er_med	er_high
atw100(-1)	-0.516***	-0.112**	-0.128***	-0.554***	-0.061	-0.139***
	(-9.54)	(-2.44)	(-4.50)	(-8.62)	(-1.21)	(-4.47)
atw167/atw67 (-1)	-1.494	-5.460***	-4.307***			
	(-0.73)	(-3.23)	(-2.87)			
atw167/atw100 (-1)				-11.622*	-2.736	-7.284**
				(-1.83)	(-0.64)	(-2.19)
atw100/atw67(-1)				1.106	-8.683***	-3.923*
				(0.38)	(-3.58)	(-1.90)
EPL(-1)	0.112	-1.910***	-0.877**	0.299	-1.827***	-0.798**
	(0.18)	(-3.44)	(-2.16)	(0.47)	(-3.40)	(-2.01)
union(-1)	0.168***	0.110***	0.063***	0.187***	0.086***	0.066***
	(5.16)	(6.77)	(5.78)	(5.13)	(6.31)	(6.06)
Obs	264	264	264	264	264	264

p<0.10, ** p<0.05, *** p<0.01
Source: own estimation.

The following conclusions can be drawn from the estimates of function (1) for the employment rates by age as shown in Table 4. The ratio of the minimum wage to the median has a statistically significant effect on the total employment rate, while the impact on the employment rate of very young people is statistically zero. The impact of the minimum wage on the total employment rate, although negative, is very small. Legal protection of employment also affects employment rates, with a much higher impact on employment rates for young people. The hypothesis of the nonlinear impact of the EPL on the employment of people aged 15-24 can also be rejected.

Analyses of the estimation results by educational level (Table 5), it can be seen that the minimum wage to the median has a statistically significant effect on employment rates across all groups, with the greatest impact on the lowest education level. The estimated parameter in this group is two and four times higher than in the employee groups with (respectively) average and higher education. The impact of the legal protection of employment on employment rates by level of education is not clear. According to the estimates, the increase in this protection has a positive impact on the employment of people with a low level of education, and the impact on the employment rates of the better educated is negative. In addition, in groups of people with middle and higher education, the hypothesis of the U-shaped relationship between the EPL and the employment rates cannot be confirmed.

Table 4. Estimation results for employment by age and minimum wage

	e	e15_24	e20_24	e25_29	e_adult
w_min	-0.062***	-0.033	-0.160***	-0.011	-0.029
	(-3.93)	(-0.83)	(-3.40)	(-0.44)	(-1.45)
union	0.033**	0.085**	0.040	-0.029	-0.098***
	(-2.39)	(2.22)	(0.69)	(-1.31)	(-4.56)
epl_y	-0.105***	-0.791***	-0.394***	0.066*	0.201***
	(-3.92)	(-13.91)	(-4.13)	(1.73)	(6.30)
epl2_y	0.002	0.139***	0.052**	-0.024**	-0.041***
	(-0.37)	(10.66)	(2.38)	(-2.53)	(-5.46)
Constant	51.419***	-36.621***	24.018***	61.767***	71.763***
		(-5.73)	(3.18)	(21.71)	(33.79)
Obs	328	232	232	232	307

p<0.10, ** p<0.05, *** p<0.01
Source: own estimation.

Table 5. Estimation results for employment by sex and education level and minimum wage

	e_men	e_women	e_low	e_med	e_high
w_min	-0.013	-0.071***	-0.158***	-0.165***	-0.066***
	(-0.80)	(-3.15)	(-3.57)	(-7.52)	(-2.97)
union	-0.018	-0.159***	0.060	-0.098***	0.012
	(-1.07)	(-6.48)	(1.31)	(-3.63)	(0.58)
epl_y	-0.008	0.107**	-0.344***	0.150**	-0.019
	(-0.26)	(2.45)	(-4.38)	(2.40)	(-0.51)
epl2_y	0.004	-0.040***	0.067***	-0.066***	-0.002
	(0.60)	(-4.02)	(3.84)	(-4.79)	(-0.25)
Constant	82.147***	48.261***	37.928***	67.310***	83.012***
	(42.92)	(18.68)	(12.53)	(22.39)	(35.47)
Obs	307	307	234	234	234

p<0.10, ** p<0.05, *** p<0.01
Source: own estimation.

Conclusions

The analysis of the labour market institutions on the employment rates can be summarized as follows:

- The relation of the minimum wage to the average significantly affects the total employment rate. Although this effect is negative it is very small.

- Analysis in subgroups of age 15-19, 25-29 and 25+ allows to obtain statistically significant estimates of the effect of minimum wage on employment rates.
- Minimum wage affects employment rates by sex. The analysis of the impact of the minimum wage on the employment rate by education shows that the minimum wage affects the employment of people with the lowest qualification level, and the impact on the employment of people with middle and higher levels is practically zero.
- One of the most common indicators of the tax burdens is the tax wedge, which is defined as the sum of taxes on income increased by social security contributions in relation to labor costs.
- The tax wedge statistically has a significant effect on the total employment rate and among men. Although in the case of women the impact of the level of taxation is at the limit of statistical significance, tax progression is relevant for this group.
- The study partially confirmed the negative impact of labor taxation on the employment rate of young people. In the case of the youngest groups, the tax wedge estimate was significantly higher than in the other groups. In addition, only in groups aged 15-19 and 20-24 the tax progression was important.
- In addition, the tax wedge statistically has a significant impact on employment rates across all groups of people according to the level of education, but this effect is significantly higher in the lowest education level.
- Tax wedge is not the only labor market institution influencing the analyzed employment rates. The hypothesis on the impact of the protection of employment legislation on employment rates cannot be denied. In addition, the impact of the degree of unionization has a significant impact on the employment rates analyzed.

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Efficient implementation of the Europe 2020 strategy goals: Is social equality achievable reality or myth perhaps?

JEL Classification: *C67; E24; E61; O52; P51.*

Keywords: *DEA Method, Economic Crisis, EU28, Europe 2020 Strategy, Social Inequality.*

Abstract

Research background: Economic crisis hit all the European Union Member States hard, the impact of crisis varied considerably. The low growth performance in the EU has increased concerns regarding an increasing wage dispersion, income inequality at large, and social exclusion in line with poverty. Inequality should be seen as a cornerstone of both sustainable and inclusive growth under the Europe 2020 Strategy. Social inequality in the EU is a very real problem which hampers sustainable economic growth.

Purpose of the article: The purpose of this study is to introduce evaluation of social development convergence and divergence trend between EU28 Member States in the context of the Europe 2020 Strategy. The study gives an outline of the issues of labour market and income disparities and poverty. Policy-makers must be clear about what social objectives they are aiming to achieve, therefore special attention is paid to headline national goals of the Europe 2020 Strategy.

Methodology/methods: The main tasks of this study is to assess social dimension and inequalities problems in the EU27 by applying Data Envelopment Analysis method, resp. time-series dynamic efficiency analysis in the form of output-oriented Malmquist Productivity Index. This study contain changes of key social equality indicators related to the Europe 2020 Strategy and compares objectives and general outlines of period 2010-2015, as well as its impact on national economics and living conditions.

Findings: Results contain elements of typology premises of the EU28 and point to a large diversity in inequality patterns, as author observe both increases and decreases in inequality at the EU level. Recent changes in social inequality have been associated with the business cycle, particularly with the accessibility of the labour market and, of course, with income inequality. Additionally the development challenges are discussed for improvement of the socioeconomic well-being of the EU27 and to avoid social disparities.

Introduction

The level of social inequalities belongs to important indicators influencing the socio-economic development and other processes taking place in the social and economic realm. Facilitating rational income distribution and reducing poverty are mentioned among the main goals of public policy. It should be mentioned that such multidimensional phenomena as income disparity and poverty might be analysed from many different perspectives, including the national and international within the European Union (EU). Striving for fairness in economic development is crucial in order for societies to be stable and citizens not to feel disenchanted. The economic crisis has put inequalities high on the political agenda, and made this an issue of serious public concern (Rajan, 2010; Stiglitz, 2009). There is an increasing recognition that social policy can reduce inequality and poverty while simultaneously improving the economic functioning of the country as reflected in the idea of inclusive growth in the EU's Europe 2020 strategy, with references to a high-employment economy delivering economic, social, and territorial cohesion in which benefits of growth and jobs are widely shared.

In view of the current debate and the literature review, the objectives of this study focus on the following key issues: 1) to describe the recent evolution of inequalities and dispersion across the EU Member States using different definitions of social inequality measures in relation to the Europe 2020 Strategy; and 2) to assess social dimension and inequalities problems in the EU Member States by applying Data Envelopment Analysis (DEA) method. The purpose of this study is to introduce evaluation of social-economic development and trends among the EU countries in the context of the Europe 2020 Strategy. The main tasks of this study is to assess social dimension and inequalities problems in the EU countries by applying time-series dynamic efficiency analysis in the form of output-oriented Malmquist Productivity Index (MPI). This study contain changes of key social equality indicators related to the Europe 2020 Strategy and compares national progress in reference period 2010-2015. Development challenges are discussed for improvement of the socio-economic well-being of the EU Member.

Research methodology

To study inequality in the EU as a whole, one needs adequate statistical tools which can be used in the geographical and political context faced by the EU. There is ongoing and increasing interest in measuring and understanding the level, causes and development of inequality (Martins, 2015; Sala-i-Martin, 2006; Quah, 1997). The necessity of having performance measured in terms of welfare beyond GDP calls for new approaches capable of simultaneously taking into account economic as well as social and environmental indicators (Galbraith, 2009). Efficiency has become very important part of governments' decisions, and the main reason are financial constraints that public finance need to face in setting of the financial crisis. Empirical studies engaging the technique of non-parametric method Data Envelopment Analysis (DEA), an approach for providing a relative efficiency assessment and evaluating performance of a set of peer entities called decision-making units (DMUs). DEA is convenient for determining the efficiency of DMUs that are mutually comparable – using the same inputs and producing the same outputs but with different performances. Determining whether a DMU is efficient from the observed data is equivalent to testing whether the DMU is on the frontier of the production possibility set (Coelli et al., 2005).

Use of DEA has been mostly engaged in assessing the efficiency in economic sectors and in country settings (Melecký, 2013; Lavado and Cabanda, 2009), the growing literature has been introduced also on DEA application in public sphere (for more cases see Štikarová (2014)). DEA method is a convenient method for comparing national efficiency as an assumption for the performance of territory, because it evaluates not only one factor but a set of different factors that determine the degree of economic development.

Empirical analysis is based on MPI measuring the change of technical efficiency and the movement of the frontier in terms of individual DMUs (Färe et al., 1994). Suppose each DMU_j ($j=1, 2\ldots n$) produces a vector of output $y_j^t = \left(y_{1j}^t, \ldots, y_{sj}^t\right)$ by using a vector of inputs $x_j^t = \left(x_{1j}^t, \ldots, x_{mj}^t\right)$ at each time period t, $t = 1..., T$. From time t to time $t+1$, DMU_0*'s* efficiency may change or (and) the frontier may shift.

MPI measuring the efficiency change of production units between successive periods *t* and *t+1,* is formulated via (1):

$$M_0\ (x^{t+1}, y^{t+1}, x^t, y^t) = EFCH_0 \cdot FS_0 \quad (1)$$

where $EFCH_0$ is change in the relative efficiency of DMU_0 in relation to other units (i.e. due to the production possibility frontier) between time periods *t* and *t+1*. FS_0 describes the change in the production possibility frontier as a result of the technology development between time periods *t* and *t+1*. The following formulation of MPI (2) makes it possible to measure the change of technical efficiency and the movement of the frontier in terms of a specific DMU_0 (Zhu, 2012):

$$M_0 = \frac{\theta_0^t\left(x_0^t, y_0^t\right)}{\theta_0^{t+1}\left(x_0^{t+1}, y_0^{t+1}\right)}\left[\frac{\theta_0^{t+1}\left(x_0^{t+1}, y_0^{t+1}\right)}{\theta_0^t\left(x_0^{t+1}, y_0^{t+1}\right)} \cdot \frac{\theta_0^{t+1}\left(x_0^t, y_0^t\right)}{\theta_0^t\left(x_0^t, y_0^t\right)}\right]^{\frac{1}{2}}. \quad (2)$$

The first component on the right hand side measures the magnitude of technical efficiency change between periods *t* and *t+1*. Obviously, $EFCH_0 = \dfrac{\theta_0^t\left(x_0^t, y_0^t\right)}{\theta_0^{t+1}\left(x_0^{t+1}, y_0^{t+1}\right)} \overset{<}{\underset{>}{=}} 1$ indicating that technical efficiency improves remains or declines. The second component measures the change in production technology, i.e. technology frontier shift, between periods *t* and *t+1*. Trends of MPI, EFCH and FS are illustrated in Table 1.

Table 1. Characteristics and trends of MPI and efficiency changes

MPI	Productivity	TEC FS	Technical Efficiency Change Technology Efficiency Change
> 1	Improving	> 1	Improving
= 1	Unchanging	= 1	Unchanging
< 1	Declining	< 1	Declining

Source: own elaboration (2017).

When the number of performance measures is high in comparison with the number of DMUs, then most of DMUs are evaluated efficient, and the obtained results are not reliable. There is a rule of thumb, which expresses the relation between the number of DMUs and the number of performance measures and it was found out by Toloo et al. (2015) that in nearly all of the cases the number of inputs and outputs do not exceed 6. Suppose there are *n* DMUs which consume *m* inputs to produce *s* outputs. A simple calculation shows that when m ≤ 6 and s ≤ 6, then 3 (m + s) ≥ m × s. As a result, in this study following formula (3) is applied:

$$n \geq 3(m+s). \tag{3}$$

In the study, DMUs number is three times higher than sum of input and outputs, i.e. 28 ≥ 3 (2 + 7), 28 ≥ 3 (9), 28 ≥ 27, so the rule has been proved.

Software tools for solving linear programming problems are used in the study, such as the DEA Frontier, and IBM SPSS Statistics 24.

The analysis presented here will try to provide estimates of European (the EU27 Member States and the EU as a whole) inequality for reference years 2010-2015. This study used the most recent data available from the EU Statistics – the Europe 2020 strategy indicators – social dimension (Eurostat, 2017), see Table 2. Reference period consists of years from 2010 to 2015 with respect to implementation of the Europe 2020 strategy. Efficiency evaluation is calculated across the reference years, and for the overall efficiency change between 2010 and 2015.

Table 2. Indicators of inputs and outputs in period 2010–2015 relevant to DEA modelling

Input indicators		
Gross domestic product (GDP)		Current prices, million euro
General government expenditure (GGE)		Total GGE, million euro
Output indicators (Europe 2020 indicators)		
Employment	Employment rate (ER)	Total employment, LFS, % of total population
Research and development	Gross domestic expenditure on R&D (GERD)	Euro per inhabitant; all sectors
Education	Tertiary educational attainment (TEA)	Tertiary education, age group 30-34
Poverty or social exclusion	People at risk of poverty or social exclusion (PRPSE)	Total age class, % of total population
	People living in households with very low work intensity (PLWI)	% of total population aged less than 60
	People at risk of poverty after social transfers (PRPST)	% of total population
	Severely materially deprived people (SMDP)	% of total population

Source: Eurostat (2017); own elaboration (2017).

Results and discussion

The results of the author' calculations (see Table 3) confirm the initial statement: inequality within the EU. With this level of inequality, the EU27 appears to be much more unequal than other large economies. During the reference period considered, between-country inequality increased as confirmed MPI decreasing trend by comparing annual MPI change. According to the efficiency analysis and derived results from the solution of MPI, it emerges that the 2010-2015 annual MPI change of the EU countries range from 0.681 to 1.352. In the case of overall MPI change, the ratio emerges from minimum 0.562 to maximum of 2.322 in the reference period 2010-2015. Overall productivity of most evaluated countries has recorded decreasing trend, thus negative. This result is not surprising because of nature of comparing periods, all evaluated European countries have solved with impacts of financial and economic crisis.

Part of the explanation to the large inequalities within EU countries may then have to do with the differences in competitiveness. An economic entity in country, which has low competitiveness, may not have similar opportunities as an economic entity in a highly competitive country. This fact remains and is confirmed. However, what does it mean for efficiency in competitiveness? In the case of efficiency analysis of competitiveness and in time comparison analysis of change, the results are just a little bit different. Why? The concept of competitiveness may then be important not only to evaluate why some countries grow faster than others do, but also why some countries have a better and more efficient distribution of competitiveness over time than others. Is it a high level of competitiveness necessarily associated with a high level of efficiency, and vice versa? It may not always be the case because evaluated countries because it is necessary to compare the values of inputs and outputs. Very important is also the fact that with given level of inputs, countries were able to achieve level of output. Finally, Table 3 show reordered countries, from best to worst, their MPI score and the corresponding rank with respect to the overall-period MPI change. Based on MPI results is clear, that efficiency changes results seem to be balanced in the EU countries.

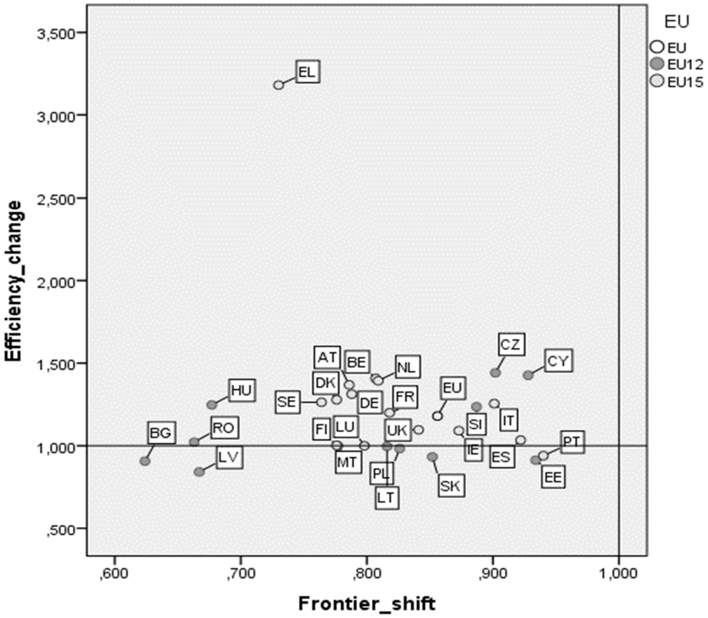
Table 3. Annual and overall MPI results for reference period 2010-2015

DMU	Annual MPI change					Overall-period MPI change		
	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	Rank	Country	2010-2015
EU	1.022	1.028	1.002	1.004	0.981		EL	2.322
BE	1.038	1.075	1.023	1.008	0.992		CY	1.324
BG	0.944	0.978	0.895	0.681	0.985		CZ	1.300
CZ	1.080	1.113	1.070	1.040	0.979		BE	1.137
DK	1.002	1.005	0.998	0.995	0.990		IT	1.132
DE	1.038	1.012	0.981	1.018	0.988		NL	1.129
EE	1.206	0.877	0.875	0.923	0.976		SI	1.099
IE	0.978	1.012	1.052	0.991	0.962		AT	1.076
EL	1.323	1.352	1.102	1.075	1.046		DE	1.035
ES	0.991	0.985	1.011	1.003	0.937		**EU**	**1.011**
FR	0.993	1.008	1.002	1.000	0.982		DK	0.992
IT	1.103	1.106	0.999	1.019	0.969		FR	0.983
CY	0.998	1.114	1.043	1.122	1.035		SE	0.967
LV	1.040	0.823	0.912	0.763	0.841		IE	0.953
LT	0.887	1.124	0.926	1.017	1.052		ES	0.953
LU	0.975	0.845	1.007	0.962	1.000		UK	0.921
HU	1.055	1.137	1.032	0.835	0.774		PT	0.884
MT	0.982	1.049	0.954	0.946	0.848		EE	0.853
NL	1.065	1.015	1.005	1.026	1.001		HU	0.845
AT	0.972	1.083	1.008	1.024	0.992		LT	0.813
PL	0.931	1.039	1.025	0.998	0.986		PL	0.812
PT	0.948	0.976	1.005	0.979	0.969		LU	0.798
RO	0.925	1.095	0.934	0.857	0.794		SK	0.796
SI	1.137	1.061	1.011	0.928	0.948		FI	0.778
SK	0.929	0.967	0.936	0.955	0.982		MT	0.777
FI	0.976	0.934	0.957	0.965	0.918		RO	0.677
SE	0.999	1.002	1.000	0.943	1.026		BG	0.565
UK	1.004	0.948	1.023	0.985	0.986		LV	0.562
Min	0.887	0.823	0.875	**0.681**	0.774	Overall Min		0.562
Max	1.323	**1.352**	1.102	1.122	1.052	Overall Max		2.322

Source: own calculation and elaboration (2017).

Classification of EU15 and EU12 Member States with respect the nature of technical and technological change is illustrated in Figure 1. In overall reference period, location of all European countries is recorded with respect to results, resp. their values of EFCH and FS. It is possible to divide European countries in four categories, resp. quadrants. Via illustration of Figure 1, information about differences in efficiency recorded by MPI in 2010-2015 period are confirmed. Across the overall-change period, most of European countries are located in quadrants with low level of FS, and higher or lower level of EFCH. It means that efficiency change is caused especially by the change in the production possibility frontier because of the technology development between reference years, i.e. technology frontier shift. This fact is positive information with respect to indicators of the Europe 2020 strategy, it signifies that countries are able to utilize their internal factor endowment in effective way and are able to apply technological progress for boosting of their competitive advantages, i.e. they contribute thus to qualitative based economic growth and it is option how to raise the steady state.

Figure 1. Comparison of EU distances in efficiency change and frontier shift



Source: own elaboration in SPSS (2017).

All these factors affect the convergence trend of the new EU Member States to the old EU Member States, and the growth in old countries has implicative impact on growth in new countries. This growth may have the same degree in EU12 countries as in EU15 countries, or is a higher and multiplied. In fact, as the catching-up of the poorer Member States is partially based on the relocation of production from high-wage to low-wage locations. Trends of the recent years of economy development in the EU, which shows moderate GDP growth require social legislation improvement, income`s level, labour market and education system development. For future`s social development investigations and governmental decisions needs to be pragmatic approach into financing in order to create employment and reduce poverty level and social disparities in the national economy.

Conclusions

Inequality is a key problem facing the EU, and it has significant impacts not only on human well-being, but also on economic performance. The only way for the EU to meet these challenges is to not only strengthen economic growth policies through broad-based economic programme promoting marketization but also by resolutely pushing for the expansion of social aspect of the EU model (Allmendinger & Driesch, 2014).

The future design of European economic policy must then provide a framework in which the policy instruments essential for a monetary, fiscal, industrial, sectorial, and social policy consistent with full employment and a reduction in inequality play a more prominent role. Europe 2020 is a credible strategy of industrial policy for the future of Europe and has the merits of presenting clear actions, clear targets and a detailed measurement strategy to monitor implementation. Combatting inequality should be considered as an instrumental target for both sustainable and inclusive growth. European policymakers have a long to-do list to foster inclusive growth in Europe (Darvas and Wolff, 2016). In all the countries of the EU, the welfare state has come under intense scrutiny as a result of budgetary pressures and wider societal developments. Simultaneously, the EU needs a sense of common purpose and a common policy framework in support of national social policies. Its aim should be to create a virtuous circle whereby both pan-European cohesion and national cohesion are enhanced.

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Forward-looking component in consumers' expectations and the central bank's forecast: some evidence for European countries

JEL Classification: *E580; E430*

Keywords: *inflation forecast; inflation forecast targeting; consumers expectations; forward-lookingness of expectations*

Research background: Modern monetary policy should be expectations-oriented. The best way to influence expectations operationally is to use inflation forecasts. As different ways of revealing central bank's intentions exist, a simple research question arises. Does the forward-looking (FL) component of consumers' expectations depend on the way in which the forecast is revealed and used by the central bank?

Purpose of the article: The main purpose of the article is to address the mentioned above question. The research hypothesis assumes that the forecasting system which is more transparent together with a greater central banks' consistency in inflation forecast targeting (IFT) result in more FL consumers' expectations.

Methodology/methods: We quantified inflation expectations of consumers on the basis of survey responses (EC Business and Consumer Surveys) with Carlson and Parkin method. When it was needed we applied its version adjusted for deflation. Then, we checked the rationality of consumer expectations (tests for their unbiasedness and orthogonality) and the degree of their FL by means of regression models. Finally, we used the IFT index, which we have elaborated ourselves in order to assess the transparency of the forecasting system and the central banks' commitment to IFT. The research covers Czechia, Hungary, Romania, Poland, Sweden and the UK and the time span of 2001-2016.

Findings: For Poland, Sweden and the UK more IFT commitment and transparency was related to more consumers' forward-lookingness. For Czechia we found

low level of FL in expectations but high level of IFT commitment. We did not succeed in estimating the extent of FL for the two remaining countries due to structural breaks in their monetary policy. The following study contributes to the literature on inflation forecast targeting as it presents the novel empirical application of IFT index for the expectations analysis.

Introduction

In this paper we investigate whether the central banks' practice in forecasting inflation, revealing their forecasts and following the inflation forecast targeting (IFT) support the forward-lookingness (FL) of consumers' expectations. The purpose of this study is to answer this question and verify the hypothesis which assumes that both the greater involvement of Monetary Policy Committee (MPC) in IFT (1) and more transparent forecasting system (2) result in more forward-looking consumers' expectations. We focus on the expectations of consumers as their choices are decisive for the economic output. The existing research covers mostly business and professional forecasters. The examination of the associations of the expectations and the central bank's forecasts, which are actually quite scarce considering the importance of the problem, did not deliver unambiguous responses on the possible interrelations. That is why we have decided to cover this matter again by applying an indirect approach to the problem.

The research covers Czechia, Hungary, Romania, Poland, Sweden and the United Kingdom. They are European countries with independent monetary policy held under inflation targeting regime (IT). The time span is 2001-2016.

The paper contains the section with theoretical and empirical findings which underline our assumptions and methodology, then the methodological section, the section with the results and their interpretation and finally – we conclude the findings.

Literature overview

Our paper deals with the expectations of consumers and central banks' possibilities to affect these expectations. The role of expectations in the monetary policy conduct is widely acknowledged in the economic literature (Mankiw, 1990, pp. 358-361, Woodford, 2003, pp. 15-19) similarly as the framework of inflation targeting - recognized to be the best way to implement theoretical premises (Bernanke et al., 2001, pp. 10-16, Mishkin, 2009, pp. 9-15). Despite the post crisis eruption of criticism, neither the monetary theory nor the monetary strategy were discarded (Woodford, 2014, p. 550).

Producing and revealing macroeconomic forecast is an immanent part of IT. If the forecast is an input to MPC deliberations and if it is published, it can enhance monetary policy FL and the FL of economic agents' expectations. Eventually, IFT implementation ensures the central banks' loss function minimization. The literature presents numerous approaches to implementing IFT adjusted to the maturity of monetary policy (Svensson, 1997, pp. 1111-1146, 2000, pp. 155–183, 2002, pp. 771 – 780, 2005, pp. 1-54).

There are a few papers examining whether inflation forecasts actually affect inflation expectations. Such an analysis based on VAR model, covering Canada, Japan, Sweden, Switzerland and the UK, proves the central banks' ability to influence the expectations in three countries: the UK, Sweden and Japan (Hubert, 2011, pp. 1-37). Similar interactions were found for the US (Hubert, 2015, pp. 655-680).

Analogue conclusion was made for the US (Bauer *et al.*, 2006, pp. 2-25). The authors analyzed the forecast errors across a large section of forecasters and several macroeconomic variables. The enhanced Fed's transparency that started in 1994 and covered more explicit information on intentions resulted in the synchronization of private forecasts. This research examines the switch of regime (of communication) impact on expectations. A study for Japanese switch (Fuijwara, 2005, pp. 255-261) covering qualitative and quantitative evaluation found that the Bank of Japan's forecast publication affected forecasts of professional forecasters and reduced their uncertainty.

Other research, including 12 European countries grasps sizable effect of central banks' transparency, including the forecast publication, on forecast disagreement of professionals and non-professionals (Ehrmann, Eijffinger & Fratzscher, 2012, pp. 1018-1052).

The research conducted for Poland finds out that the central bank's projections of inflation affect neither the dispersion nor the median of the individual forecast of professionals. This effect is observable for GDB forecast (Kotłowski, 2015, pp. 432-454). Kowalczyk & Stanisławska (2016, pp. 1-35) find no conclusive result while analyzing the forecasts distributions of the National Bank of Poland and professional forecasters due to sample shortcomings.

Shock response analysis based on the structural VECM presented in Szyszko & Płuciennik (2016) confirms the reaction of consumers expectations in Czechia, Sweden and the UK on inflation forecast change. The strength and lag of the reaction differs among the countries. Expectations react also on the change of other macroeconomic indicators.

Interdependences of the central banks' forecasts of inflation and consumers expectations were found on the basis of statistical analysis for 4 European countries for about 15 years sample (Szyszko, 2017a, p. 9).

To summarize the previous findings related to our research question we conclude that (1) the number of studies is not high. (2) Is mostly due to methodological difficulties. Regardless of the methodology applied, the authors remain cautious while interpreting the results. (3) More research is produced to assess the central banks' strategy or their general transparency impact on expectations or their dispersions. (4) Most of the examination covers professional forecasters.

We focus on the consumers expectations as they proxy business (price setters) expectations better that those of professional forecasters (Coibion & Gorodnichenko, 2015 pp. 198-199). The same individuals who are responding as consumers in one survey may express business expectations in another as small and medium businesses do not hire economic experts. From the monetary policy point of view price setters and consumers expectations are more relevant than forecasts of professionals. We are aware that, according to Carrolls' epidemiological expectations (Carroll, 2003, pp. 269-298), the link between the central banks' forecast and consumers' expectations is not direct. Nonetheless, it should exist.

Method of the research

The 4-step methodology is presented in Tab. 1.

Table 1. Steps of the research

Step	Description of the procedure	Result	Literature
I	Expectations quantification with adjusted Carlson and Parkin method. For deflation longer that 3M method with scaling factor is applied.	Time series with consumers expectations	(Carlson, Parkin, 1975, 123-138), (Łyziak, 2010, pp. 8-11)
II	Tests for unbiasedness and orthogonality.	Rejection of rational expectations hypothesis	(Gerberding, 2001, pp. 26-28)
III	Estimations of regression models in which independent variables represent forward and backward-looking components of expectations	Estimation of the forward-looking component in consumers' expectations	(Łyziak, 2014, pp. 17-19)
IV	Index-based inflation forecast targeting and its transparency assessment	Evaluation of the CBs' transparency and commitment to IFT	(Szyszko, 2017b)

Source: own.

As consumers' expectations are examined in qualitative surveys, we commence with their quantification. Except for standard quantification procedure, we apply a novel approach prepared for the periods when standard scaling factor, which is actual or perceived inflation rate (in this research we apply objectified version of the method with actual inflation), is non-positive. In the episodes of non-positive scaling factors the problem with surveys' responses interpretation in the light of Carlson and Parkin method's assumptions occurs. Łyziak (2013, pp. 77-98) proposes the suspension of the unique scaling factor assumption for the whole population and finds the solution to probabilistic approach with two scaling factors. Although we find it more proper methodologically to apply scaling factor method, we also quantified the expectations in a standard way. The details of the sample description are given in Tab. 2.

Table 2. Sample and the data

CB	**CZ**	**HU**	**PL**	**RO**	**SE**	**UK**
Time span*	01-16	01-16	05/01-16	04-16	01-16	01-16
Scaling factor**	No	No	Yes	Yes	Yes	No
Forecast	Inflation Reports or equivalent documents					
Expectations	European Commission Business and Consumers Surveys; fractions of responses on qualitative questions; monthly data					
Macroeconomic indicators	Central banks and national statistical offices. Monthly data for inflation, unemployment, industrial production index, broad money. Daily quotations of exchange rates (vis-à-vis EUR and USD) and 3M interbank offer rates averaged					
Oil prices	Macrobond. Brent oil. Monthly averages of spot prices. USD per barrel					

* 2001-2016 is the basic time span of the research. It is shortened for PL and RO due to time series on expectation accessibility

** Expectations quantified with scaling factor procedure for deflation episodes

Source: own.

Tab. 3 presents the tests held under the 1th and 2nd step of the research. Tests for expectations rationality must precede the analysis of the expectations hybrid nature: if the expectations were rational, further estimations would not be justified. We follow standard procedures presented in the literature (examples of which are presented in Tab. 1). In order to test the orthogonality we used the macroeconomic variables presented in Tab. 2.

Table 3. Regression models

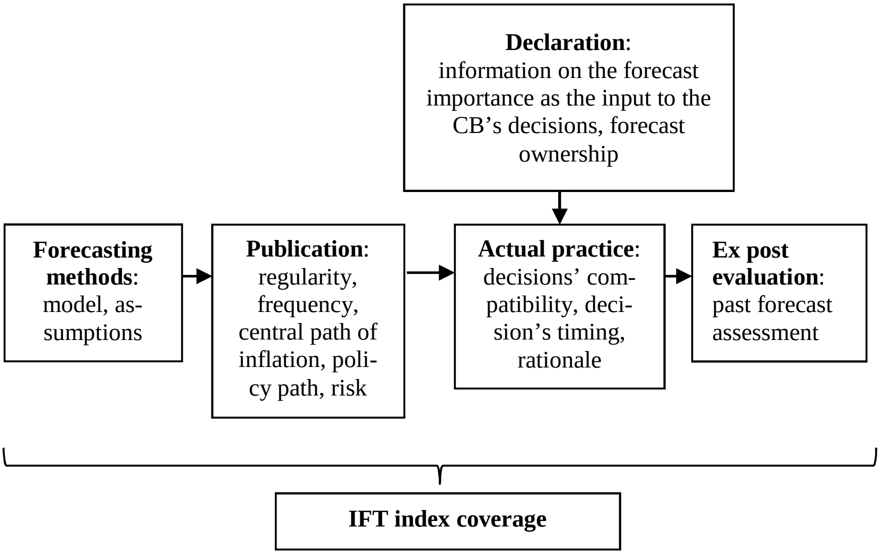
Test for:
Unbiasedness:
$$\pi^e_{t\|t-12} = \alpha + \beta\pi_t + \varepsilon_t \quad (1)$$ where: $\pi^e_{t\|t-12}$ is expected at time *t* inflation rate formed 12 months earlier, π_t is actual inflation at period *t*. ε_t is white noise error. H0: $\alpha = 0 \; i \; \beta = 1$
Orthogonality:
$$e_t = \alpha_0 + \alpha_1\Omega_t + \varepsilon_t \quad (2)$$ $$e_t = \alpha_0 + \alpha_1\Omega_t + \alpha_2 e_{t-1} + \varepsilon_t \quad (3)$$ where: $e_t = \pi^e_{t\|t-12} - \pi_t$ is expectation error Ω_t is macroeconomic variable affecting inflation H0: $\alpha_1 \neq 0$
Hybrid nature of expectations:
$$\pi^e_{t+12\|t} = \alpha_1 + \alpha_2\pi_{t+12} + (1-\alpha_2)[\pi^e_{t-2\|t-14} + \alpha_3(\pi^e_{t-2\|t-14} - \pi_{t-2}) + \alpha_4(\pi_{t-2} - \pi_{t-14})] + \varepsilon_t \quad (4)$$ $$\pi^e_{t+12\|t} = \alpha_1 + \alpha_2\pi_{t+12} + (1-\alpha_2)\pi_{t-2} + \varepsilon_t$$ (5) H0: $\alpha_2 = 1$

Source: equations specification after Łyziak (2014, pp. 14-19); same procedures with different quotations widely applicable.

Equations (4) and (5) investigate the hybrid nature of the inflation expectations. Equation (4) presents a mixture of FL and adaptive expectations, whereas equation (5) incorporates the FL and the static approach. In both equations α_2 represents the degree of forward-lookingness.

Finally, we use an index of IFT implementation in order to assess the CBs commitment in IFT implementation. The index is presented in Szyszko (2017b). We present its novel application. The index makes it possible to assess whether the central bank implements the IFT: it checks the transparency of forecasting systems and the MPC consistency in following its own forecast. Except for the calculation of the complete index we calculate subindex which detects solely the forecasting system transparency (IFT_{trans}). This index excludes the declaration and actual practice aspects from the IFT index. Our hypothesis relates FL of expectations to both IFT implementation and forecast transparency, which is why we need two indices at this point of the research.

Graph 1. IFT index aspects



Source: (Szyszko, 2017b).

The final step of the research consists in joint analysis of the level of FL and IFT implementation and the forecast transparency. As the sample covers only 6 countries, it will be done qualitatively.

Results and their interpretation

Tab. 4 presents the results of the FL estimations and IFT/IFTtrans indices. For FL we have chosen to present the α2 and R2 of the hybrid equation with better adjustment. It is static specification for most of the cases.

Table 4. Results: forward-lookingness and IFT implementation

	CZ	HU	PL	PL_SF	RO	RO_SF	SE	SE_SF	UK
Eq.	5	x	5	5	x	x	4	5	4
α_2	0.1002		0.0815	0.0832			0.1452	0.1492	0.1307
p-value	0.0000		0.0000	0.0000			0.0000	0.0000	0.0000
R^2	0.9740		0.9572	0.9531			0.9733	0.9694	0.8886
IFT	0.88	0.67	0.52		0.56		0.88		0.77
IFT-trans	0.89	0.81	0.60		0.68		0.87		0.71

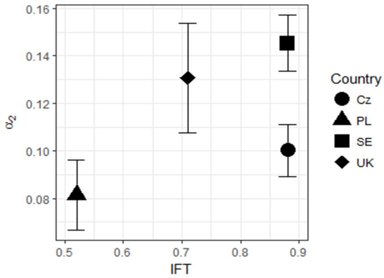
Source: own.

The starting point of the results interpretation refers to Hungary and Romania where we did not manage to estimate the hybrid expectation equation. It is in our opinion, it is due to the structural breaks in the monetary policy in these countries. In general, they both implement IT. In contrast to remaining 4 countries, the monetary policy of the National Bank of Hungary (NBH) and the National Bank of Romania (NBR) changed a lot during the research period. Up to February 2008 the NBH conducted quite eclectic monetary policy: IFT together with HUF stabilization. During the research period the NBH lowered its inflation goal remarkably. The NBR adopted inflation targeting in 2005 so the time span covers regime switch. There was no continuous disinflation process in Romania. The inflation goal was also lowered there. These changes could affect expectations formation and the learning process of the economic agents.

The results for 4 remaining countries are more obvious to interpret. The FL of expectations varies from about 8% for Poland to about 14% for Sweden. It is higher for the developed economies where the consumers have had more time to learn how the monetary policy is conducted. The application of scaling factor for expectations quantification did not bring remarkably different results. Nonetheless, it was more proper methodologically.

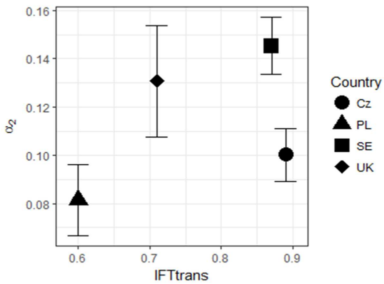
The IFT index and its transparency subindex are the highest for the Czechia and Sweden. They are the most transparent inflation forecast targeters worldwide as they are in the group of several countries which reveal explicit policy path of the monetary policy. The index for the UK shows its moderate consistency in IFT implementation and the system transparency. The Bank of England remains reluctant to endogenize and publish its interest rates. Diminished index value for Poland can be simply explained by the fact that in their cases at the beginning of the research period the IFT/IFT$_{trans}$ equaled 0 – the forecast was not revealed.

Figure 1. FL and IFT implementation



Source: own.

Figigre 2. FL and IFT transparency



Source: own.

In Fig. 1 we present the results of FL and IFT implementation while Fig. 2 presents the relation of FL of expectations and IFT transparency. The joint analysis of FL and IFT/IFT$_{trans}$ shows that more IFT commitment (1) or more transparency of forecasting system (2) is associated with higher consumers' FL for Poland, UK and Sweden. The results are mixed for Czechia (lower FL of expectations but the most transparent forecasting system and the most IFT committed MPC). The results for this sample show that it is rather the monetary policy experience that matters for expectations FL.

Conclusions

Our paper provides the analysis of consumers' expectations FL in the light of central banks' consistency in IFT implementation. The FL is measured with the use of standard procedures: after rejection of rational expectations hypothesis we regressed the hybrid specification of expectations. Then, we used the index of IFT which assesses various aspects of inflation forecast targeting implementation including central bank's transparency in this field. We conducted the examination for 6 countries and in 2 cases – due to some strategical changes in the monetary policy we did not manage to estimate the level of FR. For the remaining 4 countries we cannot simply state that more IFT means more FL. However, in the broader sample we may find this relation.

The paper contributes to the literature on expectations as we used the novel approach of their quantification and the indirect approach to verify the hypothesis of the research. We see the possible extensions of the research: 30 other inflation targeters are out of sample. Except for IFT implementation and forecast transparency we can search for the explanatory factors for FL in central banks' effectiveness and their credibility. These paths of examination are on our research agenda now.

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Sales range and innovation activity in the industry system of Poland

JEL Classification: *L52; O25; P51; O31; O32; O33*

Keywords: *innovation; industry; system; country; sale range*

Abstract

Research background: In the literature, there is a discussion on the importance of the spatial distans to the user in the context innovation activity. Although, most of this kind of studies concentrate on exporting enterprises and compare them to domestic ones. Exporting activity is very important for catching-up countries, because of technology transfer in its background.
Purpose of the article: The aim of this paper is to determine whether the innovative activity in Poland's industrial system is a consequence of close interactions (local and regional), or perhaps conditioned by the imperative of functioning on the national and international market? Main hypothesis was to claim that on the current development level of Poland, the relationship between the range of sales and innovation activities are different from those in the more developed countries.
Methodology/methods: Empirical studies was created in 2006-2012 as a result of the systematic collection of questionnaires filled by industry enterprises in Poland from all regions (5209 correct fulfilled questionnaires). Methodical analysis was based on the theory of probability - probit modeling, because dependent variables were binary (0 or 1).
Findings: Local and regional environment is not conducive to stimulating innovation activity, but national spatial is a sufficient space, but high intensity observed only when the company has been working on the international market. It means, that the industry maturity level in Poland is good enough for creating a domestic innovation environment. This kind of an aggregation level should be stimulating by the government innovation policy.

Introduction

The model of the endogenous growth suggests that internationalization is an opportunity for businesses, mobilising them to innovation activity, particularly to the research and development intensity, and as a result to the growth of export (Romer, 1990, p. 75). At the same time, heterogeneity of companies concentrated in a limited geographical space (locally, regionally) has a negative impact on their opportunities for the investment expansion, improvement of productivity or development of export (Bernard (Ed.), 2003, p. 1269) – the advantage of specialisation over diversification. Specialisation according to the concept of endogenous development should contribute to an increased number of interactions (new specialised products and processes) only at the regional level, or even local, thus leading to the growing volume of internal transactions. This fact raises the question whether internationalisation proves to be a stronger phenomenon?

The first concepts discussing the process of internationalisation of enterprises were formed in the 70s of the last century, but since then they have evolved from the level of an incremental process (stage) towards the holistic, specified and integrated approach (Daszkiewicz, 2014, p. 9). Currently, the Upssala-I model is at the front of considerations (Johanson &Vahlne, 1977, p. 28; Johanson & Wiedersheim-Paul, 1975, p. 309) (U-model) as well as the updated U-model (Johanson & Vahlne, 2009, p. 1411; Schweizer, Vahlne &Johanson, 2010, p. 350), which draw attention to the important role, which is played by knowledge and education of companies as a result of the internationalisation process.

The theoretical background of the research

In the light of previous studies on the effects of diffusion of knowledge, undertaking and intensifying export contribute to the launch of mechanisms of the so-called technological learning through export (learning-by-exporting). It is also believed that the international expansion is a gradual process, where companies increase their technological level due to learning how to operate on foreign markets (Delgado, Farinas & Ruano, 2002, p. 60). In addition, exporters are exposed to a more intensive competition and are forced to a more frequent implementation of innovations than entities operating only on the local market – this also affects their productivity (Wagner, 2007, p. 78).

Although in the literature there is a discussion whether it is export that stimulates innovations, or the other way round, these phenomena are probably linked with a number of mutual interactions. Moreover, it is a phenomenon with a more heterogeneous nature, as there are innovative companies, which do not export and entities functioning on the international market, which do not introduce new technologies, as it depends on many circumstances. Research in this area was carried out in Spain in 1994-2005 and 2001-2008 obtaining different results. In the first one, it has been argued that the interactions are turning, while only R&D has a positive impact on export, and the other way round. At the same time, only the innovation processes have a significant impact on the export activity, while this one, in turn, only determines the product innovations (Filipescu (Ed.), 2013, pp. 30-31).

In the analyses carried out in Germany and in the European Union countries of the "old 15", consistent results have been only partially achieved. It was shown that in the more developed countries, the intensity of export depends only on the innovative products, while it does not depend on innovative processes at all (Becker & Egger, 2013, p. 340). However, the attention at the same time is paid to the obtained conclusions, which are different than those achieved for research quoted previously, conducted in Spain.

Summing up these short theoretical considerations we conclude that these phenomena, even in the world research, did not gain full stability for the achieved results, and the research concepts are still evolving.

Therefore, on one hand, we are still dealing with theses that appeal for stimulating the export activities of enterprises, because it is significantly related to innovative activity, while on the other hand, new economic geography and the process of spatial approximation suggest that the companies, entering close geographical (local or regional) interactions, create innovative solutions, which ultimately lead to their export, at least outside the region. This does not change the fact that the end result of such a product system is obtained through the production, and mutual and multiple resale of intermediates in close spatial boundaries. As a result a regional product is formed, which is subject to export. The main research purpose appears in this situation: determination whether the innovative activity in the national system is the local or regional consequence, or whether it requires the over-regional or even over-national scope. On this basis a question appears: whether companies located in Poland behave differently than those functioning in much more developed countries – high technological gap?

The basic research hypothesis is formed as a statement that at the current level of development of Poland the relations between the range of sale and the innovation activity are different than the ones observed in more developed countries and only the structural changes in the economy and the acceleration of technological progress (reduction of the technological gap) will bring these trajectories closer together.

Research methodology

The empirical layer of the research was created in 2006-2012, as a result of the systematic collection of questionnaires filled by industrial enterprises from various regions, completed by conducting appropriate econometric analyses on the developed database of primary data (5209 correctly completed questionnaires). Extension over time was due to the lack of research funding, despite multiple applications for such in various institutions in Poland.

The methodological part was based on probability, and more precisely on statistical modelling of the probit type. Its usefulness arises when the dependent variable takes two values only (0 or 1), meaning that the studied phenomenon takes place or not. Its use has already been repeatedly and successfully tested by various researchers in the country and abroad (Dzikowski, 2012, pp. 475-488; Tomaszewski, 2013, pp. 101-113).

Different levels of aggregation of the sale range have been adopted for independent variables: local, regional, national, international. The selection of variables in the study was based on methodological standards applicable in all OECD countries. According to them, the innovation activity is understood as the entrance (expenditures and their structures), exit (implementations in relation to the structure) and interactions with the environment (in a division into different institutions from the area of science and industry).

The mere interpretation of the obtained models was limited to the character standing next to the main parameter of the equation and the achieved probability values. Moreover, several basis statistics have been indicated related to the model and its parameter: standard error, Wald statistics, chi-square, p-model value (the limit value p was assumed for the analyses at the level of 0,05).

Local (close) environment and innovation activity

Innovation activity of the industrial system in Poland strongly depends on the scale of operations of enterprises within the meaning the sale range. From seventy-two potential models, only eight cases did not achieve the statistical significance. What is more, every time the directions of interaction are consistent within the considered independent variables, without raising any interpretative problems.

Table 1. Coefficient value by independent variable „local range”, in probit models describing innovation activity in the polish industry system (statistical signicant models only)

Innovation activity	Coefficient	Standard error	Wald-statistic	Chi-square	p_1	p_2
Expenditures on R&D	-,684	0,055	-12,45	167,69	0,17	0,39
New investments (including):	-,380	0,049	-7,69	58,23	0,65	0,78
a) building and structures	-,381	0,056	-6,81	48,57	0,16	0,27
b) machinery and technical equipment	-,348	0,048	-7,26	52,35	0,57	0,70
Software solutions	-,589	0,048	-12,28	152,60	0,41	0,64
New products	-,320	0,048	-6,73	45,48	0,44	0,57
New technology (included):	-,565	0,048	-11,69	135,58	0,56	0,76
a) by-production systems	-,474	0,054	-8,86	82,40	0,19	0,35
b) support systems	-,534	0,060	-8,96	87,12	0,12	0,27
Cooperation with suppliers	-,303	0,054	-5,56	31,98	0,18	0,28
Cooperation with competitors	-,412	0,109	-3,77	16,71	0,02	0,05
Cooperation with customers	-,354	0,058	-6,07	38,74	0,14	0,23
Cooperation with PAN-units	-,400	0,164	-2,44	7,33	0,01	0,02
Cooperation with universities	-,380	0,105	-3,63	15,15	0,02	0,05
Cooperation with domestic R&D units	-,677	0,100	-6,82	59,86	0,02	0,09
Cooperation with foreign R&D units	-,821	0,230	-3,562	22,71	0,00	0,02
Total innovation cooperation	-,424	0,050	-8,555	74,84	0,30	0,46

P_1 – probability value of phenomenon in the purposeful group of enterprises
P_2 – probability value of phenomenon in the alternative group of enterprises
Source: the study based on own questionary research.

In the event when the company only operates on the local market, the chances to perform the innovation activity are statistically significantly lower than for the entities operating on a larger scale. It was impossible to estimate only one model for the dependent variable “new technologies directly related to production”. In the remaining seventeen cases, the interactions proved to be important when assuming a negative sign by the main parameter.

Summing up this part of the argument, we observe the system reluctance of companies limiting their activity to the local level, to show any innovation activity. Close geographical relations with customers in Poland do not create conditions conducive to entering into interactions of the technological nature. This is due to the current level of technological advancement of the country, weakness of local markets (no potentials), undemanding internal competition or the lack of pressure from the demand. Innovation activity at this level is primarily maintained through the relations with suppliers located outside the region and the passive transfer of knowledge. Given the current level of development of the local markets in Poland, it can be concluded that their development possibilities based on endogenous principles are unsatisfactory, taking into account the social mentality reluctant to change.

Space of the region and innovation activity

Since the local scope of impact proved to be unfavourable, perhaps the regional environment will also be conducive to innovation activity in Poland? Unfortunately, the boundaries of regions are also an inhibiting factor for the technological progress, however, with a slow change of some tendencies observed previously. In this situation, it has been possible to estimate fourteen out of eighteen models, which as statistically significant, which indicates the change of importance of the regional environment from the unfavourable impact towards a neutral direction. However, in other analyses cases, this level of aggregation is a de-stimulating factor for the innovation activity in the national industrial system, that is, the boundaries of provinces, in which the studied companies operate, so far have not created a friendly endogenous atmosphere for technological changes.

The boundaries of regions are the natural destimulant for innovation activity in the national industrial system, although the power of the negative impact is smaller than for the local sales range. Thus, endogenous intraregional relations cannot create circumstances conducive to technological changes in the provinces, and these are system-wide conditions, as they concern all regions in Poland. So far they have not achieved the internal potential able to spontaneously and systemically create innovations and accelerate processes related with them.

National environment and innovation activity

When analysing the patterns, which were observed for the companies with the national sales range, we can argue that the boundaries of the regions define the boundary between the low and high systemic innovation activity in Poland. Companies operating nationally are much more interested in implementing new technologies. Thus, the territory of the region is a measure of the technological inefficiency, as opening to a wider environment is conducive to accelerating the innovation activity, as evidenced by fifteen statistically significant models, in which the parameter has achieved a positive sign.

The national environment turns out to be a condition sufficient for raising the system chances for the innovation activity of industrial companies. In other words, the export activity is not a prerequisite for the acceleration of innovative processes in Poland. The supra-regional level is related to a higher level of competition, quality requirements, risk and necessity of the different organisation of the activity (increased distance). In total, they induce the break of the current thinking about the market, in order to be able to expand the sales and cross the demarcation line between the low and high productivity.

Export and innovation activity

The export activity of the companies is also closely linked with the innovation activity. Both the strength and universality of impacts are greater than in the case of the national sales range. As we can see, for the trends, the obtained results are consistent with analyses conducted in other countries, while being different in several interesting areas. From eighteen potential dependent variables, seventeen models were estimated (apart from the innovative cooperation with competitors). In all of them, the main parameters had a positive sign, Therefore, there is a positive and universal correlation between innovations and export. The achieved probabilities are naturally higher than for the national environment, that is the innovative intensity is higher in the group of experts.

Table 2. Coefficient value by independent variable „foreign range”, in probit models describing innovation activity in the polish industry system (statistical signicant models only)

Innovation activity	Coefficient	Standard error	Wald-statistic	Chi-square	p_1	p_2
Expenditures on R&D	+,617	0,039	15,66	246,46	0,53	0,29
New investments (including):	+,365	0,045	8,12	68,09	0,83	0,73
a) building and structures	+,448	0,041	10,98	119,79	0,36	0,21
b) machinery and technical equipment	+,365	0,042	8,69	77,24	0,77	0,64
Software solutions	+,540	0,041	13,07	176,16	0,75	0,55
New products	+,123	0,039	3,14	9,96	0,58	0,54
New technology (included):	+,451	0,044	10,14	106,85	0,83	0,69
a) production technology	+,381	0,039	9,74	95,65	0,59	0,44
b) by-production systems	+,428	0,040	10,82	116,7	0,44	0,28
b) support systems	+,418	0,041	10,15	102,27	0,34	0,20
Cooperation with suppliers	+,207	0,041	5,03	25,08	0,31	0,24
Cooperation with customers	+,431	0,042	10,26	104,17	0,31	0,18

Table 2. Continued

Innovation activity	Coefficient	Standard error	Wald-statistic	Chi-square	p_1	p_2
Cooperation with PAN-units	+,215	0,092	2,34	5,33	0,02	0,01
Cooperation with universities	+,477	0,063	7,56	55,97	0,08	0,03
Cooperation with domestic R&D units	+,450	0,052	8,58	72,13	0,14	0,06
Cooperation with foreign R&D units	+,709	0,085	8,32	71,83	0,05	0,01
Total innovation cooperation	+,441	0,039	11,28	127,97	0,56	0,38

P_1 – probability value of phenomenon in the purposeful group of enterprises
P_2 – probability value of phenomenon in the alternative group of enterprises
Source: the study based on own questionary research.

The export activity favours the innovation activity. The international market is very demanding and forces more dynamic adjustment of the offer in the national companies, including in terms of the used technologies. The positive impact of export on the system nature, more common and stronger than of the companies restricting their sales market to the borders of the country.

Conclusions

The Polish industry is divided into two parts. The first of them is a group of companies operating in the province boundaries, offering the manufactured products locally or regionally (34,9% of the population). It is characterised by a much lower tendency to innovations in the areas of funding and implementing new technologies, as well as innovative cooperation with the sector and scientific community. These phenomena are common and strong, especially for the entities limited to the local market. On this basis, it can be stated that the national provinces have not reached the endogenous ability (potential) so far for generating new technologies. Therefore, the Bernard thesis is confirmed about the weakness of spatial approximation in stimulating innovative processes and the limited role of intraregional specialisation, that is small system chances for creation of cluster structures in these areas.

The second group of companies are those, which go with their products beyond the region. At the same time, for the increased innovation activity the sales on the national market is sufficient, as the export additionally makes these processes more dynamic (intensifies them) in all planes under consideration. This undermines Becker’s thesis, which makes the export intensity dependent only in product innovations. Enterprises in Poland activate technological changes with the increase of the distance to the target market, which in turn increases the importance of the spatial approximation in the catching-up countries and the appropriateness or usefulness of the theory of the new Krugman economic geography.

From an evolutionary perspective, a stronger relation has been discovered between the export and new processes, when the national market remains a strong and necessary stimulant for the products, which is partly consistent with the conclusions drawn by Filipescu.

Taking into account other studies carried out in our country in this field it can be stated that the strong relation of export with innovation activity has been confirmed, but with different characteristics. As the chances for process innovations are higher than for product innovations, and in the case of the former, export additionally intensifies them, when its does not do this to the latter.

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The use of multivariate techniques for youth unemployment analysis in Poland

JEL Classification: *C38; J42*

Keywords: *labour market; unemployment; young people; cluster analysis.*

Abstract

Research background: The labour market situation is considered to be the most widely discussed part of economic development. However, it should be noted that the unemployment situation of young people (aged 15 -24 years) in Poland in general terms seems to be problematic. Overall, the unemployment rate among young people in Poland is significantly higher than the overall unemployment rate in the EU. Moreover, the situation varies greatly across the regions.
Purpose of the article: Using multivariate techniques as a theoretical framework, the main goal of the paper is to identify groups of Polish regions that share similar patterns regarding unemployment among young people.
Methodology/methods: The initial calculation is based on the concept of the taxonomic measure developed by Hellwig. The final method used to create clusters of objects (across 16 voivodeships of Poland) is cluster analysis. A segmentation of the voivodeships is observed for the years 2005 and 2014, based on selected indicators to determine the labour market situation.
Findings: Through the exploration of the advantages of multivariate methods, the nature of youth unemployment is revealed in more precise detail. Indeed, dendrogram analysis divided the voivodeships into five groups, which are characterized by similar features associated with the labour market. It was found that the groups which emerged in 2005 have a different composition of regions than in 2014; this difference seems to be connected to the economic crisis.

Introduction

Unemployment is an economic indicator that refers to the portion of people who are actively looking for a job and are unable to find work. The youth unemployment ratio is calculated as the ratio of youth unemployment to the adult unemployment rate. Youth unemployment is often estimated separately because the rate has historically been higher than that for older age groups. Moreover, this phenomenon, which has recently attracted increasing attention, has negatively influenced countries' labour markets at a time of economic crisis. In fact, there is a wide range of both theoretical and empirical literature devoted to the connections between the global economic crisis and labour markets, e.g. Rose & Spiegel (2011), Madianos *et al.*, (2014), Boeri & Jimeno (2016). However, the rather narrow range of literature regarding youth unemployment has focused on the dispersion of unemployment across Poland's regions during recessions.

In this context, the main aim of this paper is to show the local diversity of the situation on the labour market among the voivodeships of Poland in 2005 (before the economic crisis) and 2014 (under the effects of the crisis). In order to contribute to the achievement of this goal, our ambition is to detect the presence of homogeneity among different regions based on a multivariate statistical method, namely cluster analysis and Hellwig's method.

The paper consists of five main sections. Section 2 focuses on literature data and methodology. In Section 3, the main facts about the specific unemployment situation in Poland are presented, paying particular attention to youth unemployment. The results of the analysis are presented and commented on in Section 4. The main conclusions are presented in Section 5.

Research methodology

Cluster analysis is one of multidimensional methods that allows observations to be classified into groups. Cluster analysis techniques include several different algorithms, which can be broadly divided into two methods: hierarchical and non-hierarchical. Dendrograms are often used to aid visualization in the form of a tree showing the linkages between observations. In order to group the voivodeships into clusters, a hierarchical Ward's algorithm based on a squared Euclidean distance, has been chosen. This method is the most highly recommended one due to the efficiency criterion of presenting the actual data structure.

Next, in the current research, the concept of taxononomic measure proposed by Zdzisław Hellwig (Hellwig, 1968) is used. This is a commonly applied method in spatial economic research which allows the researcher to produce a synthetic measure d_i, which takes into account the impact of many indicators on socio-economic development. The main advantages of Hellwig's method are its methodological simplicity and the flexibility of its application.

The aim of this paper is to use cluster analysis and Hellwig's synthetic measure to create a new perspective for discussing differences and similarities of youth unemployment in the regions of Poland. In addition, a similar method can be applied in the context of other countries to visualize which of the regions are more similar.

Analysed data are obtained from the databases of the Central Statistical Office of Poland and Eurostat. Indicators which determined the situation of young people in Poland for two different years – 2005 and 2014 were selected. Statistical calculations were performed using SPSS statistical software, version 22.

The starting point of the analysis were indicator data for the labour market and wages. The initial set of potential diagnostic variables includes six indicators of the structure of unemployment by age, education, work experience and other measures of unemployment. The variables are presented in Table 1. All of the variables were standardized with classic standardization formulae.

Table 1. Diagnostics variables for the purpose of describing youth unemployment

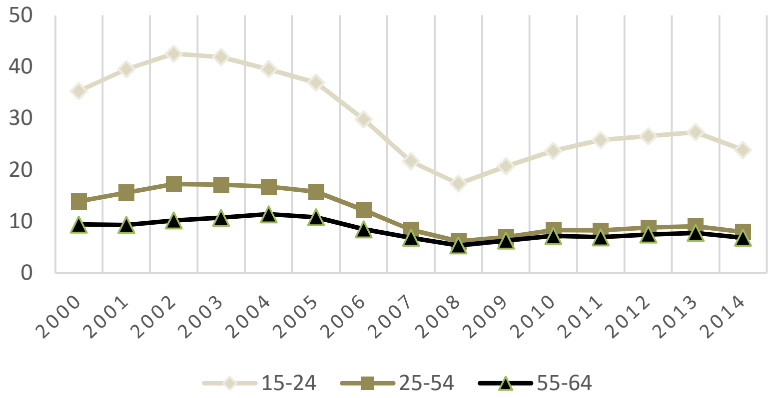
Variable	Description of diagnostic variables
X_1	participation of unemployed persons in age group of 15-24 years in the total number of unemployed
X_2	participation of unemployed persons without internship in the total number of unemployed
X_3	participation of unemployed persons with higher education in the total number of unemployed
X_4	job vacancy rate
X_5	number of unemployed persons attributable to one offer
X_6	the monthly average gross salary in relation to the national average

Source: own calculations based on Eurostat (2017).

Statement of the problem and research tasks

A main driver of Polish unemployment divergence is youth unemployment. Figure 1 plots the annual change (horizontal axis) in the unemployment rate (vertical axis) over the 2000 – 2014 period for three age groups. As Figure 3 illustrates, the highest level of unemployment is experienced by young people. Youth unemployment rates at a national level have experienced considerable turbulence. The unemployment rates within other age groups are much more stable. Since 2006, the unemployment rate among young people has declined by about 10 %, and it is still twice as high compared to those of other groups. As shown in Figure 3, the recession affected youth unemployment rates earlier than it affected other age groups; this is indeed the group most affected by the economic crisis.

Figure 1. Unemployment rate by age group in Poland between 2000 and 2014.



Source: own calculations based on OECD Statistics.

Table 2 shows the changes among the investigated factors in 2005 and 2014, these are the main unemployment facts that influenced our analysis. We observe a significant decrease in almost all chosen variables, namely X_1, X_2, X_4, X_5.

Table 2. Specification the investigated factors

Characteristics	2005	2014	Growth Rate (in %)
age: 15-24	774 575	347 325	-55.16
education: higher education	152 400	225 441	47.93
unemployed persons without internship	656 600	315 400	-51.96
job vacancy rate (%)	66	50	-24.24
number of unemployed persons attributable to one offer	158	46	-70.89
the monthly average gross salary (PLN)	4439.76	6516.26	46.77

Source: own calculations based on Eurostat (2017).

The rise in youth unemployment in Poland and increasing levels of European unemployment dispersion across countries and regions are two facts that give us the motivation required to analyse the situation. In order to pursue these problems, the paper proceeds to develop an analytic framework for identifying groups of Polish regions that share similar patterns regarding unemployment among young people.

The result of research

In order to compare the labour market situation of young people between the Polish regions in 2005 and in 2014, we implemented a two-step procedure. Firstly, we use the concept of the taxonomic measure to arrange the items being studied in a linear manner from the best to the worst. In addition, we classified the Polish regions according to their labour market performance, using cluster analysis methods. Similar results were obtained in both classifications for the years 2005 and 2014.

Table 3. Polish regions arranged according to Hellwig's measure in the years 2005 and 2014

Voivodeship	d_i in **2005**	**Voivodeship**	d_i in **2014**
Masovian	0.632	Lower Silesian	0.656
Lower Silesian	0.629	Masovian	0.62
Pomeranian	0.554	Pomeranian	0.51
West Pomeranian	0.485	West Pomeranian	0.503
Opole	0.479	Silesian	0.465
Lubusz	0.471	Lubusz	0.461
Łódź	0.444	Łódź	0.443
Silesian	0.415	Opole	0.436
Greater Poland	0.347	Kuyavian-Pomeranian	0.427
Kuyavian-Pomeranian	0.326	Greater Poland	0.414
Warmian-Masurian	0.282	Warmian-Masurian	0.329
Lesser Poland	0.258	Lesser Poland	0.216
Podlaskie	0.155	Podlaskie	0.173
Podkarpackie	0.149	Podkarpackie	0.09
Lublin	0.106	Świętokrzyskie	0.076
Świętokrzyskie	0.025	Lublin	0.058
Arithmetic average	0.360	Arithmetic average	0.367
Standard deviation	0.186	Standard deviation	0.190

Source: own calculations based on Eurostat (2017).

According to the results presented in Table 3, there is a high diversity for the different provinces with respect to the synthetic measure. For a group of provinces characterized relative to each other, the best situation on the labour market in 2014 occurred in the Lower Silesian and Masovian regions. The lowest synthetic measure value was obtained for Lublin and Świętokrzyskie voivodeships. Both of these voivodeships stand out from the others in terms of the values of the measure. This means that in these voivodeships we have to deal with the worst situation with regard to youth participation in the labour market from the viewpoint of the adopted diagnostic features. Positive changes in the labour market were observed at the Silesian voivodeship where the dynamic of the changes reached the highest level (from 8th position to 5th). It may be stated with certainty that the situation in the labour market has worsened in the Opole voivodeship (falling from 5th to 8th position). Also, a decrease by one position was observed for the Masovian, Greater Poland and Lublin voivodeships. The process of arranging the regions showed that seven of them (Pomeranian, West Pomeranian, Lubusz, Łódź, Warmian-Masurian, Podlaskie and Lesser Poland) occupied the same position with regard to the value of d_i.

In order to create groups of voivodeships, which are similar in terms of the structure of the labour market, a hierarchical cluster analysis has been used. The composition of clusters in the year 2005, is shown in Table 4, while in the year 2014 in Table 5. A detailed description of the clusters in 2005 and 2014 is presented in Table 6 an Table 7. The territorial distribution of the clusters produced by the analysis is presented in Figure 2.

Table 4. Distribution of Polish regions by clusters in 2005

2005				
1	2	3	4	5
Łódź	Lower Silesian	Opole	Podkarpackie	Świętokrzyskie
Greater Poland	Silesian	West Pomeranian	Warmian-Masurian	
Kuyavian-Pomeranian	Pomeranian	Lublin	Podlaskie	
Lubusz	Lesser Poland			
	Masovian			

Source: own calculations based on Eurostat (2017).

Table 5. Distribution of Polish regions by clusters in 2014

2014				
1	2	3	4	5
Opole	Silesian	Podlaskie	Warmian-Masurian	Łódź
Kuyavian-Pomeranian	Greater Poland	Podkarpackie	Lublin	Lesser Poland
Pomeranian	Lower Silesian	Świętokrzyskie		Masovian
West Pomeranian	Lubusz			

Source: own calculations based on Eurostat (2017).

Table 6. Cluster description in 2005

Year	**2005**				
Cluster	**1**	**2**	**3**	**4**	**5**
participation of unemployed persons in age of 15-24 years, %	22.5	22.2	19.67	24.33	24
participation of unemployed persons without internship, %	20.25	23.2	21	26.67	29
participation of unemployed persons with higher education, %	4.5	17	8.67	6.33	8
indicator of the new working places using, %	66	73.2	62.33	51.33	57
number of unemployed persons attributable to one offer	159.25	116.2	251.33	408.67	1070
the monthly average gross salary (PLN)	3397.16	4424.18	3325.02	3162.91	3208.39
Number of voivodeships in cluster	4	5	3	3	1

Source: own calculations based on Eurostat (2017).

Table 7. Cluster description in 2014

Year	**2014**				
Cluster	**1**	**2**	**3**	**4**	**5**
participation of unemployed persons in age of 15-24 years, %	16	15	18.53	18	15
participation of unemployed persons without internship, %	15.5	15	21.67	21	17
participation of unemployed persons with higher education, %	9	11.25	14.33	12	12.67
indicator of the new working places using, %	55	56	29.33	35	52
number of unemployed persons attributable to one offer	43	27	103.67	78	61
the monthly average gross salary (PLN)	5186.82	5513.26	4949.3	4740.23	6002.67
Number of voivodeships in cluster	4	4	3	2	3

Source: own calculations based on Eurostat (2017).

Cluster 1 (2005) - This cluster is characterized by the lowest level of unemployed persons without internship and the lowest percentage of unemployed persons with higher education.

Cluster 2 (2005) - This cluster is characterized by high levels of unemployment among the highly educated, although there are a lot of vacancies which are being regularly taken and the average salary in this cluster is the highest. Since the cluster includes five of the 16 voivodeships, the situation regarding unemployment among people with higher education and a lack of jobs for them was important for Poland.

Cluster 3 (2005) - The lowest indicator of unemployment among young people is a characteristic of this group. The rate of unemployment among people with higher education is almost twice as low as it is for cluster 2, but it stands at the highest level compared to clusters 1, 4, 5.

Cluster 4 (2005) - Being the cluster which is characterized by the highest rate of unemployment in the age group of 15-24, it has the lowest level of job vacancy rate The voivodeships in this cluster include the lowest levels of monthly average gross salary.

Cluster 5 (2005) - The single voivodeship in this cluster is characterized by the greatest number of unemployed persons attributable to one offer as well as the highest level of unemployment among people without experience.

Cluster 1 (2014) - It includes four voivodeships which are characterized by the lowest percentage of unemployed people with higher education, as well as by the lowest percentage of unemployed persons without internship.

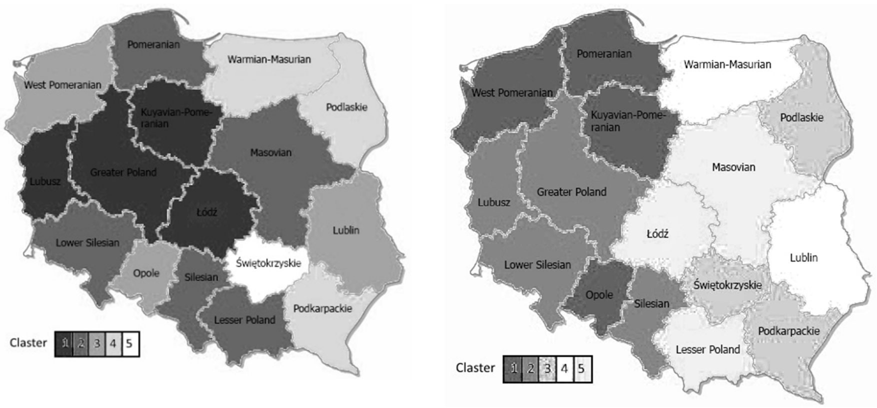
Cluster 2 (2014) - This group consists of four voivodeships. Compared with the first cluster it has lower indicators of participation of unemployed people in the age group of 15-24 years. This cluster is characterized by the lowest number of unemployed persons attributed to one offer and by participation of unemployed persons without internship.

Cluster 3 (2014) - Among all of the clusters this one is next to first in term of the participation of unemployed persons in age of 15-24 years, without internship and with high education.

Cluster 4 (2014) - A defining characteristic of the cluster is a lower monthly average gross salary than any other cluster. This cluster shares similar problems with cluster 3 when it comes to youth unemployment. It is in second place with a higher level of unemployed persons without internship. Even though these indicators in the cluster are slightly better than they are in the third cluster, this does not affect the size of the average salary.

Cluster 5 (2014) - This cluster shares a similar situation with cluster 2 when it comes to unemployed persons in the age bracket of 15-24 years. It has the highest monthly average gross salary despite the average values of other indicators.

Figure 2. Groups of the voivodeships distinguished on the basis of cluster analysis in 2005 (on the left) and in 2014 (on the right)



Source: own calculations based on Eurostat (2017).

To sum up, cluster analysis and the use of Hellwig's method have allowed us to examine the Polish unemployment situation with regard to groups of regions according to their youth labour market performances. According to the selected indicators of the market, it may be observed that advanced regions proved to be more homogenous. The clusters with highest numbers of voivodships are those with a good or at least a moderately good situation, in the sense of the synthetic variable, although their number changed over time.

Conclusions

The results of the analysis show that the methods used are suitable for interregional comparisons on the basis of the labour market. This paper presents data mining methodology, in particular, cluster analysis and Hellwig's methods which allowed us to divide the 16 voivodeships into five groups, which are characterized by similar features associated with the labour market. The measures provide a way to grasp the changes between the years 2005 and 2014 in the labour market situation in the Polish regions. Based on this analysis we may conclude that the labour market in Poland is considerably regionally structured. In the case of Poland, cluster analysis shows the division of the country into five groups which are homogenous in terms of unemployment, which is described by multiple characteristics at the same time.

This paper also has some important policy implications. Namely, the results could help decision makers to identify regional similarities/dissimilarities in the Polish labour market. The lack of stability in the labour market in the form of visible differences occurring in clusters requires special attention from the ruling elites who ought to take joint steps aimed at reducing the number of the young unemployed people. The state should actively contribute to reducing disparities between the regions. The main justification for the need for such a policy is to achieve equality of opportunity of development between the regions. The high level of regional diversity discriminates against people living in regions with high unemployment rates among young people and low per capita incomes. Furthermore, the findings of this paper may help to generate new ideas concerning which factors should be prioritized regarding equal opportunities for all young people in education and in the labour markets of the different regions of Poland.

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Global infrastructure projects as the factor of national economies's development (the case of the Turkish stream gas pipeline)

JEL Classification: *B16; C18; F02; F21; F63; H54*

Keywords: *global infrastructure projects; economic development; international investment; globalization*

Abstract

Research background: The current stage of the economy's development differs from the past ones in that the role of global infrastructure projects acquires ever more importance and that forming and designing of such programs becomes now a much more sophisticated process, all of this has led to a situation where we have to revise our system of economic methods of the evaluation benefits of a global infrastructure project for all involved countries. The existing methods and ways of evaluation influence global infrastructure projects on socio-economic development of the participating countries are to be complemented by new approaches reflecting the market changes and the advent of new financial instruments and stratagems.
Purpose of the article: The aim of the paper is to evaluate influence the global infrastructure project on socio-economic development of the participating countries in the globalized world economy with respect to its main economic and social consequences and synergy effects (the case of the Turkish Stream gas pipeline).
Methodology/methods: The authors crated methodological approach to the study of infrastructure projects influence on socio-economic development of the members based on the identification, evaluation and prediction of the influence of factors external and internal environment on the changing economic potential of the infrastructure projects participants.
Findings: Adequate investment in the development of infrastructure is an important driver of long-term economic growth. Traditionally, infrastructure has been funded mostly through public investment. However, in view of scarcity of budget-

ary resources and lack of capacity within the government to implement these ambitious programs, the strategy of the government relies significantly on promoting investment through a combination of public investment and private participation (include foreign investors). The presented methodological approach allows to define and early diagnose the global infrastructure projects which facilitate a multiplication effect within the national economy.

Introduction

The phenomenon of global infrastructure projects use as an instrument of countries' development has not been studied thoroughly by the economic science that has as its direct consequence the deficit of research directed to an integrated evaluation of creation and realization of such projects. The authors of the article set the goal to partly fill in this gap. A large-scale infrastructure project can obtain the status of a global project only if it represents a long term funds consuming project characterized by complexity, high costs, systematic character and relevance of the realized targets for all involved countries (Mitrofanova (2015)).

The current stage of the economy's development differs from the past ones in that the role of global infrastructure projects acquires ever more importance and that forming and designing of such programs becomes now a much more sophisticated process, all of this has led to a situation where we have to revise our system of economic methods of the evaluation benefits of a global infrastructure project for all involved countries. The existing methods and ways of evaluation influence global infrastructure projects on socio-economic development of the participating countries are to be complemented by new approaches reflecting the market changes and the advent of new financial instruments and stratagems.

Thus, the aim of the paper is to evaluate influence the global infrastructure project on socio-economic development of the participating countries in the globalized world economy with respect to its main economic and social consequences and synergy effects (the case of the Turkish Stream gas pipeline).

Literature review

An enormous body of (empirical) literature exists on the determinants of economic development. Even though the findings of these studies are not always consistent, most studies confirm a positive relation between investment in infrastructure and economic growth (Aschauer (1989); Esfahani & Ramirez (2003); Calderon & Serven (2004)). The level of influence depends on type, location and context of infrastructure projects. Several studies show how the complementarity and synergy of different types of infrastructure stimulate economic growth and how the efficiency in maintenance and operation of infrastructure services contributes to economic growth (Hulten (1996)).

Calderon & Serven (2004) show that infrastructure not only has a positive effect on economic development, but also on income distribution. The authors found significant effects of both quantity and quality of infrastructure. They reported large effects of infrastructure on economic growth: a standard deviation increase in the sectors included in the model (telephone, power supply and roads and railways) would raise growth rates by 5,7 percentage points.

Thus a global infrastructure project can be considered as a complex target program involving several countries. It is usually carried out consequently or simultaneously within the same life cycle of the project and is aimed at the achievement of a more serious synergy effect compared with the projects that are realized autonomously (Altshuler & Luberoff (2003); Gunton (2003); Priemus & Flyvbierg (2007)).

We intend that, by this study, to expand the scope of investigation regarding the field of infrastructure project evaluation. We will analyze the global infrastructure projects influence on economic potential of members under the conditions of globalization. The purpose of the study is development of methodological approach to the evaluation of infrastructure projects influence on socio-economic development of the members based on the identification and prediction of the influence of factors external and internal environment on the changing economic potential of the infrastructure projects participants.

Methodology of the research

The authors propose a methodology for evaluation of infrastructure projects influence on socio-economic development of the members based on the identification and prediction of the influence of factors external and internal environment on the changing economic potential of the infrastructure projects involved countries.

For each project, we conduct an assessment of its economic potential impact on involved countries. So the assessment covers not only economic development impact, but ecological development impact, and social development impact. This assessment is carried out at the start of a project and repeated after five years. The basis for the evaluation of economic potential factors became a set of indicators, divided into three groups and included in the proposed model:

1) Economic Development Impact;
2) Ecological Development Impact;
3) Social Development Impact.

Table 1 presents the different categories and their weights.

Table 1. Economic potential impact analysis

Development Impact Type	**Indicators of economic potential**	**Target / Future value (differ for all countries)**	**Nature of effect indicator**	**Weight indicator**
	group 1 - Economic Development Impact			
Financial sustainability / impact on shareholders and financiers	NPV (Disposable Income)		Direct	0,20
Impact on employees	Employment		Direct	0,20
Impact on customers and final consumers	Reducing Energy Costs		Direct	0,15
Impact on suppliers of inputs and services	Reducing Energy Import Dependence		Direct	0,15
Impact on suppliers of complementary products	Productivity		Direct	0,05
Impact on society through taxes and tariffs	Public Budgets		Direct	0,15
Impact on the balance of payments	Current Account Balance		Direct	0,1
	Weight group 1			**1,0**
	group 2 - Ecological Development Impact			
Eco-Efficiency	Reduction in GHG		Direct	0,30
Initial Environmental Risk Score	Environmental Risk Score		Return	0,40
Exploitation/Conservation of Non-Renewable Resources	Energy Asset Savings		Direct	0,30
	Weight group 2			**1,00**

Table 1. Continued

Development Impact Type	**Indicators of economic potential**	**Target / Future value (differ for all countries)**	**Nature of effect indicator**	**Weight indicator**
	group 3 - Social Development Impact			
Initial Social Risk Score	Social Risk Score		Return	0,30
Community Development Impact	Health Level (Mortality Rate)		Direct	0,40
Labor Relations Development Impact	Social Well-being		Direct	0,30
	Weight group 3			**1,00**
	Total:			**3,00**

Source: own work.

Under the proposed approach, the method of infrastructure projects influence assessment on socio-economic development of the members, comprising the following stages:

1. The formation of the indicator system to evaluate global infrastructure project impact on economic potential for different stakeholder groups (countries, investors).
2. The choice of key indicators and giving them specific weights within each group, based on the specific priorities of stakeholders related to global infrastructure project.
3. The calculation of the integral indicator of the infrastructure projects influence on socio-economic development of the members (EPI) on the basis of valuation of the actual values of key performance indicators according to the following formula:

$$EPI=\sqrt{\sum_{i=1}^{n} d_{econ}(1-Iecon_i)^2}+\sqrt{\sum_{i=1}^{m} d_{ecol}(1-Iecol_i)^2}+\sqrt{\sum_{i=1}^{j} d_{social}(1-Isocial_i)^2},$$

where: I_{econ}, I_{ecol}, I_{social} - is the normalized value of the indicators of economic potential (economic development impact, ecological development impact, and social development impact); d_{econ}, d_{ecol}, d_{social} - weighting factor (set by expert based on the specific gravity of the group of factors relates to the indicator).

It's important to determine key performance indicators and their target / future values (according macroeconomic conditions, and synergy of global infrastructure projects).

Depending on the value of the integral indicator, the authors list the following levels of the economic potential of the infrastructure projects participants:

1) [3,00–∞) – high;
2) [2,00–3,00) – average;
3) [1,00–2,00) – low;
4) [0,00–1,00) – critical.

The level of the economic potential of the infrastructure projects participants is regarded as critical in the case when the global infrastructure project's economic development impact, ecological development impact, and social development impact are very low.

Under the economic potential of the infrastructure projects participants is defined as the condition in which the values of the indicators of economic potential's factors don't reach their target values. If the value of the integral index is closer to the lower boundary of the interval [1,00–2,00), the potential increase in the level of economic potential is not clear, the upper bound shows the existence of the possibility of its increase to the average level.

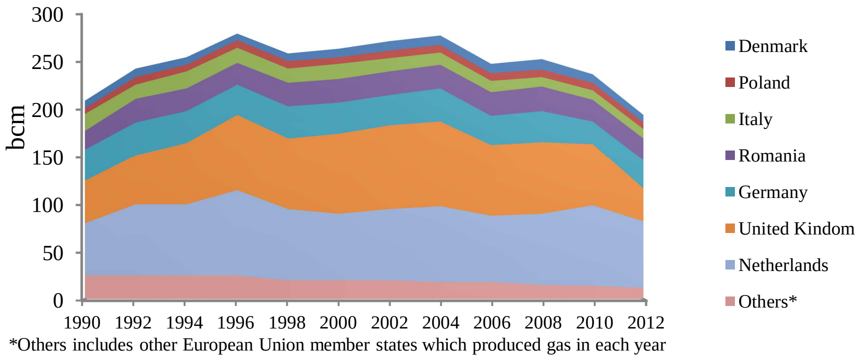
The average level of the economic potential of the infrastructure projects participants presupposes stable values of the ecological development impact, but also a sufficient degree of economic development impact and social development impact. There is a possibility of increasing the level to high due to increasing financial and investment potential. Special attention should be given to improving the indicators of social well-being.

The level of the economic potential of the infrastructure projects participants is considered to be high in the case where their activities are characterized by stable growth of indicators of the economic development impact, ecological development impact, and social development impact.

Results of empirical research

Gas output in the European Union has been falling since the mid-1990s due to depleting resources. Production reached its peak in 1997 and has been declining since, with moderate volatility. Natural gas production amounted to 173,7 bcm during 2012. Production has declined by 5,6% since 2011 and by 20,4% since 2007 (Figure 1).

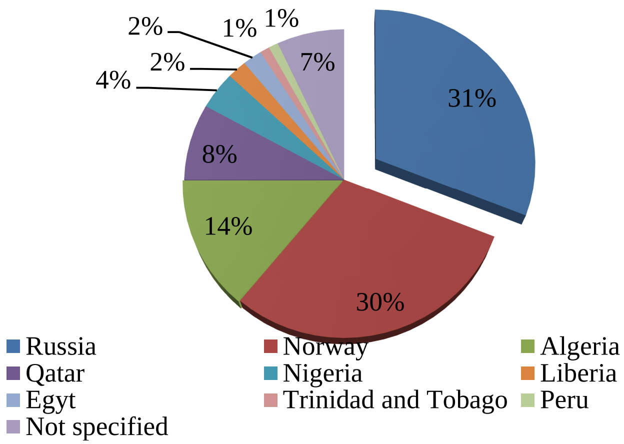
Figure 1. Natural gas production, 1990-2012.



Sources: IEA (2016), World Energy Outlook 2016, OECD/IEA, Paris, www.iea.org/bookshop/720- World_Energy_Outlook_2016.

In 2013, the European Union was the largest natural gas importing region in the world with an import bill amounting to EUR 87 billion in 2013 (Eurostat Comext database, 2014). The European Union is increasingly exposed to demand and supply trends in regional gas and global energy markets. The majority of imports reaches the European Union by pipeline. In 2014, imports were sourced from Russia (31%), Norway (30%), Algeria (14%) and Qatar (8%) as well as 17% coming from other countries, notably from Nigeria (4%), Trinidad, Tobago and others (Figure 2).

Figure 2. Gas imports to the European Union, 2014



Source: EU (2014), EU Energy in Figures, Statistical Pocketbook, 2014.

Russia who sells its gas to Europe via Ukraine, aimed at transferring its gas through alternative routes after having problems with the country. The Turkish Stream project was established with this aim. The natural gas line will carry the Russian gas below the Black sea to Turkish soil and from here will reach Europe passing through Greece.

The estimated carrying capacity of the pipeline is 63 billion cubic meters per year. Turkey will purchase about 14 billion cubic meters of gas and the remaining 49 billion will be exported to Europe. Russia's Gazprom will be responsible for the construction of all of the pipelines passing below the Black sea. The stretch through Turkey will be built jointly.

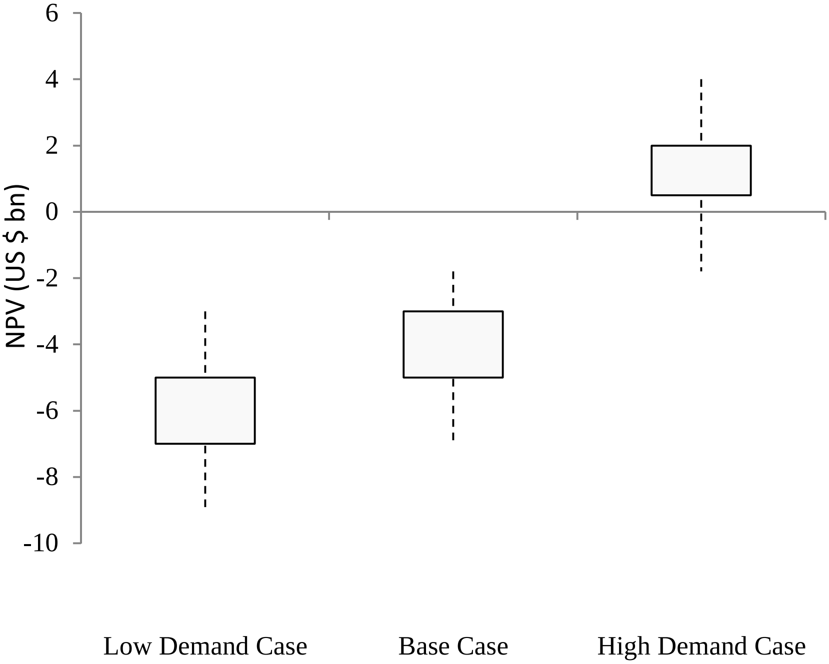
The total cost of the Turkish Stream project will be about 19 billion dollars.

Turkey will build the sections of the pipeline that run across its territory and receive a 10,25-percent discount on Russian gas purchases. An intergovernmental agreement on the gas transit pipeline remains to be ratified by the Turkish parliament.

Using the strategic gas market simulation model described in (Chyong and Hobbs, 2011), the NPV of the Turkish Stream gas pipeline investment is derived. Figure 3 shows the NPV of the Turkish Stream gas pipeline investment to Gazprom under the three demand scenarios. The black boxes with solid lines represent the minimum, average and maximum economic values of Gazprom’s investment in the Turkish Stream gas pipeline system, assuming average investment, operational and maintenance costs for the project (thus, the variability is due to the variance in discount rates only). The dotted lines show the impact on the project’s maximum and minimum NPV of capital and operational expenditures reaching their maximum and minimum values.

The preceding results show that only if gas demand in Europe grows at more than 2% per year up to 2030 will the NPV of the Turkish Stream gas pipeline investment be positive, albeit marginally (about 1.1 billion US dollars over 25 years). However, that does not mean that there is no case for the Turkish Stream gas pipeline, only that the justification might largely rest on other considerations.

Figure 3. NPV of the Turkish Stream gas pipeline under Different Gas Demand Scenarios



Source: Chyong, C. K (2011) The Economics of the South Stream pipeline in the context of Russo-Ukrainian gas bargaining Available: https://www.usaee.org/usaee2011 /best/chyong.pdf.

However, this project is in the interest of Europe as a [gas] consumer, Turkey as a consumer and provider, and Russia as a provider and producer.

The dynamics of the integral indicator EPI during the period of 2019-2029 varied by different countries (Table 2). But during the whole period of analysis, the level of the EPI will increase. So all involved countries receive some benefits from the Turkish Stream gas pipeline.

Table 2. Dynamics of the the Turkish Stream gas pipeline influence on the economic potential involved countries (EPI) in the period of 2019-2029 years

Country	Impact	2019	2024	2029
Russia	Economic	0,6	0,9	1,1
	Ecological	0,9	1,03	0,98
	Social	1,1	1,06	1,01
	EPI	2,6	2,99	3,09
Turkey	Economic	0,5	0,7	1,3
	Ecological	0,8	1,01	0,95
	Social	1,3	1,34	1,44
	EPI	2,6	3,05	3,69
EU	Economic	0,4	0,8	1,2
	Ecological	0,88	1,05	0,99
	Social	0,9	1,01	1,04
	EPI	2,18	2,86	3,23

Source: own estimates based on various sources.

Conclusions

Infrastructure is one of the drivers of sustained growth and acts as an enabler for a country's competitiveness. However, infrastructure development will not drive economic growth unless it is fully aligned with the country's economic, industrial, social and environmental priorities, and is delivered efficiently and effectively.

It was shown here that only if Ukraine increased its transit fee considerably, the economic value of the Turkish Stream gas pipeline investment would range between 1 billion and 10 billion US dollars, depending on assumed demand scenarios. Thus, as insurance against future bargaining from Ukraine, the Turkish Stream gas pipeline has far greater value than its value as insurance against transit interruptions and/or its value as a demand-driven project. The expert analysis and media commentary concerning Gazprom's investment in the Turkish Stream gas pipeline miss this important dimension. Gazprom's bypass strategy is not primarily about meeting future demand in Europe while eliminating transit risks. However, this project is in the interest of Europe as a [gas] consumer, Turkey as a consumer and provider, and Russia as a provider and producer.

The dynamics of the integral indicator EPI during the period of 2019-2029 varied by different countries. But during the whole period of analysis, the level of the EPI will increase. So all involved countries receive some benefits from the Turkish Stream gas pipeline.

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The forecasts-based instrument rule and repo rates decisions in Sweden. How closely interlinked?

JEL Classification: *E52; E58; E61*

Keywords: *inflation targeting regime; decision making process*; *repo rates*

Abstract

Research background: The Central Bank of Sweden declares the use of the Svensson's concept of inflation forecast targeting (IFT). It means that the repo rate decision making process depends on the central banks' forecasts. The concept evolved from the strict IFT with the decision making algorithm called the 'rule of thumb' to the flexible IFT which later includes the optimal monetary policy plan.
Purpose of the article: The aim of the article is to: (1) analyse the influence of the inflation rate and GDP growth rate on the repo rate decisions, (2) analyse the influence of the inflation rate and GDP growth rate forecasts (in two year horizon) on the repo rate decisions in Sweden in years 1999-2006. The main research question is as follows: did the Monetary Policy Commitee in Sweden in years 1999-2006 made the decisions on the repo rates on the basis of forecast-based instrument rules and the rule of the thumb algorithm.
Methodology/methods: The analysis encompasses the repo rates decisions, CPI inflation rate, GDP growth rate, central paths of CPI inflation forecasts and central paths of GDP growth rate forecasts in the two years horizon published by The Central Bank of Sweden in years 1999-2006. The studies are based on the Taylor-type instrument rule and forecast-based Taylor-type instrument rule. The methodology used is multiple linear regression models.
Findings: The Central Bank of Sweden in years 1999-2006 implemented direct inflation forecast targeting (DIFT) rule. The decision making algorithm was based on the CPI inflation forecasts and rule of the thumb algorithm. The exact rule of the thumb was as follow: if the inflation forecast, in the two year forecast's horizon

exceeded the inflation target by 1 p.p., then the central bank raised the repo rate by 0.4 p.p; if is below , then the central bank reduced the repo rate by 0.4 p.p. If the inflation forecast was equal to the inflation target, then the repo rate remained unchanged. The historical repo rates differ from the theoretical estimated rule of the thumb's repo rates by +/-0.28 p.p.

Introduction

In this paper we analyse the repo rate decisions in The Central Bank of Sweden (Sveriges Riksbank, SR) in years 1999-2006.The main aim of the study is to analyse empirically the application of rule of the thumb decision making algorithm and inflation forecast targeting (IFT) rule in SR. The main research question is as follows: did the Monetary Policy Commitee in Sweden in years 1999-2006 made the repo rates decisions on the forecasts-based instrument rule and the rule of the thumb algorithm.This will be achieved in the framework of the hypothesis: If the central bank implement the strict IFT with the algorithm 'the rule of the thumb', the Executive Boards' repo rate decisions depend on inflation forecasts; if flexible IFT with the algorithm ' the rule of the thumb', depend on inflation rate and GDP growth rate forecasts. According to this, the four sub-questions have been posted.

(1) Did SR apply in years 1999-2006 the rule of the thumb?
(2) What were the weights conferred on the inflation rate and GDP growth rate in the Monetary Policy Commitee repo rates decisions? How flexible were they?
(3) What were the weights conferred on the inflation rate forecasts and GDP growth rate forecasts in the Monetary Policy Commitee repo rates decisions? How flexible were they?
(4) Did the repo rates decisions easy to predict by economic agents?

The paper is organised as follows. It consists of five parts. The authors begin in section 1 by providing some theoretical background about instrument Taylor rule, Svensson's concept of IFT rule and Taylor-type forecasts-based instrument rules. The next three sections include the description of the methodology, the data and the results of the research. The conclusions and implications for monetary policy are contained in fifth section.

Theoretical background

The study relates to the two similar and based on rules concepts on conducting the monetary policy. The first one is the Taylor instrument rule and the second one, the Svensson's rule of the thumb. Both concepts refer to setting the central bank's instrument rate on the basis of the deviations from the target variables. The rule of the thumb comprised, in addition to the Taylor rule, the forward looking approach on monetary policy, which requires the forecasts publication.

The original Taylor rule showed the relation between the federal funds rate, inflation and real GDP (Taylor, 1993, p. 202). The ground of the L.E.O. Svensson's concept is the forward looking attitude on conducting monetary policy. The rule of the thumb implies that conditional inflation forecast should hit the inflation target in two year horizon. If the inflation forecast, in the chosen horizon, is above the inflation target, then the central bank should raise the repo rate. If the inflation forecast in the chosen horizon is lower than the inflation target, then the central bank should reduce the repo rate. If the inflation forecast is equal to the inflation target, then the repo rate should remain unchanged (Svensson, 1997, pp. 1111-1146). The rule of the thumb implementation indicates the publication of inflation forecasts made for two years horizon and on the assumption of constant instrument rate during the entire forecast horizon (called CIR). The inflation forecasts may shape the economic agents' inflation expectations and anchor them on the inflation target.

Inflation forecast targeting (IFT) may be divided into two types. The first one, called direct inflation forecast targeting (DIT), assumes setting the central bank's interest rate only on the basis of inflation forecasts. It is impossible to implement such an approach exactly in central banking practice. The flexible inflation forecast targeting (or forecasts targeting (Svensson, 2005a, pp.1-54) preconceived that instrument rate decisions depend on two target variables, inflation forecast and output gap forecast, and are made on the basis of its' deviations from the inflation target and potential output gap (respectively). In such a case the inflation target may be achieved in the longer horizon. The weight which is put on the output gap forecast may determine how quickly the inflation forecast is adjusted towards the inflation target (Svensson, 2009, pp. 1-9).

There are plenty of studies concerned the estimation of simple Taylor rule for specific economies. In our paper we refer to the concept, which posed the consensus between the simple original Taylor rule and L.E.O. Svensson forecasts targeting rule. In this point we refer to the Taylor-type forecasts-based instrument rules, which are the simple central bank implicit reaction functions, where the forecasts of inflation rate and output gap play a role of intermediate target variables (see: Levin *et al,* 2003, p. 625):. These forecasts are model consistent.

In our studies we are referring to the rules with the two year forecast horizon. Our choice was caused by three reasons. Firstly the original L.E.O. Svensson's rule of the thumb assumed the two year inflation forecast horizon (see: Svensson, 1997, pp. 1111-1146). Secondly, Batini & Nelson were analysing the optimal policy horizon for set of forecast-based target variables as a part of flexible inflation targeting framework. They found that 'it is optimal to remove the effects of the various shock considered over a period of 8 to 19 quarters'(2001, p. 910). Finally, SR officially declared the use of the rule of the thumb within two year time lags (see: Rosenberg, 2006, pp. 1-8). According to this, the similar rules were analysed by Rudebush & Svensson (1999, pp.203-262).

Data

The Central Bank of Sweden (Sveriges Riskbank, SR) has been implemented IT strategy since 1993 and has determined the inflation target as 2 % measured by CPI index. During the years 1993-2016 it declared two types of IT rules: the rule of the thumb and optimal monetary policy algorithm. In this connection, the central bank published the inflation forecasts conditioned by the constant instrument rate during the entire forecast horizon (called CIR) and the set of macroeconomic forecasts conditioned by the interest rate path forecast. The forecast horizon depends on the chosen rule type. The data are analysed quarterly. The potential GDP growth rate was estimated and declared to be as a desirable value in a range 2-2.5% in Sweden (Heikensten, 2000 & 2003). At the end of 1999 SR has started to publish the forecasts' data. The author of the concept of inflation forecast targeting, L.E.O. Svensson, was active as advisor to SR during the years 1990-2007. The central banks' inflation forecasts in Sweden had a large impact on consumers' inflation expectations in Sweden (Szyszko, 2016, p.9). The analysis of the rule of the thumb includes the years 1999-2006.

In this paper, the central bank forecasts' central paths are analysed at the two year prognostic moment of the forecasts' horizon. The forecasts' central paths have been downloaded from the swedish central bank website (inflation reports boxes) and Inflation/Monetary Policy Reports. The repo rates data were collected from the SR website. The CPI inflation rate and GDP growth rate data were collected from the Eurostat database.

Table 1. The main information on the forecast based monetary policy in Sweden

<table>
<tr><th>Year</th><th>The forecast based rule</th><th>The instrument rate assumption in the forecast</th><th>Published forecasts</th><th>Forecasts published per year</th><th>Forecasts horizon</th><th>Forward Guidance</th><th>Monetary Policy Committees Meetings</th><th>Monetary Policy Trade of Description</th></tr>
<tr><td>1999</td><td rowspan="8">Rule of the thumb</td><td rowspan="6">CIR</td><td rowspan="8">Inflation forecasts, GDP forecasts*</td><td rowspan="8">4</td><td rowspan="7">8 Q</td><td rowspan="8">No</td><td rowspan="8">Each month</td><td rowspan="8">No</td></tr>
<tr><td>2000</td></tr>
<tr><td>2001</td></tr>
<tr><td>2002</td></tr>
<tr><td>2003</td></tr>
<tr><td>2004</td></tr>
<tr><td>2005</td><td rowspan="2">CIR and ME</td></tr>
<tr><td>2006</td><td>12 Q</td></tr>
</table>

CIR-Constant instrument rate during the forecast horizon; ME- Market expectations instrument rate during the forecast horizon; E- Endogenous instrument rate dovetailed with instrument rate forecast path. *In these years GDP growth forecasts were not published in the form of charts but were described in the inflation reports with all necessary central paths data

Source: Own elaboration.

During the years 1999-2006 forecasts were made on the basis of the DSGE model RAMSES. The model application assumed setting the instrument rate on the rule of the thumb. The enforced in the model instrument rule has the following form (Adolfson *et al.*, 2007b, p. 21):

$$i_t = f(\pi_t - \pi^*; \Delta\pi_t; y_t; \Delta y_t; i_{t-1}; x_t) + \varepsilon_{i,t}, \tag{2}$$

We shall denote: i_t – policy rate; π_t – underlying inflation rate; $\Delta\pi_t$ – change in the rate of underlying inflation; π^* – inflation target; y_t – GDP gap; Δy_t – change in the GDP gap; x_t – exchange rate gap; $\varepsilon_{i,t}$ – is called as a as a measure of the element of monetary policy surprises; t – years, $t \in \{1,2,...\}$. According to the model of Adolfson *et al.* (2007a, pp.481-511) the real exchange rate gap is measured as the percentage deviation of the actual real exchange rate from an assumed equilibrium level that is constant. The model implemented also the interest rate smoothing.

Research methodology

The research includes the estimations of different type-Taylor instrument rules for the Sweden economy based on historical data and a preposition. The estimations differ in the chosen targets variables and assumptions. The main method used is multiple linear regression models. The studies conducted have been divided into two parts. The whole research plan is presented in Table 2.

Table 2. Research plan

Part	Stage	Research question?	Rule	Equation
Part I	Stage I	How flexible is SR in his interest rate decisions?	Simple Taylor-type instrument rule	(Svensson, 2003, p.426, Taylor, 1999, p. 5) : $i_t = \alpha_0 + \alpha_\pi(\pi_t - \pi^*) + \alpha_y(y_t - y^*) + \alpha_i i_{t-1} + \varepsilon.$
	Stage II		Taylor-type instrument rule form from RAMSES	(Adolfson *et al.*, 2007, pp.5-40): $i_t = \alpha_0 + \alpha_\pi(\pi_t - \pi^*) + \alpha_{\Delta\pi}\Delta\pi_t + \alpha_y(y_t - y^*) + + \alpha_{\Delta y}\Delta y_t + \alpha_i i_{t-1} + \varepsilon.$
Resultts comapsrison with the exact historical repo artes and exact repo rates derived from the original instrument equation from the model RAMSES*				
Part I	Stage I	How flexible is SR in his forecast-based interest rate decisions?	Forecast-based Taylor-type instrument rule	(Svensson, 1997, pp. 1111-1146): $i_t = \alpha_0 + \alpha_{\pi\|t+2}(\pi_{t+2\|i_{t-1}} - \pi^*) + + \alpha_{y\|t+2}(y_{t+2\|i_{t-1}} - y^*) + \alpha_i i_{t-1} + \varepsilon.$
	Stage II		Forecast-based Taylor-type instrument rule form from RAMSES	$i_t = \alpha_0 + \alpha_\pi(\pi_{t+2\|i_{t-1}} - \pi^*) + \alpha_{\Delta\pi}\Delta\pi_t + + \alpha_y(y_{t+2\|i_{t-1}} - y^*) + \alpha_{\Delta y}\Delta y_t + \alpha_i i_{t-1} + \varepsilon.$
Resultts comapsrison with the exact historical repo artes and exact repo rates derived from the original instrument equation from the model RAMSES*				

i_t – policy rate; π_t – CPI inflation rate; π^* – CPI inflation target settled at 2%; y_t – GDP growth rate, y_t^* – potential GDP growth rate; t – years, $t \in \{1,2,...\}$. GDP growth rate gap is calculated as the difference between real GDP growth rate and the potential GDP growth rate (which was settled by the authors at 2.25% (as the midpoint of the range 2-2.5%)); $\Delta\pi_t$ change in the CPI inflation rate; Δy_t change in the GDP growth rate; $\pi_{t+2|i_{t-1}}$ - CPI inflation forecast in eight quarter horizon made on the assumption of CIR, $y_{t+2|i_{t-1}}$ – GDP growth rate forecast in eight quarter horizon made on the assumption of CIR.

*.The RAMSES model assumed the following weights: 1.7 for the inflation deviations from the inflation target, 0.3 for inflation changes, 0.04 for GDP growth rate gap and 0.1 for GDP growth rate changes (Adolfson *et al.*, 2007b, p.21).

Source: own.

Results

Firstly we estimated the simple linear Taylor-type instrument rule with target variables: deviations from the CPI inflation rate and inflation target, ad GDP growth rate gap. After that we estimated the Taylor-type instrument rule form downloaded from the model RAMSES. The derived in both cases target variables coefficients have significant, positive and similar influence on instrument rate (α_{π} =.14 and, α_{y} =0.1; α_{π} =0.14 and α_{y} =0.11) and indicate the flexible type of implemented IT regime

Secondly we estimated the simple linear Taylor-type forecast-absed instrument rule with target variables: deviations from the inflation forecast and inflation target, and deviations from GDP growth rate forecast and potential GDP growth rate. After that we estimated the Taylor-type instrument rule form from the model RAMSES. . The results are similar in both cases. Only the deviations of inflation forecast from the inflation target have significant, positive influence on instrument rate (0.4). It indicates the implementation of strict inflation forecast targeting and the original rule of the thumb. The repo rates from the model estimated differ from the historical by +/- 0.29.

In Table 3 there are the differences (absolute and average) between the exact historical repo rates and the theoretical repo rates derived from the calculation of weights from the RAMSES instrument equation put on the target variables.

Table 3. Differences between the exact historical repo rates and the theoretical repo rates derived from the exact RAMSES equation

Rule	Target variables	Diference (absolute average)
Simple Taylor-type instrument rule	CPI inflation, GDP growth rate	+/-1.65
Forecast-based Taylor-type instrument rule	CPI inflation, GDP growth rate forecasts	+/-0.4

Source: Own elaboration.

Table 4. Instrument rules' estimation results

		α_0	α_i	α_π	α_y	$\alpha_{\Delta\pi}$	$\alpha_{\Delta y}$	$\alpha_{\pi_{t+2}\mid i_{t-1}}$	$\alpha_{y_{t+2}\mid i_{t-1}}$
Simple Taylor-Type Instrument Rule	Coefficient	0.25 [0.15]	0.91*** [0.04]	0.14*** [0.04]	0.1*** [0.04]	-	-	-	-
	R square	0.91							
	ε	0.27							
Taylor-Type Instrument Rule form from RAMSES	Coefficient	0.22 [0.16]	0.92*** [0.04]	0.14** [0.05]	0.11*** [0.03]	-0.1 [0.09]	-0.1* [0.05]	-	-
	R square	0.92							
	ε	0.27							
Weights declared in RAMSES (Adolfson *et al.*, 2007b, p.21)	Coefficient	-	-	1.7	0.004	0.3	0.1	-	-
Forecast-Based Simple Instrument Taylor Rule	Coefficient	0.07 [0.12]	0.96*** [0.03]	-	-	-	-	0.4* [0.17]	-0.01 [0.09]
	R square	0.91							
	ε	0.29							
Direct Inflation Forecast-Based Instrument Taylor Rule	Coefficient	0.07 [0.11]	0.91*** [0.03]	-	-	-	-	0.4* [0.16]	-
	R square	0.9							
	ε	0.29							
Forecast-Based Instrument Taylor-type Rule form from RAMSES	Coefficient	0.08 [0.12]	0.96*** [0.04]	-	-	0.004 [0.09]	-0.04 [0.05]	0.4* [0.17]	-0.01 [0.09]
	R square	0.9							
	ε	0.29							
Weights declared in RAMSES- forecasts based target variables (Adolfson *et al.*, 2007b, p.21)	-	-	-	-	-	0.3	0.1	1.7	0.004

***Significant at 0.001**Significant at 0.01*Significant at 0.05. Robust standard errors in parentheses

Source: own elaboration.

Conclusions

In the years 1999-2006 The Swedish Central Bank declared the implementation of inflation targeting strategy. According to the estimated simple Taylor-type rule, we may state that the central bank applied inflation targeting flexible type, with the weights put on the CPI inflation rate and GDP growth rate. The estimations results for the simple Taylor-type rule and the form of this rule from the model RAMSES did not differ significantly.

The Central Bank of Sweden in years 1999-2006 also declared the use of the concept of inflation forecast targeting and the rule of the thumb decision making algorithm. In this case the deviations of CPI inflation forecasts from the inflation target and the deviations of GDP growth rate forecasts from the potential GDP growth rate were our target variables in Taylor-type forecast based instrument rules. The estimation results describe the implemented strategy as a direct inflation forecast targeting (DIFT), with the weight put on the CPI inflation forecast. The GDP growth rate forecasts transpired to be not significant in setting the repo rates. The weight put on the inflation forecasts is positive, consistent with the rule of the thumb. The exact rule of the thumb for Sweden in years 1999-2006 was as follow: if the inflation forecast, in the two year horizon exceeded the inflation target by 1 p.p., then the central bank raised the repo rate by 0.4 p.p. If the inflation forecast in the two year forecast horizon was lower by 1 p.p. than the inflation target, then the central bank reduced the repo rate by 0.4 p.p. If the inflation forecast was equal to the inflation target, then the repo rate remained unchanged. The historical repo rates differ from the theoretical rule of the thumb repo rates by +/-0.28 p.p.

There were large differences between the exact historical repo rates and theoretical the repo rates calculated from the exact instrument equation from forecasting model RAMSES. It means that the economic agents might not predict the repo rates changes on the basis of declared weights put on target variables from the model.

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Lithuanian agri-food industry responses to Russian import ban on agricultural products

JEL Classification: *F14; Q17; Q18*

Keywords: *agri-food products export; processing industry; Russian import ban; profitability*

Abstract

Research background: For a long time before the Russian import ban, Russia was the second most important destination for Lithuania's agricultural exports (after the EU common market), especially for processed dairy and meat products, and edible vegetables. Russia imposed a ban on most agricultural products from the EU in August 2014. Moreover, a year earlier, Russia closed its market for Lithuanian dairy products citing safety concerns. Among the EU countries, the economic impact of the Russian import ban of agricultural products may be most acute in Lithuania.

Purpose of the article is to examine the Russian import ban consequences for Lithuanian agricultural products export and the agri-food industry responses to the Russian import restrictions.

Methodology/methods: The examination has been based on trade and production performance indicators. Time series and spatial analysis of agricultural export flows by HS and the food production.

Findings: Due to the Russian embargo Lithuania's agricultural production export worth sharply declined in 2014-2015. In volume terms, Lithuania's export of cheese, cream, yogurt and other fermented milk products was significantly lower in 2016 than in 2013, although, butter export has increased, whereas a higher share of raw milk was processed into butter. The production profile of the dairy processing industry has been changing since 2014. Processors have increased output of products like butter and skimmed milk powder which can be sold or stored within the

EU intervention programs or exported to alternative markets within the EU or beyond. In 2015-2016, the export of banned agricultural products has been reoriented towards new markets. The profitability of dairy processors decreased in 2014. However, in 2015, main dairy processors increased the profitability again due to the greatly reduced farm-gate milk prices. Despite the drop of farm-gate milk prices, majority of farmers are continuing milk production. Some of the farms completely switched to local food markets.

Introduction

Lithuanian agri-food industry is export-oriented. In recent years, 44% of processed food have been exported. Total agricultural export worth accounted for approximately EUR 4392 million and representing for over 19% of total goods export in 2016. For a long time pre-Russian import ban, Russia was the second most important destination for Lithuania's agricultural exports, especially for dairy and meat products and edible vegetables. Russia imposed a ban on of certain agricultural products in August 2014[1]. Moreover, a year earlier, in August 2013, Russia closed its market for Lithuanian dairy products citing safety concerns. In both cases, sanctions were of political nature. Pickett & Lux (2015) argues that the Russian import ban is inconsistent with the provisions of four instruments such as the Agreement on Agriculture, the GATT, Russia's Protocol of Accession, and the WTO Dispute Settlement Understanding.

Of all the affected countries by Russian agricultural import ban, the EU was potentially the most affected (Boulanger *et al.*, 2016). Among the EU countries, the economic impact of the Russian import restrictions may be most acute in Lithuania which agricultural exports to Russia averaged for 3.5% of Lithuania’s GDP in 2009-2013. In the other hand, Kutlina-Dimitrova (2015) argue that the economic literature shows that sanctions may not be very effective instruments to achieve the desired goals especially in the case of an import ban. The import embargo has a redistributional impact on both sanctioning and target country. It decreases welfare in both countries. The analyses concerning Russian agricultural import ban impact on the export flow or the economy generally in sanctioning countries have been carried out by Kutlina-Dimitrova (2015), Oja (2015), Fedoseeva

[1] On 7 August 2014, Russia imposed a 1-year import ban on a list of agricultural products from the EU, the USA, Norway, Canada and Australia. This list covers almost all meat products, milk and dairy products, fruits and vegetables, fish and crustaceans. On 25 July 2015, Russia announced a 1 year prolongation of the ban on agricultural products (Boulanger *et al.*, 2016).

(2016), in target country by Kiselev *et al.* (2015), in both countries by Smutka *et al.* (2016), Klinova & Sidorova (2016). The aim of the article is to examine the Russian import ban consequences for Lithuanian agricultural products export and the agricultural industry responses to the Russian import restrictions.

Method of the research

To determine the Russian import ban consequences for Lithuanian agricultural export and the agri-food industry responses to the Russian import restrictions in question in different groups of products, we focus on different trade performance indicators:

To determine the Russian import ban consequences for Lithuanian agricultural products export and the agri-food industry responses to the Russian import restrictions in question in different groups of products, the following trade performance indicators were used:

- Export worth growth
- Share of export to destination country's market in total national exports
- Absolute change of destination market share
- Relative change of market share
- Trade entropy index for export
- Herfindahl Hirschman Index (HHI)
- Equivalent number of export markets
- Sales and gross margin

As is known, the econometric application of entropy indicator that is applied to international trade relations comes from information theory and has also taken its way to various economic concentration problems, such as income distribution or market power analyses (Laaser and Schrader, 2002). The entropy index Hirsch and Lev (1971) used as the export diversification indicator, while Yilmaz (2005) this index used as one of the indicators of the international competitiveness. Based on the export entropy index, La (2011) proposes adjusted export market diversification indices to identify the actual effects of export market diversification on export instability.

The trade entropy index for export can be expressed mathematically as follows (Laaser and Schrader, 2002):

$$I_{xi} = \sum_j b_{ij} \ln(1/b_{ij}) \text{ with } 0 < b_{ij} < 1 \text{ and } \sum_j b_{ij} = 1, \qquad (1)$$

where: I_{xi} denotes the trade entropy index for export of country i and $b_{ij} = x_{ij} / X_i$ is the export share of country i to country j. This entropy indicator is used to measure the spatial concentration or dispersion of the export flow of the reporting country. The higher the I_{xi}, the more spatial dispersed the export flow of that country, i.e. the more diversified the export markets. The maximum value of this entropy index is achieved when all export share is shares are equal to each other and vice versa its minimum value is achieved when all exports are concentrated in a single export destination (Yilmaz, 2005; La, 2011).

The most commonly accepted measure of market concentration is the Hirschman-Herfindahl index (HHI), which sums the squared shares of each commodity market in total exports (Agosin *et al.*, 2012). The following mathematical expression gives this identity:

$$HHI_{xi} = \sum (x_{ij}/X_i)^2 , \qquad (2)$$

where: HHI_{xi} denotes the export market concentration index, x_{ij} is the export of country i to market of destination country j and X_i denotes total export of country i. The HHI index above 0.25 indicates the high concentrated export market, between 0.15 and 0.25 indicates the moderate concentrated export market and below 0.15 indicates an unconcentrated export market.

The equivalent number of export markets is the inverse of the corresponding Herfindahl-Hirschman Index (HHI). According to the technical notes of Trade Performance Index (TPI) developed by International Trade Centre (ITC, 2007) the equivalent number, is a theoretical dimension which represents the number of export markets of identical size that would lead to the degree of export concentration exactly equal to the observed one. The number of equivalent export markets *(NE = 1/*HHI_{xi}*)* used for measuring export market diversification distinguishes for each country when the number of partner countries weighed according to their importance. The bigger the NE, the greater the diversification of markets. Diversifying partner countries reduces a country's dependence on a small number of destination countries.

Export flow data comes from the ITC Trade Map dataset by Harmonized System (HS Rev. 2012) 2-digit and 4-digit levels for the time-period 2011-2016. In calculating trade performance indicators, the grouping used is as follows: all agricultural products (HS 01-24); dairy produce and ice cream (HS from 0401 to 0406 and 2105); meat and preparations of meat

(02 and from 1601 to 1602) and edible vegetables (HS 07). The data of sales and gross margin of dairy processors extracted from Nasdaq Baltic dataset in 2011-2016.

Results

In 2014-2016, export worth of Lithuania's agricultural products declined an average by 2.8% per year, meanwhile export worth of dairy produce and edible vegetables fell sharply (Table 1) with average by 15% and 17.5% per year respectively.

Table 1. Lithuania's agricultural export trends in pre- and post-Russian import ban

Products' group (CN code)	Export growth (2013=100)	Export change per annum (%)						Relative change of export market share per annum (%)			
		to Russian Federation		to World		to EU		in World		in EU	
	2013-2016	2011-2013	2014-2016	2011-2013	2014-2015	2011-2013	2014-2016	2011-2013	2014-2015	2011-2013	2014-2016
All agricultural products	93.4	18,0	-37.7	19.4	-2.8	12.3	8.1	9.9	-4.1	5.2	2.9
Dairy produce and ice cream	72.2	5.0	-92.1	12.3	-15.0	12.6	-3.4	3.2	-13.9	6.4	-0.9
Meat and preparations of meat	86.6	1.5	-77.3	12.2	-3.6	18.2	7.5	9.5	-8.9	9.6	9.4
Edible vegetables	49.8	25.0	-88.8	27.6	-17.5	20.4	21.2	23.1	-32.4	11.8	10.1

Source: own calculations based on ITC Trade Map data.

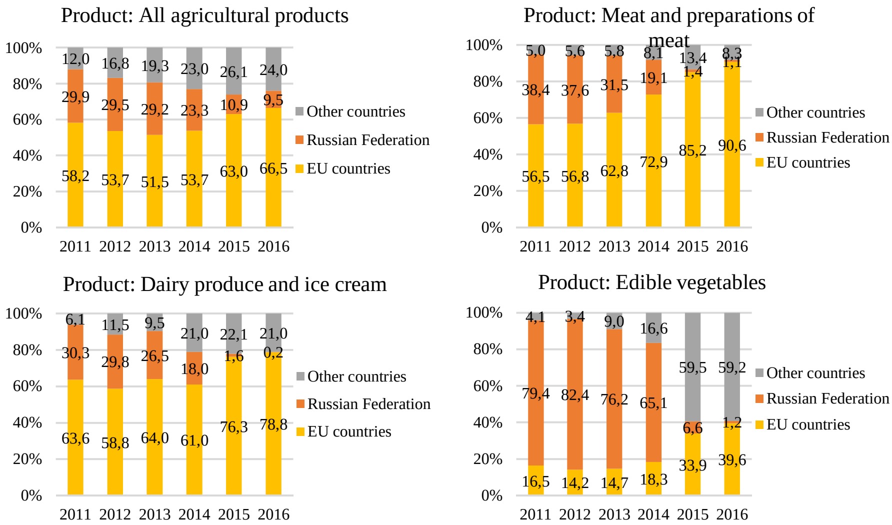
The main Lithuania's agricultural export destination has been the EU for more than two decades. The EU common market received more than two-thirds of total Lithuania's agricultural export in 2016 (Figure 1). Moreover, since Russian import ban in 2014 Lithuania's agricultural export worth to the EU by almost a quarter, while export indicator for vegetables doubled and for dairy products increased by more than a quarter. Most of the industries affected by Russian import ban either found alternative markets within the EU or beyond as indicates graphs in table 3.

For a long time pre-Russian import ban, Russia was the second most important destination for Lithuania's agricultural exports, especially for processed food, and for the three product groups – dairy and meat products and edible vegetables. Regardless of the high level of political and economic risk, the Russian market was very profitable and attractive for Lithuania's food exporters. For instance, in pre-Russian import ban the export to Russia accounted for more than three-quarters of vegetable export (including re-export), one third of meat products export, and around 30% of dairy products export in 2010-2013.

Traditional Lithuanian export markets for the dairy and meat products are characterized by fierce competition and relatively low annual import growth. Meanwhile, the Lithuania's export meagerly oriented towards the fastest growing food import markets.

Foremost, Lithuania's agricultural export markets has been diversified over 2013-2015 period. According to ITC data, the rank of Lithuania's processed food market diversification has risen from 49 in 2013 to 28 in 2015 and the rank of fresh food market diversification has risen from 102 to 21 at the same time. Table 2 summarizes the markets concentration and diversification results and their allocation matrix for the exports of dairy and meat products and edible vegetables. For instance, Lithuanian producers found new export markets, e.g. for dairy produce – in Saudi Arabia, Korea, Morocco, Hong Kong, Armenia, Singapore, for vegetables in India, Egypt, Malaysia, Pakistan, Sudan; for meat and preparations of meat – in Georgia, Hong Kong, China, United States, Croatia.

Figure 1. Most important destinations for Lithuania's agricultural exports in 2011-2016 (share of export in %)



Source: own calculations based on ITC Trade Map data.

The results of the analysis of export markets concentration and diversification suggest that:

- The HHI show that the export market concentration of dairy products and edible vegetables was greater in pre-Russian import ban period than post.
- The significant growth of markets diversification observed in edible vegetables export, i.e. in post-Russian import ban the number of equivalent markets raised more than threefold.
- The export entropy index show the decreased export markets diversification of meat and preparations of meat in post-Russian import ban. Vice versa situation can be observed in edible vegetable export.

Table 2. Lithuania's export market concentration and diversification in pre- and post-Russian import ban

Products' group (CN code)	Herfindahl Hirschman Index (HHI)			Market diversification (Number of equivalent markets)			Trade entropy index for export		
	2011-2013	2014	2015-2016	2011-2013	2014	2015-2016	2011-2013	2014	2015-2016
Dairy produce and ice cream	0.15	0.10	0.11	7	10	9	0.48	0.40	0.42
Meat and preparations of meat	0.09	0.15	0.09	11	7	12	0.49	0.42	0.39
Edible vegetables	0.63	0.45	0.13	2	2	7	0.33	0.47	0.46

Source: own calculations based on ITC Trade Map data

As mentioned above, the Russian import ban affected Lithuanian dairy and vegetable industries the most. The edible vegetables export mainly declined due to reduced re-export, while the dairy produce export was the most on products by Lithuanian origin. In 2014-2016, sales of main Lithuania dairy processors declined an average by 25.2% per year (Table 3).

In 2014, gross margin of companies Pieno zvaigzdes AB and Zemaitijos pienas AB decreased by 2.5% and 2.7% respectively. There was one-time business solution made by Rokiskio suris AB as a quick response to the Russian import embargo. In August 2014, the company Rokiskio suris AB immediately began to export dairy products to the United States, due to the need to empty the accumulated stocks, even though the financial result was zero. Due to a recent change in the euro-dollar exchange rate, the food export to the United States has become profitable and gross margin of total sales increased.

Table 3. Trade performance indicators of major Lithuanian dairy processors in pre- and post-Russian import ban

Company	Sales growth (2013 = 100)	Change in sales per annum (%)						Gross margin (% of sales)				
		in non EU market		in EU market		in Lithuanian market						
		2011-2013	2013-2015	2011-2013	2013-2015	2011-2013	2013-2015	2012	2013	2014	2015	2016
Rokiskio suris AB	82.2	-36.4	-18.8	16.5	-18.3	1.5	-8.0	14.2	11.2	12.2	7.7	12.5
Pieno Zvaigzdes AB	68.3	5.9	-58.0	1.7	23.8	3.3	0.4	18.9	19.0	16.5	15.6	20.4
Vilkyskiu pienine AB	76.4	28.3	-41.0	3.5	12.9	23.6	-11.2	10.1	10.2	11.2	10.3	10.5
Zemaitijos Pienas AB	9.5	1.2	-16.0	13.5	4.2	0.2	0.7	19.2	19.0	16.4	24.7	24.6

Source: own calculations based on Nasdaq Baltic data.

In 2014-2015, the export of banned agricultural products has been reoriented in to alternative markets within the EU or beyond. In 2015, Pieno zvaigzdes AB and Vilkyskiu pienine AB increased export to the EU market by 23.8% and 19% respectively. Some share of displaced food exports was sold in domestic markets, bringing down the prices which, in turn, benefit consumers.

Due to the Russian import ban, Lithuanian dairy industry situation was critical and a wide spectrum of policy instruments and initiatives to stabilize market had been offered at both EU and Lithuanian government levels. However, increased financial support has negatively determined dairy processors' pricing behavior. Paradoxically, the special financial assistance for milk producers, which are aimed to effectively eliminate market disturbance caused by a significant price fall, encourage the processors to reduce milk farm gate prices. Besides that, dairy processing industry changed production profile. For instance, dairy processors decreased production of cheese, curd, yoghurt, creams, ice cream, however increased production of butter, fresh cheese, drinking milk, and non-fat dried milk products. Processors have increased output of products like butter and skimmed milk powder which can be sold or stored within the EU intervention programs. As the outcome, major dairy processors increased profitability from 2014 to 2016. A drop in farm-gate milk prices reduced profitability in raw milk production. Despite such prices drop, most Lithuanian farmers continued milk production. Some of the farms completely switched to local food markets. Unlike large farmers, small farmers were the most vulnerable segment of the Lithuania’s dairy supply chain in the context of the Russian import ban.

Conclusions

The empirical analysis was made on trade performance indicators based on Lithuanian agricultural exports flows and on four major dairy processors data in pre- and post-Russian import ban period. The analysis reveals that the Russian import ban affected Lithuanian dairy and vegetable industries the most. However, estimating the possible extension of empirical research agricultural exports are not likely to be affected by sanctions' extension because the export flow has already been redirected to other markets: export increased to already established markets as well as new markets. However, profitability of Lithuanian dairy processors will remain relatively lower than in 2014, because exports to Russia have been more profitable than to other markets.

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Does experience exert impact on a PPP performance?

JEL Classification: *C41; D01; H54; L32; O22*

Keywords: *survival analysis; public – private partnership (PPP); organizational learning; investment decisions*

Abstract

Research background: Researchers traditionally assume that learning is a product of experience. In general it means that learning can only take place through the attempt to solve a problem and therefore only takes place during activity (Arrow, 1962). On the ground of organizational theory it has two implications. First we can agree that repeated activity requires less effort. Second we can argue that firms undertake activities, with which they have been the most successful in the past and that they expect to be the most successful in the future.
Purpose of the article: The aim of the research is twofold. Firstly, this article aims to investigate if we can identify a relationship between the experience in PPP projects and the performance of initiatives of this kind. Secondly, the article aims to provide an interpretation of the relationship between experience and PPP performance.
Methodology/methods: This research investigates factors influencing the survival of PPP projects in Poland over the period 2009-2015. Cox proportional hazard model is utilized to distinguish between PPPs that succeeded to the operation phase and those that were cancelled on the procurement stage.
Findings: The research confirms the existence of a positive relationship between experience in PPP and the outcome of a PPP development.

Introduction

The problem of understanding how organizations develop competence has been widely discussed on the ground of organisational (Cyert & March, 1963; Levitt & March, 1988; Argyris & Schon, 1978; Argote, 1999, 2001) and strategic management literature (Zollo & Winter, 2002). In Poland, the problem was raised by B. Mikuła (2006) and K. Olejniczak (2012).

One of areas that has been receiving increasing attention from scholars is the study of experience – performance relationship (Anand, Mulotte & Ren, 2016). This relationship is generally described as the association between the number of times a firm has conducted particular activity and the resulting performance and is interpreted consistent with the long standing idea that learning is the product of experience (Arrow, 1962). The role of experience in increasing productivity was first observed by aeronautical engineers, particularly by T.P. Wright (1936). He measured that the number of labor-hours expended in the production of a particular part of a plane is a decreasing function of the total number of the same parts previously produced. Other scholars took up the idea and has shown the existence of the same type of "learning curve" in a wide range of operational processes.

More recently the study on experiential learning processes has been expanded to numerous corporate development activities, including new product introduction, international expansion, alliances, and acquisitions (Hayward, 2002; Zollo & Reuer 2002). This studies generally confirm the existence of a learning effect. Yet some scholars argue that the learning through corporate development activities differs from learning through operational processes (Anand, Mulotte & Ren 2015). Consistent with this reasoning, the experience accumulation in corporate development activities is more complex and depends not only on the experiential learning but also on the willingness to repeat this types of activities that are associated with the highest past performance.

There appears to be an interesting inconsistence to explain the learning across organizational activities and open area for potential contribution. We will focus in particular on the public-private partnership (PPP) project development activities.

This paper intends (i) to investigate if we can indicate the relation between the experience in PPP projects and the performance of this kind of undertakings and (ii) to provide an interpretation of the relationship between experience and PPP performance.

PPP as a subject of the research

We can identify a range of economic, social and political reasons and motives for the growth of PPPs. For example there is a growing number of evidence-based literature attempting to explain why in some cases public authorities are more willing to choose this organizational form of delivering infrastructure services (Hammami, Ruhashyankiko, & Yehoue, 2006), (Galilea & Medda, 2010), (Buso, Marty, & Tra, 2014), (Moszoro, Araya, Ruiz-Nuñez, & Schwartz, 2014).

Investigating the factors that exert impact on the development of PPP some scholars emphasise the importance of choice that must be undertaken by potential provider of public services (McQuaid & Scherrer, 2009). This decisions can be affected by poor contractual design and arrangements and inappropriate risk-sharing (based partly on limited expertise, experience and capacity, especially at a local level), as well as accountability (Pollock et al., 2007). Recently E. Klijn and J.Koppenjan (2016) investigated what kind of contracts characteristic influence PPP performance.

According to Huxman and Hubbert (2009) the performance of a PPP project has several dimensions. One of this dimensions can be described as reaching the emerging milestones by the project.

That is why it was assumed that a basic characteristic of PPP projects can be reduced to its main property. This property is to bundle facility construction and service provision (Hart, 2003). This two phases can be considered as the most important in PPP contracts. However to obtain a wider research perspective on the process that supports implementing PPPs we should get back to the date of announcement of a PPP tender. In this case we can assume that the willingness to cooperate under PPP is revealed firstly by public party. This can be described as the date 0. The tender continues to the date 1 when the private partner is selected and the contract is specified. The facilities are delivered at the date 2 and the services are provided between the date 2 and date 3, when the contract finally comes to a close. Identified milestones allow us to distinguish three phases in a PPP project.

In this context we can utilize the market data to find out what features of the PPP contract and its main actors help to move PPP project from one to the next phase. Adopted research approach would help to assess the importance of experience among other factors contributing to the PPP performance.

Method of the research

To uncover causal relationship between PPP characteristics and its performance the research employed survival analysis. In general survival analysis is a statistical framework for studying the duration of an event. This type of analysis is well established in several fields of knowledge. This methods has been extensively used in medical and engineering research for studying the survival time of patients or the reliability of devices (Sokołowski, 2010).

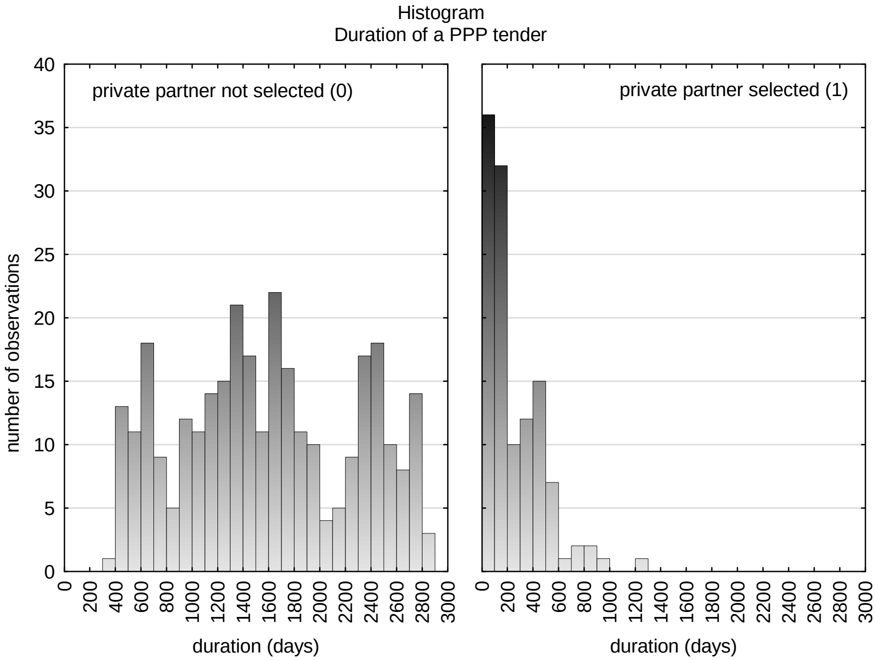
Recently the use of survival analysis is increasingly widespread across different disciplines of social science. Several authors have employed duration models to analyse the determinants of length of stay in tourist accommodation (De Menezes, Vieira, & Moniz, 2009) or the survival of ski lift operators (Falk, 2013). Such methods have been also used for the duration analysis of software projects (Sentas, Angelis, & Stamelos, 2008).

Considering PPP literature Buso, Marty and Tran (2014) utilised this method to examine under what conditions public authorities are more likely to use a PPP rather than traditional procurement methods. However to the Author's best knowledge there is no prior application of such models to the analysis of PPPs duration.

This study focused on the first phase of a PPP project, namely procurement stage. The necessity to limit the study to this stage resulted from three main reasons. First of all the duration of the procurement stage is closely related to its cost – especially the cost that has been already incurred by all participants and can't be recovered. Next reason is associated with the specific feature of PPP market in Poland - a prevailing number of PPP initiatives that did not reached the next phase described as a service provision. The final argument is the data availability. Statistics on PPP in Poland covers information on two dates – the date of a tender announcement (t0) and the date of private partner selection (t1). Information of these two relevant dates can be obtained only for projects that succeeded to the next phase. Information on the duration of the initiatives, that did not succeed are – in practice – unavailable.

The reasons stated above determined the choice of the survival analysis as a tool to study the project duration. The benefit of using the survival analysis is the fact that we can construct probabilistic models for the durations utilizing the data not only from projects, for which we know both dates but also from projects that we don't have information on a termination date. In this specific case, projects having the private partner selected were defined as completed observations (coded as 1). Projects that were not completed in the way that allowed them to move to the next phase were defined as uncompleted observations (codes as 0). The duration of uncompleted observations (right censored) is defined as the time from the start date until the date when the data collecting was stopped. A graphical distributions of duration of PPPs – procurement stage – is presented on the Figure 1.

Figure 1. Distribution of the duration of completed and uncompleted observations



Source: own calculations.

The set covers data on 423 PPP projects. The number of PPPs that proceeded to the next phase (completed observations) was 118 while the unsuccessful (uncompleted observations) procedure reached 305. The median durations were as follow: 5,66 months for completed observations and 51,57 months for uncompleted observations.

Duration of a PPP procurement may be affected by a range of factors characterizing the project, PPP partners or the market. The data used in the model were obtained individually for each project. Information on PPP projects is available on official websites dedicated to public procurement: Teds Electronic Daily (TED) and Public Procurement Bulletin (BZP). Data obtained from 423 tender announcements enabled to prepare a following set of factors describing PPP projects (Table1).

Results of the research

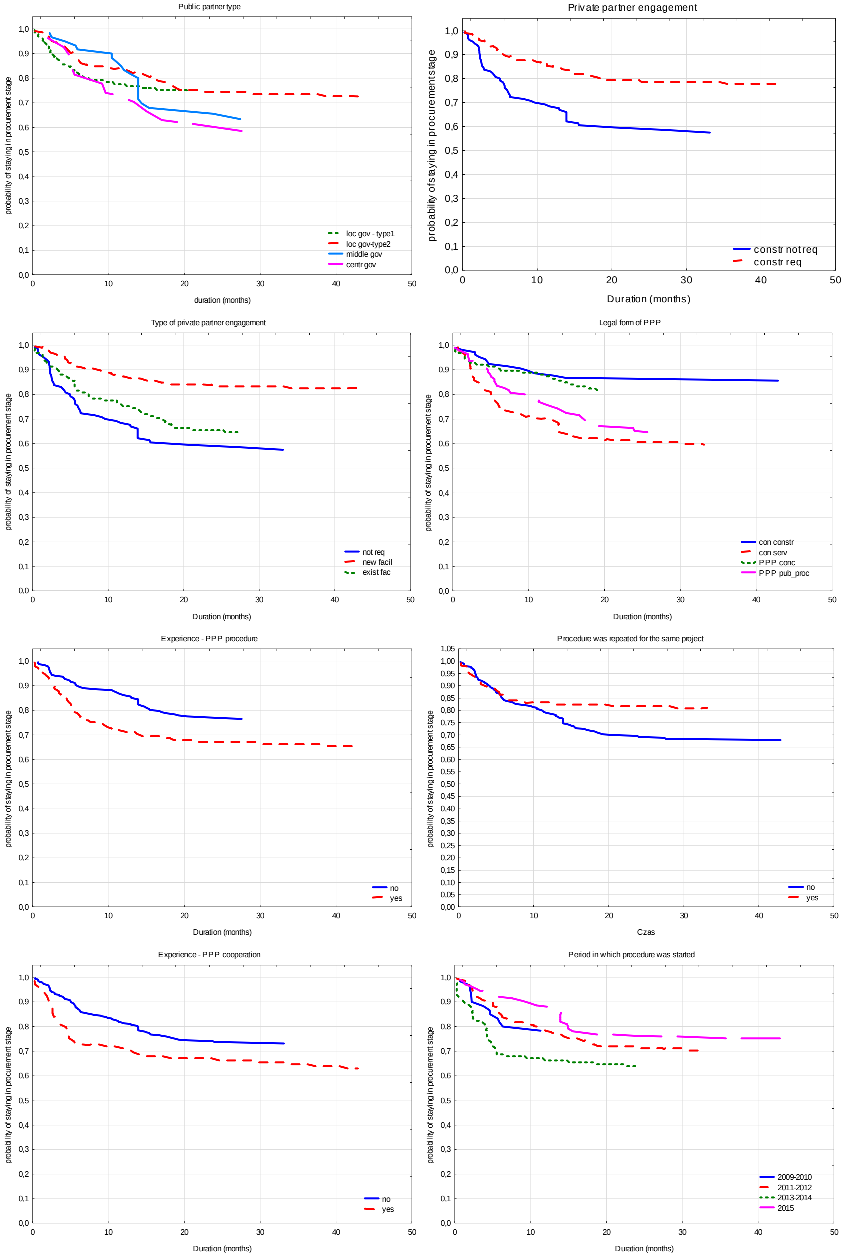
To report the results we present the Kaplan-Meier estimation of the duration curves, and we construct a Cox regression models describing the relationship between the duration and different groups of PPP projects. The Kaplan-Meier survival estimates help to identify what kind of PPP project are more likely to reach next phase (in our case it means that are less likely to survive). These estimates are shown on Figure 2.

Table 1. Median duration for the levels of each factor

Factor	Description	Levels	Median duration (months)
Public partner	local governments – type1 (rural, semi urban, urban)	1	41,8
	local governments – type 2 (big cities)	2	48,5
	middle level of government	3	23,4
	central government	4	27,6
Private partner engagement	building of facilities is not required	1	22,1
	required	2	44,7
Type of engagement	building of facilities is not required	1	22,1
	new facilities required	2	49,4
	modernization/renovations is required	3	31,5
Legal form of procedure	concession for construction works	1	22,3
	concession for services	2	60,9
	PPP under concession law	3	51,3
	PPP under public procurement law	4	27,3
No. of procedures for the same project	project was initiated only one time	1	32,1
	procedure was repeated for the same project	2	42,6
Experience – PPP procedure	public entity has no experience in PPP procedures	1	47,5
	public entity has experience in PPP procedures	2	40,3
Experience – PPP cooperation	public entity engaged in cooperation under PPP	1	33,5
	public entity not engaged in cooperation under PPP	2	43,3
Year of starting procedure	project started between 2009-2010	4	80,1
	2011-2012	3	61,0
	2013-2014	2	39,7
	2015	1	17,7

Source: own calculations.

Figure 2. Survival function of completed observations



Source: own calculations.

In general, the types of PPPs that are most likely to proceed to the next phase are following: initiated by central government and its representatives, PPPs for which private partners is not engaged in building facilities and/or conducted under concession for services procedure.

Concerning public private experience we could say that either previous experience in initiating PPPs or undertaken cooperation increase the likeliness for new projects success. However the chance to proceed the contract is decreasing with the next announcement of the same project. The last figure doesn't suggest that the likeness to survive depends on the period in which PPP procedure was initiated.

To get a further idea of the magnitude of these relations there is a need for statistical testing. There are various statistical tests in the literature. In the study, two test were chosen: *log-rank test* and *Gehan-Wilcoxon test.* Considering the results of these two tests we can’t reject the null hypothesis on the lack of differences between Kaplan-Meier distributions in two cases: *public partner type* and *year of starting procedure*.

Finally *Cox’s proportional hazard* model was used to estimate the influence of explanatory variables on the hazard of private partner selection. One of key assumptions in the model is that of proportional hazards. According to this condition the survival distributions should have hazard functions that are proportional over time. *Schoenfeld residuals test* indicated that the proportional hazard condition was not validated for factors: (1) *legal form of procedure* and (2) *number of procedures for the same project*. That is why this two factors were excluded from further analysis. Additionally correlation test were conducted for the remaining variables and these tests didn't reveal any significant relations between factors. Table 2 shows the results of the *Cox proportional hazard* models.

We were interested in exploring the link between PPP performance and public entities experience in PPPs. The relationship is described in the models by hazard ratio which exhibits the ratio of the probability of an event (going to the next PPP phase) in one group to the probability in the reference group. A hazard ratio higher than 1 indicates a higher probability of ending procedure with a success while lower than 1 respectively lower probability.

Table 2. Results for Cox proportional hazard models, α=0,05

Factor	Model 1		Model 2		Model 3		Model 4	
	HR	**p**	**HR**	**p**	**HR**	**p**	**HR**	**p**
Priv_eng_1/2					2,120	,000		
Typ_eng_1/3							1,400	,000
Typ_eng_2/3							,490	,000
Exp_p_1/2	,609	,008			,645	,018	,668	,030
Exp_c_1/2			,674	,085				
AIC		1381,77		1386,22		1366,75		1361,05
SBC		1384,54		1388,99		1372,29		1369,36
R2		0,059		0,023		0,186		0,237
No. of. c. obs.		118		118		118		118
No of obs.		423		423		423		423

Source: own calculations.

The first two models investigates *Exo_p* and *Exp_c* separately. We found that experience obtained from PPP cooperation (*Exp_c*) has less impact on PPP procedure than experience obtained during conducting previous PPP procedures. Due this fact in the next two models we used *Exp_p* indicator. The difference between Model 3 and Model 4 lies in the way of disaggregating private partner engagement in terms of a type of building facilities or its lack. We found that Model 4 explains survival of a PPPs in more complete manner.

Presented results are quite intuitive – expected private partner engagement is the most powerful predictor of the survival of PPP projects. If private partner is not required to build facilities, there is more than two times as likely to find a private partner as for the other cases (Model 3). However previous experience in PPP also influence PPP procedure. The hazard ratio is 0.668 indicating that lack of experience in PPP procedure leads to a 33 percent lower probability to proceed the project to the next phase.

Conclusions

This study delivered a detailed examination of the determinants of performance of PPP projects under procurement stage over the period 2009-2015. Our objective was to offer an interpretation of the relationship between experience and PPP performance in the context of investment decisions. The overall conclusion is that if a public entity has an experience in conducting PPP procedures it is more likely that PPP initiative it offers will be positively verified by the market. If we compare this outcomes to the results obtained from PPP projects for which the procedure was conducted more than once, we can say that public entities are rewarded for those activities which involve the search for new opportunities for public - private cooperation contrary to these activities that try to modify previous unsuccessful projects. Investment decisions are characterized by high levels of causal and outcome ambiguity and low levels of frequency and similarity (Anand et al., 2016). That is why repetitive projects were not likely to perform better, as it is observed in the case of repetitive operations process.

The major limitation of the study is related to the nature of the data. A lack of reliable, publically accessible database on PPPs limits more detailed examination of PPP in Poland. Another field for future work is to include additional variables into the survival model. One suggestion is to include time-varying factors to obtain information on possible trends that may occur if we consider a longer period of the analysis.

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The role of venture capital funds in developing innovative activities of the European Union countries

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Keywords: *innovativation; venture capital; Innovative activity; efficiency*

Abstract

Research background: Venture capital funds are very important in the development of innovative activity of economic entities. The funds contribute to closing the equity gap in the financing of innovative companies.
Purpose of the article: The purpose of the study is to show the role that venture capital funds play in the development and functioning of business entities in EU companies.
Methodology/methods: DEA (Data Envelopment Analysis), a non-parametric decision making unit (DMU), was used to examine the relationship.
Findings: The study covered the 2010 and 2015 periods. The results confirm the assumption that venture capital funds operate most effectively in the most innovative economies of the EU.

Introduction

It is important to emphasize that today, especially in highly developed and catching up countries, the issue of innovation plays a bigger role than ever before (Anokin, Peck, 2016, p.4744-4749). The conditions for the development of innovative enterprises are not the same everywhere. Many of them have to deal with the problem of capital gaps, the inability to raise capital for their own development. This problem is particularly acute in countries with less developed capital market.

Venture capital funds have grown to varying degrees in Europe, in particular, depending on the economic level of the country, the system, the propensity of risk capital holders, and many other socio-economic factors (Sokołowska, 2016, p. 1125-1129). It is defined as an independently managed, purposeful equity fund targeted at investing in private equity with high growth potential (Gompers, Lerner, 1999, p. 349). According to J. Węcławski (1997, p. 17), venture capital is an activity consisting of raising capital for a limited period by external investors to small and medium enterprises having an innovative product, method of production or service that has not yet been verified by the market.

Venture capital funds are an important part of the process of creating innovation (Moritz *et al*., 2016, p.118). Moreover - which is not a charge against the funds themselves - they are not a source of capital to replace the state in research and development spending. Venture capital funds are more widespread in those countries where higher R&D is spending (Jakusonoka 2016, pp. 248-256). There are more economically attractive innovations, whose minor refinement and commercialization are a chance for funds to make above-average profits (Groh, Wallmeroth, 2016, p.130).

Countries belonging to the structures of the European Union use available finances in various ways. In developed countries, where the capital market has a long history of existence and strong support from the government, bank lending is complementary to venture capital (Czerniak 2010, p. 819), which is different for counry like Poland or other developing countries. In addition, countries classified in the group of innovating and technology-transferring economies (not belonging to the innovators) spend less than 1% of GDP on research and development. This is a different situation for highly developed countries (innovators), where expenditure of this type is over 2% of GDP and even more than 3% in countries like Sweden, Denmark, Germany (Ciborowski, 2016, p. 75).

Table 1 Expenditures on innovation activities in the European Union countries in 2010, 2015

			GDP (billion PPS)		PE investment as % of GDP		Business R&D expenditures as % of GDP		Public R&D expenditures as % of GDP		Venture capital investments as % of GDP	
			2010	2015	2010	2015	2010	2015	2010	2015	2010	2015
1	EU	EU	11517	14635	0,314	0,3	1,2	1,3	0,73	0,72	0,096	0,063
2	BE	Belgium	290	378	0,266	0,34	1,31	1,76	0,65	0,7	0,124	0,072
3	BG	Bulgaria	66	96	0,228	0,1	0,15	0,52	0,35	0,27	0,158	0,015
4	CZ	Czech Rep	190	259	0,133	0,01	0,73	1,12	0,56	0,87	0,163	0,013
5	DK	Denmark	155	202	0,165	0,65	2,14	1,95	0,91	1,08	0,102	0,059
6	DE	Germany	2221	2933	0,186	0,22	1,84	1,95	0,88	0,91	0,068	0,049
7	EE	Estonia	19	28	0,176	0,09	0,62	0,63	0,74	0,8	0,068	0,136
8	IE	Ireland	141	193	0,5	0,31	1,11	1,11	0,51	0,4	0,227	0,086
9	EL	Greece	233	220	0,001	0,14	0,23	0,28	0,43	0,54	0,013	0,001
10	ES	Spain	1018	1221	0,276	0,14	0,7	0,65	0,65	0,58	0,090	0,043
11	FR	France	1606	2020	0,335	0,38	1,36	1,46	0,77	0,76	0,099	0,083
12	HR	Croatia	58	70	0,027	0,02	0,34	0,38	0,5	0,41	0,014	0,054
13	IT	Italy	1438	1663	0,1	0,16	0,65	0,72	0,53	0,54	0,045	0,022
14	CY	Cyprus	17	19	0	0	0,09	0,08	0,3	0,32	0,084	0,071
15	LV	Latvia	26	37	0,029	0,15	0,16	0,25	0,29	0,45	0,051	0,098
16	LT	Lithuania	41	61	0,006	0,13	0,2	0,3	0,62	0,72	0,003	0,081
17	LU	Luxembou	26	44	0,222	1,25	1,3	0,66	0,42	0,59	0,402	0,047
18	HU	Hungary	146	192	0,068	0,15	0,65	0,98	0,47	0,38	0,032	0,055
19	MT	Malta	8	11	0	0	0,33	0,5	0,19	0,33	0,011	0,000
20	NL	Netherlan	509	625	0,333	0,5	0,79	1,11	0,89	0,87	0,107	0,096
21	AT	Austria	239	314	0,246	0,32	1,78	2,11	0,82	0,86	0,038	0,051
22	PL	Poland	441	757	0,192	0,21	0,19	0,44	0,48	0,5	0,027	0,029
23	PT	Portugal	194	237	0,1	0,09	0,75	0,59	0,7	0,66	0,061	0,069
24	RO	Romania	171	323	0,1	0,09	0,18	0,16	0,31	0,22	0,073	0,013
25	SI	Slovenia	40	49	0,019	0,03	1,79	1,85	0,64	0,54	0,011	0,007
26	SK	Slovakia	74	119	0,022	0,02	0,2	0,33	0,28	0,56	0,010	0,008
27	FI	Finland	141	170	0,325	0,5	2,68	2,15	1,05	1	0,191	0,107
28	SE	Sweden	259	347	0,775	0,38	2,45	2,12	1	1,04	0,171	0,081
29	UK	United Kir	1750	2051	0,75	0,48	1,05	1,09	0,65	0,57	0,170	0,103

Source: study based on: European Private …2015, (20.03.2017).

The effects of innovative activity that can be financed by venture capital funds have different uses and characteristics. They can be seen as a new product marketed by an enterprise, a new production method, or even an increase in the workplace of an enterprise applying a new marketing strategy. As already mentioned, it largely depends on the economic situation of the country. For the purposes of this study, the effects of innovative activities are:

– SMEs innovating in-house as % of SMEs,
– Innovative SMEs collaborating with others as % of SMEs,
– PCT patents applications per billion GDP (in PPS€)

- PCT patent applications in societal challenges per billion GDP (in PPS€)
- Community trademarks per billion GDP (in PPS€)
- Community designs per billion GDP (in PPS€)
- SMEs introducing product or process innovations as % of SMEs
- SMEs introducing marketing or organisational innovations as % of SMEs
- Sales of new to market and new to firm innovations as % of turnover
- Employment in fast-growing enterprises (average innovativeness scores).

Scandinavian countries, United Kingdom, Germany use funds to finance projects at the initial stage of development, ie when conducting basic research, hypothesis building, which is different from, for example, Poland, which uses VC to finance, for example, the distribution stage (Przybylska-Kapuścińska, Łukowski, 2014, p. 288).

Methodological basis of the study

The DEA (Data Envelopment Analysis) (Kao *et al*., 2011, p. 310) methodology, which belongs to the group of non-parametric decision making (DMU) methods, was used to demonstrate the role of venture capital funds in developing innovative enterprises. The main advantage of the DEA method is that, as a nonparametric method, it does not require knowledge of the functional dependency to evaluate the effect of multiple input variables on multiple output variables, thereby enabling multi-criterion evaluation, while eliminating procedural and interpretative problems arising from the use of parametric methods. The structure of the model is adapted to the data, which makes it more flexible compared to parametric methods (Ćwiąkała-Małys, Nowak, 2009, p. 6).

In this study, the DEA methodology was used to create a ranking of EU states (decision-makers) by determining the effectiveness of innovation activities. For the purposes of this article, the definition of the effectiveness of innovative activities, measured by the influence of venture capital funds (input) on the manifestations and consequences of innovative work, such as the number of patents, the number of trademarks, the number of companies using innovations, has been adopted..

It should be added that the analysis of the literature of innovative activity is relatively rarely discussed (Chaney *et al*., 1991, p. 573-610, Sawang et al. 2012, p. 110-125, Karaganov 2008, pp. 133-146). Authors addressing this problem are primarily trying to define the effectiveness of innovative activity (usually with respect to defining the effectiveness of other types of enterprise activity) and use classic performance measures, based mostly on measurable attributes of innovation (Bijańska, 2011, p. 123).Such an approach may produce some results in the case of a single innovation project, but it seems insufficiently useful in trying to assess the overall performance of an innovative enterprise or, perhaps, the industry or even the economy as a whole.

The effects of venture capital in the European Union

As mentioned earlier, in this article the considered objects (DMU) will be the countries belonging to the structures of the European Union. The first step of the analysis consisted in the substantive selection of the data. A group of variables was identified which for the purposes of this paper was adopted as a result of innovative activity

Table 2. Effects of innovation activity-selection of variables

Starting variable	Specifying the effects of the innovative activity
y1	SMEs innovating in-house as % of SMEs
y2	Innovative SMEs collaborating with others as % of SMEs
y3	PCT patents applications per billion GDP (in PPS€)
y4	PCT patent applications in societal challenges per billion GDP (in PPS€)
y5	Community trademarks per billion GDP (in PPS€)
y6	Community designs per billion GDP (in PPS€)
y7	SMEs introducing product or process innovations as % of SMEs
y8	SMEs introducing marketing or organisational innovations as % of SMEs
y9	Sales of new to market and new to firm innovations as % of turnover
y10	Employment in fast-growing enterprises (average innovativeness scores)

Source: study based on: European Private …2015, (20.03.2017).

The purpose of this article was to present the role and significance of venture capital in the creation of the effects of innovative activity. Therefore, from the assumption of significant influence of Venture capital investments as% of GDP (impact) on the effectiveness of innovation activity from given names y1 to y10. For this purpose, the Persona linear correlation coefficient (r coefficient) was calculated to obtain the results set out in Table 3.

Table 3 Pearson's Linear Correlation Coefficient. Effects of innovation

	variables	r (2010)	r (2015)	Change (%)
y1	SMEs innovating in-house as % of SMEs	0,3456	0,3965	14,7%
y2	Innovative SMEs collaborating with others as % of SMEs	0,2900	0,2358	-18,7%
y3	PCT patents applications per billion GDP (in PPS€)	0,2947	0,2734	-7,2%
y4	PCT patent applications in societal challenges per billion GDP (in PPS€)	0,2109	0,3272	55,2%
y5	Community trademarks per billion GDP (in PPS€)	0,5980	0,2828	-52,7%
y6	Community designs per billion GDP (in PPS€)	0,3019	0,2332	-22,8%
y7	SMEs introducing product or process innovations as % of SMEs	0,3751	0,4209	12,2%
y8	SMEs introducing marketing or organisational innovations as % of SMEs	0,1769	0,3565	101,6%
y9	Sales of new to market and new to firm innovations as % of turnover	-0,2400	-0,0724	-69,8%
y10	Employment in fast-growing enterprises (average innovativeness scores)	0,7080	0,2805	-60,4%

Source: own calculations.

For the purposes of interpreting the data in Table 3, the correlation value of 0.2 was used as a measure of the existence of the relationship[1]. By analyzing the Pearson's linear correlation coefficient, most of the positive relationship between VCI and the variables analyzed can be seen. These are rope, clear dependencies. Only variable y9 in both periods shows a negative direction of dependence (if the venture capital is growing, then the sales of new firms are decreasing). In 2010 it was higher than in 2015, with no linear relationship (r <0.2). The highest correlation coefficient was obtained for y10 (Average innovativeness scores), because it was 0.708 in 2010, indicating a significant linear relationship with VCI. However, in the following period, VCI's impact on Employment in fast-growing enterprises (average innovativeness scores) decreased by 60.4%. The strong correlation is observed with the variable y5, Community trademarks per billion GDP (PPS €), whose correlation coefficient in 2010 was 0.598. However, it is interesting to reduce this dependency in 2015 (a decrease of 52.7%). The stability of the relationship is dominated by two variables y3 (PCT patents applica-

[1] The absolute value of the correlation coefficient, ie | rxy |, tells us of the strength of dependency. If the absolute value |(rxy):

– is less than 0.2, practically no linear relationship between the features tested,
– 0.2 - 0.4 - linear but pronounced but low,
– 0.4 - 0.7 - moderate linear dependence,
– 0.7 - 0.9 - Significant linear relationship,
– above 0.9 - linear relationship very strong (Cohen, 2012).

tions per billion GDP (in PPS €)) and y7 SMEs introducing product or process innovations as% of SMEs.

Only variables that have a clear linear relationship and slight variation in the periods analyzed (change in correlation coefficient below 15%[2]) were selected for the next step. Based on this assumption, the following variables are left as the effects of the effort we are discussing. VCI: SMEs innovating in-house as% of SMEs and SMEs introducing product or process innovations as% of SMEs. For the selected variables, Pearson's linear correlation coefficient (table below) was calculated. The obtained results show that there is a moderate linear relationship between the variables y1, y2 and y7, with a very strong correlation between the variables y1 and y7 (coefficient r greater than 0.9). On the basis of these considerations, it is decided to choose two variables y7, SMEs introducing product or process innovations as% of SMEs and y2, Innovative SMEs collaborating with others as% of SMEs.

Table 4 Correlation index for the variables with the strongest correlation

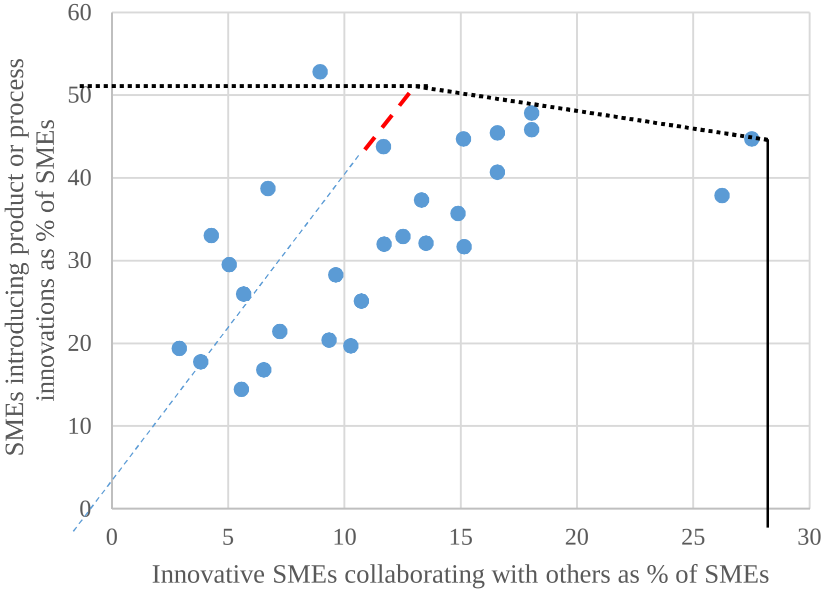
Variables	**Correlation index**
SMEs innovating in-house as % of SMEs and Innovative SMEs collaborating with others as % of SMEs (y_1 i y_2)	r = 0,6253 (2010) r = 0,5342 (2015)
SMEs innovating in-house as % of SMEs and SMEs introducing product or process innovations as % of SMEs (y_1 i y_7)	r = 0,9791 (2010) r = 0,9797 (2015)
Innovative SMEs collaborating with others as % of SMEs and SMEs introducing product or process innovations as % of SMEs (y_2 i y_7)	r = 0,6227 (2010) r = 0,6072 (2015)

Source: own calculations.

The next section assesses the effectiveness of EU countries, depending on the size of the VCI transformed into SMEs introducing product or process innovations as% of SMEs and Innovative SMEs collaborating with others as% of SMEs. Each time a group of countries were selected that set the performance boundary for the rest (master units on the data boundary). Constant resources have been established in the form of VCI (effects-oriented model) - figure 1 and 2.

[2] The value was assumed on the basis of the calculation of the correlation coefficient in the consecutive periods analyzed (change column in Table 3), taking the quartile I, which means that 25% of the observations showed a change of less than 15%.

Figure 1 Effectiveness of innovative activities of UE Member States in 2010

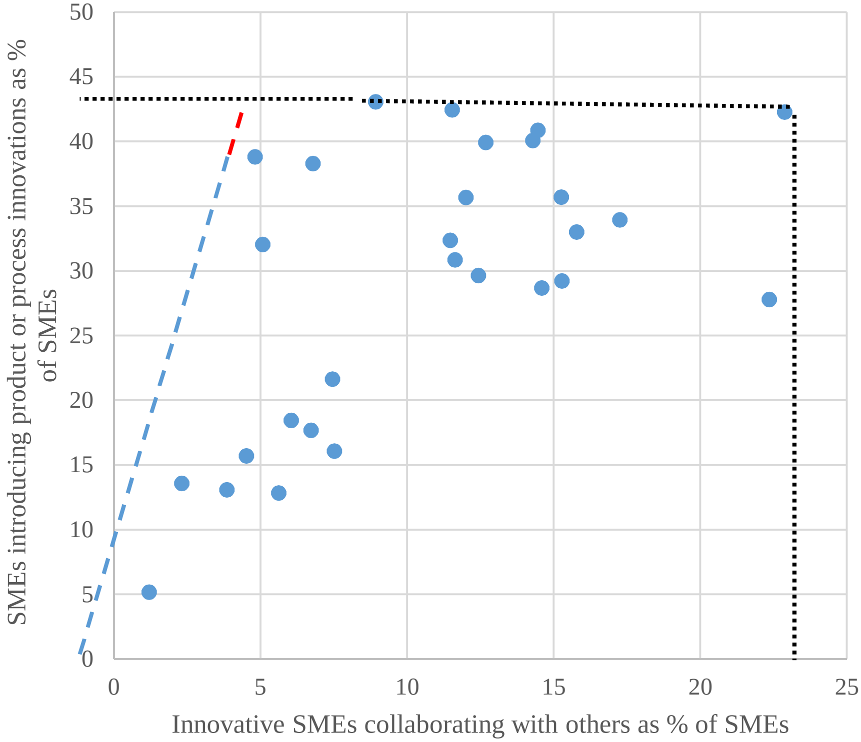


Source: own calculations.

The figure illustrates the effectiveness of innovative activities in EU countries, using an impact-oriented model (in this case, SMEs introducing product or process innovations as% of SMEs and SMEs innovating in-house as% of SMEs). The envelopes included countries such as Germany and Finland, which proved to be the most effective. Very close to the efficiency limit is also Austria. Larger countries are represented by countries such as Belgium, Estonia, Cyprus, Shia, Luxembourg, Denmark. Latvia, Bulgaria, Romania, Hungary, Poland, Lithuania and Slovakia are countries that are the least efficient, adopting innovations and transferring technology (Ciborowski 2016, p. 75,). In the case of Ireland, a straight line is shown which illustrates the inefficiency of the state, that is, the distance of the point on the graph that represents it, to the bounding box defined by the patterns (segment marked with a dashed red line).

The situation is quite different in 2015. The countries that are in the envelope are Luxembourg and Belgium. Very close to the border are Germany (the country shows a change compared to 2010 by 1%), Great Britain, which compared to 2010 shows an increase in efficiency by 46% and the Netherlands, an increase of nearly 30% (table 5). There weren't countries like Germany, Finland on the envelope, with the distance 1% or 6%. The countries below are (as in 2010) Estonia, Sweden, Austria, Denmark, Ireland. Similar situation as in 2010 is in countries like Romania, Bulgaria, Hungary, Poland, Lithuania, Latvia and Slovakia, because they are very far to the best of the country.

Figure 2 Effectiveness of innovative activities of EU Member States in 2015



Source: own calculations.

Mathematical formulas have been used to calculate the distance from the point and the distance from the origin to the coordinate system. The results are shown in the table below.

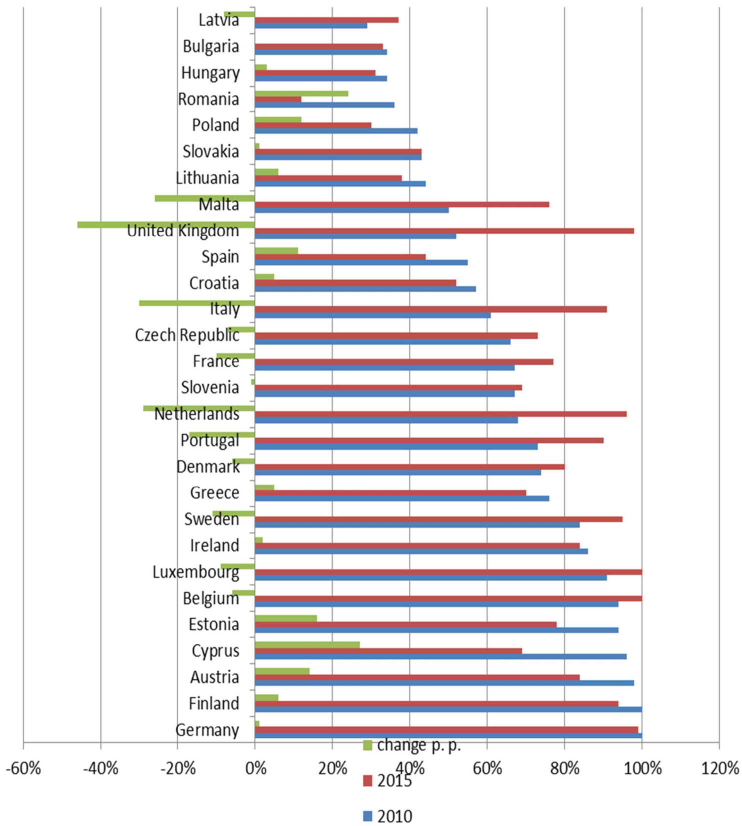
Table 5 Distances from the envelope for EU countries in 2010 and 2015

	Countries	2010	2015	change p. p.
DE	Germany	100%	99%	1%
FI	Finland	100%	94%	6%
AT	Austria	98%	84%	14%
CY	Cyprus	96%	69%	27%
EE	Estonia	94%	78%	16%
BE	Belgium	94%	100%	-6%
LU	Luxembourg	91%	100%	-9%
IE	Ireland	86%	84%	2%
SE	Sweden	84%	95%	-11%
EL	Greece	76%	70%	5%
DK	Denmark	74%	80%	-6%
PT	Portugal	73%	90%	-17%
NL	Netherlands	68%	96%	-29%
SI	Slovenia	67%	69%	-1%
FR	France	67%	77%	-10%
CZ	Czech Republic	66%	73%	-7%
IT	Italy	61%	91%	-30%
HR	Croatia	57%	52%	5%
ES	Spain	55%	44%	11%
UK	United Kingdom	52%	98%	-46%
MT	Malta	50%	76%	-26%
LT	Lithuania	44%	38%	6%
SK	Slovakia	43%	43%	1%
PL	Poland	42%	30%	12%
RO	Romania	36%	12%	24%
HU	Hungary	34%	31%	3%
BG	Bulgaria	34%	33%	0%
LV	Latvia	29%	37%	-8%

Source: own calculations.

It can be observed that Germany maintained the strongest position in the top of the ranking both in 2010 and 2015. Finland was equally strong, but in this case, the use of venture capital funds fell by 6% compared to 2015. In turn, countries such as Belgium and Luxembourg in 2015 were higher than in 2010, raising the index accordingly. 6% and 9%. Countries such as Great Britain (up 46%), Italy (up 30%) and the Netherlands (up 29%) showed the greatest increase. The greatest decrease in the use venture capital are in Cyprus (27% decrease).

Figure 3 Change in use of venture capital funds in 2010 and 2015



Source: own calculations.

Conclusions

Venture capital funds play an important role in developing the innovative activity of EU countries. Those institutions are financial intermediaries, specializing in investments in capital companies with high growth potential and equally high risk. Their involvement in the development of individual entities, and consequently of economies, depends on the degree of development of a given country, as indicated in the foregoing considerations.

The study presents an assessment of the effectiveness of EU countries. The figures presented in the present discussion confirm the assumption that the most innovative countries of the European Union (EROPEN Innovation Innovation Scoreboard 2015, The Innovation Index 2015), are the most innovative innovations according to the DEA method and they can use venture capital most effectively.

Germany, Switzerland, Sweden, United Kingdom, Finland, Ireland, Denmark, the Netherlands, Belgium, Luxembourg are among the most innovative countries in the list. These state in recent years are at the top positions in terms of innovation and development of innovative activity. The countries that use venture capital funds most effectively in both 2010 and 2015 are Germany, Finland, Belgium and Luxembourg, and in particular the United Kingdom in 2015.

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Regional differentiation of information infrastructure in Poland in the context of building a knowledge-based economy

JEL Classification: *O30; O33; R11*

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

Abstract

Research background: Information infrastructure creates the key infrastructure of the knowledge-based economy. The widespread use of information and communication technologies contributes not only to the increased efficiency of individual economic entities, but also to the possibilities of enhancing the entire economy. Information infrastructure is also a significant determinant in the development of territorial units, and therefore, it influences the regional dimension of building knowledge-based economy in Poland.
Purpose of the article: The purpose of the study was the evaluation of the regional differentiation of the level of information infrastructure in Poland, and changes which occurred in this respect between 2010 and 2015. The following research hypothesis was formulated: *Regional differentiation of the level of information infrastructure in Poland is decreasing, i.e. a regional convergence process is taking place in this respect.*
Methodology/methods: The study was performed at the regional NUTS II level. Taxonomic methods, including linear ordering based on a synthetic variable and a method of grouping linearly-ordered objects, were used.
Findings: The regional differentiation of the level of information infrastructure in Poland is at an average level, whereas the scale of this differentiation has slightly decreased. This may be confirmed by the value of the variation coefficient, which fell from the level of 17.6% in 2010 to the level of 14.4% in 2015. The regional convergence with respect to the level of information infrastructure in Poland was

accompanied by the internal convergence and divergence of provinces. In consequence of such processes, the position of individual provinces with respect to others, has changed quite significant. Into the group of provinces with a very high ICT level were classified three provinces: Mazowieckie, Dolnośląskie and Pomorskie. The group of provinces with very low ICT level includes: Lubelskie, Świętokrzyskie and Zachodnipomorskie.

Introduction

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

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

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

Information infrastructure as a pillar of knowledge-based economy

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

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

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

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

Research methodology

In line with the *Knowledge Assessment Methodology*, to evaluate the level of information infrastructure, the following variables are used: number of telephones, computers, Internet users and television sets per 1,000 person, expenditure on ICT as % of the GDP or availability of e-administration (Wasiak, 2008, pp. 83-84; Bashir, 2013, p. 32; Ujwary-Gil, 2013, p. 168). Nevertheless, numerous studies are performed on the basis of a modified set of variables as compared to the KAM (cf. Kukliński & Burzyński, 2004, pp. 2-41; Shapira et al., 2006, pp. 1522-1537; Strożek & Jewczak, 2016, pp. 208-217). When selecting the set of variables, authors try to choose variables that correspond best to the adopted definition, are adequate to the level of the performed analysis and are available for the adopted research period.

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

- X_1 – percentage of households with PCs with Internet access;
- X_2 – percentage of households with mobile phones;
- X_3 – percentage of households with satellite or cable television devices;
- X_4 – percentage of companies[1] using computers;
- X_5 – percentage of companies[1] with Internet access;
- X_6 – percentage of companies[1] with their own websites;
- X_7 – percentage of companies[1] receiving orders via computer networks;
- X_8 – percentage of companies[1] filing orders via computer networks;
- X_9 – percentage of companies[1] using the Internet in contacts with public administration bodies.

Normalisation of variables was performed with the use of the zeroed unitarisation procedure. Due to the fact that all variables were assigned

[1] Concerns non-financial sector companies.

with the character of stimulators[2], the procedure was performed in line with the formula below (Panek & Zwierzchowski, 2013, p. 37):

$$z_{ij} = \frac{x_{ij} - \min\limits_{i}\{x_{ij}\}}{\max\limits_{i}\{x_{ij}\} - \min\limits_{i}\{x_{ij}\}} \qquad i = 1, 2, \dots, n; j = 1, 2, \dots, m, \qquad (1)$$

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

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

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

where:
s_i – value of synthetic variable in the i^{th} object;
z_{ij} – normalised value of j^{th} variable in the i^{th} object;
m – number of variables.

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

Regional differentiation of the level of information infrastructure in Poland

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

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

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

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

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

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

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

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

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

2010			**2015**		
Position in ranking	Province	Level of ICT	Position in ranking	Province	Level of ICT
1	Pomorskie	Very high $s_i \geq 0.602$	1	Mazowieckie	Very high $s_i \geq 0.744$
2	Mazowieckie		2	Pomorskie	
3	Śląskie	High $0.602 > s_i \geq 0.502$	3	Dolnośląskie	
4	Kujawsko-Pomorskie		4	Śląskie	High $0.744 > s_i \geq 0.643$
5	Dolnośląskie		5	Lubuskie	
6	Wielkopolskie		6	Kujawsko-Pomorskie	
7	Zachodniopomorskie		7	Wielkopolskie	
8	Lubuskie		8	Podkarpackie	
9	Opolskie		9	Opolskie	Low $0.643 > s_i \geq 0.542$
10	Małopolskie		10	Łódzkie	
11	Łódzkie	Low $0.502 > s_i \geq 0.402$	11	Podlaskie	
12	Podkarpackie		12	Małopolskie	
13	Podlaskie		13	Warmińsko-Mazurskie	
14	Warmińsko-Mazurskie	Very low $s_i < 0.402$	14	Lubelskie	Very low $s_i < 0.542$
15	Lubelskie		15	Zachodniopomorskie	
16	Świętokrzyskie		16	Świętokrzyskie	

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

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

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

Conclusions

The level of information infrastructure in Poland has improved significantly. The highest growth of the synthetic index of information infrastructure was recorded in Świętokrzyskie and Lubelskie Provinces, i.e. in provinces which were characterised by the lowest level of this index at the beginning of the examined period. The lowest growth was recorded in Kujawsko-Pomorskie and Małopolskie Provinces. In one province, i.e. Zachodniopomorskie, a drop in the synthetic ICT index was recorded.

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

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Poland vs Spain in the first decade after EU accession. Parallel convergence patterns?

JEL Classification: *O15, P25, R11, C21*

Keywords: *Poland vs Spain; parallel regional convergence; convergence of clubs; distribution dynamics; spatial model*

Abstract

Research background: Poland and Spain share many common features resulting both from similarities of historical experience and also cultural, political, socio-demographic factors. Both countries have similar area, population and GDP structure. They also share historical experience related to political and economic transformation after a long period of non-democratic, centralized governments. Therefore the experience of Spanish membership in the EU is often considered as a model for Poland.
Purpose of the article: The purpose of this research is to perform a comparative empirical analysis of income convergence processes in Poland and Spain on a regional level (NUTS3). We aim to verify if and how these processes are related to one another (show similar paths). Special attention is paid to the periods after accession of these countries to the EU. Convergence patterns in both countries are compared with several tools.
Methodology/methods: Spatial econometric model for absolute beta convergence, sigma convergence indicators and the analysis of distribution dynamics – transition matrices.
Findings: The impact on EU accession on income convergence in Spain was positive both on a national and regional level. Regional convergence processes sped-up and interregional disparities decreased. The poorest subregions had relatively high probability to increase their income and catch-up with initially more developed regions. In the first decade after accession to EU Poland has also achieved a signif-

icant improvement of income indicators on a national level. However, empirical analyses of GDP *per capita* distribution and its dynamics on a regional level in Poland show that the above mentioned progress does not spread out proportionally on all regions. Neither beta nor sigma convergence is observed. Instead, relatively fastest growth of initially richest regions (mostly large cities) introduces convergence of clubs leading to polarization. EU accession accelerated divergence processes in Poland.

Introduction

Poland and Spain share many common features resulting both from similarities of historical experience and also cultural, political, socio-demographic factors. Both countries have similar area, population and GDP structure. They also share historical experience related to political and economic transformation after a long period of non-democratic, centralized governments. In the context of these analogies Spanish experience in the period during EU accession and in subsequent years is often seen as a model for Poland. For both countries, joining the EU was seen from a common perspective as a chance for a civilizational jump and catching-up to the level of development of European countries.

It is important to check to what extent the internal disparities between regions of the two countries are sustainable and whether they decrease over time since EU entry. This is an interesting research question in the context of the EU cohesion policy aimed at eliminating disparities in the regional level of development.

The subject of research in this article will be the phenomenon of convergence of income in Poland and in Spain at the regional level in the first decade after the accession to EU. The main purpose of this research is to perform a comparative empirical analysis of regional income convergence processes in Poland and Spain after joining EU and to verify if these processes show similar paths, or in other words are parallel.

There are several types of convergence. Beta convergence involves verification of the relationship between average yearly growth rate over some period and initial income. Sigma convergence analyses whether the dispersion of *per capita* income among countries or regions decreases with time – see e.g. Barro, Sala-i-Martin (2004).

The hypothesis about beta convergence is derived from neoclassical growth models assuming decreasing marginal productivity of capital (Solow, 1956) and is verified as absolute or conditional convergence. Absolute convergence assumes that countries or regions converge independently of their initial conditions and poorer regions grow faster than the richer ones. Conditional convergence assumes that countries or regions converge only if they are similar in terms of some structural characteristics. The process of increasing disparities is called divergence. These approaches tell nothing about the mobility within the distribution. This can be modelled with the use of transition matrices as proposed by Quah (1996a, 1996b) or Durlauf and Quah (1999). This also allows to verify existence of convergence of clubs, observed in subgroups of regions similar in terms of initial income. Its presence leads to polarization.

The remaining part of the article is structured as follows. The next section explains research methodology. In the empirical part we provide the description of the data and apply different methods to analyse regional convergence patterns in Poland and Spain. The last part summarizes conclusions. All calculations and figures were prepared with R environment (R Core Team, 2016).

Research Methodology – sigma and beta convergence

The traditional approach of beta and sigma convergence analysis uses relatively simple statistical tools (see for example Sala-i-Martin, 1996). Sigma convergence is tested by calculating a selected measure of dispersion of *per capita* income across countries or regions and comparing its values in subsequent periods of time. If dispersion is decreasing, one concludes about sigma-convergence. Increasing dispersion indicates sigma+divergence.

The verification of beta convergence is applied by running a regression model[1]:

$$\frac{1}{T}\log\left(\frac{y_{i,t+T}}{y_{i,t}}\right)=\alpha-\left(\frac{1-e^{-\beta T}}{T}\right)\log(y_{i,t})+\gamma X_{i,t}+u_{i,t,t+T} \quad (1)$$

where $y_{i,t}$ indicates *per capita* income of region i at time t, $X_{i,t}$ is a vector of exogenous structural variables that can influence *per capita* income, T refers to time interval (for yearly data T=1), and $u_{i,t,t+T}$ is an error term. If structural variables $X_{i,t}$ are omitted, one tests for the absolute convergence hypothesis, while using additional control variables $X_{i,t}$ in the regression

[1] Estimated by Nonlinear Least Squares.

results in testing for conditional convergence. Positive β means that poorer regions grow faster than richer and the value of β is interpreted as convergence speed.

This approach ignores the fact that observations are located in space and their proximity might result in autocorrelated residuals. The spatial regression solves this issue. It has an additional component – in the simplest form there is only a spatially lagged dependent variable included. This captures the spatial interaction effect. Usually it is applied in a linear form, as

$$y_i = \rho W y_i + X_i \beta + \varepsilon_i \qquad (2)$$

where W is a spatial weights matrix and ρ is the spatial autoregressive coefficient. The matrix W defines how units relate to one another. Its values depend on a definition of neighbourhood. The term Wy is a spatially lagged dependent variable or spatial lag – see e.g. Herbst and Wójcik (2012) or Tortosa-Ausina *et al.* (2005) for applications of spatial models to regional convergence analysis.

Research methodology – distribution dynamics

Alternative methodology is based on transition matrices, which allow to analyze the whole distribution and its dynamics in time. One can also test for convergence of clubs and polarization (see e.g. Magrini 1999).

Initial distribution is divided into intervals. Based on that division the transition matrix (M) is estimated. It shows how the distribution of relative GDP *per capita* (d) changes with time[2]:

$$d_t = M \times d_{t-1} \qquad (3)$$

Estimated elements of transition matrix M show the share of regions which being initially in a particular income class, remain in the same group or move to other classes[3].

$$p_{ij} = P(X_{t2} = j \mid X_{t1} = i) \qquad (4)$$

[2] This method can be compared to the first order autoregression in time series analysis.

[3] Therefore all the values in transition matrix are nonnegative and sum of probabilities in each row equals unity.

Transition matrix allows also for estimation of the long-run evolution of income distribution[4]. Ergodic vector is a synthetic indicator of tendencies in the analyzed period. One concludes about convergence if ergodic probabilities move towards the average group. If probability moves into extreme groups, it shows polarization and convergence of clubs. High probabilities on the diagonal reflect strong persistence. The limitation of transition matrices is an arbitrary selection of interval boundaries.

Data description and research hypotheses

The research is based on the data for subregions (NUTS3). Data for Polish GDP *per capita* were collected from the Local Data Bank of CSO for the period 2000-2014. In order to obtain comparable data GDP *per capita* for each region was reflected in relation to the average on the country level.

Data for Spain was obtained from the Spanish National Institute of Statistics (INE) for the period 1980-2014. Data for different periods were expressed in different currencies and in current prices. To obtain fully comparable data all GDP *per capita* values were converted into relative to country average for a particular year. Canarias were treated as a single region, similarly to the Balearic Islands. Finally, 51 Spanish subregions were considered in the analysis.

In the analysis we put particular emphasis on the first decade after EU accession (2004-2014 for Poland and 1986-1996 for Spain).

Empirical results

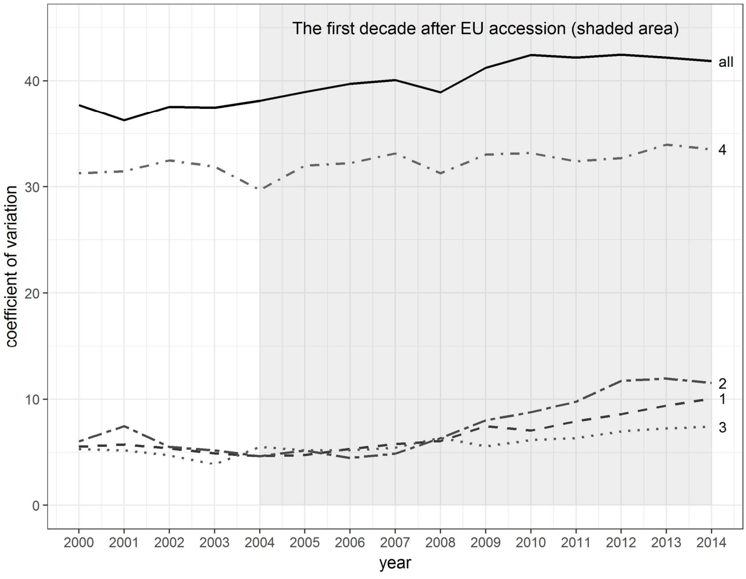
Caselli *et al.* (2004) attempted to answer the question of whether Poland could follow Spain with the analogous path of development after EU accession. Spain managed to achieve an above-average increase in productivity. In less than 15 years from the late 1950s to the early 1970s, Spain managed to increase its labour productivity in relation to France from 65% to 90%. When joining EU Poland had similar level of productivity as observed in the southern European countries during their accession to the EU. Therefore, the experience of Spain might indicate opportunities for Poland.

[4] Transition matrix M raised to power s with $s \to \infty$ converges to an ergodic matrix (with rank=1), called also an ergodic vector.

First we analyse sigma convergence for Polish regions with the use of coefficient of variation (CV) - see Figure 1. The light-grey shaded area indicates the first decade after Polish accession to EU (2004-2014). A solid line shows CVs for all regions and dashed lines CVs for regions from particular quartile groups. Before joining EU the dispersion of income *per capita* was stable and between 2004 and 2010 it increased to 42 and remained stable until 2014.

In the first years after EU accession income disparities in Poland were increasing with exception in 2008. Largest and relatively stable disparities were observed for the top quartile group (4). The remaining groups were much less diversified. Since 2008 disparities across regions from two lowest quartile groups significantly increased. Polish subregions faced sigma-divergence process strengthened by EU accession.

Figure 1. Analysis of sigma convergence for Poland: CV of relative GDP *per capita* (2000–2014, all subregions and different quartile groups)



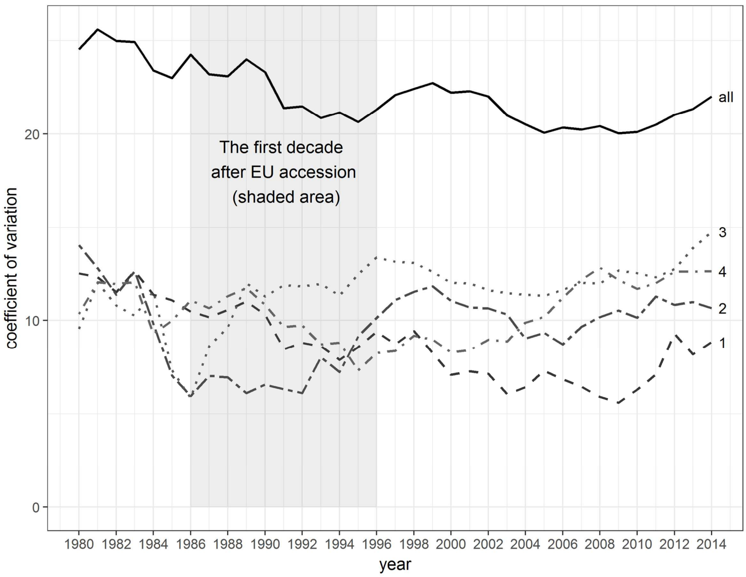
Note: labels on the right refer to the quartile group number – division based on GDP *per capita* in 2004; shaded area is the first decade after Polish EU accession.
Source: own calculations based on Polish CSO data.

Figure 2 shows sigma convergence analysis across Spanish regions between 1980 and 2014. Conclusions are different than for Poland. Before joining EU the dispersion of income was stable, but on much lower level than for Poland. Between 1986 and 1996 it decreased. Therefore in the first decade after accession to EU income disparities between Spanish regions decreased, sigma-convergence was observed. Disparities in four quartile groups were small and stable over the whole long period.

Therefore sigma convergence patterns for Polish and Spanish regions were not parallel.

In the next step we verify the existence of absolute beta convergence, taking into account only the first 10 years after EU accession. Figure 3 depicts the relationship between the average yearly growth of relative GDP *per capita* in the period 2004–2014 and initial relative GDP *per capita* (2004) for Polish regions, which appears to be positive (beta divergence). In addition we run a spatial autoregression model in which average yearly growth is regressed on initial income and spatial lag[5]. Results are presented in Table 1. We assumed k-nearest neighbours as the definition of neighbourhood and applied several values (3, 5, 10).

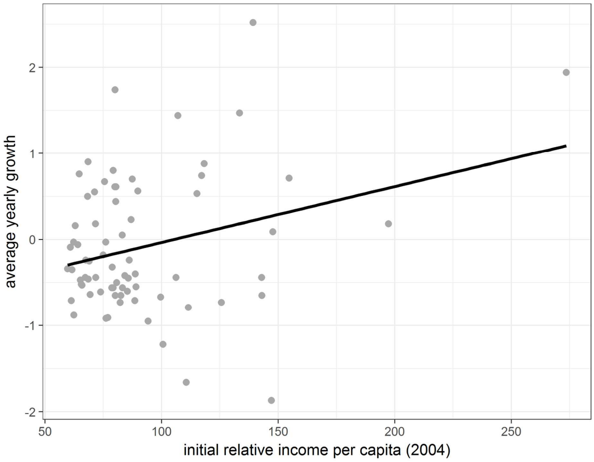
Figure 2. Analysis of sigma convergence for Spain: CV of relative GDP *per capita* (1980–2014, all subregions and different quartile groups)



Note: labels on the right refer to the quartile group number – division based on GDP *per capita* in 1986; shaded area is the first decade after Spanish EU accession.
Source: own calculations based on Spanish INE data.

[5] A simplified linear approach to beta convergence – we only need to assess the direction of relationship and its statistical significance.

Figure 3. Analysis of beta convergence for Polish subregions: average yearly growth of relative GDP *per capita* in 2004–2014 vs. initial income (2004)



Source: own calculations based on Polish CSO data.

Table 1. Analysis of beta convergence for Polish subregions: average yearly growth of relative GDP *per capita* in 2004–2014 vs. initial income (2004)

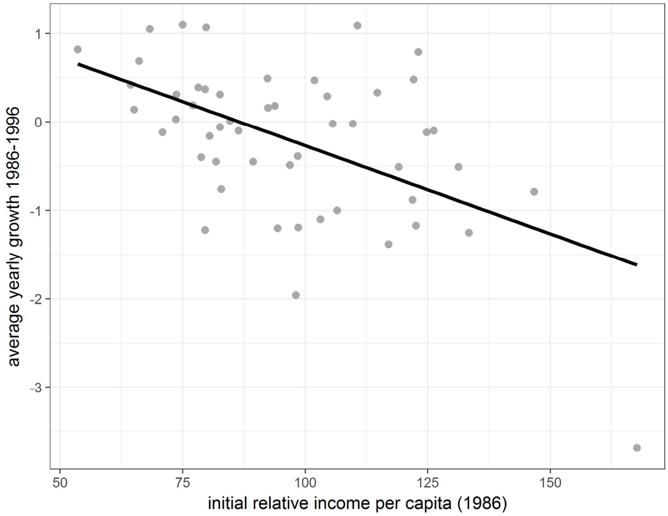
variable	**knn = 3**		**knn = 5**		**knn = 10**	
intercept	-0.6757	**	-0.6347	**	-0.6309	**
initial income (2004)	0.0064	**	0.0062	**	0.0063	**
spatial AR (ρ)	0.3524	**	0.5144	***	0.4937	**

Source: own calculations based on Polish CSO data.

Initial income is significantly and positively related with the average growth. This confirms that in the first decade after joining EU Polish regions faced beta-divergence.

Similar analysis was applied for Spain. Figure 4 depicts the relationship graphically and one can observe a negative slope (beta convergence). The results of a spatial autoregression are presented in Table 2. It confirms that initial income is significantly and negatively related with the average growth. Therefore Spanish subregions faced beta-convergence process.

Figure 4. Analysis of beta convergence for Spanish subregions: average yearly growth of relative GDP *per capita* in 1986-1996 vs. initial income (1986)



Source: own calculations based on Spanish INE data.

For transition matrices we divide regions into five quintile groups with respect to the initial distribution of relative GDP *per capita*. Table 3 depicts the transition probabilities calculated for regions for yearly transitions between 2004 and 2014.

Table 2. Analysis of beta convergence for Spanish subregions: average yearly growth of relative GDP *per capita* in 1986-1996 vs. initial income (1986)

variable	**knn3**		**knn5**		**knn10**	
intercept	2.0106	***	2.0540	***	1.9957	***
initial income (1986)	-0.0240	***	-0.0247	***	-0.0242	***
spatial AR (ρ)	-0.4471	**	-0.6156	**	-0.7838	*

Source: own calculations based on Spanish INE data.

Table 3. Transition matrix for Polish subregions (2004–2014, yearly transitions)

	group 1 <=67.18	**group 2** (67.18, 76.26]	**group 3** (76.26, 84]	**group 4** (84, 108.24]	**group 5** >108.24
group 1 (144)	95.8%	4.2%			
group 2 (144)	7.6%	86.8%	5.6%		
group 3 (145)		9.0%	83.4%	7.6%	
group 4 (143)			8.4%	90.9%	0.7%
group 5 (144)				1.4%	98.6%
ergodic	59.2%	25.2%	9.9%	5.4%	0.3%

Source: own calculations based on Polish CSO data.

One can observe a strong persistence of the distribution (high values on the diagonal), the strongest in extreme groups. There is little chance to get richer for the poorest group of regions (4.2%). The probability of becoming poorer is always higher than for getting richer. This suggests strong tendencies to polarization, confirmed by the ergodic vector.

Table 4. Transition matrix for Spanish subregions (1986–1996, yearly transitions)

	group 1 <=77.78	**group 2** (77.78, 84.76]	**group 3** (84.76, 98.2]	**group 4** (98.2, 116.52]	**group 5** >116.52
group 1 (102)	88.2%	11.8%			
group 2 (102)	11.8%	70.6%	17.6%		
group 3 (103)	1.0%	14.6%	79.6%	4.9%	
group 4 (101)			8.9%	86.1%	5.0%
group 5 (102)				6.9%	93.1%
ergodic	32.7%	27.2%	27.3%	9.6%	3.6%

Source: own calculations based on Spanish INE data.

Table 4 shows transition matrix calculated for Spanish regions (group borders based on quintiles of income distribution in 1986). One can also observe strong persistence of the distribution, but all diagonal probabilities are lower than for Poland. The chance to get richer for the poorest group of Spanish regions is equal to 11.8%. Tendencies to polarization (ergodic vector) are still moderately high. Most of the probability mass is concentrated in the two poorest groups, but now “only” 32.7% in the poorest and 27.2% in group 2.

One can therefore conclude that the analysis of mobility within the distribution of income revealed somehow different results for Polish and Spanish regions. Both show tendencies for polarization, but much weaker in Spain. The poorest Spanish regions had much higher chance to catch-up after Spain joined UE than the poorest Polish regions after 2004.

Conclusions

The aim of the study was to compare regional (NUTS3) income convergence patterns in Poland and Spain in the first decade after their EU accession with a variety of research tools.

Poland's accession to the EU has accelerated the divergence process. Neither beta nor sigma convergence was observed in Poland. The fastest growing regions were the largest cities and regions abounding in natural resources. Regions were more often becoming poorer than richer.

Spain was subject to much smaller dispersion in regional income. In contrast to Poland, both beta and sigma convergence was observed. Spain's accession to the European Union has accelerated regional convergence processes. The poorest regions were more likely to increase their relative income and catch-up with the initially more developed regions. Faster development of the richest regions led to income polarization both in Poland in Spain, but it was weaker in case of Spain.

Based on the analysis one can conclude about the existence and persistence of the problem of regional disparities in *per capita* income. The gap between the poorest and richest regions is not diminishing or is even increasing over time. And convergence patterns in Poland and Spain were not parallel.

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Enhancing Polish firms' innovation activities in comparison to the other moderate innovators countries

JEL Classification: *O30; O52; R11*

Keywords: *innovation activities; firm; the European Union; Moderate Innovators countries*

Abstract

Research background: Faced with circumstances of rapid changes, the crucial is stimulation of actions aimed at enhancing competitiveness. In this regard, the European Union strategy Europe 2020 should be mentioned. Concerning the role of firms' innovation activities in economic growth of regions and countries, it is important to explore how enhancing Polish firms' innovation activities differ between the EU countries with a similar to Poland level of innovation. Thus, the particular emphasis was put on the Moderate Innovators countries.
Purpose of the article: The aim of this paper is to investigate enhancing Polish firms' innovation activities against those from the other Moderate Innovators countries.
Methodology/methods: The study was based on data from the European Innovation Scoreboard 2016 related to firm activities dimensions: firm investments, linkage & entrepreneurship and intellectual assets. The time period was 2008–2015 and was limited by data availability. To study multivariate analysis and the zero unitarization methods were applied. These methods allowed to multivariate analysis of enhancing firms' innovation activities in Poland and those from the other EU countries with similar to Poland level of innovation.
Findings: This paper contributes to the existing literature by providing new insight on understanding the issues related to firms' innovation activities. The results reveal, among others, that although Polish firms' innovation activities have improved against those from the other Moderate Innovators counties, it requires further en-

hancing. The findings have practical and policy implications. It is assumed that the obtained results may be useful for firms, regions and country in enhancing competitiveness.

Introduction

The circumstances of rapid changes impact on the necessity of stimulation of actions aimed at enhancing competitiveness of firms, regions and countries. Such actions are noticeable in the European Union strategy Europe 2020 (European Commission, 2016, pp. 4). Here, the special attention is put on innovation as an important driver of competitiveness. The ability of innovation to foster competiveness of countries, regions and firms has been widely argued in the economic literature (see, e.g., Acs *et al.*, 2002, pp. 1069-1085; pp. 1-50; Acs *et al.*, 2016, pp. 527-535) and is noticeable especially in endogenous growth theory and knowledge spillovers theory. With this regard, the particular emphasis should be put on firms' innovation activities as the core to build a competitive advantage of firms, regions and countries.

Regarding the above, it is very important to explore how enhancing firms' innovation activities differ between countries with a similar level of innovation. Thus, the aim of this paper is to investigate enhancing Polish firms' innovation activities against those from the other Moderate Innovators countries.

The study was carried out under theoretical and empirical analysis of the problem based on a related literature review and data from the European Innovation Scoreboard (EIS). The time period is 2008–2015 and is limited by data availability.

The paper is organized as follows: First part presents a brief overview of the literature on the innovation activities of firms. Second part presents method of the research. Next part provides the findings. Last part concludes the paper.

This paper contributes to the existing literature by providing new insight on understanding of the issues related to firms' innovation activities. To understand the differences in enhancing firms' innovation activities between Poland and the other EU countries with a similar to Poland level of innovation, multivariate analysis and the zero unitarization method was applied.

Theoretical background and hypothesis development

Faced with the dynamic environment, firms' innovation activities become an important driver of innovation and competitiveness (see, e.g., Acs *et al.*, 2002, pp. 1069-1085). Hence, the essential is cooperation between regions and firms (see, e.g. Huggins & Williams, 2011, pp. 909-910; Tödtling& Grillitsch, 2015, pp. 1741-1758). In this regard, regions should develop regional innovation ecosystems and build backgrounds for stimulation firms' innovation activities (see, e.g., Acs *et al*., 2016, pp. 527-535; Huggins & Williams, 2011, pp. 909-910; Spencer *et al*., 2005, pp. 321–337). This issue is emphasised particularly in endogenous growth theory and knowledge spillovers theory.

Concerning the rank of firms' innovation activities in competitiveness of firms, regions and countries, the emphasis is put on indicators connected with innovation performance of firms. Thus, in the past decades a number of studies deal with a key indicators of firms' innovation (see, e.g., Asheim *et al*., 2016, pp. 1-19; Zahra & George, 2002, pp. 185-203; Tödtling& Trippl, 2005, pp. 1203-1219; Cooke *et al*., 2000, pp. 1-183; Fritsch & Franke, 2004, pp. 245-255). These indicators are also an increasingly considered by the European Union, especially in the place-based approach. Based on this approach, the combination of endogenous and exogenous indicators of regional development is essential for building competitive advantage of firms, regions and countries (Barca, 2009, pp. 1-244). Thus, the special importance is also put on a diversity of economic, social and territorial conditions of regions as the essential component of policy-making to support firms to stimulate innovation.

An increasing rank of firms' innovation activities in enhancing competitiveness of firms, regions and countries requires undertake studies how enhancing innovation activities of firms differ between the EU countries with a similar level of innovation.

Thus, the following hypothesis was posed: despite Poland belongs to the group of the EU countries with a similar level of innovation, enhancing Polish firms' innovation activities differ from those from the other Moderate Innovators counties.

Methods of the research

The data of this study were gathered from the last report of the European Innovation Scoreboard (European Commission, 2016). The special emphasis was put on data related to firms' innovation activities. In this respect, the EIS contains three dimensions regarding to firm investments, linkage & entrepreneurship and intellectual assets. These dimensions and their nine specific indicators stay in accordance with endogenous growth theory and knowledge spillovers theory. The study uses data related to the Moderate Innovators countries, which contains such countries as: Croatia, Cyprus, Czech Republic, Estonia, Greece, Hungary, Italy, Latvia, Lithuania, Malta, Poland, Portugal, Slovakia, and Spain. The time period was 2008–2015 and was limited by data availability. The descriptive statistics of diagnostic variables are presented in Table 1.

Table 1. Descriptive statistics of diagnostic variables

Variables			Mean	St. dev.	Min	Max
Firm investments	x_{1t}	Business R&D expenditure	0.49	0.27	0.08	0.99
	x_{2t}	Non-R&D innovation expenditure	0.98	0.51	0.45	2.31
Linkages & entrepreneurship	x_{3t}	SMEs innovating in-house	25.41	8.59	11.73	39.44
	x_{4t}	Innovative SMEs collaborating with others	9.93	5.37	4.42	22.76
	x_{5t}	Public-private co-publications	14.40	7.37	3.19	24.89
Intellectual Assets	x_{6t}	PCT patent applications	0.91	0.56	0.32	2.13
	x_{7t}	PCT patent applications in societal challenges	0.26	0.17	0.04	0.57
	x_{8t}	Community trademarks	6.33	6.40	0.91	23.73
	x_{9t}	Community designs	2.94	2.89	0.33	11.08

Source: own calculations based on data from the European Innovation Scoreboard 2016 (European Commission, 2016).

All diagnostic variables distinguish sufficient variability (coefficient of variation is higher than 0.1).

To analyze how enhancing Polish firms' innovation activities differ between the EU countries with a similar to Poland level of innovation multivariate analysis and the zero unitarization method was applied. Such combination of methods allows an analysis the differences between the European Union countries (Balcerzak, 2015, pp. 190-205) and "enables comparing the values of synthetic index for all years" (Balcerzak, 2015, pp. 191). The application of these methods was used for each of the EIS innovation dimensions related to firm activities: firm investments, linkage & entrepreneurship and intellectual assets.

At first, on the ground of zero unitarization method, the normalisation of diagnostic variables was carried out. In this context, constant reference point (the range of the normalized variable) was calculated, according to the following formula (Kukuła & Bogocz, 2014, pp. 7):

$$R(X_{jt}) = \max_{it} x_{ijt} - \min_{it} x_{ijt} \tag{1}$$

Regarding that all diagnostic variables are the stimulants to normalisation of diagnostic variables the following formula was used (Kukuła & Bogocz, 2014, pp. 7):

$$z_{ijt} = \frac{x_{ijt} - \min_{it} x_{ijt}}{\max_{it} x_{ijt} - \min_{it} x_{ijt}} \tag{2}$$

where $z_{ijt} \in [0,1]$; $(i = 1,2,\dots,n)$; $(j = 1,2,\dots,m)$; $(t = 1,2,\dots,l)$

Next, the synthetic measure was calculated using the formula (Balcerzak, 2015, pp. 196):

$$SM_{it} = \frac{1}{m}\sum_{j=1}^{m} z_{ijt} \tag{3}$$

where $z_{ijt} \in [0,1]$; $SM_{it} \in [0,1]$; $(i = 1,2,\dots,n)$; $(j = 1,2,\dots,m)$; $(t = 1,2,\dots,l)$

Above procedure allowed to investigate how enhancing Polish firms' innovation activities differ between the EU countries with a similar to Poland level of innovation.

Findings

The results of multivariate analysis of firms' innovation activities between the Moderate Innovators countries are presented in Tables 2 to 4 (in appendix). According to the obtained results, in the period 2008-2015 enhancing Polish firms' innovation activities differed from those from the other the EU countries with similar to Poland level of innovation. Considering firm investments dimension, the results indicate relatively high diversity in enhancing level of business R&D expenditure and non-R&D innovation expenditure in the most the Moderate Innovators countries and between this countries (Table 2). Against this background, Polish firms distinguished relatively high development in the field of investments (especially in the period 2008-2012). This situation, in relation to decrease of the level of business R&D expenditure and non-R&D innovation expenditure in the most the Moderate Innovators countries, should be treated as positive in the context of enhancing competitiveness of firms, regions and country. According to the obtained results, such development highlighted also firms from Cyprus and Lithuania (especially in the period 2011-2013).

Concerning linkage & entrepreneurship dimension, the obtained results distinguished relatively low changes in the most of the Moderate Innovators countries (Table 3). Among the EU countries with similar to Poland level of innovation, Polish firms highlighted lack of enhancement of SMEs innovating in-house, innovative SMEs collaborating with others and public-private co-publications. This situation, in relation to the lowest rank of Polish firms in terms of linkage & entrepreneurship dimension, should be treated as negative, especially in the context of enhancing competitiveness of firms, regions and country.

Regarding intellectual assets dimension, the results imply relatively high changes in enhancing level of PCT patent applications, PCT patent applications in societal challenges, community trademarks and community designs, in the most of the Moderate Innovators countries and between this countries (Table 4). In line with the obtained results, Polish firms distinguished relatively high rank in terms of intellectual assets dimension. Within the EU countries with similar to Poland level of innovation, Polish firms highlighted also the decrease of level PCT patent applications, PCT patent applications in societal challenges, community trademarks and community designs. This situation concerned the period 2010-2013 and was improved in the next years.

Conclusions

The results confirm that despite Poland belongs to the group of the EU countries with a similar level of innovation, enhancing Polish firms' innovation activities differ from those from the other Moderate Innovators counties. The results reveal that although Polish firms' innovation activities have improved against those from the other Moderate Innovators counties, it requires further enhancing. This concerns all firm activities' dimensions with special interest in improvement of linkage & entrepreneurship dimension.

These findings have policy and practical implications. In this regard, the findings call for strengthening actions concerning firms' capabilities to competitive advantage, especially in the area of the network between universities, institutional environment and research organisations. On the other hand, the findings imply the necessity to further supporting firms 'innovation activities in all dimensions.

This study is not without limitations. This paper based on firms' innovation activities indicators and data from the European Innovation Scoreboard. It would be interesting to investigate whether the obtained results also hold in regions context.

The complexity of firms' innovation activities requires further studies. It seems necessary to investigate the causes of differences in terms of enhancing firms' innovation activities between Poland and the other EU countries with similar to Poland level of innovation.

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Annex: Table 2. The results of multivariate analysis of firms' innovation activity between the Moderate Innovators countries – Firm investments dimension (in the period 2008-2015)

2008			2009			2010			2011			2012			2013			2014			2015		
No.	Co.	SM	No.	Co.	SM	No.	Co.	SM	No.	Co.	SM	No.	Co.	SM	No.	Co.	SM	No.	Co.	SM	No.	Co.	SM
1	EE	0,8015	1	EE	0,8516	1	EE	0,9015	1	EE	1,0000	1	EE	1,0000	1	EE	0,7526	1	EE	0,6432	1	EE	0,7644
2	CZ	0,5593	2	PT	0,5645	2	PT	0,5723	2	CZ	0,7064	2	CZ	0,5006	2	CZ	0,5057	2	CZ	0,6178	2	CZ	0,6690
3	ES	0,4632	3	CZ	0,5593	3	CZ	0,5441	3	HU	0,5376	3	CY	0,4843	3	CY	0,5000	3	CY	0,5000	3	HU	0,5893
4	PT	0,4326	4	ES	0,4922	4	ES	0,4621	4	PT	0,5207	4	MT	0,3670	4	LT	0,4241	4	HU	0,4732	4	MT	0,5606
5	IT	0,3791	5	IT	0,4255	5	HU	0,4558	5	CY	0,4843	5	PL	0,3578	5	MT	0,4138	5	LT	0,4351	5	PL	0,4648
6	HU	0,3257	6	HU	0,3675	6	IT	0,4357	6	IT	0,4674	6	HU	0,3491	6	PL	0,3654	6	MT	0,4325	6	LT	0,4225
7	MT	0,2961	7	MT	0,3007	7	MT	0,2794	7	MT	0,4540	7	PT	0,3040	7	IT	0,3526	7	IT	0,4196	7	IT	0,4122
8	CY	0,2788	8	HR	0,2890	8	CY	0,2788	8	ES	0,4296	8	IT	0,2682	8	HU	0,3364	8	PL	0,4104	8	HR	0,4020
9	SK	0,2379	9	CY	0,2788	9	SK	0,2551	9	PL	0,3785	9	HR	0,2510	9	PT	0,3231	9	PT	0,3476	9	PT	0,3620
10	HR	0,2237	10	SK	0,2577	10	HR	0,2440	10	HR	0,3313	10	ES	0,2199	10	ES	0,2672	10	ES	0,3125	10	EL	0,3226
11	EL	0,1365	11	PL	0,1504	11	PL	0,1480	11	SK	0,2256	11	LT	0,1752	11	SK	0,2183	11	HR	0,2637	11	SK	0,3152
12	PL	0,1311	12	EL	0,1429	12	EL	0,1396	12	LT	0,2206	12	EL	0,1630	12	EL	0,2146	12	SK	0,2634	12	ES	0,2740
13	LT	0,1193	13	LT	0,0945	13	LT	0,0997	13	EL	0,2119	13	SK	0,1627	13	HR	0,2073	13	EL	0,2412	13	CY	0,1074

Legend: HR – Croatia, CY – Cyprus, CZ – Czech Republic, EE – Estonia, EL – Greece, HU – Hungary, IT – Italy, LT – Lithuania, MT – Malta, PL – Poland, PT – Portugal, SK – Slovakia, ES – Spain.

Source: own calculations based on data from the European Innovation Scoreboard 2016 (European Commission, 2016).

Annex: Table 3. The results of multivariate analysis of firms' innovation activity between the Moderate Innovators countries – Linkage & entrepreneurship dimension (in the period 2008-2015)

2008			2009			2010			2011			2012			2013			2014			2015		
No.	Co.	SM	No.	Co.	SM	No.	Co.	SM	No.	Co.	SM	No.	Co.	SM	No.	Co.	SM	No.	Co.	SM	No.	Co.	SM
1	EE	0,8591	1	EE	0,8591	1	CY	0,8848	1	CY	0,9738	1	CY	0,8597	1	CY	0,9218	1	CY	0,8438	1	EE	0,6308
2	CY	0,7241	2	CY	0,7241	2	EE	0,8488	2	EE	0,8599	2	EE	0,7677	2	EE	0,6557	2	EE	0,6653	2	CY	0,6254
3	CZ	0,6515	3	CZ	0,6515	3	CZ	0,6515	3	HR	0,6134	3	HR	0,6134	3	IT	0,5963	3	IT	0,5995	3	CZ	0,6215
4	EL	0,5651	4	EL	0,5651	4	IT	0,6123	4	CZ	0,6066	4	CZ	0,6063	4	HR	0,5844	4	CZ	0,5421	4	IT	0,6129
5	HR	0,5406	5	HR	0,5406	5	HR	0,5581	5	IT	0,5699	5	IT	0,5532	5	CZ	0,5673	5	EL	0,5317	5	EL	0,5743
6	IT	0,5989	6	IT	0,5989	6	EL	0,5543	6	EL	0,5166	6	PT	0,5178	6	EL	0,5491	6	HR	0,4557	6	PT	0,4633
7	PT	0,4179	7	PT	0,4179	7	PT	0,4149	7	PT	0,5006	7	EL	0,5173	7	ES	0,4455	7	ES	0,4444	7	HU	0,3880
8	ES	0,3973	8	ES	0,3973	8	ES	0,3898	8	HU	0,3464	8	ES	0,3434	8	PT	0,4302	8	PT	0,4279	8	ES	0,3557
9	HU	0,3374	9	HU	0,3374	9	HU	0,3334	9	ES	0,3208	9	HU	0,2795	9	HU	0,3472	9	HU	0,3859	9	HR	0,3543
10	SK	0,2457	10	SK	0,2457	10	SK	0,2386	10	LT	0,1918	10	LT	0,1906	10	SK	0,3187	10	SK	0,2862	10	MT	0,2811
11	LT	0,1923	11	LT	0,1923	11	LT	0,2283	11	SK	0,1751	11	SK	0,1437	11	LT	0,1593	11	MT	0,1752	11	SK	0,2414
12	MT	0,1720	12	MT	0,1720	12	MT	0,1702	12	MT	0,1428	12	MT	0,1049	12	MT	0,1550	12	LT	0,1521	12	LT	0,1487
13	PL	0,1387	13	PL	0,1387	13	PL	0,1387	13	PL	0,0369	13	PL	0,0369	13	PL	0,0000	13	PL	0,0208	13	PL	0,0304

Legend: Like in table 2.

Source: own calculations based on data from the European Innovation Scoreboard 2016 (European Commission, 2016).

Annex: Table 4. The results of multivariate analysis of firms' innovation activity between the Moderate Innovators countries – Intellectual assets dimension (in the period 2008-2015)

2008			2009			2010			2011			2012			2013			2014			2015		
No.	Co.	SM	No.	Co.	SM	No.	Co.	SM	No.	Co.	SM	No.	Co.	SM	No.	Co.	SM	No.	Co.	SM	No.	Co.	SM
1	IT	0,8011	1	IT	0,8256	1	IT	0,8021	1	IT	0,7738	1	IT	0,7603	1	EE	0,6215	1	IT	0,5810	1	MT	0,6546
2	ES	0,5572	2	ES	0,5538	2	EE	0,6067	2	EE	0,7150	2	EE	0,7220	2	IT	0,5735	2	MT	0,5536	2	IT	0,5804
3	CY	0,4886	3	EE	0,4855	3	ES	0,5533	3	ES	0,5813	3	ES	0,6137	3	MT	0,5532	3	ES	0,4963	3	ES	0,4774
4	HU	0,4006	4	MT	0,4206	4	MT	0,4704	4	CY	0,4420	4	HU	0,4088	4	ES	0,4965	4	HU	0,3371	4	HU	0,2618
5	HR	0,3522	5	HU	0,3633	5	HU	0,4630	5	HU	0,3832	5	MT	0,3872	5	HU	0,3516	5	EE	0,2856	5	EE	0,2552
6	PT	0,3366	6	PT	0,3438	6	PT	0,3474	6	PT	0,3654	6	PT	0,3833	6	PT	0,2548	6	CY	0,2465	6	CZ	0,2150
7	MT	0,3334	7	HR	0,3151	7	CZ	0,3280	7	CZ	0,3264	7	CZ	0,3681	7	CY	0,2462	7	CZ	0,2438	7	CY	0,1943
8	EE	0,3208	8	CZ	0,2976	8	CY	0,3094	8	MT	0,3179	8	CY	0,3566	8	CZ	0,2146	8	PT	0,2120	8	PT	0,1923
9	CZ	0,2841	9	CY	0,2618	9	PL	0,2266	9	PL	0,2592	9	PL	0,3050	9	PL	0,1444	9	HR	0,1847	9	PL	0,1367
10	PL	0,2124	10	PL	0,1941	10	HR	0,1659	10	LT	0,1872	10	HR	0,1695	10	HR	0,1375	10	PL	0,1598	10	HR	0,0932
11	SK	0,1173	11	SK	0,1141	11	EL	0,1121	11	HR	0,1244	11	SK	0,1429	11	LT	0,1121	11	EL	0,1194	11	LT	0,0690
12	EL	0,1068	12	EL	0,0908	12	SK	0,1114	12	SK	0,0921	12	LT	0,1358	12	SK	0,0963	12	LT	0,1130	12	EL	0,0629
13	LT	0,0835	13	LT	0,0515	13	LT	0,0806	13	EL	0,0848	13	EL	0,1081	13	EL	0,0765	13	SK	0,0928	13	SK	0,0538

Legend: Like in table 2.

Source: own calculations based on data from the European Innovation Scoreboard 2016 (European Commission, 2016).

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What drivers affect entrepreneurial activity in the transition economies? The case of the Visegrad countries

JEL Classification: *L26; P25; R11*

Keywords: *entrepreneurship; transition economies; the Visegrad countries*

Abstract

Research background: While a large literature exists linking entrepreneurship with its drivers in developed economies, entrepreneurship issues in the transition economies are still no entirely recognised. The Visegrad countries represent a unique scope for examining drivers affecting entrepreneurial activity in the transition economies, since they faced similarities at the beginning of the transformation. The findings may be supportive in identifying threats and opportunities of the economic development of Central and Eastern Europe regions.
Purpose of the article: This paper contributes to the literature on entrepreneurship by focusing on drivers of entrepreneurial activity in the transition economies. The aim of the paper is to analyse how entrepreneurial activity in respective Visegrad countries is influenced by various drivers.
Methodology/methods: Entrepreneurship activity and its drivers in the Visegrad countries were considered for the 2004-2014 period. Hypotheses were tested with the usage of an Ordinary Least Squared regression. F-test was employed to test estimated regressions. Goodness-of-fit of the regressions was controlled with the coefficient of determination. To check for the collinearity, Pearson's correlation coefficient was used.
Findings: In this paper the approach for improving the understanding of issues related to entrepreneurship in the transition economies is made. This paper contributes to the understanding of how entrepreneurship activity in the Visegrad countries is influenced by various drivers. The main finding is that although entrepreneurial activity in the Visegrad countries seems to be influenced by similar drivers

that have been identified for developed economies, the way in which respective drivers matters for entrepreneurship is, in certain cases, distinct. The findings may attract attention of policymakers and may be useful in the processes of policy pursuing.

Introduction

The relationship between entrepreneurial activity and economic growth has received substantial attention in recent years, both from researchers and policy makers (see, e.g., Fritsch, 1997, pp. 437-448; Audretsch & Lehmann, 2005, pp. 1194-1197; Bosma &Schutjens, 2011, pp. 711-742; Huggins &Thompson, 2015, pp. 114-120). While entrepreneurship issues in developed economies have been extensively examined, little is known about mechanisms related to entrepreneurship in the transition economies. The understanding of entrepreneurship issues in these economies seems important since it may provide a valuable insight on processes of reintroducing or establishing entrepreneurial attitudes in a transforming society. Since entrepreneurial activity is regarded as a pivotal factor of economic development in the transition economies (McMillan & Woodruff, 2002, pp. 153-170) it seems essential to understand its essence.

Entrepreneurship issues in the transition economies has been regarded in the literature in recent years (see, e.g., Smallbone & Welter, 2001, pp. 229-262; Kshetri, 2009, pp. 246–254; Wyrwich, 2013, pp. 667-682; Fritsch & Wyrwich, 2016, pp. 157-189). However, the debate on challenges faced by the transition economies with regard to entrepreneurship regions is still incomplete.

This paper extends research on entrepreneurship issues in the transition economies by focusing on entrepreneurial activity drivers. Hence, the aim of the paper is to analyse how entrepreneurial activity in respective Visegrad countries is influenced by various drivers. The focus on the Visegrad countries may provide compelling conclusions since these countries shared similar characteristics at the moment of the transition start. To test for an impact of various drivers on entrepreneurial activity an Ordinary Least Squared regression has been used.

This paper contributes to the literature on entrepreneurship by focusing on drivers affecting entrepreneurial activity in the transition economies. New insights on understanding of entrepreneurial activity in the transition economies is provided. The findings may be supportive in identifying threats and opportunities of the economic development of Central and Eastern Europe regions.

The structure of the paper is as follows. Theoretical background and hypotheses development is provided in first section. This is followed by method of the research. Another section includes empirically based findings. The final section includes conclusions.

Theoretical background and hypotheses development

An engagement in entrepreneurial activity during the transition process is accompanied with an extremely high level of uncertainty, since transformation into market economy is a challenging and usually rapid process. It is related mostly with unstable and sometimes adverse environment with, particularly at the beginning, the absence of market institutions and transparent law, and with limited access to finance. Such circumstances lead in large part to notably high business risk. However, a structural change generally does not suppress entrepreneurial activity. On the contrary, the enormous growth in entrepreneurship rate is mostly observed. On the example of East Germany, Fritsch *et al.* provide evidence that transformation to market economy involves a significant increase in entrepreneurial activity (2014, pp. 429-430). The same conclusion draw Ireland *et al.* for Central and Eastern Europe countries (Ireland *et al.*, 2008, pp. 107-108), and McMillan & Woodruff for China and Vietnam (2002, pp. 154).

The motivation to engage in entrepreneurial activity is heterogeneous. After decades of conditions which can be considered as unfavorable to entrepreneurship, one may expect that entrepreneurial attitude in the society is severely inhibited. Indeed, the central planned economy does influence entrepreneurial activity (Kshetri, 2009, pp. 236-254), with the effects visible long after the transition process. On the example of East Germany it was indicated by Wyrwich that the generation which was exposed the most to socialistic values was less willing to involve in entrepreneurship even 15 years after structural change in economy (2013, pp. 667-682). Nevertheless, the adverse environment for business does not entirely hinder entrepreneurial attitudes. A possible explanation for this phenomenon may refer to informal institutions (North, 1990, pp. 1-159), including patterns and attitudes towards entrepreneurship which occurred before the socialism and remained persistent (Fritsch *et al.*, 2014, pp. 441). Entrepreneurship activity which existed under the centrally planned economy has constituted a “seedbed” (Smallbone & Welter, 2001, pp. 250) for taking advantage on emerging market opportunities, which at the beginning of the transition were highly profitable (McMillan & Woodruff, 2002, pp. 159). However, the expansion of entrepreneurial activity may have different foundation.

Since the transition from centrally planned to free market entails a massive unemployment growth, it gives the reasons to the necessity entrepreneurship to emerge (Fritsch *et al*., 2014, pp. 429-430).

Entrepreneurial activity is determined by heterogeneous drivers. On the grounds of the literature studies the principal drivers may be recognised as: unemployment level, economy structure, knowledge creation and transfer, human capital (see, e.g., Reynolds *et al*., 1995, pp. 389-407; Audretsch & Lehmann, 2005, pp. 1194-1197; Bosma &Schutjens, 2011, pp. 711-742; Fritsch *et al*., 2014, 427-446; Huggins &Thompson, 2015, pp. 114-120). Although the identification of these drivers is based mostly on observations for developed Western economies, it seems that they also apply to these economies which undergo a transformation towards free market structure. Hence, the following hypotheses are tested in this paper:

H1 Unemployment level in the Visegrad countries tends to influence positively entrepreneurial activity.

H2 Economy structure has a significant impact on entrepreneurial activity in the Visegrad countries.

H3 Entrepreneurial activity in the Visegrad countries increases with the growth of knowledge inflows.

H4 Human capital in the Visegrad countries has a positive effect on entrepreneurial activity.

Method of the research

To examine how entrepreneurial activity in respective Visegrad countries is influenced by various drivers an Ordinary Least Squared regression was used. The empirical model to be estimated can be written as below:

$$E_i = \beta_0 + U_i\beta_1 + S_i\beta_2 + I_i\beta_3 + HW_i\beta_4 + M_i\beta_5 + R\&D_i\beta_6 + G_i\beta_7 + D_i\beta_8 + \varepsilon_i \qquad (1)$$

where,
$E_i -$ entrepreneurial activity,
other variables as described below.

Estimated regression was tested using an F-test. Pearson's correlation coefficient was employed to exclude variables with high level of collinearity (Pearson's correlation above 0.85). Coefficient of determination was used to indicate goodness-of-fit of the regression. Lagged impact of variables was taken into consideration.

Sample and variables

Entrepreneurship issues in the Visegrad countries were considered for the 2004-2014 period. The data source is EUROSTAT.

Dependent variable (E) was proxy as the share of self-employed within total workforce. Explanatory variables used for assessing the value of different drivers on entrepreneurial activity in the Visegrad countries, together with expected signs of coefficients are shown in table 1. Control variables have been applied (variables: G and D).

Table 1. Definition of variables and expected sign of coefficient

Variable $(Indicator)$	Definition	Expected sign
Unemployment (U)	Unemployment rate	+
Inflows of knowledge $(R\&D)$	Spending in R&D per capita	+
Economy structure:		
Services (S)	Share of employment in services to total employment	+
Industry (I)	Share of employment in manufacturing industries to total employment	-
Human capital:		
Highly skilled workforce (HW)	Share of population with university degrees in relation to total employment	+
Migration (M)	Rate of net migration	-
Economic growth:		
Output country growth (G)	Real GDP per capita	+
Demand for goods and services (D)	Number of people per square kilometre	+

Source: Own based on Reynolds *et al.* (1995), Audretsch & Lehmann (2005), Bosma &Schutjens (2011), Fritsch *et al.* (2014), Huggins &Thompson (2015).

Descriptive statistics of variables are included in table 2.

Table 2. Descriptive statistics

Variable	Obs	Mean	SD	Min	Max
E	44	0.15	0.03	0.10	0.20
U	44	10.19	3.63	4.40	19.40
S	44	0.58	0.03	0.53	0.65
I	44	0.34	0.04	0.29	0.40
HW	44	0.28	0.06	0.17	0.41
M	44	0.99	1.69	-0.90	7.70
R&D	44	111.36	68.14	29.80	294.00
G	44	10840.91	2673.93	5400.00	15600.00
D	44	118.51	10.93	106.10	136.30

Source: Own estimation.

Correlation matrices of dependent variable and explanatory variables are shown in Appendix (tables: 4-7).

Findings

The results of estimations (table 3) allow to conclude that the intensity and the significance of entrepreneurial activity drivers vary among the Visegrad countries.

In accordance to research expectations, the impact of unemployment on entrepreneurial activity is positive and significant. It supports Hypothesis 1 and is consistent with previous studies (see, e.g., Fritsch *et al.*, 2014, pp. 427-446). The results indicate that growth in the number of the unemployed is followed by an increase in the share of self-employed within total workforce. However, it takes time for this dependence to emerge (at least one year). The sign and significance of this influence remain similar for all Visegrad countries with the exception of Hungary, where relationship between unemployment and entrepreneurial activity is reverse.

With the correspondance to research assumptions, economy structure do have an impact on entrepreneurial activity, which is consistent to the observations of Reynolds *et al.* (1995, pp. 389–407). Hypothesis 2 is supported. The results provide evidence that decrease in the share of employment in manufacturing industries to total employment is accompanied by the growth in the share of self-employed within total workforce. However, in the case of the Czech Republic the positive coefficient is observed suggesting that entrepreneurial activity diminishes with the decline in employment in the industry. For the Slovak Republic, the impact of economy structure on entrepreneurship is not statistically significant.

Table 3. Estimation results

	the Czech Republic	Hungary	Poland	the Slovak Republic
$const$	−0.0141 (0.0622)	0.4472*** (0.0508)	2.5404** (0.8117)	0.2745* (0.1163)
U_{t-1}			0.0015*** (0.0002)	0.0020** (0.0007)
U_{t-2}	0.0040*** (0.0006)	−0.0017** (0.0004)		
I_t	0.3679* (0.1475)	−0.6129** (0.1522)	−0.1643* (0.0615)	−0.5669 (0.2813)
M_t	−0.0022** (0.0004)	−0.0097** (0.0027)	−0.0030 (0.0016)	−0.0021 (0.0032)
$R\&D_t$			−0.0003** (6.3154e-05)	−0.0003* (0.0001)
$R\&D_{t-1}$	0.0002*** (3.3137e-05)	−0.0007*** (0.0001)		
G_t	−2.6569e-06*** (3.7385e-07)			6.8979e-06*** (9.9920e-07)
G_{t-1}		−2.1864e-06 (1.1034e-06)		
D_t			−0.0189** (0.0067)	
R^2	0.9895	0.9521	0.9899	0.9696
$Adjusted\ R^2$	0.97195	0.8724	0.9774	0.9316
$p-value$ $for\ test\ F$	0.0011	0.0047	0.0001	0.0002

Heteroscedasticity and autocorrelation consistent. Standard errors in parenthesis. Level of statistical significance: ***$p \leq 0.01$; ** $p \leq 0.05$; *$p \leq 0.10$.
Source: Own estimation.

As opposed to research anticipation, findings reveal that for Hungary, Poland, and the Slovak Republic relationship between spending in R&D per capita and the share of self-employed within total workforce is reverse. Hypothesis 3 is not supported. Nevertheless, inflows of knowledge tend to influence positively entrepreneurial activity in a case of the Czech Republic. The estimation results confirm the expected effect of migration rate on the share of self-employed within total workforce. This supports Hypothesis 4. However, the influence of human capital on entrepreneurship activity is statistically significant only for the Czech Republic and Hungary.

Interestingly, the control variables, being overall statistically significant, do not show expected sign. In particular, in a case of the Czech Republic and Hungary, the adverse effect of real GDP per capita on the share of self-employed within total workforce is observed. For that matter, entrepreneurial activity responds negatively to increase of demand in Poland, being inconsistent with research assumptions. However, for the Slovak Republic, the relation between entrepreneurial activity and the country growth is positive and consistent with previous studies.

Conclusions

This paper may contribute to the understanding of how entrepreneurial activity in the transition economies is influenced by different drivers. Although it seems apparent that similar environment at the beginning of the transformation towards free market economy should be reflected to a degree in an economy of respective Visegrad countries, the results provide evidence of ambiguity in terms of entrepreneurship. Specifically, the impact of drivers on entrepreneurial activity seems to vary between the Visegrad countries. Results indicate that this influence for particular transition economies has not only distinct significance, but also is disparate with regard to the course of interaction. This may provide some practical implications, especially for policymakers by affording an insight into fundamental drivers which should be considered to enhance entrepreneurial activity.

This study is not without limitations. Firstly, this paper does not account for long-lasting entrepreneurial tradition which may outlive a socialism period (as suggested by Fritsch *et al.* for East Germany (2014, pp. 427-446)). Secondly, this paper does not refer directly to the entrepreneurship policies which have been implemented over the transition process in respective Visegrad countries. Hence, it may be interesting to test both for the significance of entrepreneurial tradition, and the efficiency of entrepreneurship policy in these economies. Another limitation of this paper refers to a proxy used for entrepreneurial activity. Although it has been chosen in accord with earlier studies (see, e.g., Fritsch, 1997, pp. 437-448; Audretsch *et al.*, 2008, pp. 691), some may argue that it applies only to individuals starting new firms, leaving aside e.g. corporate entrepreneurs. This may set a starting point for further discussion on entrepreneurial activity in the Visegrad countries.

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Appendix

Table 4. Correlation matrix of dependent variable and explanatory variables (the Czech Republic)

Variable	E	U	S	I	HW	M	R&D	G	D
E	1								
U	0.2202	1							
S	0.8191**	0.1586	1						
I	-0.8209**	-0.3565	-0.9695**	1					
HW	0.8159**	-0.0742	0.9261**	-0.8637**	1				
M	-0.6721**	-0.7284**	-0.7014**	0.8177**	-0.5548	1			
R&D	0.7163**	-0.3113	0.8189**	-0.7150**	0.9637**	-0.3419	1		
G	0.5067	-0.5876	0.6455**	-0.4529	0.7375**	-0.0254	0.8347**	1	
D	0.7531**	-0.2729	0.8966**	-0.7773**	0.9259**	-0.3842	0.9251**	0.9003**	1

Level of statistical significance: ** $p \leq 0.05$
Source: Own estimation.

Table 5. Correlation matrix of dependent variable and explanatory variables (Hungary)

Variable	E	U	S	I	HW	M	R&D	G	D
E	1								
U	-0.5609	1							
S	-0.8443**	0.8423**	1						
I	0.8054**	-0.8207**	-0.9714**	1					
HW	-0.8792**	0.7888**	0.9494**	-0.9662**	1				
M	0.6614**	-0.4487	-0.6655**	0.6515**	-0.7006**	1			
R&D	-0.9519**	0.6211**	0.9062**	-0.9048**	0.9564**	-0.7789**	1		
G	-0.8791**	0.4179	0.6350**	-0.5559	0.7092**	-0.6262**	0.7951**	1	
D	0.8984**	-0.5803	-0.8835**	0.9229**	-0.9473**	0.7340**	-0.9787**	-0.6986**	1

Level of statistical significance: ** $p \leq 0.05$
Source: Own estimation.

Table 6. Correlation matrix of dependent variable and explanatory variables (Poland)

Variable	E	U	S	I	HW	M	R&D	G	D
E	1								
U	0.9260**	1							
S	-0.7952**	-0.6289**	1						
I	-0.7594**	-0.9099**	0.2993	1					
HW	-0.7693**	-0.5496	0.9734**	0.2435	1				
M	-0.0272	-0.1267	0.1865	0.0177	0.1006	1			
R&D	-0.8134**	-0.6248**	0.9493**	0.3524	0.9812**	0.1244	1		
G	-0.9270**	-0.8392**	0.8729**	0.6369**	0.8758**	0.0746	0.9269**	1	
D	-0.2266	-0.0439	0.2563	-0.0933	0.3254	0.0022	0.3365	0.1813	1

Level of statistical significance: ** $p \leq 0.05$
Source: Own estimation.

Table 7. Correlation matrix of dependent variable and explanatory variables (the Slovak Republic)

Variable	E	U	S	I	HW	M	R&D	G	D
E	1								
U	-0.2572	1							
S	0.8757**	-0.0451	1						
I	-0.7342**	-0.1591	-0.9619**	1					
HW	0.8528**	-0.0416	0.9603**	-0.9083**	1				
M	0.1026	-0.3850	0.1151	-0.0461	0.3063	1			
R&D	0.7949**	-0.1408	0.9131**	-0.8612**	0.9739**	0.4011	1		
G	0.8919**	-0.5295	0.8113**	-0.6492**	0.8430**	0.3978	0.8763**	1	
D	0.7605**	-0.0348	0.9111**	-0.8913**	0.9709**	0.4101	0.9877**	0.8140**	1

Level of statistical significance: ** $p \leq 0.05$
Source: Own estimation.

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