Determinants of Employment and GDP Resilience in the Context of an Economic Crisis: Evidence from EU countries and regions

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Abstract
There are many studies that analysed impacts of a set of indicators on economic resilience of countries and regions but studies focusing on the differences between the effects of determinants of employment resilience and GDP resilience are missing. This paper is a preliminary attempt to fill that gap by providing a new cross-country as well as cross-regional evidence on the different effect of determinants of resilience measured by GDP and employment. The analytical part of this paper is based on the analysis of employment and GDP resilience of EU countries as well as with the regional NUTS 2 level in the context of the economic crisis from 2008. The main method used in this study is the correlation analysis. Results show the existence of specific determinants for a different type of resilience on the country level (e.g. indicators of economic structure). Determinants connected with human capital show a strong positive relationship concerning both types of resilience on the country as well as the regional level (especially in terms of growth of employment and product).

Keywords: resilience, product, employment, recession, economic crisis

Introduction

The main aim of this paper is focused on comparing the effects of the determinants of two different forms of economic resilience (employment resilience and GDP resilience). The comparison of the different effects of determinants could be useful for effective decision making in the field of regional policy within the regional management processes. This study used part of the results from previous research that was focused on identifying important factors of a regional economic resilience measured via employment growth (Svoboda, Klementová, 2014). This study is different from the previous study as we are now focused not only on employment resilience but also on GDP resilience. New results are available also thanks to a comparison of country and regional-specific determinants.

The primary sub-objective of this research is to find a possible relationship between five groups of indicators of potential determinants and four resilience indicators. For this purpose, we use correlation analysis for a set of 25 countries and 256 regions in the EU. We could have also used multivariable methods for purposes of this analysis. But the results from this study show linkage between all potential determinants which is usually connected with so called multicollinearity. This fact rejects use of regression analysis. Another possible approach is to use a method of dimension reduction (e.g. factor analysis) connected with a little bit of difficulties in terms of results interpretation. That is why we use only correlation analysis in this preliminary research.

This analysis was carried out to determine whether the determinants of employment or GDP based resilience are different or not (as proven determinant we see only that indicator selected from the set of potential determinants of economic resilience which showed statistically significant correlation relationship with some indicator of resilience). The above mentioned analysis is focused on describing the differences between determinants of regional and national economic resilience in connection to the economic crisis of 2008 and this study follows similar studies (e.g. Martin, 2012; ESPON, 2014).

Regional Economic Resilience

Since the 1970s, the study of the resilience of socio-ecological systems has been the topic of many investigations. From the beginning of the 21st century it has also been used in economics (see e.g. Reggiani, De Graaff, Nijkamp, 2002). Most of this research aims at dynamics of regional employment and product (it explores why some regions are better at withstanding an economic downturn than others, or are able to recover faster). The special term "regional economic resilience" has been widely put to practice in recent years, especially in connection with the assessment of regional impacts concerning the 2008 economic crisis. Economic resilience is usually defined in terms of a regional economy's ability to withstand or overcome a recessionary event. The concept takes into account the ability of the region to face adverse events and deal with them without any major problems or difficulties. Some authors argue that resilience could help us understand how such systems respond to shocks, disturbances and perturbations.

The term resilience has a quite broad meaning and use thanks to its multidisciplinary origin (the first use was in the field of ecological modeling). The first fundamental definitions were given to us by Holling (1973) and Perrings (1994). Nowadays, the term can also be found e.g. in the area of the crisis management concerning the evaluation of impacts of extraordinary events (disaster resilience) and in many others areas (e.g. psychology etc.). In this context, we can see regional economic resilience as a closely defined subset of a more generally perceived regional resilience (without the adjective "economic"). Regardless of the various approaches, to resist and subsequently to adapt to deviations is the common interpretation of regional economic resilience. Deviation of a regional economy can be caused by a whole spectrum of events, including national or global economic downturns, social disorders or natural disasters (these events are interpreted as an external economic shock). Many empirical studies use one of the following indicators for measuring economic resilience (Martin, 2012), (ESPON, 2014): product, employment, unemployment, number of patents, etc. In this study, we use only the first two indicators (employment resp. product per capita). There are also many other possibilities on how to quantify resilience (e.g. it might be possible to use the information of wages and salaries which vary within regions (Kraftová, Kraft, 2015)).

Materials and Methods

The first step of cross-country resp. cross-regional analysis is the design of indexes for the quantification of economic resilience. Regional resilience is commonly looked upon through the eyes of development concerning regional indicators of labour market or regional product.

In the case of examining regional resilience, there is often regional employment dynamics chosen as a suitable indicator for economic resilience. This attitude is obvious in a study done by UK economic-geographer Ron Martin (2012), who focused his work on studying the impacts of recessions examined via long-term data of employment on NUTS 1 level of the UK regions. Our approach is focused not only on the regional level but also on the country level and that is why it combines data from regions and countries. In addition, we were studying two types of resilience (resilience measured on the base of GDP per capita in Purchasing Power Standard (PPS) and employment (employed people according Labour Force Survey methodology). We adopt this approach to get an answer to the research questions: What are the differences between the determinants of the two types of resilience examined? What are the determinants which increase resilience?

Sample of Countries and Regions

The above mentioned analysis was carried out for 25 countries and 256 regions at NUTS 2 level and include the following countries of the EU: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, United Kingdom. The choice of the above states is based on the current fulfilment of the following criterion. Because we study resilience or the precise reactions of employment and GDP at national and subnational level in terms of the EU's regional policy, we need to use countries and regions that have been a part of the EU even before the economic crisis of 2008. That is why our data sample consists of only EU's countries and their regions from 2004 (countries and regions NUTS 2, which were not part of the EU corresponding to the state after the EU enlargement in 2004, were removed from sample).

Implemented Indexes and Hypotheses

We used following four indexes of resilience: gEM as an indicator which describes growth in terms of the number of employed people through the decline of regional (or national) employment (abbreviation EM is used for the word "employment"); gGDP as an indicator describing GDP growth through the decline of regional (or national) product (GDP in our study means "Gross Domestic Product per capita in Purchasing Power Standard (PPS)"); I_{EM} as an index describing change of employment between 2008 and 2012; I_{GDP} as an index describing change of employment between 2007 and 2011 (the difference between indexes I_{EM} and I_{GDP} in mentioned years is due to delay between GDP and employment development).

The specific objective of the research is to test the following six hypotheses:

H1a: Determinants of GDP resilience and employment resilience differs at the country level.

H1b: Determinants of GDP resilience and employment resilience differs at the regional level.

H2a: The quality of human capital decreases the size of decline in terms of country employment growth (measured by the gEM index at the country level calculated based on the business analysis within the period 2007 - 2014).

H2b: The quality of human capital decreases the size of decline in terms of regional employment growth (measured by the gEM index at the regional level calculated based on the business analysis within the period 2007 - 2014).

H3a: The intensity of R&D and innovation activities increases the change of GDP (measured by I_{GDP} index in the period 2007 - 2011) at the country level.
H3b: The intensity of R&D and innovation activities increases the change of GDP (measured by I_{GDP} index in the period 2007 - 2011) at the regional level.

The following part of the article describes methodology of our research. The main aim of this paper is to compare effects of determinants of two different forms of economic resilience (employment resilience and GDP resilience). The measuring of regional economic resilience was based on the yearly time series of GDP and employment on both the country and subnational (regional) level. The main data source which was used was the Eurostat Statistical Office - both for the countries and NUTS 2 regions. Due to examination of the impact of the economic crisis in 2008, we used a set of examined potential determinant values from the year 2007. Values of the year 2007 represent the last year when the financial crisis did not influence the real economic indicators (similar conclusion in e.g. ESPON, 2014; Kraft, 2011). These datasets consist of 12 indicators that we used as potential determinants from the two types of resilience examined (the selection of indicators was based on previous research (Svoboda, Klementová, 2014)). In addition, we use 4 indexes (gGDP, gEM, I_{GDP}, I_{EM}) for the quantification of economic resilience (two in terms of GDP and two in terms of employment). Time series of regional GDP is available in two forms: old methodology called ESA95 (available only until 2011) and the new one ESA2010 (available only from 2010). Because of this methodology change and because of evaluation of economic crisis from 2008 we had to use regional GDP data based on ESA95 which was available only until 2011.

According to previous studies (e.g. Martin, 2012) we focused separately on the size of decline (in terms of employment and also GDP development). Another focus was put on the change of GDP in the period 2007-2011 and on the change of employment in the period 2008-2012. Because of focusing on the size of decline we had to use analysis of business cycles and identification of breakpoints. The entire process of identifying breakpoints was based on the literature dealing with the analysis of business cycles (e.g. Poměnková, 2011; Harding, Pagan, 1999; Bry, Boschan, 1971). Peaks and troughs were identified for each country and region (to identify the period of decline). Simply it could be said that the recession phase begins in a point where the local maximum is reached (peak) and ends in a point of its local minimum (trough). For identification of recession phase we used definition of the recession phase (Czech Statistical Office, 2015): “Recession is a significant decline in activity across the economy, lasting longer than six months”.

The beginning of the recession phase varies within countries and regions. We used at least one year long (4 quarters of the year) continuous recession that could start only within period 2008-2010 for an individually constructed calculation of gGDP and gEM indexes. Thanks to that we include not only countries and regions which experienced beginning of decline exactly in 2008 to evaluation but also countries and regions with 2 years delay of decline. The earliest beginning of recession phase for countries in terms of GDP was identified in 2008. It was the case of 9 countries from all 25 countries and the latest year of the end of recession phase was identified in 2011 (it was case of Greece). At this point it should be noted that the

recession phase in the case of Greece was longer, but to get comparable indexes for countries and regions, we had to use only data until 2011. The earliest beginning of recession phase for countries in terms of employment was identified at 2008. It was the case of 7 countries from all. The latest year of the end of recession phase in terms of employment was identified in 2014 (e.g. Greece and Portugal). The first year of recession phase in terms of GDP was identified at the regional level in 2008. It was the case of 116 regions from all 256 regions. The latest year of the end of recession phase in terms of GDP was identified in 2011 and it was the case of some regions of Spain and Italy. This could, however, be the effect of the absence of more recent data. The first year of recession phase in terms of employment was identified at the regional level in 2008. It was the case of 67 regions from all 256 regions and the latest year of the end of recession phase in terms of employment was identified in 2014. It was the case of some regions of Greece, Spain and Italy.

According to the previous research (Martin, 2012), (Svoboda, 2013), we calculated four indexes of resilience (gGDP, gEM, I_{GDP}, I_{EM}) for two types of resilience (GDP per capita in PPS resp. employment). Firstly, we calculate the average growth of GDP per capita in PPS for the recession period of each country and region based on identification of the beginning and the end of the recession phase (similarly for employment). These indicators are calculated according to the formulas:

$$gGDP = G(x_1, x_2, \dots, x_n) = (\prod_{i=1}^{n} x_i)^{\frac{1}{n}}, \text{ where } x_i = \frac{GDP_t}{GDP_{t-1}} \quad (1)$$

$$gEM = G(x_1, x_2, \dots, x_n) = (\prod_{i=1}^{n} x_i)^{\frac{1}{n}}, \text{ where } x_i = \frac{EM_t}{EM_{t-1}} \quad (2)$$

where x_i is the growth rate of GDP per capita in PPS or employment (it means inter-year rates of change in output or employment). Then n is equal to number of years of recession phase specific for each country and region and t is time (year). gGDP index is calculated based on the business analysis within period 2007 – 2011 (because of available regional data only until 2011; to have comparable indexes we had to use the same period (values until 2011) also for gGDP calculated for countries – although GDP at a country level is accessible for later years). gEM index is also calculated based on the business analysis within period 2007 – 2014. gGDP and gEM indexes were calculated for all countries (except of Poland in the case of gGDP and Malta in the case of gEM – both due to absence of recession phase). Regional version of gGDP was calculated only for regions with recession phase of GDP (95 % resp. 244 regions from 256 regions experienced recession phase in terms of GDP per capita). gEM was calculated only for regions with recession phase of employment (88 % resp. 226 regions from 256 regions experienced recession phase in terms of employment level).

In the next two indexes of resilience, we calculate I_{GDP} as the percentage change in GDP per capita in PPS between 2007 and 2011. Then I_{EM} as the percentage change in employment measured between 2008 and 2012. The difference of periods is due to one year's delay of employment compared with the dynamics of GDP. In contrary to the first two indexes of resilience we used the same period for each country and region. This characteristic is

symbolised as I_{GDP} and I_{EM} – where "I" expresses "index". The indexes I_{GDP} and I_{EM} are calculated according to following formulas:

$$I_{GDP} = \frac{GDP_{2011}}{GDP_{2007}} * 100\ [\%], \quad (3)$$

$$I_{EM} = \frac{EM_{2012}}{EM_{2008}} * 100\ [\%], \quad (4)$$

where GDP_{2007} is the value of GDP per capita in PPS for the year 2007 (similarly GDP_{2011}) and EM_{2012} is the value of employed people for the year 2008 (similarly EM_{2012}). These indexes were calculated for each country and region. Considering the duration of the examined period, it can be said that 16 quarters (resp. 4 years) represent a suitable time period for the evaluation of an economic recession (e.g. Duval, Vogel (2008) suggest that the minimal period for evaluating the impact of an economic crisis is at least 4 years).

Potential Determinants of Economic Resilience

In accordance with previous research we used a set of 12 potential determinants which showed a medium or strong correlation with economic resilience in the past research (Svoboda, Klementova, 2014). The indicators used in this research are provided below:

Labour Market (3 indicators): "The Job Vacancy Rate" (**JVr**); "Employment rate with people aged 15 to 64 years old" (EMr); "The Unemployment Rate" (**UNr**).

Human Capital (2 indicators): "Human Resources in Science and Technology – according to occupation" (**HRST**); "Percentage of people between ages of 25-64 with Upper Secondary or Tertiary Education according to ISCED-97 - level from 3 to 6" (**EDU**); the second indicator is according to the International Standard Classification of Education (ISCED-97).

Structure of the Economy (3 indicators): "Percentage of employed people between ages of 15-64 within primary sector (A, B)" – (**$EM_{A, B}$**); "Percentage of employed people between ages of 15-64 within secondary (C, D, E, F)" – (**EM_{C-F}**); "Percentage of employed people between ages of 15-64 within secondary (G - Q)" – (**EM_{G-Q}**). Letters (A-Q) are based on the NACE Rev. 1.1 (The Statistical Classification of Economic Activities).

Innovation Activity and R&D (2 indicators): "Total intramural R&D expenditure in Purchasing Power Standard (PPS) per inhabitant at constant 2005 prices" (**GERD**); "Number of Patent Applications per million inhabitants (European patent application)" – (**PAT**).

Economic Performance (2 indicator): "Labour Productivity (gross value added of the number of people employed)" – (**LP**), "Gross Domestic Product at PPS per capita at current prices" (**GDP**).

All indicators were acquired from the European Statistical Office (from the year 2007). We considered the possible effect of a one year delay between values of determinants and values of resilience indexes. In the previous research we used data not only from 2007 but also from the year 2006. But the analysis of correlation coefficients showed that the effect of the delay of determinant influence on indexes of resilience is negligible. At this point it should be noted that Shapiro - Wilk W test failed to show the normality of the used datasets (except: "Percentage of employed people between ages of 15-64 within tertiary sector (G-Q)", "Human Resources in Science and Technology – according to occupation" both mentioned at

a regional level and the index "The Unemployment Rate" at a country level). Therefore, a nonparametric correlation analysis was used (specifically Spearman's correlation coefficient).

Results

The next part of the paper is focused on the results from the correlation analysis. Table 1 shows the results of the correlation analysis between all determinants at regional level. Calculation is based on Spearman's coefficient for the 256 regions NUTS2 and all values are from the year 2007. Due to the absence of a normal distribution we use the Spearman rank correlation coefficient. The statistically significant relationship was found in most of correlation pairs. A strong relationship was found especially between GDP and LP, GERD and PAT, EMr and UNr (this is thanks to similar construction of indices and causal influences between them). The results of this correlation matrix indicate suitability of dimension reduction. This could be realized for example by using a factor analysis. Dimension reduction could be however connected with problematic results interpretations. That is why we use only correlation analysis in this preliminary research.

Tab. 1: The results of the correlation analysis for determinants of resilience – Spearman's coefficient (the significant values are in grey cells, values above 0.8 or below -0.8 are in bold) – 256 regions

	EDU	**HRST**	**$EM_{A, B}$**	**EM_{C-F}**	**EM_{G-Q}**	**GDP**	**LP**	**GERD**	**PAT**	**EMr**	**UNr**	**Jvr**
EDU	1	0.49	-0.17	0.20	-0.09	0.02	-0.13	0.22	0.25	0.17	0.08	0.61
HRST	0.49	1	-0.65	-0.15	0.46	0.72	0.56	0.77	0.80	0.61	-0.40	0.23
$EM_{A, B}$	-0.17	-0.65	1	0.21	-0.68	-0.65	-0.54	-0.66	-0.58	-0.48	0.35	0.10
EM_{C-F}	0.20	-0.15	0.21	1	-0.78	-0.23	-0.24	-0.17	-0.04	-0.14	0.09	0.00
EM_{G-Q}	-0.09	0.46	-0.68	-0.78	1	0.52	0.50	0.47	0.35	0.36	-0.27	-0.16
GDP	0.02	0.72	-0.65	-0.23	0.52	1	**0.87**	0.77	0.74	0.63	-0.58	-0.31
LP	-0.13	0.56	-0.54	-0.24	0.50	**0.87**	1	0.66	0.62	0.28	-0.31	-0.29
GERD	0.22	0.77	-0.66	-0.17	0.47	0.77	0.66	1	**0.84**	0.54	-0.41	-0.14
PAT	0.25	0.80	-0.58	-0.04	0.35	0.74	0.62	**0.84**	1	0.57	-0.42	-0.03
EMr	0.17	0.61	-0.48	-0.14	0.36	0.63	0.28	0.54	0.57	1	**-0.80**	-0.18
UNr	0.08	-0.40	0.35	0.09	-0.27	-0.58	-0.31	-0.41	-0.42	**-0.80**	1	0.13
Jvr	0.61	0.23	0.10	0.00	-0.16	-0.31	-0.29	-0.14	-0.03	-0.18	0.13	1

Source: authors according data from (EUROSTAT, 2015)

Abbreviations used in table 1: EDU - Percentage of people between ages of 25-64 with Upper Secondary or Tertiary Education according to ISCED-97 - level from 3 to 6 (%); **HRST** - Human Resources in Science and Technology – according to occupation (%); **$EM_{A, B}$** - Percentage of employed people between ages of 15-64 within primary sector (A, B - NACE Rev. 1.1); **EM_{C-F}** - Percentage of employed people between ages of 15-64 within secondary sector (C, D, E, F - NACE Rev. 1.1); **EM_{G-Q}** - Percentage of employed people between ages of 15-64 within tertiary sector (G – Q - NACE Rev. 1.1); **GDP** - Gross Domestic Product at PPS per capita at current prices; **LP** - Labour Productivity (gross value added of the number of people employed); **GERD** - Total intramural R&D expenditure in Purchasing Power Standard (PPS) per inhabitant at constant 2005 prices; **PAT** - Number of Patent Applications per million inhabitants (European patent application); **EMr** - Employment rate with people

aged 15 to 64 years old (%); **JVr** - The Job Vacancy Rate (%); **UNr** - The Unemployment Rate (%).

Correlation analysis focused on potential determinants shows that quality of human capital is positively correlated with level of economic performance and also with innovation and R&D activities in regions (EDU and HRST indicators are positively correlated with GDP and PAT indicator). Sectoral structure as well as innovation and R&D activities in regions (especially expenditures of R&D) are also influencing economic performance. To be able to get a new perspective on the determinants we were interested not only in determinants at the NUTS2 regional level, but also in the determinants at the country level. This part of the analysis was motivated by the effort to find country and region-specific determinants. The first step was analysis of determinants from the perspective of 25 countries (Table 2). The second step was analysis of determinants from the perspective of 256 regions NUTS2 (Table 3).

Tab. 2: The results of the correlation analysis for indexes of resilience – Spearman's coefficient (the significant values are in grey cells, values above 0.3 or below -0,3 are in bold) – 25 countries

Factor	Index	gEM	gGDP	I_{EM}	I_{GDP}
Human Capital	Percentage of people between the age of 25-64 with upper secondary or tertiary education according to ISCED-97 (level from 3 to 6)	-0.08	**-0.49**	-0.12	**0.45**
	Human Resources in Science and Technology – according to occupation	**0.49**	-0.28	**0.40**	0.08
Sectoral Structure	Percentage of employed people between the age of 15-64 within primary sector (A, B)	**-0.69**	-0.32	**-0.61**	0.05
	Percentage of employed people between the age of 15-64 within secondary sector (C, D, E, F)	-0.26	-0.04	-0.36	0.30
	Percentage of employed people between the age of 15-64 within tertiary sector (G-Q)	**0.49**	0.13	**0.50**	-0.22
Economic Performance	Gross domestic product (GDP) at current market prices in Purchasing Power Standard per inhabitant	**0.41**	-0.07	0.30	**-0.50**
	Labour productivity (GDP in PPS of employed people)	**0.51**	0.08	**0.40**	**-0.43**
Innovation and R&D	Total intramural R&D expenditure (in PPS)	0.37	-0.17	0.27	-0.26
	Number of patent applications per million inhabitants	**0.49**	-0.07	0.38	-0.21
Labour Market	Employment rate between the ages of 15 to 64 years old	0.19	0.36	0.02	-0.13

	The unemployment rate	-0.13	**0.49**	0.05	0.28
	The job vacancy rate	0.37	-0.28	0.22	0.16

Source: authors according data from (EUROSTAT, 2015)

Tab. 3: The results of the correlation analysis for indexes of resilience - Spearman's coefficient (sign. values are in grey cells, values above 0.3 or below -0.3 are in bold) – 256 regions NUTS2

Factor	Index	gEM	gGDP	I_{EM}	I_{GDP}
Human Capital	Percentage of people between the age of 25-64 with upper secondary or tertiary education according to ISCED-97 (level from 3 to 6)	0.25	-0.18	**0.38**	**0.57**
	Human Resources in Science and Technology – according to occupation (% of active pop.)	**0.44**	-0.20	**0.44**	0.26
Sectoral Structure	Percentage of employed people between the age of 15-64 within primary sector (A, B)	**-0.33**	0.06	-0.29	0.08
	Percentage of employed people between the age of 15-64 within secondary sector (C, D, E, F)	0.08	-0.08	-0.06	**0.36**
	Percentage of employed people between the age of 15-64 within tertiary sector (G-Q)	0.12	-0.05	0.22	-0.29
Economic Performance	Gross domestic product (GDP) at current market prices in Purchasing Power Standard per inhabitant	**0.35**	-0.21	0.17	-0.11
	Labour productivity (GDP in PPS of employed people)	**0.31**	-0.07	0.25	-0.07
Innovation and R&D	Total intramural R&D expenditure (in PPS)	**0.36**	-0.19	0.21	**0.34**
	Number of patent applications per million inhabitants	**0.47**	-0.21	**0.39**	0.14
Labour Market	Employment rate between the ages of 15 to 64 years old	0.24	**-0.31**	0.00	-0.17
	The unemployment rate	-0.29	0.20	0.02	0.23
	The job vacancy rate	0.28	0.20	**0.50**	**0.45**

Source: authors according data from (EUROSTAT, 2015)

Firstly, we identified determinants protecting employment. These determinants seem like they decrease the employment decline (in our case they are increasing index gEM – positive correlation) or they increase the change of employment (I_{EM}). Quality of human capital and innovation and R&D activities belong between determinants protecting employment resilience both at the national and the regional level. But effects of determinants of quality of

human capital differ at the national and the regional level in the case of the index "Percentage of people aged between 25-64 with upper secondary or tertiary education" (it shows significant relationship only at regional level). Innovation and R&D activities has also employment protecting impact (but GERD shows significant relationship only at regional level) as does labour productivity (GDP in PPS of employed people). We also find that some of the sectoral-specific indicators - indicator "Percentage of employed people between age of 15-64 within primary sector (A, B)" - belong between determinants reducing employment resilience both at the national and the regional level (this indicator seems like it increases employment decline (decreasing gEM) or decreasing the change of employment (decreasing I_{EM}). Secondly, we identified determinants protecting product. These determinants seem like they decrease product decline (in our case they are increasing index gGDP – positive correlation) or they increase the change of product (I_{GDP}). Quality of human capital and innovation and R&D activities belong also between determinants protecting GDP resilience both at the national and the regional level.

We can find only a few differences between the national and regional level. In the case of determinants at regional level we can find more significant correlations. For example, there is a significant relationship between an indicator "The job vacancy rate" and all resilience indicators (except gGDP). These significant relationships are, however, found only at the regional level.

To summarize that, one can conclude that at a national level a higher level of human capital plays a positive role as a resilience protector (except for a negative correlation between gGDP and EDU). More precisely, there is a difference between the effect of EDU (this indicator plays the role of a protector only for the change of GDP but not for growth in a decline) and HRST (this indicator plays at the national level the role of a protector only for employment resilience not for GDP resilience). The results at the regional level suggest a similar effect but not so strict – see Tab. 3. One can conclude also that the indicators within the innovation and R&D activities (except correlation pairs PAT and gEM at national level) were not found at a national level as determinants of both employment resilience and GDP resilience (contrary to the results at a regional level – see Tab. 3). This can be explained due to lack of national dataset in contrary with regional dataset. Also labour productivity and level of GDP at country level decrease decline of employment. Countries with a higher labour productivity or a higher level of GDP have a higher rate of growth of employment in decline (it means higher gEM). Labour productivity also significantly increases the change of employment (the higher LP, the higher I_{EM}). We find the same result at the regional level – see Tab. 3.

Our results show that at the regional level there are more linkages between all potential determinants and indexes of resilience. Only in the case of the factor concerning Economic Performance and the index gEM, differences are negligible (stronger relations were found at the regional level). The same results are in the case of the factor concerning Sectoral Structure and the index I_{EM} – the differences are also negligible (but in the contrary to previous similarities the stronger relations were found at the country level). It means that if we consider the results at the country level, there is a stronger relationship between employment resilience

and the determinants associated with the factor Sectoral Structure (not so in the case of GDP resilience at the country level). In the case of GDP resilience, there is a relatively strong link to the indicator "Percentage of people between age of 25-64 with upper secondary or tertiary education according to ISCED-97 (level from 3 to 6)" for both levels. The factor Economic Performance shows a significant relationship with both GDP and employment resilience. If we consider the results at a regional level, there is a relatively strong positive relationship between employment resilience and the determinants associated with R&D (especially if we consider the indicator gEM). In the case of employment regional resilience, it seems that there is a strong link to the indicators concerning human capital (we obtain similar results as at the country level).

Hypotheses H1a and H1b were not rejected (see the results located in Tab. 2 and Tab. 3). There are differences between the correlation coefficients of determinants in both types of resilience. Some of the potential determinants are more related only to one type of resilience (e.g. indicators of factor Sectoral Structure is much more related to employment resilience at the country level than to GDP resilience). At the country and also regional level there is at least one specific determinant for employment resilience: "Human Resources in Science and Technology – according to occupation (%)" – this indicator shows relatively strong and positive statistically significant relationship at level higher than 0.3 only with gEM and $I_{\mathbf{EM}}$ – not with gGDP and I_{GDP}). Hypothesis H2a was not rejected (thanks to significant correlation of HRST vs. gEM at the country level). Hypothesis H2b was not rejected thanks to both human capital indicators (EDU and HRST showed positive significant correlation relationship with indicator gEM). Hypothesis H3a was rejected. Hypothesis H3b was not rejected for both innovation and R&D indicators (GERD and PAT showed positive significant correlation relationship with indicator I_{GDP} at the regional level).

Discussion

All showed results are in accordance with other studies, for example ECR2 ESPON project (ESPON Final report, 2014). The lower degree of post-crisis recovering of employment was recorded in countries and regions where there is a greater concentration of people working primarily in the sectors of agriculture, fisheries, forestry and mining. Innovation and research activity represented by the "Number of patent applications per million inhabitants", and the size of spending on research and development (GERD) positively affects the response of regions in the event of economic shock (especially in terms of both employment and GDP resilience at a regional level except gGDP). It appears that the regions with a lack of scientific research base are the worst within these results. They are usually characterized by minimum innovation activity. ESPON ECR2 project (2014) comes to similar conclusions as well.

Limitations of the results arise from the fact that the data structure is based on the uniqueness of input data. This uniqueness is based on a selection of factors, countries, regions and also the event period examined (the economic crisis of 2008). All of these parameters could affect the results. Future research will focus more on the relationships between determinants and will take into account the results of different methods, including more variables.

Conclusion

Analysis used in this paper confirmed that regions and countries with a higher quality of factor human capital tend to have higher levels of both GDP and employment resilience – this finding was confirmed by two indicators: "Percentage of people between the age of 25-64 with upper secondary or tertiary education" and "Human Resources in Science and Technology – according to occupation". This confirmation is valid except of gGDP where negative relationship with two mentioned indexes was found. Analysis shows that this conclusion is also valid for regional level in the case of GERD and number of patent application. An important role of human capital and innovation and R&D activities was also proved by the ECR2 ESPON research project (ESPON, 2014). It should be stated that the presence of a well-educated and skilled workforce as well as innovation and R&D activities can be seen as a main protective factor for economic resilience (in terms of GDP as well as employment resilience). The analysis shows that the way to improve economic resilience of regions may stem from regional policy measures affecting the key factors that were found.

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