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 have been many studies that have analysed the impact of a set of indicators on the economic resilience of countries and regions, but none that focus on the effects of determinants on the resilience of employment and GDP. This paper is a preliminary attempt to fill that gap by providing new cross-country, as well as cross-regional, evidence of the different effects of determinants on resilience measured in terms of GDP and employment. The analytical part of this paper is based on an analysis of the resilience of employment and GDP of EU countries, as well as at the NUTS 2 regional level, within the context of the economic crisis that began in 2008. The main method used in this study is correlation analysis. The results show the existence of specific determinants for a different type of resilience at the country level (e.g. indicators of economic structure). The determinants connected with human capital show a strong positive relationship with regards to resilience both at the country and regional levels (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). A comparison of the different effects of determinants can be useful for effective decision making in the field of regional policy within regional management processes. This study used part of the results garnered from previous research that focused on identifying important factors of regional economic resilience measured in terms of employment growth (Svoboda and Klementová 2014). This study differs from the previous study in

that it not only focuses on employment resilience, but also on GDP resilience. New results presented in our study are available thanks to a comparison of national 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, correlation analysis was applied to a set of 25 countries and 256 regions in the EU. It would also have been possible to apply multivariable methods to this analysis. However, the results from this study show that there is a link between all the potential determinants, which is usually indicative of so-called multicollinearity. This fact meant that the use of regression analysis had to be rejected. Another possible approach was to use a method of dimension reduction (e.g. factor analysis), but this raised difficulties in terms of how to interpret the results. It is for these reasons that only correlation analysis was used in this preliminary research.

The analysis was carried out to determine whether the determinants of the resilience of employment and GDP are different or not. The aforementioned analysis was focused on describing the differences between determinants of the resilience of regional and national economies in connection with the economic crisis of 2008. This study follows in a similar vein (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 actively used in economics (see e.g. Reggiani, De Graaff and Nijkamp 2002). Most of this research has been focused on the dynamics of regional employment and product; they explore why some regions are better at withstanding an economic downturn than others, or are able to recover faster. The term "regional economic resilience" has become widely used in recent years, especially in connection with the assessment of the regional impact of 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 a region to face adverse events and deal with them without any major problems or difficulties. Some authors argue that resilience helps us to understand how such systems respond to shocks, disturbances and perturbations.

The term resilience has quite a broad meaning and use, which is due to its multidisciplinary origin (it was first used in the field of ecological modelling). The first fundamental definitions were given to us by Holling (1973) and Perrings (1994). Nowadays, the term is also used, for example, in the field of crisis management to evaluate the impact of extraordinary events (disaster resilience), as well as in many other fields (e.g. psychology, etc.). Within 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, regional economic resilience is commonly interpreted as the ability to resist and subsequently

adapt to deviations. The deviation of a regional economy can be caused by a wide spectrum of events, including national or global economic downturns, social disorder 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. For this study only the first two indicators (employment resp. product per capita) are used. There are also many other possibilities of how to quantify resilience (e.g. differences in wages and salaries between regions (Kraftová and Kraft 2015)).

Materials and Methods

The first step of cross-country analysis, respectively cross-regional analysis, is the generation of indexes for the quantification of economic resilience. Regional resilience is commonly perceived in terms of the development of regional indicators with regards to the labour market or regional product. The dynamics of regional employment is often selected as a suitable indicator for measuring regional economic resilience. This approach is very apparent in a study conducted by Ron Martin (2012), an economic-geographer, who focused on the impact of recessions on the regions of the UK using long-term data on employment at the NUTS 1 level. The approach applied in this study not only focuses on the regional level, but also on the country level. It is for this reason, that data from regions and countries are combined. In addition, the study focuses on two types of resilience: Resilience measured on the basis of GDP per capita according to the Purchasing Power Standard (PPS); and, employment measured in terms of the number of employed people according to the Labour Force Survey methodology. This approach was adopted in order to find answers to the following research questions: What are the differences between the determinants of the two types of resilience examined? Which determinants increase resilience?

Sample of Countries and Regions

The aforementioned analysis was carried out for 25 countries and 256 regions at the 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, the Netherlands, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, United Kingdom. These countries were selected because they were part of the EU prior to the economic crisis of 2008. This is of particular importance when studying the resilience or the precise reactions of employment and GDP at the national and subnational levels in terms of the EU's regional policy over time. It is for this reason, that our data sample consists of only EU countries and their regions from 2004 onwards (countries and regions at the NUTS 2 level, which joined the EU after its enlargement in 2004, were removed from the sample).

Implemented Indexes and Hypotheses

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

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

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

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

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

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

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

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

A description of the methodology used in this study now follows. The main aim of this paper is to compare the effects of determinants on two different forms of economic resilience (employment resilience and GDP resilience). The measurement of regional economic resilience was based on a yearly time series of GDP and employment at both the country and subnational (regional – NUTS 2) levels. The main data source was the Eurostat Statistical Office. Due to the examination of the impact of the economic crisis in 2008, a set of examined potential determinant values from the year 2007 were used. These values represent the last year in which the financial crisis did not influence the real economic indicators; this is in line with the conclusions of other authors (e.g. ESPON 2014; Kraft 2011). The datasets consisted of 12 indicators that were used as potential determinants for the two types of resilience examined (the selection of indicators was based on previous research (Svoboda and Klementová 2014)). In addition, four indexes

(gGDP, gEM, I_{GDP}, I_{EM}) were used for the quantification of economic resilience (two in terms of GDP and two in terms of employment). The time series for regional GDP were available in two forms: according to old methodology - ESA95 (available only until 2011); and according to new methodology – ESA2010 (available only from 2010). Due to this change in methodology and because of this study´s aim of evaluating the impact of the economic crisis of 2008, regional GDP data were used based on the ESA95 methodology.

According to previous studies (e.g. Martin 2012) the emphasis was put on studying the size of the decline in employment and GDP development. In addition, attention was paid to the change in GDP over the period 2007-2011 and on the change in employment over the period 2008-2012. By focusing on the size of the decline it was necessary to make an analysis of business cycles and identify breakpoints. The process of identifying the breakpoints followed that which has been previously published by, for example, Poměnková (2011), Harding and Pagan (1999), and Bry and Boschan (1971). The peaks and troughs were subsequently identified for each country and region (to identify the period of decline). Simply put, the recession phase begins at that point where the local maximum is reached (peak) and ends at that point where it reaches the local minimum (trough). For the identification of the recession phase we used the definition maintained by the 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 varied from country to country and region to region. For the calculation of the individually constructed gGDP and gEM indexes we worked on the basis of a continuous recession lasting at least one year (4 quarters) that started in the period 2008-2010. By applying this rule, countries and regions were included in the evaluation which already experienced the beginning of the decline in 2008, as well as those countries and regions which experienced a delayed decline over the following two years. In terms of GDP, the earliest signs of the recession phase were already evident in 9 countries in 2008, with the last of the 25 countries (Greece) coming out of the recession phase in 2011. At this point it should be noted that the recession phase for Greece was longer, but in order to generate comparable indexes for countries and regions, we only applied data until 2011. In terms of employment, the earliest evidence of the beginning of the recession phase for countries was identified in 2008. This was the case for 7 out of the 25 EU member states. The latest year for the end of the recession phase in terms of employment was identified in 2014 (Greece and Portugal). At the regional level, and in terms of GDP, the first year of the recession phase was also identified in 2008. This was the case for 116 of the in total 256 regions. The latest year for the end of the recession phase in terms of GDP was identified in 2011 (regions of Spain and Italy). However, this may be due to a lack of availability of more recent data. At the regional level, and in terms of employment, the first year of the recession phase was also identified in 2008, which was the case for 67 of the in total 256 regions. The latest year for the end of the recession phase was identified in 2014, which was the case for some regions in Greece, Spain and Italy.

According to previous research (Martin, 2012; Svoboda, 2013), four resilience indexes (gGDP, gEM, I_{GDP}, $I_{\mathbf{EM}}$) were calculated for two types of resilience (GDP per capita in PPS resp. employment). Firstly, the average growth of GDP per capita in PPS for the recession period of each country and region was calculated on the basis of the identification of the beginning and the end of the recession phase (likewise for employment). These indicators were calculated according to the formulae:

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

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

where x_i is the growth rate of GDP per capita in PPS or employment (i.e. inter-year rates of change in output or employment), n is the specific number of years of the recession phase for a country or region, and t is time (year). The gGDP index was subsequently calculated on the basis of the business analysis conducted for the period 2007 – 2011 (because regional data was only available up to 2011; to have comparable indexes it was necessary to use the same period (values up to 2011). This also applied to the calculation of gGDP for countries – although GDP data at country level is available for later years). The gEM index was also calculated on the basis of the same business analysis. The gGDP and gEM indexes were calculated for all EU countries with exception to Poland with regards to the gGDP index and Malta with regards to gEM index; both due to absence of a recession phase. The regional equivalents for gGDP were only calculated for regions with a recession phase in terms of GDP per capita, which was the case in 244 of the 256 regions (95%). The regional gEM indexes were also only calculated for those regions with a recession phase in terms of employment levels, which was the case in 226 of the 256 regions (88%).

I_{GDP} was subsequently calculated as the percentage change in GDP per capita in PPS between 2007 and 2011. Similarly, $I_{\mathbf{EM}}$ was calculated as the percentage change in employment measured between 2008 and 2012. The different periods reflect the one year delay in the dynamics of employment compared with that of GDP. In contrast to the first two indexes of resilience, the same period was used for each country and region. This characteristic is symbolised as I_{GDP} and I_{EM} – where "I" expresses "index". The I_{GDP} and I_{EM} indexes were calculated according to following formulae:

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

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

where GDP_{2007} is the value of GDP per capita in PPS for the year 2007 (likewise for GDP_{2011}) and EM_{2012} is the value of employed people for the year 2008 (likewise for EM_{2012}). These indexes were calculated for each country and region. When taking into consideration the duration of the examined period i.e.16 quarters (resp. 4 years), Duval and Vogel (2008) suggest that this is the minimal period of time period required for the evaluation of the impact of an economic crisis or recession.

Potential Determinants of Economic Resilience

In accordance with previous research, a set of 12 potential determinants was used which showed a medium or strong correlation with economic resilience (Svoboda and Klementová 2014). The indicators used in this research are given below:

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

Human Capital (2 indicators): "Human Resources in Science and Technology – according to occupation" (**HRST**); "Percentage of people aged between 25 to 64 years old 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 aged between 15 to 64 years old within the primary sector (A, B)" – (**$EM_{A, B}$**); "Percentage of employed people aged between 15 to 64 years old within the secondary sector (C, D, E, F)" – (**EM_{C-F}**); "Percentage of employed people aged between 15 to 64 years old within the tertiary sector (G - Q)" – (**EM_{G-Q}**). The 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 by the number of people employed)" – (**LP**), "Gross Domestic Product at PPS per capita at current prices" (**GDP**).

All the indicators were acquired from the European Statistical Office (from 2007 onwards). The possible effect of a one year delay between the values of the determinants and the values of the resilience indexes was taken into consideration. In previous research data was also used from 2006, however analysis of the correlation coefficients showed that the effect of the delay of determinant influence on the indexes of resilience was negligible. At this point it should be noted that a Shapiro - Wilk W test failed to show the normality of the used datasets (at the regional level with exception to "Percentage of employed people aged between 15 to 64 years old within the tertiary sector (G-Q)" and "Human Resources in Science and Technology – according to occupation", and at the country level with exception to "The Unemployment Rate"). As a result, a nonparametric correlation analysis was used (specifically Spearman's correlation coefficient).

Results

The following section contains the results of the correlation analysis. Table 1 shows the results of the correlation analysis for all the determinants at regional level. The calculations are based on Spearman's coefficient for the 256 regions at NUTS2 level; all the values are from 2007. Due to the absence of a normal distribution, the Spearman rank correlation coefficient was used. A statistically significant relationship was found in the majority of correlation pairs. A strong relationship was found especially between GDP and LP, GERD and PAT, EMr and UNr (this is due to the similarity in the construction of the indices and the causal influences between them). The results of the correlation matrix indicate a suitability for dimension reduction. This could be achieved through, for example, factor analysis. However, dimension reduction could prove problematic with regards to the interpretation of the results. It is for this reason, that only correlation analysis was used in this preliminary research.

Table 1: Results of the correlation analysis for determinants of resilience – Spearman's coefficient (the significant values are in the 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 - based on data from EUROSTAT (2015)

Abbreviations used in Table 1: EDU - Percentage of people aged between 25 to 64 years old with Upper Secondary or Tertiary Education according to ISCED-97 - levels 3 to 6 (%); **HRST** - Human Resources in Science and Technology – according to occupation (%); **$EM_{A, B}$** - Percentage of employed people aged between 15 to 64 years old within the primary sector (A, B - NACE Rev. 1.1); **EM_{C-F} -** Percentage of employed people aged between 15 to 64 years old within the secondary sector (C, D, E, F - NACE Rev. 1.1); **EM_{G-Q}** - Percentage of employed people aged between 15 to 64 years old within the 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 by 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 among people aged 15 to 64 years old (%); **JVr** - Job Vacancy Rate (%); **UNr** - Unemployment Rate (%).

The correlation analysis of potential determinants shows that there is a positive correlation between the quality of human capital and the level of economic performance, as well as with innovation and R&D activities in regions (EDU and HRST indicators correlate positively with GDP and PAT indicators). It is also evident that the sectoral structure, as well as innovation and R&D activities in the regions (especially expenditure on R&D) also influence economic performance. To be able to get a fresh perspective on the determinants we were not only interested in the determinants at the NUTS2 regional level, but also in the determinants at the country level. This part of the analysis was motivated by the desire to find country and region-specific determinants. The first step to achieving this was to conduct an analysis of the determinants from the perspective of the 25 countries (see Table 2). The second step was to conduct an analysis of the determinants from the perspective of the 256 regions at the NUTS2 level (see Table 3).

Table 2: Results of the correlation analysis for indexes of resilience – Spearman's coefficient (the significant values are in the 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 aged between 25 to 64 years old 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 aged between 15 to 64 years old within the primary sector (A, B)	**-0.69**	-0.32	**-0.61**	0.05
	Percentage of employed people aged between 15 to 64 years old within the secondary sector (C, D, E, F)	-0.26	-0.04	-0.36	0.30
	Percentage of employed people aged between 15 to 64 years old within the 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 among people aged between 15 to 64 years old	0.19	0.36	0.02	-0.13
	Unemployment rate	-0.13	**0.49**	0.05	0.28
	Job vacancy rate	0.37	-0.28	0.22	0.16

Source: Authors - based on data from EUROSTAT (2015)

Table 3: Results of the correlation analysis for indexes of resilience - Spearman's coefficient (the significant values are in the grey cells, values above 0.3 or below -0.3 are in bold) – 256 regions at the NUTS2 level

Factor	Index	gEM	gGDP	I_{EM}	I_{GDP}
Human Capital	Percentage of people aged between 15 to 64 years old 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 aged between 15 to 64 years old within the primary sector (A, B)	**-0.33**	0.06	-0.29	0.08
	Percentage of employed people aged between 15 to 64 years old within the secondary sector (C, D, E, F)	0.08	-0.08	-0.06	**0.36**
	Percentage of employed people aged between 15 to 64 years old within the 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 among people aged between 15 to 64 years old	0.24	**-0.31**	0.00	-0.17
	Unemployment rate	-0.29	0.20	0.02	0.23
	Job vacancy rate	0.28	0.20	**0.50**	**0.45**

Source: Authors - based on data from EUROSTAT (2015)

Firstly, determinants protecting employment were identified. These determinants appear to reduce the rate of employment decline (in this case represented by an increase in the gEM index – positive correlation) or increase the change in employment ($\mathbf{I_{EM}}$). The quality of human capital and innovation and R&D activities protect employment resilience both at the national and regional levels. However, the effect of the quality of human capital determinant differs at the national and regional levels in the case of the index "Percentage of people aged between 25 to 64 years old with upper secondary or tertiary education" (it only shows a significant relationship at the regional level). Innovation and R&D activities also has an employment protecting impact (although GERD shows only a significant relationship at the regional level), as does labour productivity (GDP in PPS of employed people). The results also show that some of the sectoral-specific indicators, namely "Percentage of employed people aged between 15 to 64 years old within the primary sector (A, B)", reduce employment resilience both at the national and regional levels (this indicator seems like it increases employment decline (decreasing gEM) or decreases the change in employment (decreasing I_{EM}).

Secondly, determinants protecting product were identified. These determinants appear to decrease product decline (in our case represented by an increasing gGDP index – positive correlation) or increase the change in product ($\mathbf{I_{GDP}}$). The quality of human capital and innovation and R&D activities protect GDP resilience both at the national and regional levels.

Overall, only a few differences were identified between the national and regional levels. However, there were more significant correlations for the determinants at the regional level. For example, there is a significant relationship between the indicator "Job vacancy rate" and all the resilience indicators (with exception to gGDP). These significant relationships are, however, found only at the regional level.

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

The results show that at the regional level there are more linkages between all the potential determinants and indexes of resilience. The differences are negligible only for the factor Economic Performance and the gEM index (stronger relationships were found at the regional level). The differences were also negligible for the factor Sectoral Structure and the I_{EM} index (however, in contrast to the previous similarities, stronger relationships were found at the country level). This means that when taking into consideration the results at the country level, there is a stronger relationship between employment resilience and the determinants associated with the factor Sectoral Structure (this is not the case for GDP resilience at the country level). In the case of GDP resilience, there is a relatively strong link to the indicator "Percentage of people aged between 25 - 64 years old with upper secondary or tertiary education according to ISCED-97 (levels 3 to 6)" at both the regional and country levels. The factor Economic Performance shows a significant relationship with both GDP and employment resilience. The results at the regional level show that there is a relatively strong positive relationship between employment resilience and the determinants associated with R&D (in particular for the indicator gEM). In the case of employment resilience at the regional level, it appears that there is a strong link to the indicators concerning human capital (the results were similar to those at the country level).

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

Discussion

All the results in this study are in accordance with other studies, for example the EPSON ECR2 project (ESPON Final report 2014). The lower degree of post-crisis recovery in employment was recorded in countries and regions where there was a greater concentration of people working in the agriculture, fisheries, forestry and mining sectors. Innovation and research activities, as represented by the "Number of patent applications per million inhabitants", as well as the size of spending on research and development (GERD), positively affected the response of regions in the event of an

economic shock (especially in terms of both employment and GDP resilience at the regional level, with exception to gGDP). It would appear that the regions which lack a scientific research base suffer the worst; they are usually characterized by minimum innovation activity. The ESPON ECR2 project (2014) came to similar conclusions.

The value of the results of this study are limited by the fact that the data structure was based on the uniqueness of the input data. This uniqueness was based on the number of factors, countries and regions, as well as the event period examined (the economic crisis of 2008). All of these parameters could have affected the results. Future research will focus more on the relationships between determinants and will take into account the results accrued through the application of different methods, including more variables.

Conclusion

The analysis carried out in this paper confirms that regions and countries with human capital of a higher quality tend to have higher levels of both GDP and employment resilience. This finding was confirmed by two indicators: "Percentage of people aged between 25 – 64 years old with upper secondary or tertiary education" and "Human Resources in Science and Technology – according to occupation". This confirmation is valid with exception to gGDP, for which a negative relationship was found with the two aforementioned indexes. The analysis shows that this conclusion is also valid at the regional level for GERD and the number of patent applications. The important role human capital and innovation and R&D activities has to play was also proven in the research conducted as part of the EPSON ECR2 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 the main protective factors for economic resilience (in terms of both GDP and employment resilience). The analysis shows that the way to improve the economic resilience of regions stems from regional policy measures which affect the key factors that were found.

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