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## A MEASURE FOR REGIONAL RESILIENCE TO ECONOMIC CRISIS<sup>1</sup>

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### ABSTRACT

The purpose of the study (presented in this article) was to develop a measure of resilience to crisis, one that may be applied to regional data. In principle, such measure can take either positive or negative values. A positive value confirms resilience to crisis, whereas a negative one confirms the absence of resilience (sensitivity/vulnerability). The measure uses growth rates referred to the previous year under the assumption that crisis results in a slowdown in growth, or even in a decline in values of important economic indicators. Growth rates are standardized by dividing values of original change rates by medians specified based on spatio-temporal data modules. Such division results in each characteristic being brought to equal validity. Simultaneously, the original character is maintained and variables are not “flattened” by the outliers. Changing destimulants into stimulants occurs during growth rates calculation. The measure of resilience to crisis is calculated as an arithmetic mean of the values of characteristics brought to comparability. The measure of resilience can be converted into the measure of sensitivity by multiplying it by (-1).

The application of the proposed measure to assessing the resilience to crisis in the period 2006-2011 is presented for regions meant as the European Union NUTS2 units. The measure is based on comparable data, which allowed for using only six variables measuring changes in GDP, salaries, investments, household income, employment and unemployment.

**Key words:** economic crisis, aggregate measure, NUTS 2.

### 1. Introduction

Economic resilience to crisis with reference to a region is defined as its economic capacity to overcome negative external impacts. It depends on macroeconomic factors and internal determinants. Among macroeconomic factors the following can be listed: fiscal, economic and monetary policy. Internal factors

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take the form of, e.g.: economic structure, restructuring and modernization level of enterprises, competitiveness and innovation. Among the important internal factors the level of human capital, including entrepreneurship, is also considered (Masik, Rzyski 2014).

The objective of the article is to present the proposal for the construction of a measure of resilience to economic crisis, possible to be applied to regional data.

## 2. Sensitivity to crisis – research overview

The assessments of economic reactions to shocks resulting from, e.g. an economic crisis are performed by analyzing macroeconomic sensitivity specified:

- in a more extensive sense as the “*vulnerability to external factors distracting a particular economy from following the desirable trajectory of development*” (Zaucha *et al.* 2014: 208),
- whereas in a narrower sense (sensitivity) in the context of “*economic structures and their tools for weakening negative stimuli and threats, as well as deriving benefits from the occurring opportunities without any structural changes*” (Zaucha *et al.* 2014: 208).

The studies of resilience and sensitivity to macroeconomic impacts, covering especially small countries, have been conducted for twenty years both independently and in a team by L. Briguglio (Briguglio 1995) from the University of Malta. The team’s output includes, among other things: methods for the “construction” of economic resilience in small countries (Briguglio, Kisanga 2004, Briguglio, Cordina, Kisanga 2006, Briguglio 2014), developing the concept and measuring both sensitivity and resilience (Briguglio *et al.* 2006a, Briguglio *et al.* 2009), updating and extending the Economic Vulnerability Index (Briguglio, Galea 2003), the proposal of sensitivity and resilience profiles (Briguglio *et al.* 2010), the identification of economic resilience pillars in small countries (Briguglio *et al.* 2008), the analysis of growth problems in terms of resilience (Briguglio, Piccinino 2012), the assessment of economic resilience and adaptation potential (Briguglio, Cordina 2003).

Moreover, the studies focused on regional resilience were carried out by, e.g.: S. Christopherson, J. Michie and P. Tyler (2010) – theoretical and empirical aspects, K. Chapple, M. Belzer (2010) – job market, G. Bristow (2010) - competitiveness, J. Clark, H.-I. Huang and J. Walsh (2010) – innovation districts; R. Hassink (2010) as well as A. Pike, S. Dawley and J. Tomaney (2010) – differences in regional adaptation.

The research team, under the leadership of P. Churski (The National Centre for Science Project entitled: *Socio-economic growth vs. the development of growth and economic stagnation areas (2011-2013)*) conducted research the results of which

are available on the project website: [www.owsg.pl](http://www.owsg.pl). The identification and assessment cover growth and stagnation areas based on the set of 49 indicators divided into five blocks (population and settlement, job market and economy structure, technical infrastructure and spatial availability, financial situation and wealth level, innovative economy and business environment), whereas within the framework of blocks – the factors described by means of qualities characteristic for a given factor (Perdał, Hauke 2014: 71). The studies presented by the research team are mainly focused on the territory of Poland (various NUTS levels), with particular emphasis on Wielkopolska region. For the purposes of performing comparisons the data from Slovakia, Lithuania and Latvia were used, among other things. The identification of factors and analyses were carried out with reference to the following groups of spatial units: all units, growth areas, transition areas and stagnation areas, mainly in the period 2000-2010.

The research on resilience to crisis, especially in Pomorskie region, is conducted within the framework of the project: Economic Crisis, Resilience of Regions – ESPON 2013 (partners: Cardiff University (project leader), FTZ-Leipzig, Aristotle University, Tartu University, University of Gdańsk, Manchester University, Experian Plc.), the purpose of which is (Masik 2013): *“the identification of economic crisis impacts on regional economies, the analysis of structural and functional determinants in regions, an attempt to answer the question why some regions are more resilient than others, the identification of policies supporting economic resilience”*.

The team under the leadership of J. Szlachta (Zaucha *et al.* 2014: 206-234) conducted the review of the subject literature in terms of approaches to regional sensitivity measurement within the framework of the project – *The sensitivity of Polish regions to challenges of contemporary economy. Implications for regional development policy*, grant from the National Centre for Science 1635/B/H03/2011/40 and within the framework of project implementation supervised by D. Strahl entitled: *“Smart growth vs. sensitivity to economic crisis in regional dimension – measurement methods”* (grant from the National Centre for Science 2013/09/B/HS4/00509) M. Markowska (2014), focused on such areas as: economy, job market and households, listed as the most vulnerable in the context of crisis phenomena assessment.

### **3. Proposal for measuring regional resilience to economic crisis (RRC)**

It has been initially assumed that the suggested measure can take both positive and negative values. Its positive value indicates that a region is resistant to crisis, whereas a negative one informs about the absence of resistance, i.e. sensitivity and vulnerability to crisis phenomena.

The growth rate of variables calculated against previous years (formulas (1) and (2)) was used in the construction of the measure. It results from the assumption that the effect of crisis is manifested in a slowdown in growth or even a decline in the values of crucial economic factors. Destimulants are changed into stimulants in the course of growth rates calculation:

$$w_{ijt} = 100 \left( \frac{x_{ijt}}{x_{ij,t-1}} - 1 \right) \text{ for stimulants,} \quad (1)$$

$$w_{ijt} = 100 \left( 1 - \frac{x_{ijt}}{x_{ij,t-1}} \right) \text{ for destimulants.} \quad (2)$$

At this point a conclusion can be drawn that in order to calculate an average rate a geometric mean rather than an arithmetic one should be used, however,  $w^*$  values calculated below represent in fact the ratios of the rate and the median rather than the rate itself. The comparability of characteristics is obtained as a result of dividing the original rate values of variables changes (1) or (2) by the medians determined from spatio-temporal data modules (3). This transformation results in equal validity of the discussed characteristics. Such procedure maintains the original change rate sign and, moreover, the phenomenon of variables "flattening" by outlier values does not occur. Standardization (understood as achieving comparability) of changes of rates is performed by applying the following formula:

$$w_{ijt}^* = w_{ijt} / Me(|w_{ijt}|) \quad (3)$$

The measure of resistance to crisis is calculated as an arithmetic mean of the values of characteristics standardized by formula (3). The suggested measure takes the following form:

$$RRC_{it} = \frac{1}{m} \sum_{j=1}^m w_{ijt}^* \quad (4)$$

where:

$i$  – object's number (region),

$j$  – characteristic's number,

$t$  – time unit number,

$m$  – number of characteristics,

$w^*$  - standardized change rate,

$RRC$  – measure for regional resilience to crisis.

The range of measure values does not have either upper or lower limit. It should be assumed that it corresponds to a rational opinion that, on the one hand, it is never so bad that it could not be worse and, on the other, it can always be better than it actually is. The measure of resistance can be transformed into the measure of sensitivity by multiplying it by (-1).

#### 4. Basic characteristics of RRC – preliminary assessment of results

Economy, job market and households represent the areas of regional sensitivity to economic crisis. In order to perform the assessment of regional economic situations, in terms of their resilience or sensitivity to economic crisis, the following indicators were used in the study covering the period 2005-2011 (as of 31<sup>st</sup> October 2014 the information for 2012 regarding the data presented in values and necessary to calculate change rates was not provided by Eurostat database):

- GDP in million PPS in a region (CR\_GDP),
- investments in million Euro in a region (CR\_IN),
- employment rate (as a percentage of professionally active population in 15-64 age group) (CR\_ER),
- unemployment rate (destimulant) (as a percentage of the total number of professionally active population) (CR\_UR),
- salaries in million Euro in a region (globally) (CR\_S),
- disposable income per capita in a household in PPS (CR\_DI).

The choice of variables was preceded by checking Eurostat database resources in terms of data availability, whereas the preliminary selection of variables was performed by assessing their changes, especially in 2009 against the previous years, among other things.

The EU territorial units at NUTS 2 level constituted the base of regions covered by the assessment – the total of 264 regions (excluding Croatian and overseas Spanish and French regions – due to significant data gaps).

In the dynamic assessment of changes the declines in 2009 against 2008 should be emphasized, since they were recorded in 250 regions (CR\_GDP), 173 (CR\_S), 212 (CR\_IN), 202 (CR\_DI), 205 (CR\_ER). Moreover, for 171 EU NUTS 2 regions an increase in the unemployment rate was observed. It should also be emphasized that in the case of over 100 regions a decline in investments and GDP values was recorded also in 2008 (against the previous year). Simultaneously, further drops were observed in over 100 regions in the subsequent years for 159 and 110 regions with respect to employment rate and investments (127 and 120), along with an increase in the unemployment rate for 171 and 114 regions.

In performing the assessment of regions in terms of RRC attention was also paid to the EU 15 regions (the so-called “old” EU) and the EU 12 regions – from the accessions in 2004 and 2007.

The modules of medians of variables determined jointly in the entire period under analysis (dynamics in the period 2006-2011) were used in the standardization process and their values are presented in table 1. With reference to job market the attention should be paid to the median module of the unemployment rate which is several times higher than the employment rate.

The preliminary analysis of the obtained results indicates that 2009 represents the main crisis year in the EU NUTS 2 regions – the median is negative (median measure), as well as the mean value, and even the third quartile. In 2011 a group of weak regions was identified (Greek regions, in which a dramatic drop in salaries was recorded, among other things) which resulted in a strong left-sided asymmetry of the measure. The basic characteristics of the Measure for Regional Resilience to Economic Crisis are included in table 2.

**Table 1.** Medians used in standardization

Variable	The median of change rate module in regions
GDP change rate	4.54
Salaries change rate	4.15
Investments change rate	9.32
Household income change rate	3.22
Employment rate change	1.52
Unemployment rate change (destimulant)	12.50

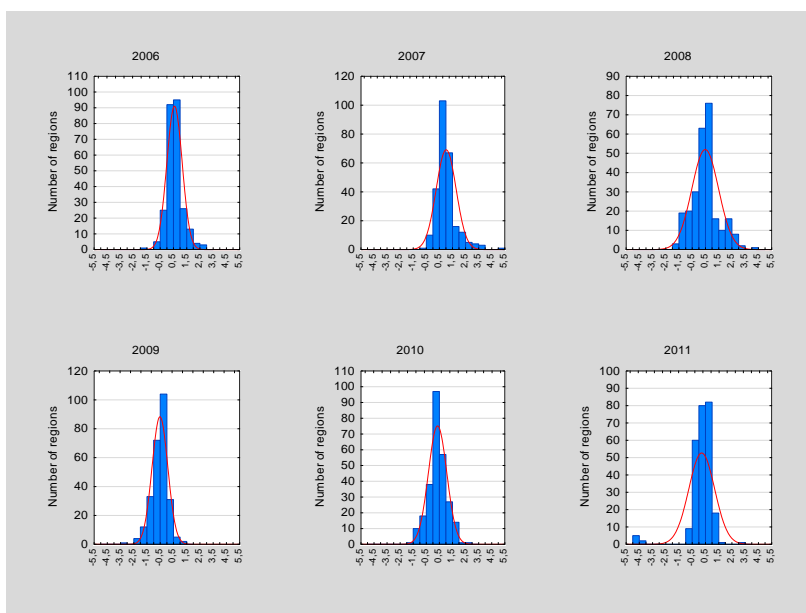
Source: author's estimations.

**Table 2.** RRC characteristics

Year	$\bar{x}$	Min	$Q_{0.10}$	$Q_{0.25}$	Me	$Q_{0.75}$	$Q_{0.90}$	Max	SD	As
2006	0.58	-1.55	-0.04	0.24	0.53	0.77	1.28	2.72	0.58	0.82
2007	1.02	-0.76	0.31	0.57	0.89	1.20	1.98	5.06	0.76	1.69
2008	0.48	-1.59	-0.90	-0.10	0.48	0.87	2.03	4.12	1.01	0.46
2009	-0.52	-3.12	-1.31	-0.80	-0.44	-0.15	0.16	1.23	0.60	-0.72
2010	0.36	-1.76	-0.54	-0.01	0.37	0.87	1.24	2.73	0.70	-0.17
2011	0.09	-5.34	-0.47	-0.11	0.27	0.73	0.97	3.29	1.26	-3.04

Source: author's compilation.

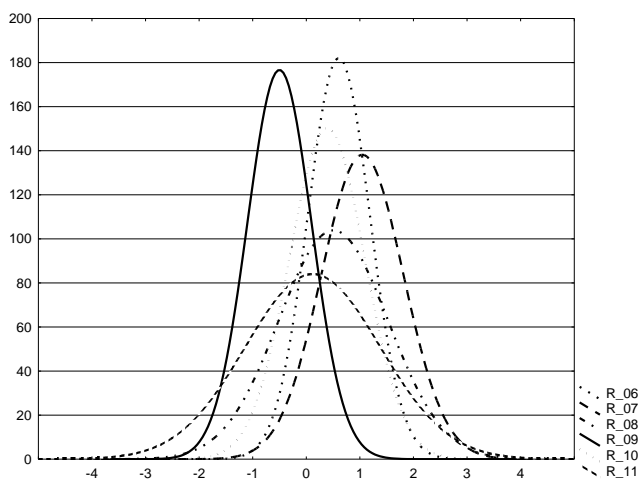
Picture 1 presents the distribution of regions in terms of RRC values. The same scale of horizontal axis allows one to “follow the moves” of the measure distribution. The highest diversification is observed for 2008, whereas the highest deviation is true for 2011 (the Greek group visible on the left side of the distribution). The effect of RRC distribution approximation by a normal distribution on one graph is illustrated on fig. 2.



**Figure 1.** RRC distribution in the period

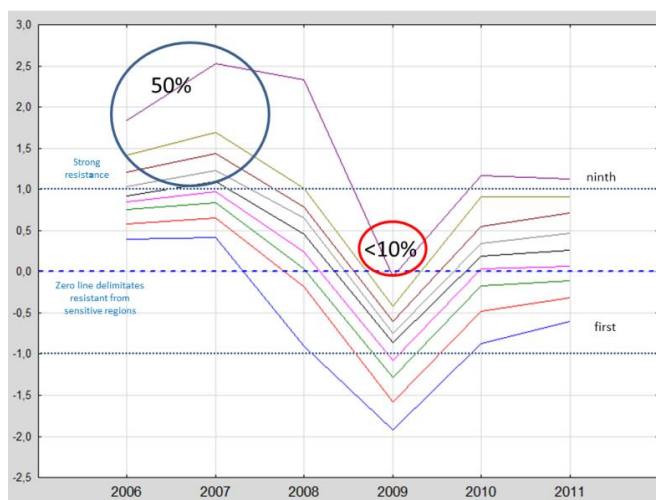
*Source: author’s compilation.*

Picture 3 presents RRC deciles (the first decile at the bottom and the ninth on the top). The line at the zero level stands for the division of sensitivity and resilience. Line 1 above represents the resistant regions. In the period 2006–2007 about 50% regions were included in this part. The 2009 crisis is well visible. Only slightly less than 10% of regions were placed on the positive side, thus only the best ones were resistant to crisis.



**Figure 2.** Approximation of RRC distribution by a normal distribution

*Source: author’s compilation.*



**Figure 3.** RRC deciles

*Source: author's compilation.*

On the basis of the analysis of numerical values of characteristics and the distributions of empirical values the division of RRC measure variability range into six classes can be proposed (see tab. 3).

**Table 3.** The suggested RRC classes

RRC value	Class
below -1	(-3) Strong sensitivity to crisis
from -1 to -0.5	(-2) Average sensitivity to crisis
from -0.5 to 0	(-1) Poor sensitivity to crisis
from 0 to 0.5	(+1) Poor resilience to crisis
from 0.5 to 1	(+2) Average resilience to crisis
above 1	(+3) Strong resilience to crisis

*Source: author's compilation.*

These classes allow for a more generalized assessment of sensitivity or resilience to crisis, as well as the quantification of these responses to crisis.

## 5. Results of the EU nuts 2 regions' division into groups based on RRC values

In each year of the study each region was assigned to one of the classes identified before. An even more general assessment than assigning to one of the six classes specified whether a particular region in a given year was resilient to crisis (a class coded with a plus), or sensitive to crisis (one of the classes coded with a



minus). The assessment of regional response to crisis in the entire analyzed 6-year period can be easily obtained by counting pluses – from zero to six. The analysis of the distribution of regions into these seven values results in suggesting four classes of resilience to crisis presented in table 4.

The number of regional positive measure values of resilience to crisis in the period 2006-2011 constituted the basis for identifying particular classes – see tab. 4.

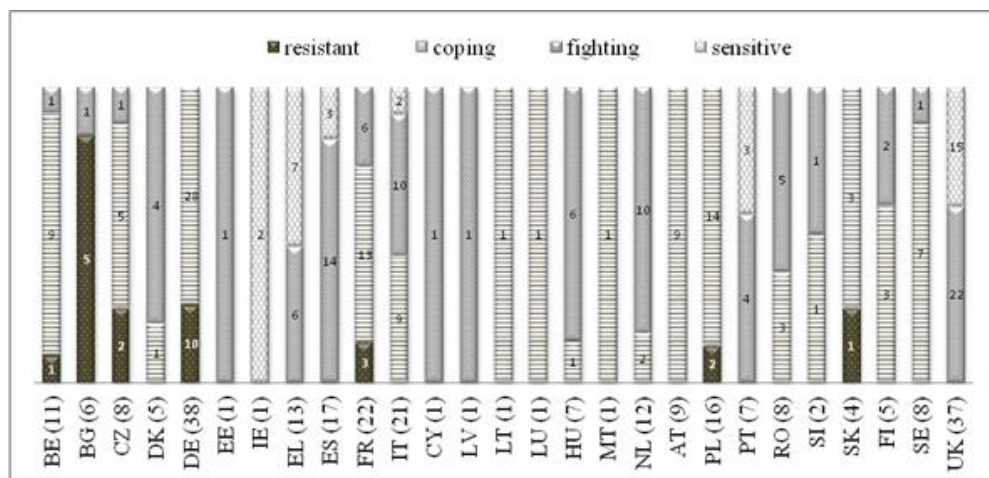
The most numerous classes are made up of the “coping” or “fighting” regions – 111 and 97 regions respectively, whereas the least numerous one covers the “resistant” regions – see tab. 4 and 5. Table 4 also summarizes the information about the number of positive measure values in the period 2006-2011.

**Table 4.** Classes based on RRC values in the period 2006-2011

Number (+) for RRC in the period 2006-2011	Regions	Number of regions in a class	Percentage
0-2	Sensitive	32	12.1
3-4	Fighting	97	36.7
5	Coping	111	42.0
6	Resistant	24	9.2

Source: author’s compilation.

While assessing the distribution of the EU NUTS 2 regions in classes attention should be paid to the fact that the regions from four countries were included in three classes: French, Czech and Belgian regions in “resistant”, “coping” and “fighting” classes, whereas Italian regions in the “coping”, “fighting” and “sensitive” classes.



**Figure 4.** Summary – the number of regions in a class in the EU countries

Source: author’s compilation.

Île de France (FR) was the only region recorded in the group of EU 15 capital regions or the ones including the capital of a country in the “resistant” class. The “coping” regions group covered the following ones: Région de Bruxelles-Capitale (BE), Berlin (DE), Lazio (IT), Wien (AT), Stockholm (SE), and the “fighting” regions class included: Hovedstaden (DK), Noord-Holland (NL), Etelä-Suomi (FI), Outer London and also Inner London (UK), Comunidad de Madrid (ES) and Lisboa (PT), whereas the Greek Attiki and the Irish Southern and Eastern regions were listed in the class of “strongly sensitive” ones (see fig. 4).

The region capital or the ones including the capital of a country from the countries of 2004 and 2007 accessions were classified in the following groups:

- “resistant”: Yugozapaden (BG), Mazowieckie (PL) and Bratislavský kraj (SK),
- “coping”: Praha (CZ) and Bucuresti – Ilfov (RO),
- „fighting”: Zahodna Slovenija (SI) and Közép-Magyarország (HU).

Among NUTS 1 regions the following were listed in the “coping” class: Lithuania, Malta and Luxemburg, whereas Eesti, Kypros and Latvia were included in the “fighting” class.

**Table 5.** Assigning the EU regions to classes

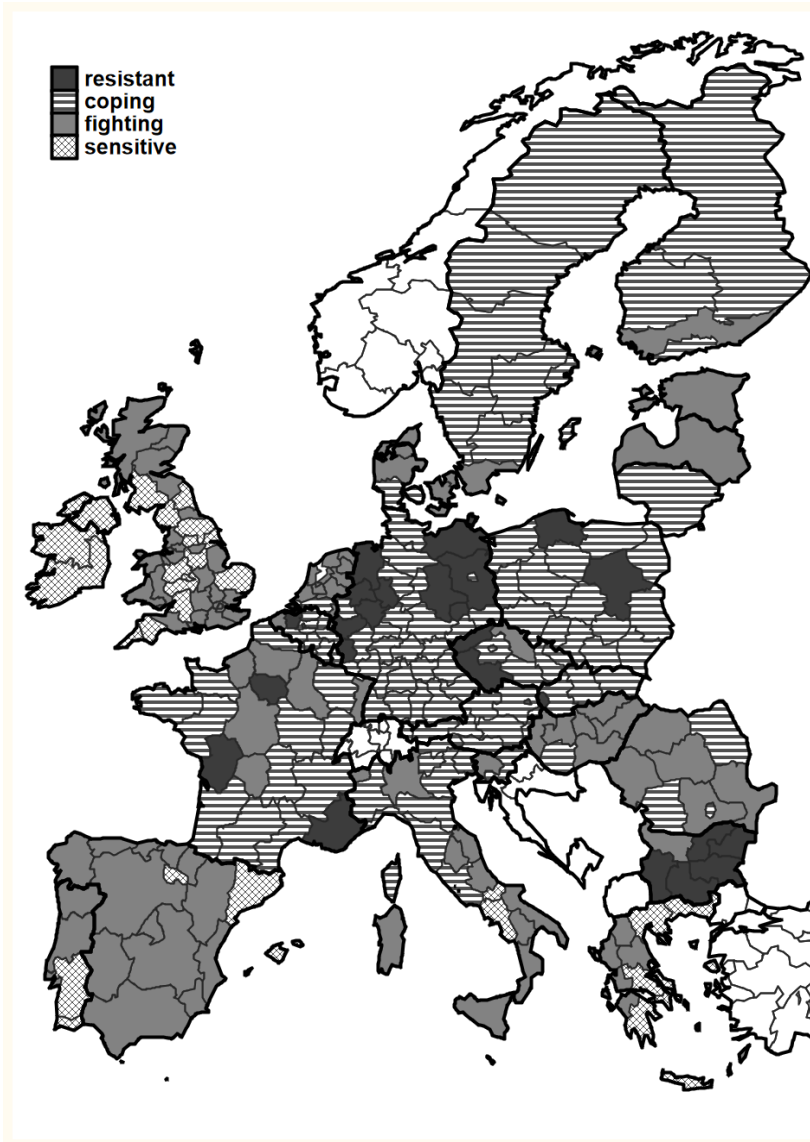
Country (number of regions): regions	Class
BE (1): Prov. Oost-Vlaanderen; BG (5): Severents entralen, Severoiztochen, Yugoiztochen, <b>Yugozapaden</b> , Yuzhen tsentralen; CZ (2): Jihozápad, Severozápad; DE (10): Brandenburg, Mecklenburg-Vorpommern, Weser-Ems, Köln, Münster, Detmold, Arnsberg, Trier, Leipzig, Sachsen-Anhalt; FR (3): <b>Île de France</b> , Poitou-Charentes, Provence-Alpes-Côte d'Azur; PL (2): <b>Mazowieckie</b> , Pomorskie; SK (1): <b>Bratislavský kraj</b> .	Resistant(24)
BE (9): <b>Région de Bruxelles-Capitale</b> , Prov. Antwerpen, Prov. Limburg, Prov. Vlaams-Brabant, Prov. Brabant Wallon, Prov. Hainaut, Prov. Liege, Prov. Luxembourg, Prov. Namur; CZ (5): <b>Praha</b> , Střední Čechy, Jihovýchod, Střední Morava, Moravskoslezsko; DK (1): Syddanmark; DE (28): Stuttgart, Karlsruhe, Freiburg, Tübingen, Oberbayern, Niederbayern, Oberpfalz, Oberfranken, Mittelfranken, Unterfranken, Schwaben, <b>Berlin</b> , Bremen, Hamburg, Darmstadt, Gießen, Kassel, Braunschweig, Hannover, Lüneburg, Düsseldorf, Koblenz, Rheinhessen-Pfalz, Saarland, Dresden, Chemnitz, Schleswig-Holstein, Thüringen; FR (13): Basse-Normandie, Bourgogne, Nord-Pas-de-Calais, Lorraine, Franche-Comté, Pays de la Loire, Bretagne, Aquitaine, Midi-Pyrénées, Rhône-Alpes, Auvergne, Languedoc-Roussillon, Corse; IT (9): Piemonte, Liguria, Provincia Autonoma di Bolzano, Provincia Autonoma di Trento, Veneto, Friuli-Venezia Giulia, Emilia-Romagna, Toscana, <b>Lazio</b> ; <b>LT Lithuania</b> ; <b>LU Luxembourg</b> ; HU (1): Dél-Dunántúl; <b>MT Malta</b> ; NL (2): Zeeland, Noord-Brabant; AT (9): Burgenland, Niederösterreich, <b>Wien</b> , Kärnten, Steiermark, Oberösterreich, Salzburg, Tirol, Vorarlberg; PL (14): Łódzkie, Małopolskie, Śląskie, Lubelskie, Podkarpackie, Świętokrzyskie,	Coping (111)

<p>Podlaskie, Wielkopolskie, Zachodniopomorskie, Lubuskie, Dolnośląskie, Opolskie, Kujawsko-pomorskie, Warmińsko-mazurskie; RO (3): Nord-Est, <b>Bucuresti-Ilfov</b>, Sud-Vest Oltenia; SI (1): Vzhodna Slovenija; SK (3): Západné Slovensko, Stredné Slovensko, Východné Slovensko; FI (3): Länsi-Suomi, Helsinki-Uusimaa, Pohjois- ja Itä-Suomi; SE (7): <b>Stockholm</b>, Östra Mellansverige, Smaland med öarna, Västsverige, Norra Mellansverige, Mellersta Norrland, Övre Norrland.</p>	
<p>BE (1): Prov. West-Vlaanderen; BG (1): Severozapaden; CZ (1): Severovýchod; DK (4): <b>Hovedstaden</b>, Sjælland, Midtjylland, Nordjylland; <b>EE Eesti</b>; EL (6): Dytiki Makedonia, Thessalia, Ipeiros, Ionia Nisia, Dytiki Ellada, Notio Aigaiio; ES (14): Galicia, Principado de Asturias, Cantabria, País Vasco, Comunidad Foral de Navarra, Aragón, <b>Comunidad de Madrid</b>, Castilla y León, Castilla-la Mancha, Extremadura, Comunidad Valenciana Andalucía, Región de Murcia, Canarias; FR (6): Champagne-Ardenne, Picardie, Haute-Normandie, Centre, Alsace, Limousin; IT (10): Valle d'Aosta, Lombardia, Umbria, Marche, Abruzzo, Puglia, Basilicata, Calabria, Sicilia, Sardegna; <b>CY Kypros</b>; <b>LV Latvia</b>; HU (6): <b>Közép-Magyarország</b>, Közép-Dunántúl, Nyugat-Dunántúl, Észak-Magyarország, Észak-Alföld, Dél-Alföld; NL (10): Groningen, Friesland, Drenthe, Overijssel, Gelderland, Flevoland, Utrecht, <b>Noord-Holland</b>, Zuid-Holland, Limburg; PT (4): Norte, Centro, <b>Lisboa</b>, Regiao Autónoma dos Açores; RO (5): Nord-Vest, Centru, Sud-Est, Sud-Muntenia, Vest; SI (1) <b>Zahodna Slovenija</b>; FI (2): <b>Etelä-Suomi</b>, Aland; SE (1): Sydsverige; UK (22): Tees Valley and Durham, Greater Manchester, Lancashire, Cheshire, Merseyside, South Yorkshire, Leicestershire, Rutland and Northamptonshire, Lincolnshire, Bedfordshire and Hertfordshire, Essex, <b>Inner London</b>, <b>Outer London</b>, Berkshire, Buckinghamshire and Oxfordshire, Surrey, East and West Sussex, Hampshire and Isle of Wight, Kent, Dorset and Somerset, West Wales and The Valleys, East Wales, Eastern Scotland, North Eastern Scotland, Highlands and Islands.</p>	Fighting (97)
<p>IE (2): Border, Midland and Western, <b>Southern and Eastern</b>; EL (7): Anatoliki Makedonia, Thraki, Kentriki Makedonia, Sterea Ellada, Peloponnisos, <b>Attiki</b>, Voreio Aigaiio, Kriti; ES (3) La Rioja, Cataluna, IllesBalears; IT (2): Molise, Campania; PT (3): Algarve, Alentejo, Regiao Autónoma da Madeira; UK (15): Northumberland and Tyne and Wear, Cumbria, East Yorkshire and Northern Lincolnshire, North Yorkshire, West Yorkshire, Derbyshire and Nottinghamshire, Herefordshire, Worcestershire and Warwickshire, Shropshire and Staffordshire, West Midlands, East Anglia, Gloucestershire, Wiltshire and Bristol, Cornwall and Isles of Scilly, Devon, South Western Scotland, Northern Ireland.</p>	Sensitive (32)

Capital regions or the regions including the capital of a country are marked in bold.

Source: author's compilation.

Figure 5 illustrates the geographical distribution of regions from the established classes.



**Figure 5.** Graphic presentation of the classification results

*Source: author's compilation.*

Out of 208 EU 15 NUTS 2 regions the “resistant” class included 6.7% of regions (mainly German – 10 out of 14 regions in this class, three French ones and a Belgian region - Prov. Oost-Vlaanderen). The following two classes covered a

similar number of regions from the EU 15: “coping” 39.4% and “fighting” 38.5%. The “sensitive” class included 15.4% of regions from the “old” EU, however, none of the EU 12. It is worth emphasizing that more than half of EU 12 regions (51.8%) were listed in the “coping” class, 30% in the “fighting” class and 17.9 in the “resistant” class.

## 6. Conclusions

The suggested construction of the measure allows for the assessment of resilience (resistance) to crisis in regions. The measure facilitates:

- arranging regions by their resilience (sensitivity) level to crisis,
- dynamic analyses and
- the synthetic identification and interpretation of classes obtained as a result of applying the dynamic taxonomy of regions,
- the generalized assessment of resilience (sensitivity) to crisis by assigning it to the suggested quality classes.

The obtained results indicate that the crisis affected the wealthy regions to a much larger extent, which is related to overproduction (resulting from the lack of moderation in meeting the needs) of banking products, as S. Bartosiewicz emphasizes (Bartosiewicz 2014).

It can be assumed that primarily in the case of the EU 12 regions, included in the group of resilient and coping regions, the cohesion policy carried out by the EU had a decisive impact on economy of these regions. For the regions from the countries of recent accession, structural funds and their influence on many spheres of economic life turned out to be a kind of “catalyst” for resilience to economic crisis. The effect of pre-accession structural funds was observed: (Bulgarian and Romanian regions), prolonged financial activities from the period 2004-2006 and also the period 2007-2013 (e.g. Polish regions).

The above mentioned assumptions were also confirmed by another research (Markowska, Strahl 2015), which assess the relations of variables characterizing smart growth of the European Union regions at NUTS 2 level (in the system of three pillars, i.e. innovation, creative regions and smart specialization described by several variables) with their sensitivity to economic crisis using logit models.

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