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XX. mezinárodní kolokvium o regionálních vědách

Concept of resilience

in the context of regional development: literature review of theory and realistic aspects

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OUTLINE

Theoretical Part

- Introduction/Motivation
- Economic Resilience: Concept, Literature Review, Measurement
- Composite Weighted Index of Regional Resilience: Methodology

Empirical Part

- Empirical Analysis Background
- Data
- Preliminary Results
- Conclusion

ACKNOWLEDGEMENT

Regional Specialization and Diversity of the EU 28 NUTS 2 regions: Analysis of Regional Dynamics Determinants	
Project registration number:	SP 2017/111 (Ing. Michaela Staníčková, Ph.D.)
Period of research:	1. 1. – 31. 12. 2017
Recipient:	VŠB –Technical University of Ostrava, Faculty of Economics, Department of European Integration

Impact of Economic Shocks on Efficiency and Competitiveness of the European Union in Terms of Regional and International Levels: Nonparametric Approach	
Project registration number:	SP 2015/106 (Ing. Michaela Staníčková, Ph.D.)
Period of research:	1. 1. – 31. 12. 2015
Recipient:	VŠB –Technical University of Ostrava, Faculty of Economics, Department of European Integration

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INTRODUCTION/MOTIVATION

- **The aim:**
  - **Introduction** of methodology for assessing the resilience of EU28 NUTS 2 regions based on construction of composite weighted index calculated from factors of regional resilience derived from EU Regional Competitiveness Index approach.
  - **Determination** and **computation** of Composite Weighted Index of Regional Resilience (CWIRR).
- **Research assumptions:**
  - Based on the general concept of regional competitiveness (*Gardiner et al. (2004); Bristow (2005); Meyer-Stamer (2008); IMD (2014)*)
    - regions with the lower level of productivity and ability to create and maintain an environment that sustains more value creation for its enterprises and more prosperity for its people' achieve the lower level of resilience in the territory that provide worse conditions and assumptions for regional development potential, and vice versa.
    - NUTS 2 regions of (more) developed EU28 Member States have higher level of regional resilience in comparison with the level of regional resilience in NUTS 2 regions of less developed EU28 Member States.

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ECONOMIC RESILIENCE: CONCEPT AND LITERATURE REVIEW (i)

- **Frequently used** but **rarely well defined** concept. Routinely used in research in disciplines ranging from **environmental research to materials science** and engineering, psychology, sociology, and economics.
- No **uniform definition** of economic resilience → concept remains one of the ***basic standards of performance*** evaluation and ***reflection of area success*** in wider comparison.

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- Conceptually, there are **two** separate, though not necessarily unrelated, **concepts of economic resilience**:
  - **Equilibrium analysis** in which resilience is the **ability to return to a pre-existing state** in a single equilibrium system (*ability to adjust to 'normal' or anticipated levels of stress*).
  - **Resilience in terms of complex adaptive systems** and relates to the **ability of a system to adapt and change in response to stresses and strains** (*ability to adapt to sudden shocks and extraordinary demands*).
- **The most natural conceptual meaning of economic resilience** → the **ability of regional economy to maintain or return to pre-existing state in the presence of some type of exogenous shock.**

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ECONOMIC RESILIENCE: CONCEPT AND LITERATURE REVIEW (ii)

Time	Authors	Understanding of resilience concept
2015	Martin, Sunley	Resilience refers to a capacity to withstand or recover from market, competitive and environmental shocks.
2012	Martin	The capacity of regional economy to reconfigure, that is adapt, its structure (firms, industries, technologies and institutions) so as to maintain an acceptable growth path in output, employment and wealth over time.
2010	Gunderson et al.	The resilience concept does not necessarily imply a return to the pre-existing state, but could be referred to as the capacity to respond to opportunities which arise as a result of change.
2009	Rose	Process by which a community develops and efficiently implements its capacity to absorb an initial shock through mitigation and to respond and adapt afterward so as to maintain function and hasten recovery, as well as to be in a better position to reduce losses from future disasters.
2008	Cutter et al.	Resilience is the ability of social system to respond and recover from disasters and includes those inherent conditions that allow the system to absorb impacts and cope with an event, as well as post-event, adaptive processes that facilitate the ability of the social system to reorganize, change, and learn in response to a threat.
2008	Hill et al.	The ability of regional economy to maintain a pre-existing state in the presence of some type of exogenous shock; the extent to which a regional or national economy that has experienced an external shock is able to return to its previous level and/or growth rate of output, employment or population.
2008	Norris et al.	Process linking a set of adaptive capacities to a positive trajectory of functioning and adaptation after a disturbance.
2006	Foster	The ability of region to prevent, prepare, respond and 'recover' after a disturbance so as not to stand this obstacle to its development.
2006	Perrings	The ability of system to withstand either market or environmental shocks without losing the capacity to allocate resources efficiently
2004	Coles et al.	A community's capacities, skills, and knowledge that allow it to participate fully in recovery from disasters.
2004	Walker	Capacity of system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks.
2003	Bruneau et al.	The ability of system to reduce the chances of shock, to absorb shock if it occurs (abrupt reduction of performance) and to recover quickly after a shock (re-establish normal performance).
2001	Carpenter et al.	The adaptive capacity that allows for continuous development like a dynamic interplay between sustaining and developing with change.
1997	Reich	The structure of relationships among macroeconomic variables that persists over a long period of time and the economic, political, and social institutions that condition this structure.
1973	Holling	The amount of disturbance that ecosystem could withstand without changing self-organized processes and structures, defined as alternative stable states, i.e. measure of the persistence of systems and of their ability to absorb change and disturbance and still maintain the same relationships between populations or state variables.
1958	Elton	Resilience as the amplitude of changes brought about by disturbance and by dynamics of post-disturbance recovery.

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ECONOMIC RESILIENCE: CONCEPT AND MEASUREMENT (i)

- **No mainstream approach** for measurement and expression of resilience.
- **Own meta-analyses of more than 70 approaches to conceptualizing and measuring of resilience in different theoretical and methodological ways.**
- **Quantifying systems of regional resilience is a complex process**, and scales for measuring resilience, at any level, do not currently exist.
- **Main characteristics (factors) for regional resilience (literature review):**
  - **First group:** dynamic growth of region, structure of the economy, export orientation and specialization of region, human capital, innovation rate, business and corporate culture, localization of region, and institutional arrangement in region *(Martin, 2012).*
  - **Second group:** regional economic capacity, socio-demographic capacity of region and regional community capacity *(Foster, 2006).*
  - **Third group:** main macroeconomic indicators, labour market indicators and additional ones *(Koutský et al., 2012), (Tamásy and Diez, 2013).*

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- In the paper, **we link the concepts of regional resilience with regional competitiveness** → we **define** (with a certain degree of generalization proceed) **a set of indicators of regional resilience** which are important in terms of regional competitiveness (based on common relation).

ECONOMIC RESILIENCE: CONCEPT AND MEASUREMENT (ii)

- **Several possible ways of measuring** the degree and 'shape' of a region's resilience to an economic shock can be found in literature.

Method	Focus	Literature Review
Case study based	Mainly narrative based, may involve simple descriptive data and interviews with key actors, interrogation of policies	Munich (Evans and Karecha, 2013); Cambridge and Swansea (Simmie and Martin, 2010); Buffalo and Cleveland (Cowell, 2013), EU (**ESPON, 2014**)
Resilience indices	Singular or **composite**, comparative, measures of (relative) resistance and recovery, using key system variables of interest	UK regions (Martin, 2012); US cities and counties (**Kathryn A. Foster, 2011**; Augustine et al, 2012; Hans and Goetz, 2013)
Statistical time series models	Impulse response models; error correction models. These estimate how long it takes for impact of shock to dissipate	US regions (Blanchard and Katz, 1992); UK regions (Fingleton, Garretsen and Martin, 2012)
Causal structural models	Embedding resilience in regional economic models to generate counterfactual positions of where system would have been in the absence of shock	US metropolitan areas (Doran and Fingleton, 2013)

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COMPOSITE WEIGHTED INDEX OF REGIONAL RESILIENCE: METHODOLOGY (i)

- **Composite indicators** (CIs) which compare country or region performance are increasingly recognised as a **useful tool to the measurement and evaluation of competitiveness and resilience.**
- **CIs can be much 'better' to describe** (instead of ten values for each region we have only one) than to examine several independent indicators separately.
- **Different types of CIs can be used** for univariate, bivariate or multivariate analyses of data in any territorial level (country, region, district, municipality, etc.):
  - *Bandura (2006):* cites more than 160 composite indicators in his study,
  - *Al Shramin (2011):* district-level analysis,
  - *Kutscherauer et al. (2010); Svatošová and Boháčková (2012); Žižka (2013); Melecký (2014, 2015)*: measuring regional disparities in different spatial level,
  - *Staníčková and Melecký (2014, 2015, 2016):* describing various features of territorial diversification,
  - and many others...

COMPOSITE WEIGHTED INDEX OF REGIONAL RESILIENCE: METHODOLOGY (ii)

- **Own construction design of composite synthetic index** is based on selected indicators of economic, social and territorial indicators of regional resilience coming from **RCI approach** database and our CI presents **three-layer model** based on selected mathematical and multivariate statistical methods.
- **Composite index used in the paper is based on sub-indicators that have no common meaningful unit of measurement and there is no obvious way of weighting these sub-indicators** (see e.g. *Saisana and Tarantola, 2002*).

Input data analysis
Pre-processing phase » Collection of indicators » Groups of indicators for resilience » Bivariate correlation of normalized variables for 273 EU28 NUTS 2 regions

Factor analysis
Correlation » Standardization (Z-score) » Principal component analysis » Varimax with Kaiser Normalization » Resilience factors » Resilience factors description

Entropy method
Weighting scheme for factors of resilience » Set of weights for each resilience dimension (factor)

Composite weighted index calculation
Linear combination of factor analysis and entropy method results » Final calculation of CWIRR

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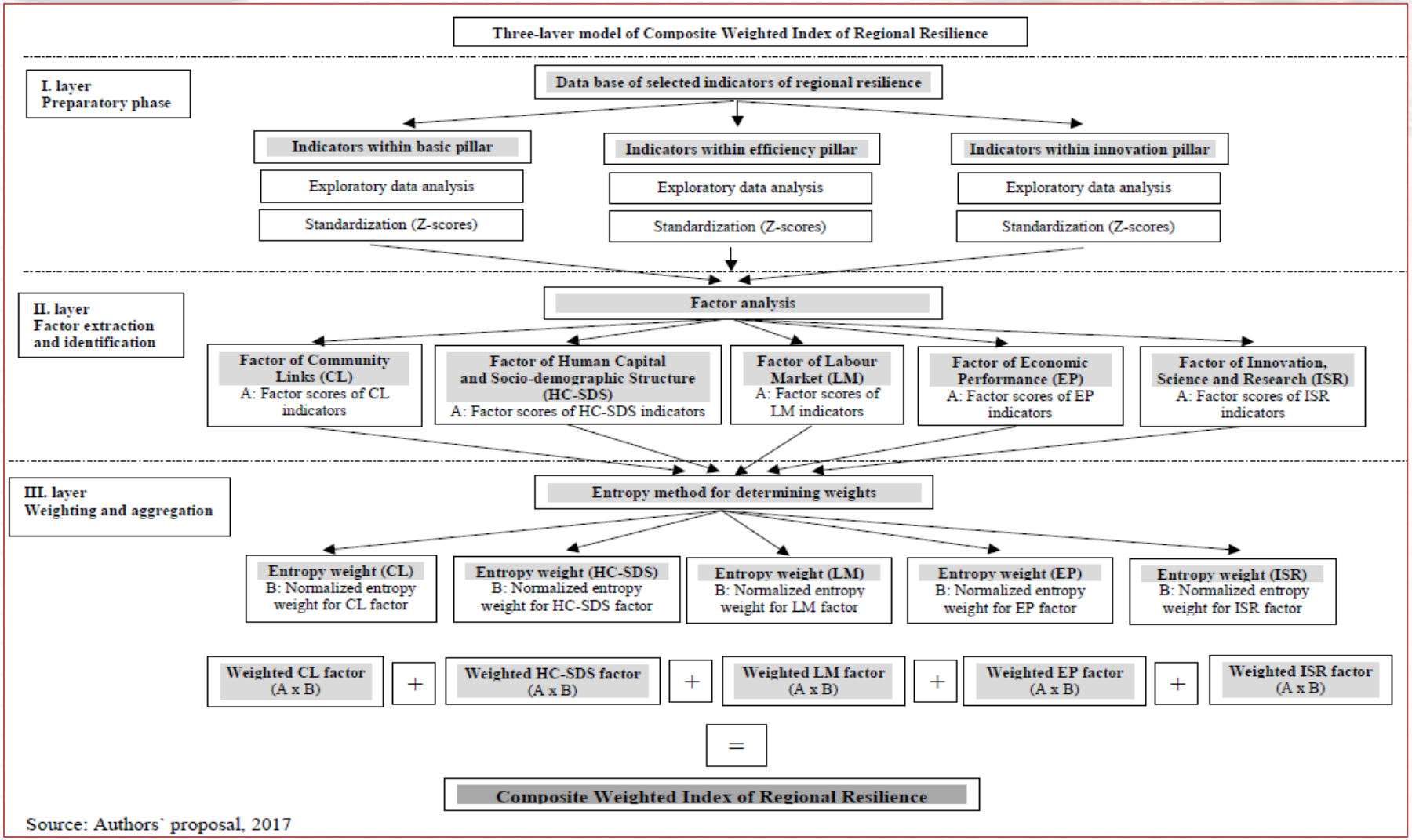
COMPOSITE WEIGHTED INDEX OF REGIONAL RESILIENCE: METHODOLOGY (iii)



Source: Authors` proposal, 2017

COMPOSITE WEIGHTED INDEX OF REGIONAL RESILIENCE: METHODOLOGY (iv)

- **Weighting and aggregation systems** have a **crucial effect on outcome** of each composite index.
- In standard practice, a composite indicator (CI) can be considered as **weighted linear aggregation rule applied to a set of variables** (*Munda and Nardo, 2005, p. 3*) as shown in following equation (1):

$$CI = \sum_{i=1}^{n} w_i . x_i , \qquad (1)$$

where x_i is a scale adjusted variable and w_i is a weight attached to x_i, usually with $\sum_{i=1}^{N} w_i = 1$ and $0 \le w_i \le 1, i = 1,2,...,N.$

- **Crucial issue** presents the **concept of weight.** We used the ***entropy method*** to determine the weight of evaluating factors → **objective approach** to calculating the criteria weights evaluate the structure of matrix **R** representing the values r_{ij}, while the values of the weights may change together with the values themselves. Entropy method requires **knowledge of the values of all the criteria for all variants** in the matrix **R.**

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COMPOSITE WEIGHTED INDEX OF REGIONAL RESILIENCE: METHODOLOGY (v)

- **Entropy method (I)**
  - In the theory of information the entropy is the **criterion of uncertainty** posed by a **discrete probability distribution** (p_i.) This degree of uncertainty is expressed e.g. by *Karmeshu (2003)* in the following formula (2):

$$S(\mathrm{p}_1, p_2, \ldots, p_n) = -c.\sum_{i=1}^{n} p_i.\ln p_i, \qquad (2)$$

  - Suppose all p_i equal, then for given i, $p_i = \frac{1}{n}$ reaches $S(p_1, p_2, \ldots, p_n)$ maximum value.
  - From matrix **R** we can determine share of the i-th variant on the sum of the j-th criteria for all criteria p_{ij} from the formula (3):

$$p_{ij} = \frac{r_{ij}}{\sum_{i=1}^{p} r_{ij}}, i = 1,2,\ldots,p, j = 1,2,\ldots,k. \qquad (3)$$

  - For the j-th criterion entropy (s_j) is determined by formula (4):

$$s_j = -c.\sum_{i=1}^{p} p_{ij}.\ln p_{ij}, \mathrm{j} = 1,2,\ldots,\mathrm{k}. \qquad (4)$$

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COMPOSITE WEIGHTED INDEX OF REGIONAL RESILIENCE: METHODOLOGY (vi)

- **Entropy method (II)**
  - If suppose $c = \frac{1}{\ln p}$, then $0 \le s_j \le 1$ is guaranteed. Non normalized entropy weight of *j*-th criteria (*dj*) can be found in formula (5):

$$d_j = 1 - s_j, j = 1,2,\ldots,k, \quad (5)$$

while the respective **normalized weights** w_j are obtained from the formula (6) where sum of weights in each dimension is equal to one:

$$w_j = \frac{d_j}{\sum_{j=1}^{k} d_j}, j = 1,2,\ldots,k. \quad (6)$$

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COMPOSITE WEIGHTED INDEX OF REGIONAL RESILIENCE: METHODOLOGY (vii)

- **CWIRR**
  - Based on general equation (1) we can calculate the **Composite Weighted Index of Regional Resilience (CWIRR).**
  - CWIRR is designed for **five factors of regional resilience for each of 273 EU28 NUTS 2** regions by equation (7) as **weighted linear aggregation**:

$$CWIRR_r = \sum_{f=1}^{5} zw_f . F_{f_r}, \qquad (7)$$

where:

$CWIRR_r$ Composite Weighted Index of Regional Resilience for *r*-th region;

zw_f normalized weights of *f*-th factor of regional resilience;

F_{f_r} factor score of *f*-th factor of regional resilience for *r*-th region;

r EU28 NUTS 2 region; r = {1 = AT11, … , 273 = UKN0};

f factor of regional resilience; f = {1 = CL, 2 = HC-SDS, 3 = LM, 4 = EP, 5 = ISR}.

EMPIRICAL ANALYSIS BACKGROUND

- **Territory**
  - 273 NUTS 2 regions within EU-28 Member States.
  - NUTS 2 region: 800,000 – 3,000,000 inhabitants.
  - Administrative or statistical regions which do not take into account functional economics links.
- **Reference period**
  - 2007-2013
- **Periodicity of data**
  - Annual
- **Source of data**
  - Regional Competitiveness Index.

- **Indicators**
  - Cross-sectional data.
  - 25 selected indicators important for regional resilience from the competitiveness point of view.
- **Methods**
  - Z-score transformation
  - Factor analysis (Principal Component analysis)
  - Entropy method
  - Weighted linear aggregation
- **Statistical software**
  - SPSS Statistics 24, Microsoft Excel 2016, ArcGIS 10.5

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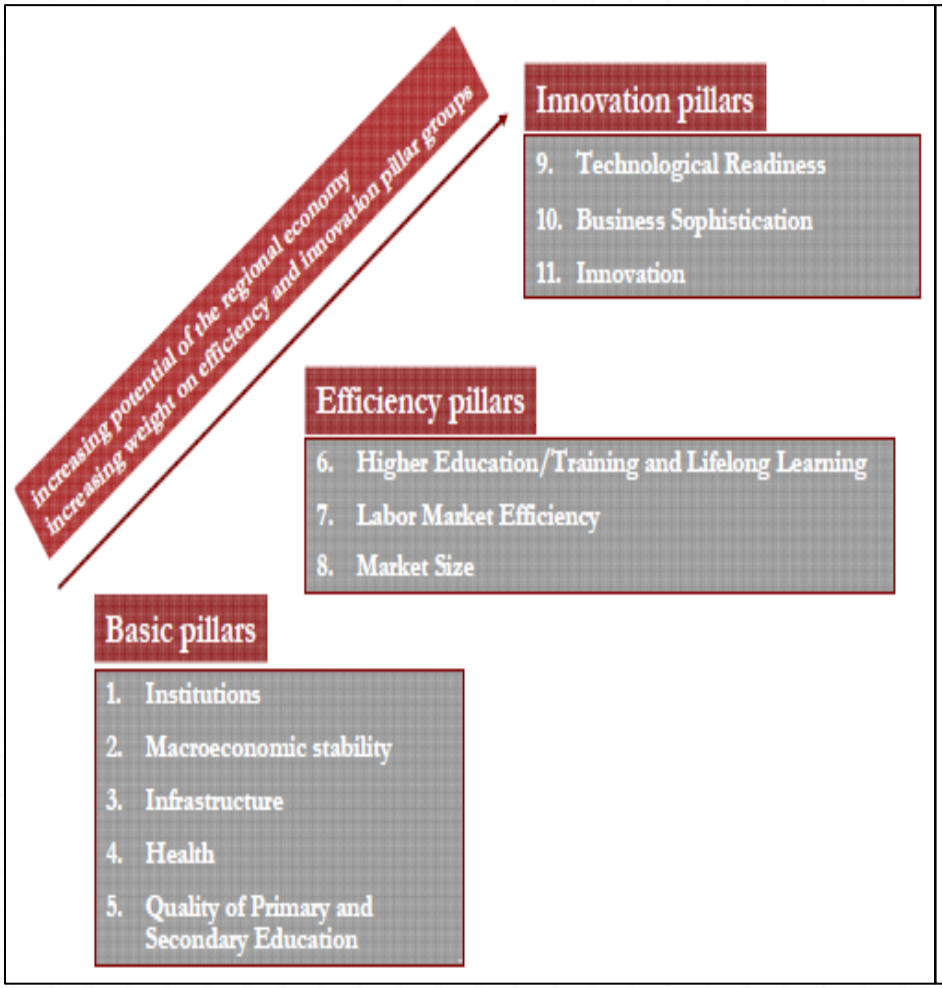
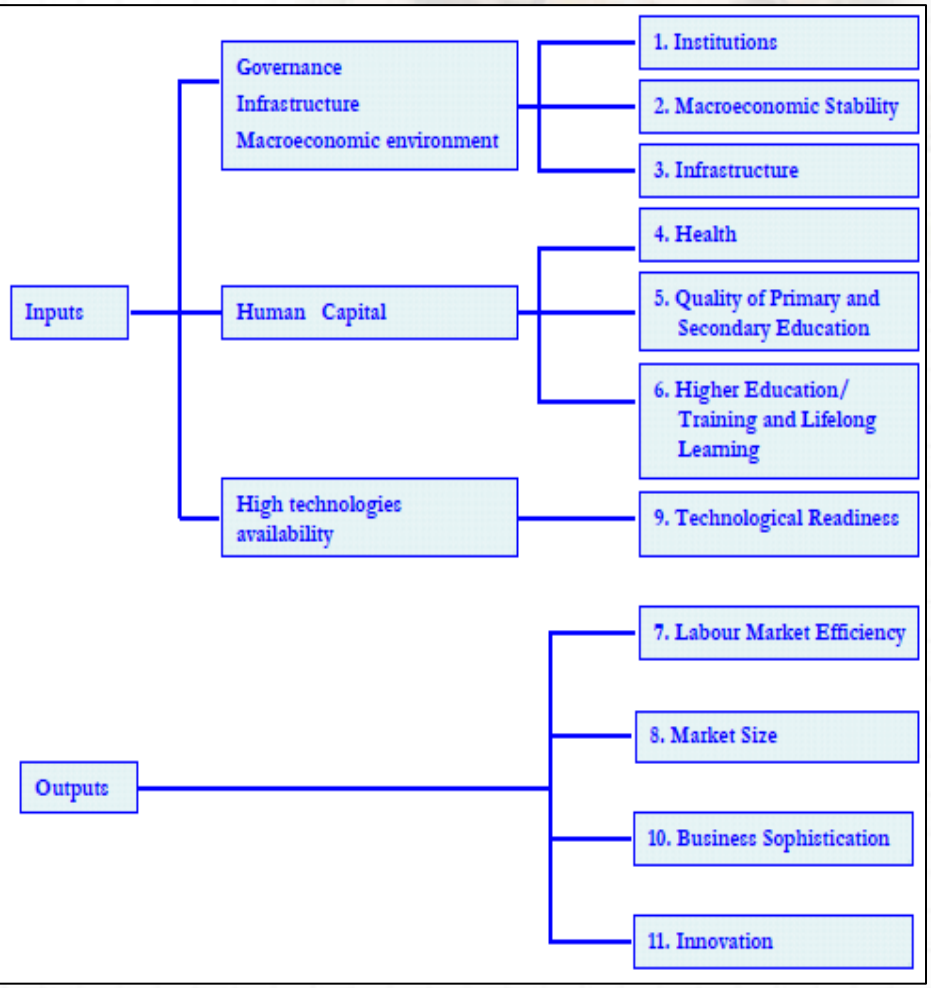
DATA FRAMEWORK





OBSERVED DATA

Dimension	Indicators
Institution	Government effectiveness (GE), Corruption (C), Rule of law (RL)
Infrastructure	Motorway potential accessibility (MPA), Railway potential accessibility (RPA)
Health	Healthy life expectancy (HLE), Cancer disease death rate (CDDR), Heart disease death rate (HDDR)
Education	Population 25-64 with higher education (PE), Lifelong learning (LL), Accessibility to universities (AU)
Labour market	Employment rate (ER), Long-term unemployment (LTUR), Labour productivity (LP)
Market size	Disposable income (DI), Gross domestic product (GDP)
Business sophistication	Employment in sophisticated (K-N) sectors (ESS), Gross valued added of sophisticated (K-N) sectors (GVA)
Innovation	Total patent applications (TPA), Core creative class employment (CCCE), Gross expenditure on research and development (GERD), Human resources in science and technology (HRST), High-tech patents (HTP), ICT patents (ICT)

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RESULTS (i)

Results of Factor Analysis and Entropy Method

- **Five dominating factors has been extracted**: Community links (CL), Human capital and socio-demographic structure (HC-SDS), Labour market (LM), Economic performance (EP), Innovation, science and research (ISR).
- **Extracted factors explained 84.368 %** of total variability of selected indicators.
- **Indicators** associated within each factor **are relevant for its dimension of resilience**; also **number of indicators** is **balanced across factors**.

Factors	CL	HC-SDS	LM	EP	ISR	Sum of Normalized Weights
Indicators	GE, C, RL, MPA, RPA	HLE, CDDR, HDDR, PE, LL, AU	ER, LTUR, ESS, CCCE	LP, GVA, DI, GDP	TPA, GERD, HRST, HTP, ICT	
Number of indicators	6	6	4	4	5	
Weights	0.205	0.223	0.195	0.194	0.182	**1.000**

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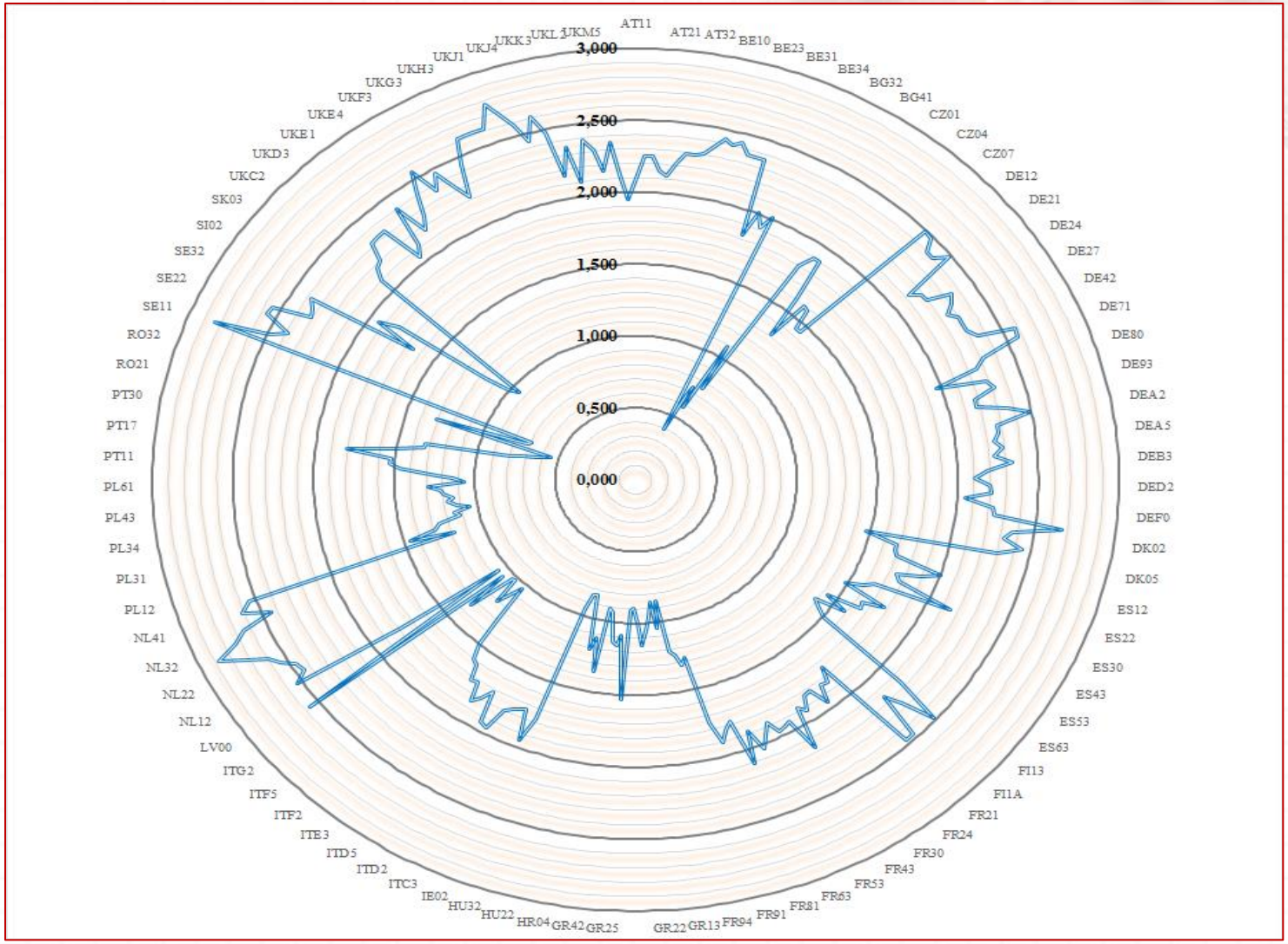
RESULTS (ii) - CWIRR for EU28 NUTS 2 regions

Note:
The higher CWIRR score → the more resilient and resistant region (e.g. to crises).



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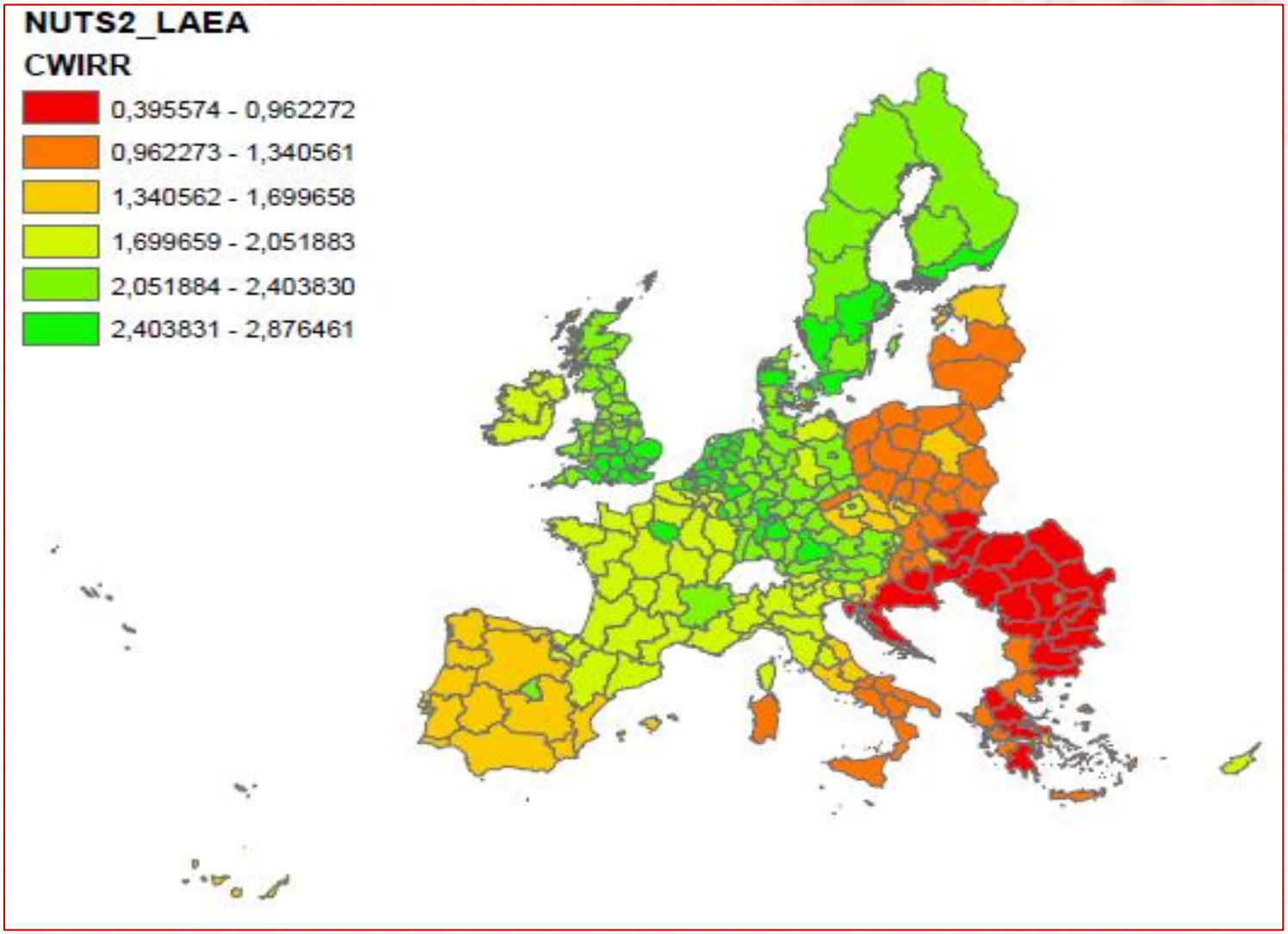
RESULTS (iii)

Note:
The higher CWIRR score, the greener colour → the more resilient and resistant region (e.g. to crises).



CONSLUSION

- **Contribution of the paper:**
  - **Framework** for defining regional resilience and specifying quantitative measures of resilience that can serve as foci for comprehensive characterization of the socio-economic problem to establish needs and priorities.
  - Framework makes it possible to assess and evaluate the contribution to resilience of **various activities implemented in regions**, whether focusing on components, systems, or organizations.
  - A proactive approach could considerably minimize the role of external economic factors; therefore, cooperation of all crucial institutional actors is desirable particularly concerning those measures aimed at safeguarding economic growth and employment, which ultimately can contribute to increasing resilience.
  - **Not only proactivity can provide an adequate response to external challenges, it can also put regions in a position where they generate and lead a change**.

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Thank You for Your Attention

Q/A

Comments

Suggestions

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