

# THE HIGH TECH COMPOSITE INDICATOR (HTCI)

## A TOOL FOR MEASURING EUROPEAN REGIONAL DISPARITIES

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### COMPOSITE INDICATORS

*A **new proposal**: measuring high technology through **composite indicators**.*

*How to **construct** them for this purpose?*

2

### HIGH TECH

***Innovative measure** with composite indicators:  
what are **European Regional disparities**?*

*what are the determinants of this phenomenon?*

## COMPOSITE INDICATORS: DEFINITIONS

*A **composite indicator** is a combination of elementary indicators representing different dimensions of a phenomena and it is usually applied when a multidimensional concept cannot be measured by an only one of them.*

*Source: Saisana and Tarantola (2002)*

***Composite indicators** are widely used by various national and international organizations to analyse economic, environmental and social scenarios (e.g. industrial competitiveness, sustainable development, quality of life assessment, globalisation, etc.).*

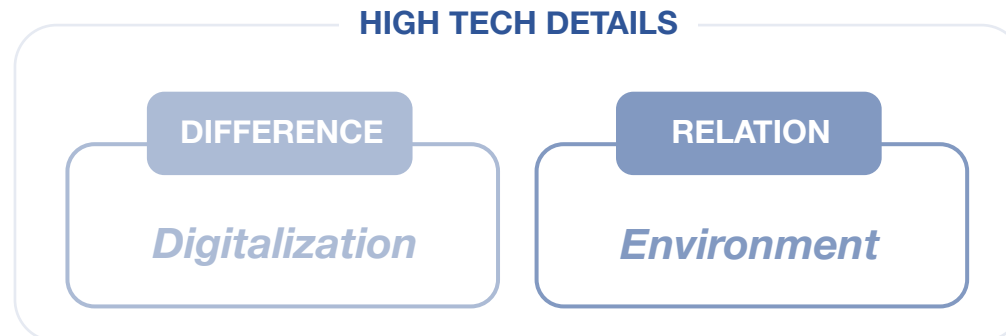
*Source: OECD (2008)*

## HIGH TECH PHENOMENON

***High tech** could be expressed as the ability of a firm to remain competitive, to renew itself, to be innovative, as well as to steer investment in science and technology and in R&D.*

***High tech** could be interpreted as the tight network of social, political and economic forces that interact each other, leading to economic growth.*

Source: *Literature review*



# DATA

## SOURCE: EUROSTAT

- **European Regional Statistics** according to **NUTS territorial classification**
- **NUTS Level 2:** basic regions for the application of regional policies

## STATISTICS SELECTED

### SCIENCE & TECHNOLOGY

- *Intramural R&D expenditure (GERD)*
- *Employment in technology and knowledge-intensive sectors (EMPL)*
- *Human resources in science & technology (HRST)*
- *EU trademark applications (EUTM)*
- *Community designs (CD)*

### SOCIO-ECONOMIC

- *Population density*
- *Households income*
- *Employment rates*
- *Long-term unemployment*
- *Young people neither in employment nor in education and training (NEET)*

# HIGH TECH COMPOSITE INDICATORS: CONSTRUCTION

## THEORETICAL FRAMEWORK

01

### **Formative model**

- The concept is a function of the variables observed
- **NOT** interchangeability of indicators
- Correlation between indicators **NOT** explained

## DATA SELECTION

02

### **Literature analysis**

- **POSITIVE** polarity

## MISSING DATA IMPUTATION

03

### **Temporal proximity rule**

*Less than 25% of missing values*

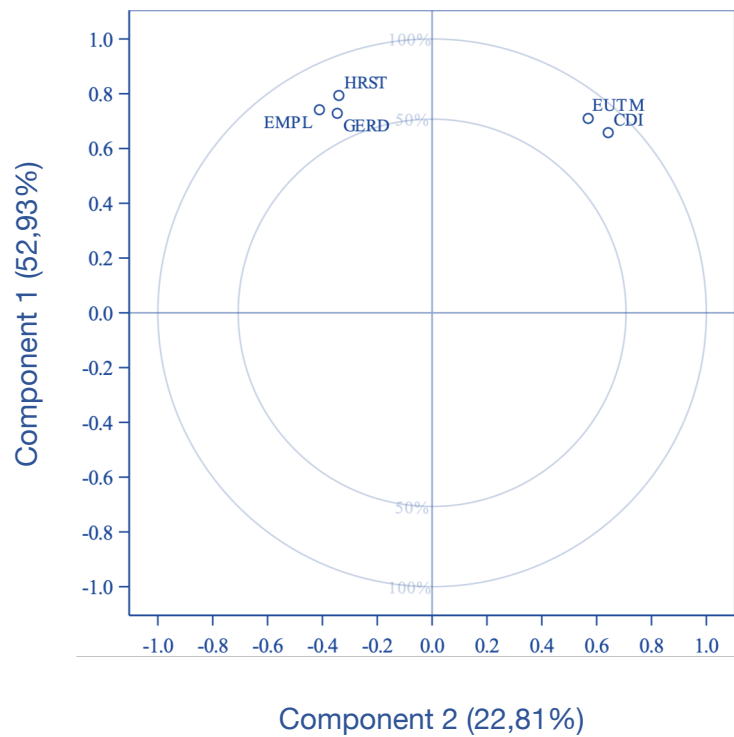
- **25** out of 28 European Union Countries: Greece, Lithuania and Slovenia (excluded)
- **238** regions **from 2006 to 2016**
- Proximity values
- Small distortion

04

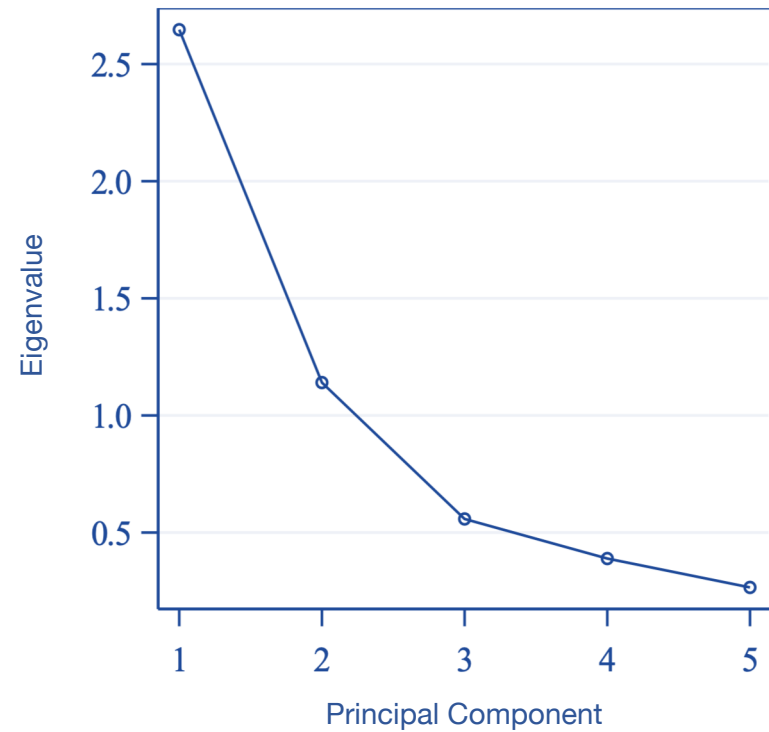
MULTIVARIATE ANALYSIS

## Principal Component Analysis (PCA)

*CORRELATION CIRCLE (2016)*



*SCREE PLOT (2016)*



# HIGH TECH COMPOSITE INDICATORS: CONSTRUCTION

05

NORMALISATION

**Measureless**

- **Percentage value** of GERD, EMPL, HRST, EUTM
- **Adjusted Mazziotta - Pareto Index (AMPI)** for CD

06

WEIGHTING AND AGGREGATION

**AMPI method**

- **Equal weight of 1**
- **Sensitivity analysis**

Requirements \ Methods	<i>Spatial comparability</i>	<i>Temporal comparability</i>	<i>Non-substitutable</i>	<i>Simplicity and transparency</i>	<i>Immediate availability</i>	<i>Robustness</i>
<i>Mean 0-1</i>	✓	✓	✗	✓	✗	✓
<i>Mean z-scores</i>	✓	✗	✗	✓	✗	✓
<i>MPI</i>	✓	✗	✓	✓	✓	✓
<i>Jevons</i>	✓	✓	✓	✓	✗	✗
<i>IMG</i>	✓	✓	✓	✓	✓	✗
<b>AMPI</b>	✓	✓	✓	✓	✓	✓

Source: **Tinto A. (2016)**



## 1. Standardization:

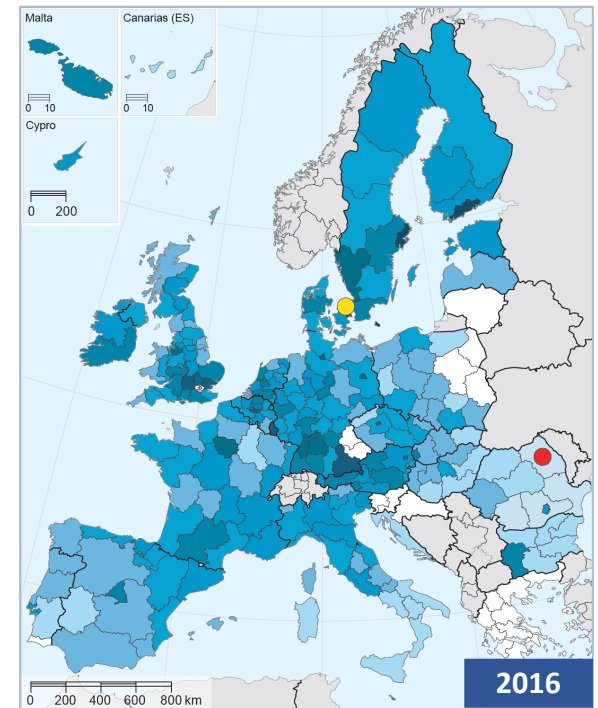
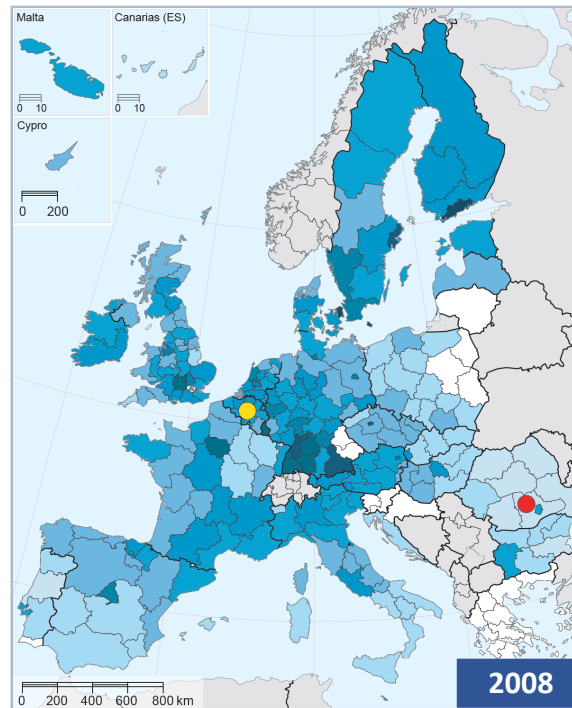
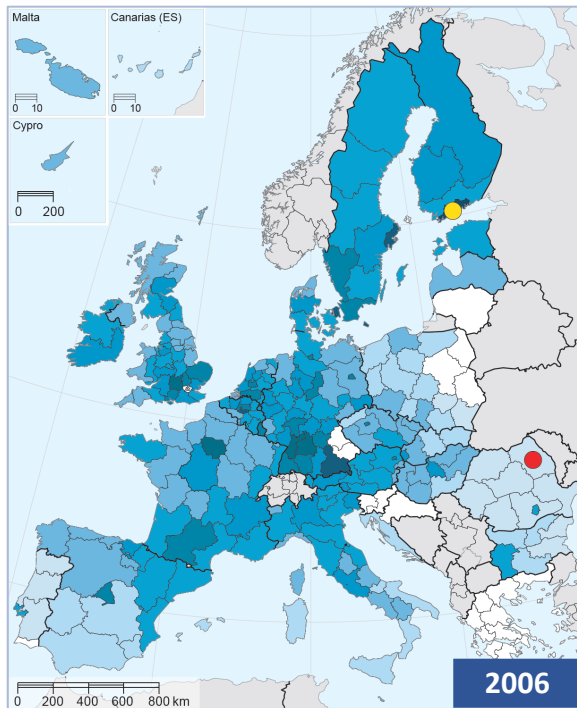
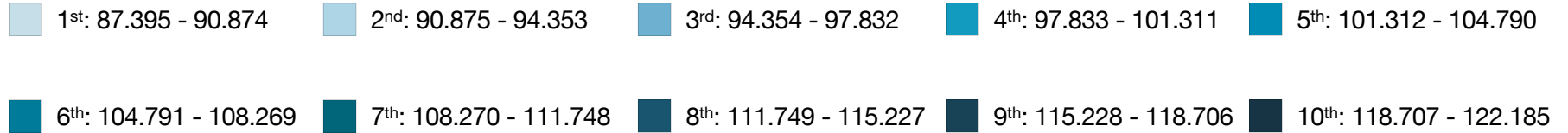
Standardized matrix  $R = \{r_{ij}\}$   $r_{ij} = \frac{(x_{ij} - \text{Min}_{x_j})}{(\text{Max}_{x_j} - \text{Min}_{x_j})} 60 + 70$  where  $x_{ij}$  is the value of the indicator  $j$  on the unit  $i$ .

## 2. Calculation of goalposts with a reference value:

Goalposts:  $\begin{cases} \text{Min}_{x_j} = \text{Ref}_{x_j} - \Delta_{x_j} \\ \text{Max}_{x_j} = \text{Ref}_{x_j} + \Delta_{x_j} \end{cases}$  where  $\begin{cases} \Delta_{1x_j} = \text{Sup}_{x_j} - \text{Ref}_{x_j} \\ \Delta_{2x_j} = \text{Ref}_{x_j} - \text{Inf}_{x_j} \\ \Delta_{x_j} = (\Delta_{1x_j} + \Delta_{2x_j}) / 2 \end{cases}$

**3. Aggregation:** the composite index is  $AMPI_i^{+/-} = M_{r_i} \pm S_{r_i} cv_i$

# MAPS



Cartography: Eurostat - GISCO, 02/2019

Administrative boundaries: © EuroGeographics © UN-FAO © Turkstat

EU Region excluded from the analysis

Region not in the European Union (EU-28)

Maximum    Minimum

# MAPS

● Helsinki-Uusimaa (FI1B):

115.624

● Nord - Est (RO21):

87.831

● Prov. Brabant wallon (BE31):

116.329

● Sud - Muntenia (RO31):

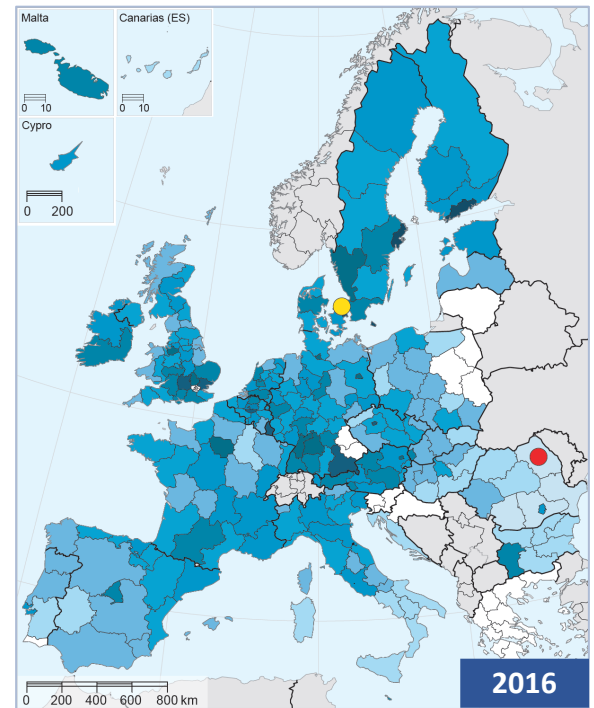
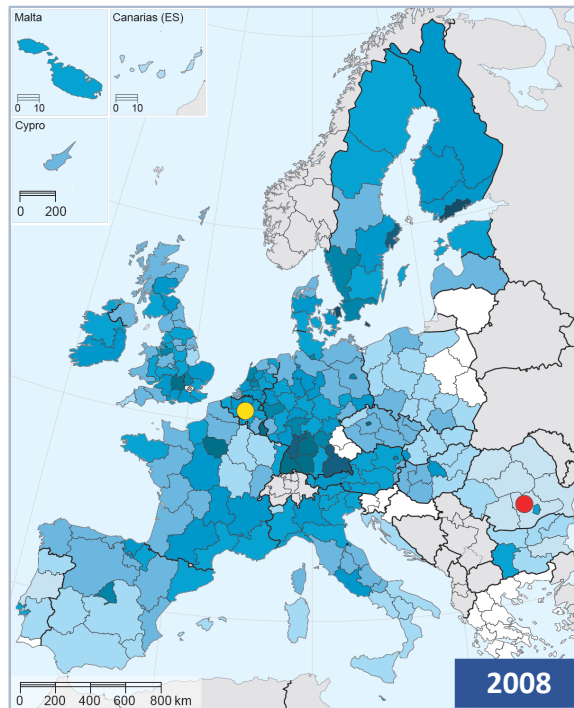
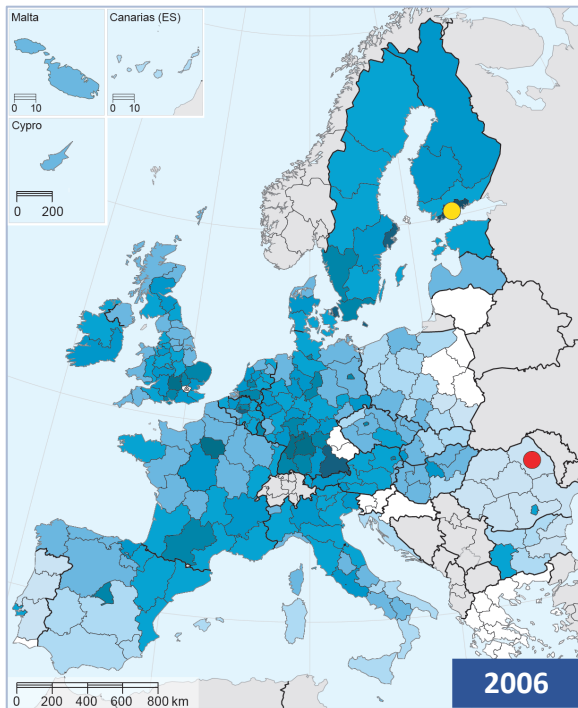
87.513

● Hovedstaden (DK01):

117.673

● Nord - Est (RO21):

87.970



Cartography: Eurostat - GISCO, 02/2019

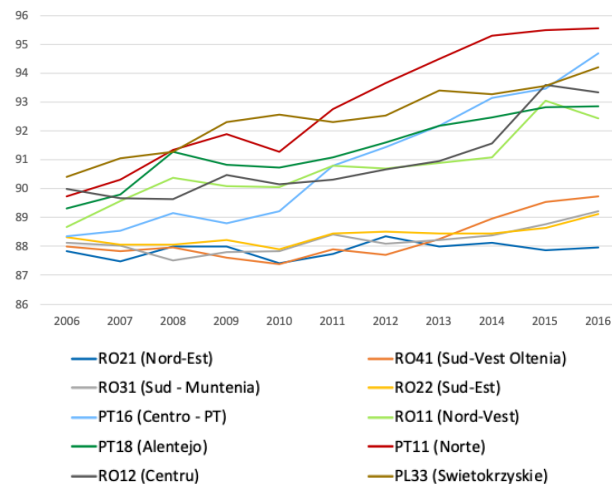
Administrative boundaries: © EuroGeographics © UN-FAO © Turkstat

● Maximum ● Minimum

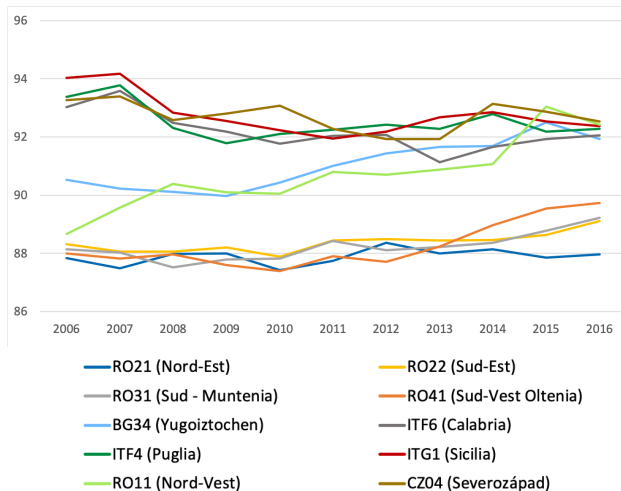
# WORST/BEST REGIONS

2006

## WORST

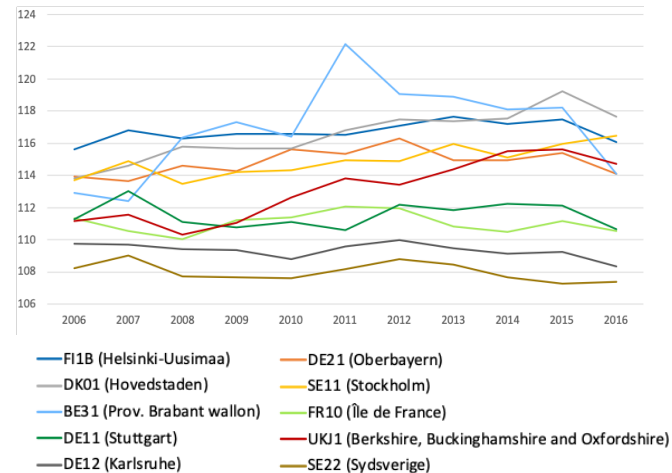


2016

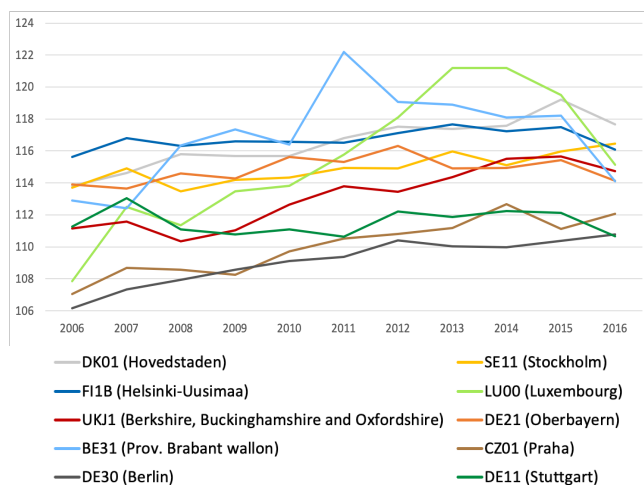


2006

## BEST



2016

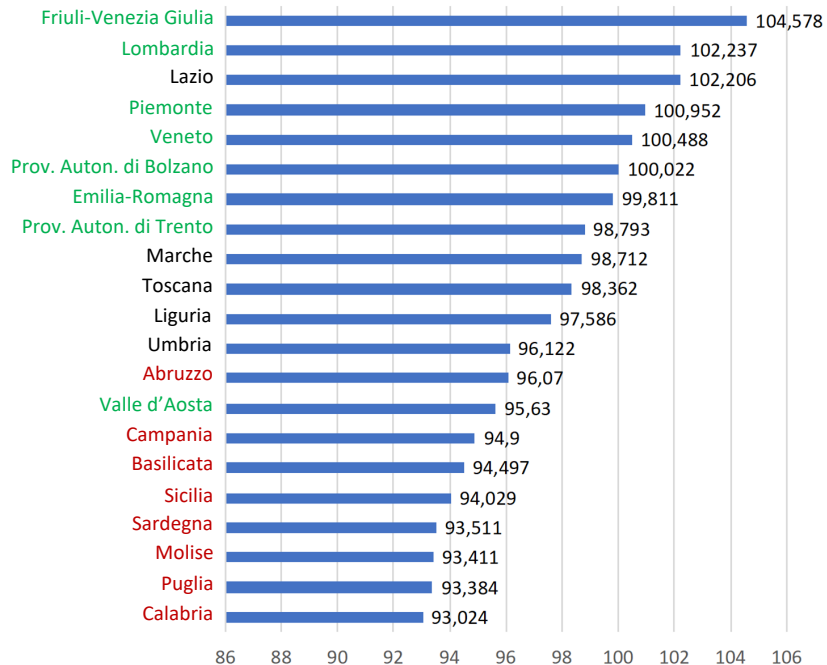


# FOCUS ON ITALY

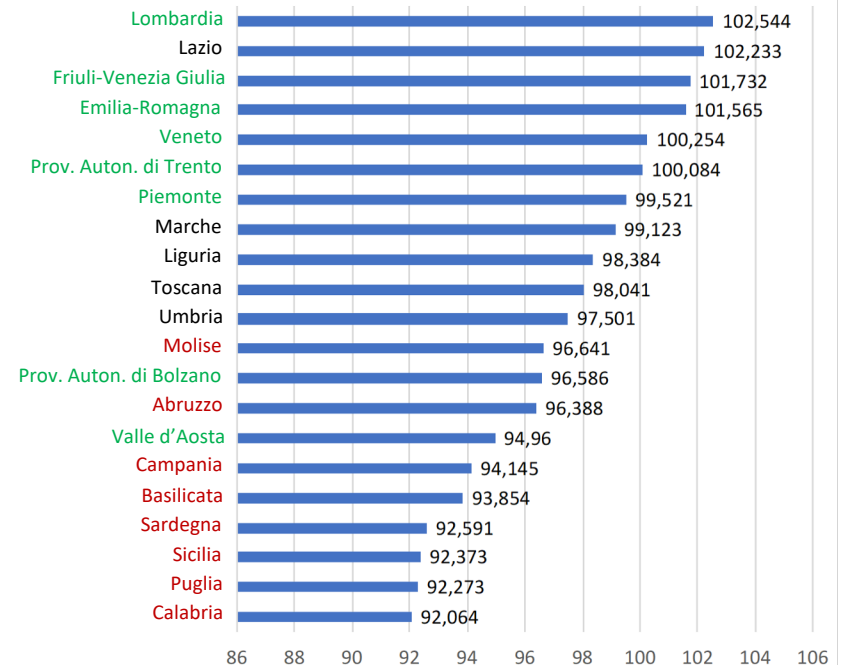
## CLEAR GAP

in terms of High Tech composite indicator scores  
between **North** and **South** Regions in both years

2006



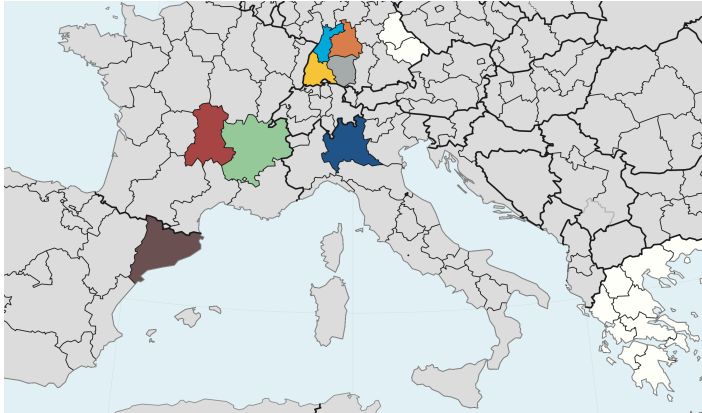
2016



# "MOTORS OF EUROPE"

DISTRIBUTION

## MOTORS OF EUROPE

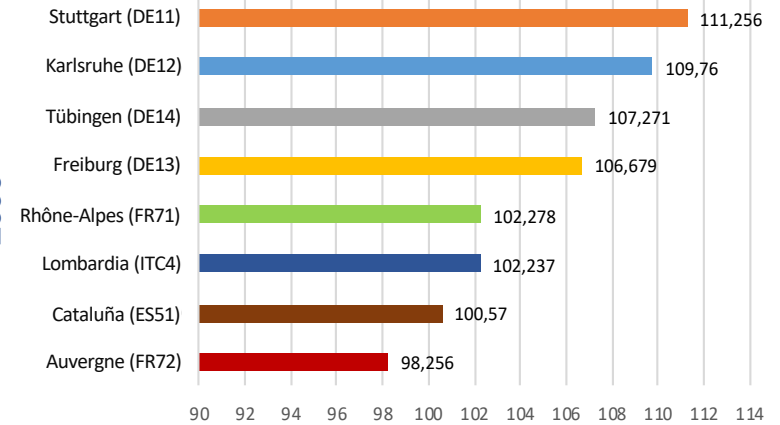


LEGENDA

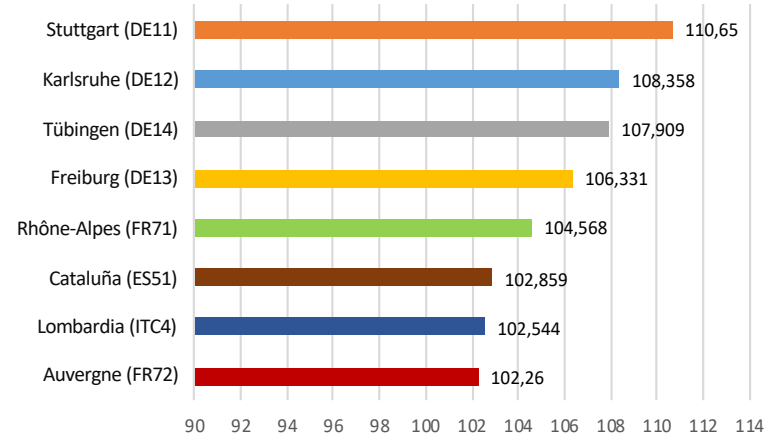


## HIGH TECH INDEX

2006



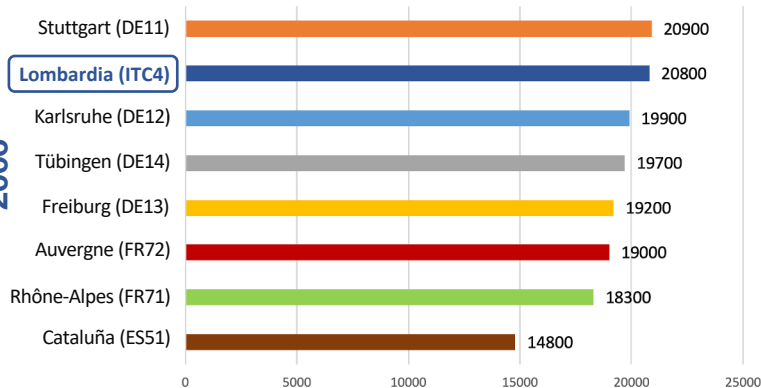
2016



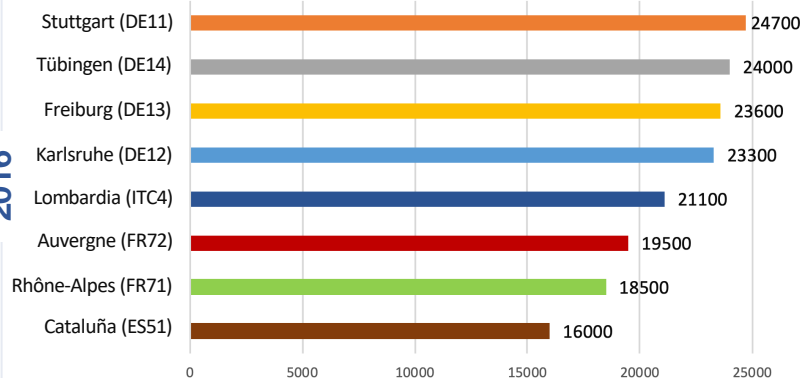
# ENVIRONMENTAL CONTEXT

## INCOME OF HOUSEHOLDS (EURO PER INHABITANT)

2006

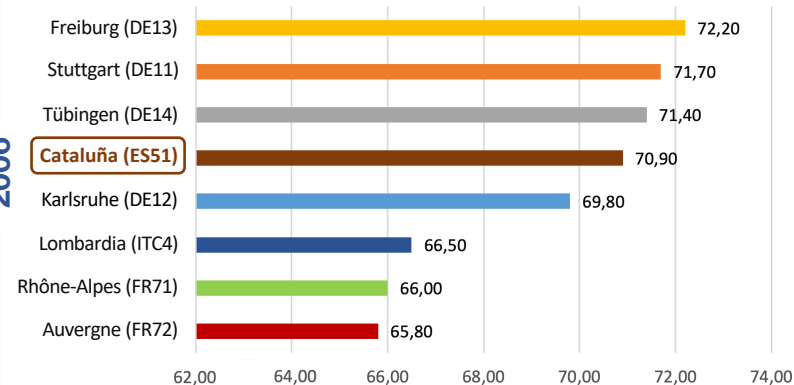


2016

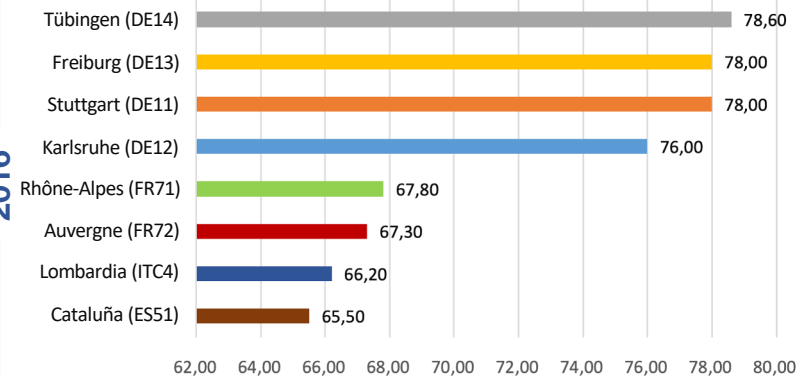


## EMPLOYMENT RATES (PERCENTAGE)

2006

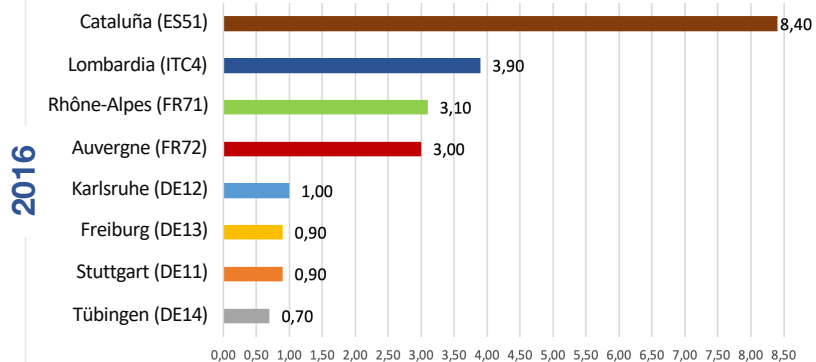
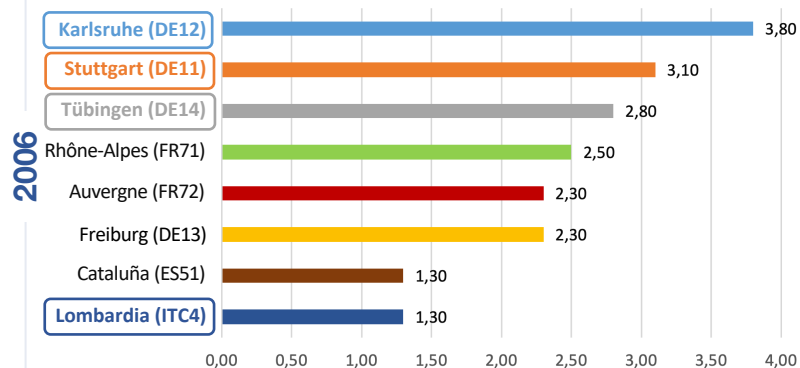


2016

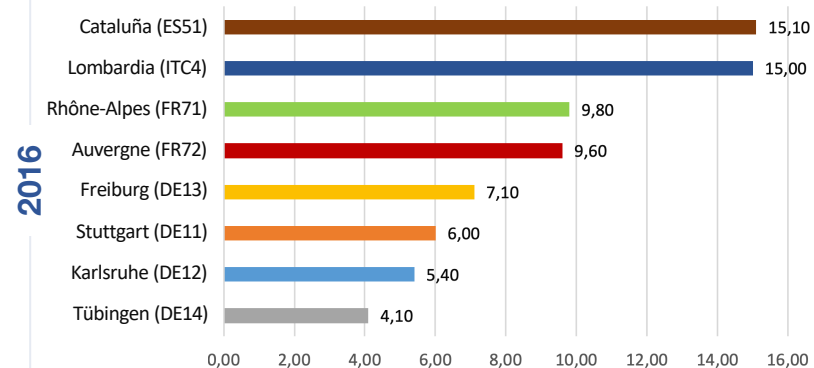
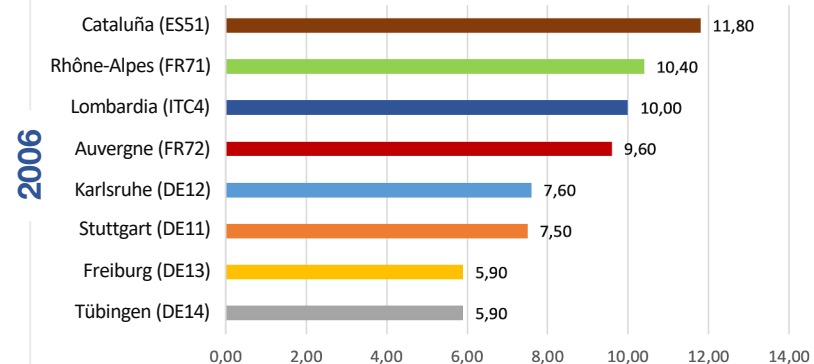


# ENVIRONMENTAL CONTEXT

## L.T. UNEMPLOYMENT (PERCENTAGE)



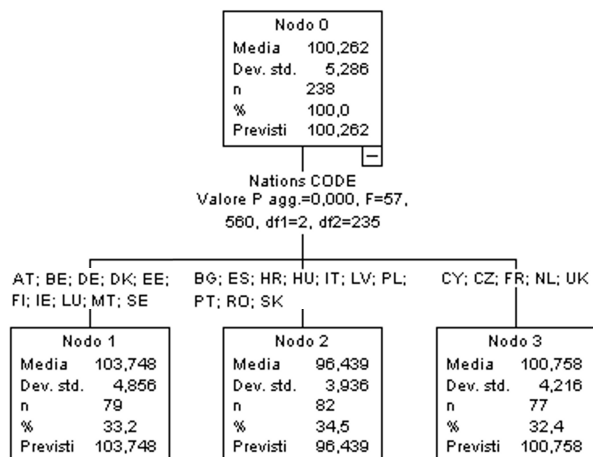
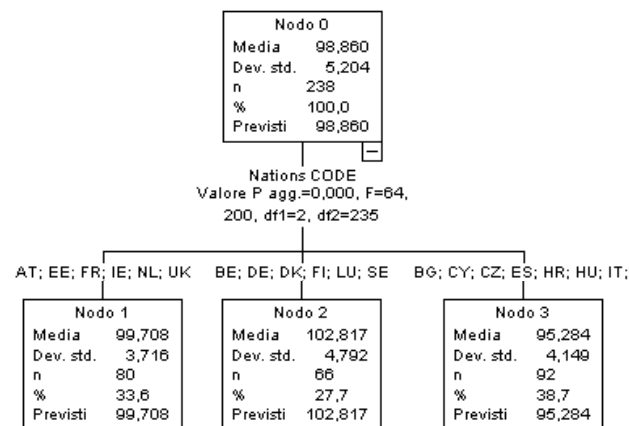
## NEET (PERCENTAGE)





# REGRESSION TREES

## HT COMPOSITE INDEX (AMPI)



## LEVEL AND NODE RELATED TO A VARIABLE

Variables	2007	2008	2009	2010	2011	2012	2013	2014	2015
Regions code									
Regions Name									
Nations code	F		F	S **					F
Nations name									
Classes of pop density									
Income of households		F		F	F	F	F	F	
Empl: total	S ***								
Empl: male									
Empl: female									
Long term unempl.									
NEET: total									
NEET: male									
NEET: female									
Total N° of nodes	5	3	3	4	3	3	3	3	3
N° terminal nodes	2	3	3	2	3	3	3	3	3

Notes: **F** or **S** whether the regression tree level is the first or the second.

**\*\*** or **\*\*\*** the node number where there is an additional split in the tree.

# SPATIAL AUTOCORRELATION INDICES

***Spatial autocorrelation*** is “the influence of territorial contiguity”

Source: **Mazziotta and Mazziotta (2009)**

**MORAN INDEX AND GEARY INDEX OF HIGH TECH COMPOSITE INDEX (AMPI)**

<i>Index</i>	<b>2006</b>	2007	2008	<b>2009</b>	2010	2011	2012	2013	2014	2015	<b>2016</b>
Moran's I	<b>0.687</b>	0.671	0.684	<b>0.687</b>	0.673	0.662	0.645	0.676	0.655	0.666	<b>0.687</b>
Geary's C	0.425	0.444	0.451	0.454	0.465	0.471	0.484	0.468	0.478	0.474	0.467

The **highest spatial autocorrelation** is recorded in **2006, 2009 and 2016**  
according to the **Moran Index**

# SPATIAL AUTOCORRELATION INDICES

## MORAN INDEX AND GEARY INDEX OF “ENVIRONMENTAL FACTORS”

<i>Variables</i>	<i>Index</i>	<i>2006</i>	<i>2016</i>
Income of household	Moran's I	0.638	<b>0.723</b>
	Geary's C	0.205	0.173
Employment: total population	Moran's I	0.671	0.644
	Geary's C	0.190	0.186
Employment: male	Moran's I	0.638	0.680
	Geary's C	0.247	0.231
Employment: female	Moran's I	0.687	0.620
	Geary's C	0.145	0.161
Long term unemployment	Moran's I	<b>0.654</b>	0.532
	Geary's C	0.306	0.150
NEET: total population	Moran's I	0.527	0.577
	Geary's C	0.247	0.202
NEET: male	Moran's I	0.435	0.503
	Geary's C	0.366	0.276
NEET: female	Moran's I	0.494	0.516
	Geary's C	0.303	0.265

*The **highest spatial autocorrelation** is recorded in **2016**  
according to the **Moran Index** in function of **Income of household***

# CONCLUSIONS

## Composite indicators literature

### Composite indicators

- **Dimensional reduction** methods

### Pros

Simplicity of:

- comparison
- interpretation
- use

### Cons

Many mistakes if:

- **Not** in-depth knowledge
- **Insufficient/inadequate** elementary indicators
- Data **not** of good quality and irrelevant quantities

## High tech phenomenon

### High tech

- Indicator of **economic development**
- Interaction of socio-economic
- Improve quality life

### High tech and digitalization

- Erroneously used as synonyms
- **Close** relationship

### High tech determinants

- Importance of **external** context

## High tech composite indicator results

### Best technique

- *Adjusted Mazziotta-Pareto Index*

### “High tech” Regions

- *North European Regions*
- *North Italian Regions*
- *German Regions between the “motors of Europe”*

### Low “High tech” Regions

- *East European Regions*
- *South Italian Regions*
- *Auvergne (FR) and Cataluña (ES)*

### Statistical analysis

- *High tech is a function of **disposable household income***
- **Significant influence** between neighbouring areas

# SELECTION OF REFERENCES

## GENERAL DEFINITIONS

**OECD (2008).** *Handbook on Constructing Composite Indicators. Methodology and user guide.* Paris: OECD Publications.

**Saisana M. and Tarantola S. (2002).** State-of-the-art report on current methodologies and practices for composite indicator development, EUR 20408 EN, *European Commission-JRC*: Italy.

## METHODS

**Mazziotta, C., & Mazziotta M. (2009).** *Intensità dell'autocorrelazione spaziale in misure alternative della dotazione territoriale di capitale pubblico.*

**Mazziotta M., Pareto, A. (2019).** *Metodi per la costruzione di indici sintetici: teoria e pratica (ISTAT).*

**Tinto A. (2016).** *Il processo di costruzione degli indicatori compositi di Bes 2015 (ISTAT)*  
<https://www.istat.it/it/files/2016/03/06-Tinto-Pres.pdf>.

**THANKS FOR  
THE ATTENTION**



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