

# Are Smart Cities more resilient to economic crises?

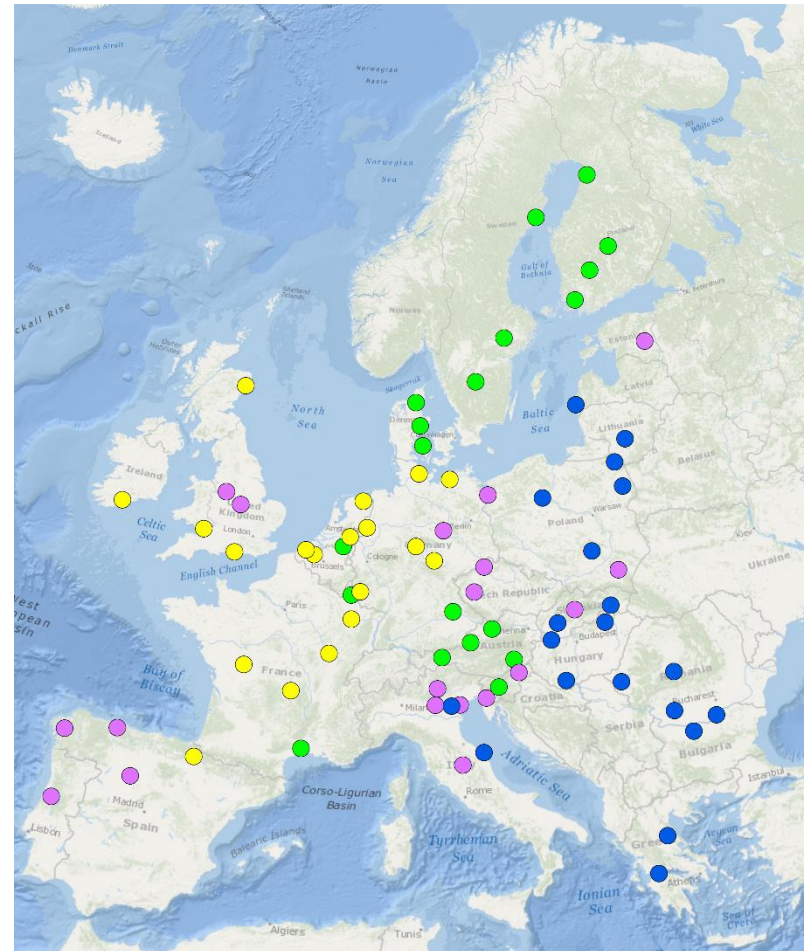
An empirical evidence of economic development in selected European medium-sized cities

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# The concept of „resilience“: Origin and meaning of the term

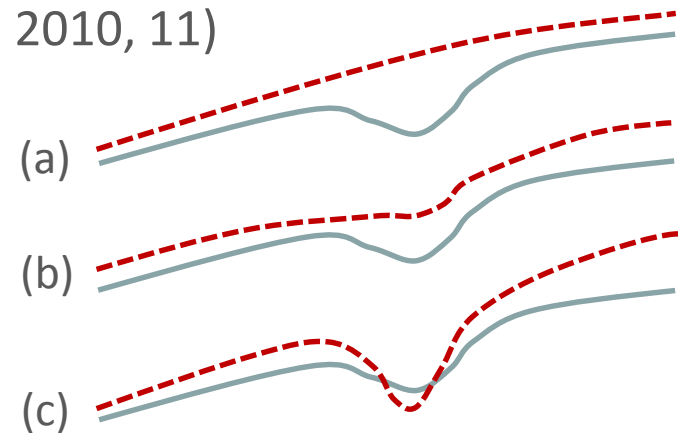
- ❑ **“resilire” (lat.):** to leap or spring back, to rebound, to recoil
- ❑ **implemented in many sciences:** engineering, ecology, social sciences,...
- ❑ **social sciences:** partly overlapping the concept of „sustainability“, but more specific (Jakubowski 2013, 372)
- ❑ **general definitions**
  - “ability (of a system) to cope with change” (Wikipedia)
  - “[...] persistence of systems and of their ability to absorb change and disturbance” (Holling 1973, 14)
  - resistance against
    - “external shocks” (Davoudi 2012, 300)
    - in particular “external risks” (“beyond human influence or control”), in contrast to “preventable risks” or “strategy risks” (Kaplan and Mikes 2012)
    - the unexpected, perturbations and structural breaks (Vogt 2015, 15)

# The concept of „resilience“: different approaches

- ❑ **approaches of resilience** (Davoudi 2012, 300f)
  - **engineering resilience:** “ability of a system to return to an equilibrium or steady-state after a disturbance” (objective: speed of return to equilibrium, fail-safe system)
  - **ecological resilience:** “magnitude of the disturbance that can be absorbed before the system changes its structure” (objective: remain within critical thresholds)
  - **evolutionary resilience:** “ability of complex socio-ecological systems to change, adapt, and, crucially, transform” (objective: transformation, flexibility)
- ❑ **dimensions of resilience** (Holling 1973, Walker et al. 2004, Folke et al. 2010, Keck and Sakdapolrak 2013)
  - **persistability** (“ability to absorb [...] disturbance”) → “coping capacities” (re-active)
  - **adaptability** (“capacity [...] to re-organize while undergoing change”) → “adaptive capacities” (pro-active)
  - **transformability** (“capacity [...] to create new system pathways”) → “transformative capacities” (pro-active, radical changes)

# The concept of „resilience“: determinants

- ❑ **determinants (“characteristics”) of resilience** (World Economic Forum 2013, 38f)
  - **robustness:** “ability to absorb and withstand disturbances and crises”: reliability of protective mechanisms
  - **redundancy:** “excess capacity and back-up systems, which enable the maintenance of core functionality in the event of disturbances”: hidden reserves (Vogt 2015: contrast to “efficiency”: most effective use of available resources), diversity of solutions
  - **resourcefulness:** “ability to adapt to crises, respond flexibly and [...] transform a negative impact into a positive”: creativity, adaptability, flexibility, innovation
  
- ❑ **temporal dimension of reaction** (Lukesch et al. 2010, 11)
  - **shock-resistance**
    - no reaction on external shocks (a)
  - **economic resilience**
    - buffering of external shocks (b)
    - fast recovery from external shocks (c)

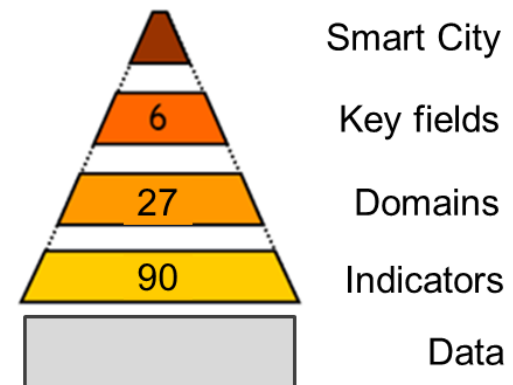


# The concept of „European Smart Cities“: idea and method

- ❑ **idea of „European Smart Cities“** (Giffinger et al. 2007, <http://www.smart-cities.eu/>)
  - first project in year 2007 led by TUWIEN team, three follow-up projects (co-funded by cities, industrial partners and European Union) until now
  - integrative approach to **profile and benchmark European medium-sized cities**
  - instrument for **effective learning processes** in specific fields of urban development
  - **broader understanding:** „A Smart City is a city well performing in these 6 key fields, built on the ‘smart’ combination of endowments and activities of self-decisive, independent and aware citizens.“

- ❑ **method of evaluation**

- hierarchical approach
- aggregation of 90 standardised indicator values
- different public data sources



# The concept of „European Smart Cities“: key fields and domains

Smart Economy	
Eco_1	Innovative spirit
Eco_2	Entrepreneurship
Eco_3	City image
Eco_4	Productivity
Eco_5	Labour market
Eco_6	International integration

Smart People	
Peo_1	Education
Peo_2	Lifelong learning
Peo_3	Ethnic plurality
Peo_4	Open-mindedness

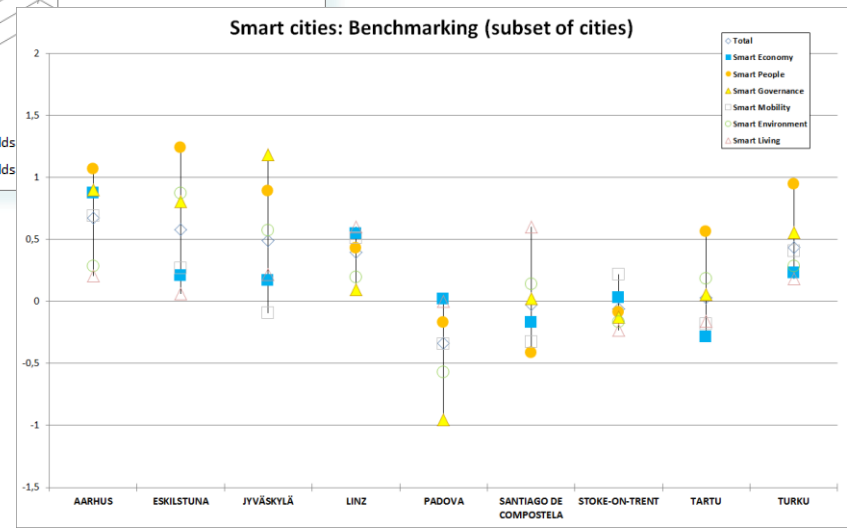
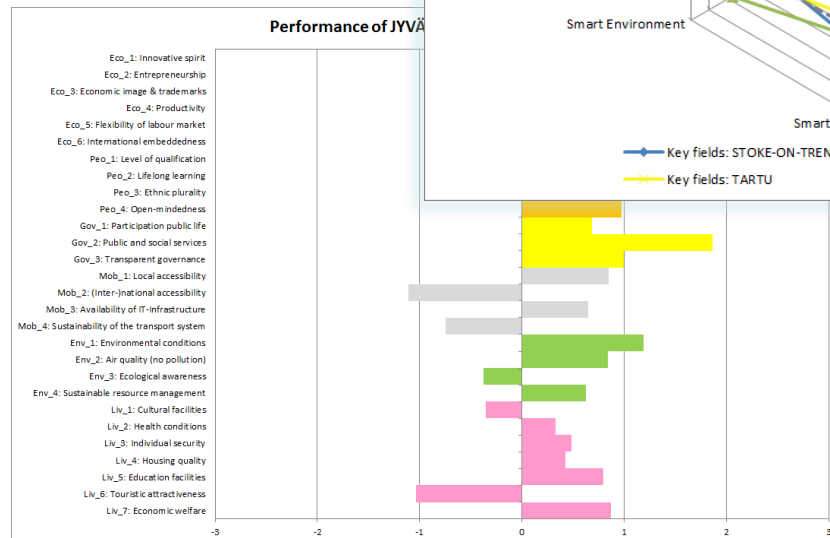
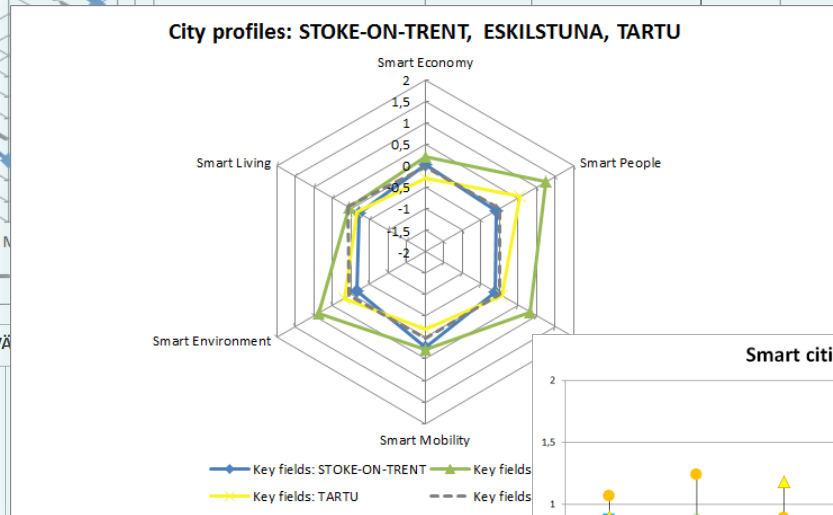
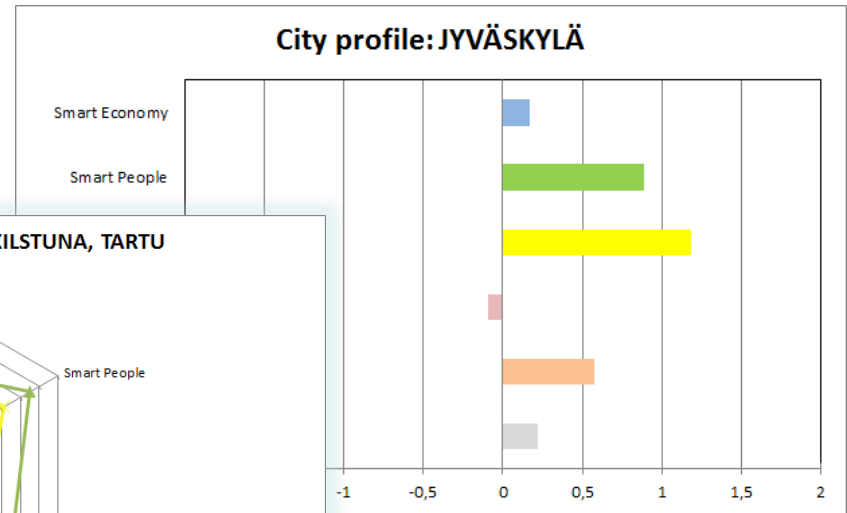
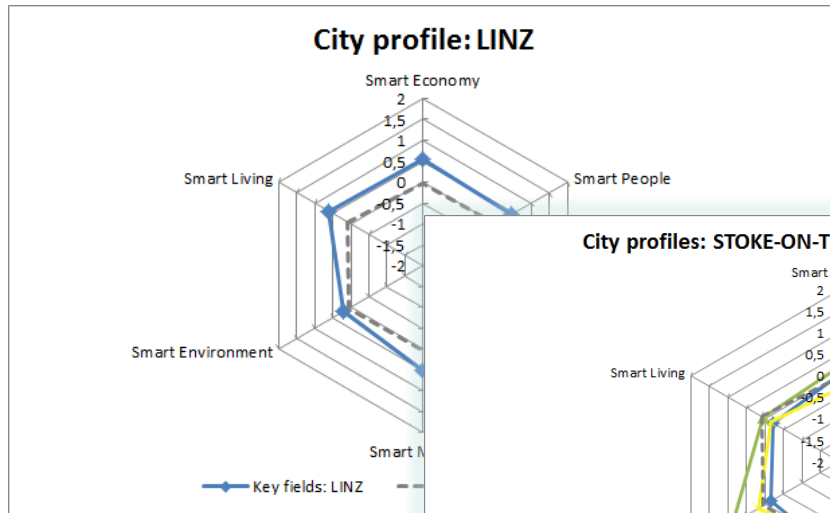
Smart Governance	
Gov_1	Political awareness
Gov_2	Public and social services
Gov_3	Efficient and transparent administration

Smart Mobility	
Mob_1	Local transport system
Mob_2	International accessibility
Mob_3	ICT-Infrastructure
Mob_4	Sustainable transport system

Smart Environment	
Env_1	Air quality
Env_2	Ecological awareness
Env_3	Sustainable resource management

Smart Living	
Liv_1	Cultural and leisure facilities
Liv_2	Health conditions
Liv_3	Individual security
Liv_4	Housing quality
Liv_5	Education facilities
Liv_6	Touristic attractiveness
Liv_7	Social cohesion

# The concept of „European Smart Cities“: selected results





# The concept of „European Smart Cities“: Connections to „resilience“

- ❑ **5 subsystems of resilience** (World Economic Forum 2013, 37)
  - economic subsystem (markets for goods and services, financial and labour market)
  - environmental subsystem (natural resources, ecological system)
  - governance subsystem (institutions, government, policies, law)
  - infrastructure subsystem (communication, transport, energy and health infrastructure)
  - social subsystem (human capital, community)

→ similar to 6 “key fields” of the “European Smart Cities” approach
- ❑ **importance of governance-based development processes both in resilience concepts** (Jakubowski 2013, 376) **and in Smart City approach** (Giffinger et al., PLEEC project, 2014)

→ strengthening of a city’s adaptability and transformability
- ❑ **Claim of evidence-based assessment of cities’ conditions in the context of resilience** (Jakubowski 2013, 377)

→ SC-indicators as determinants of resilience?

# Empirical evidence: The global economic crisis since 2008

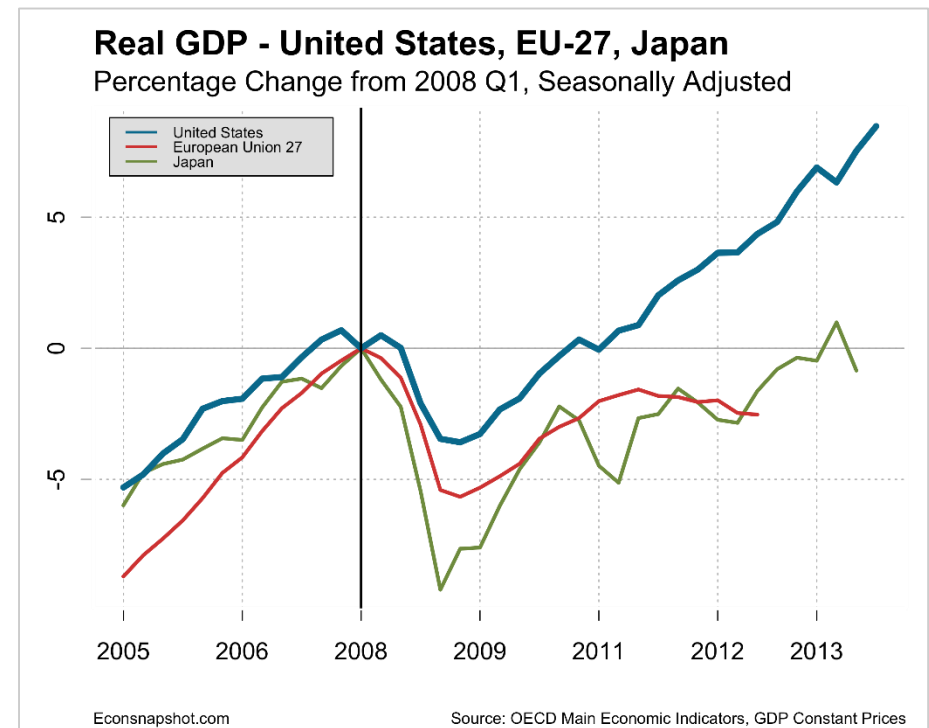
## the Great Recession: ongoing global economic crisis since 2008

process of “circular cumulative causation” (Myrdal 1957)

starting point: US subprime mortgage crisis (real-estate bubbles) in 2007

- global Banking and Financial Crisis
- European debt crisis in 2009
- spill over to the real economy
- global recession
- economic recovery in Europe decelerated after 2012

Evidence: Development of Real GDP in the US, EU27 and Japan 2005 - 2013

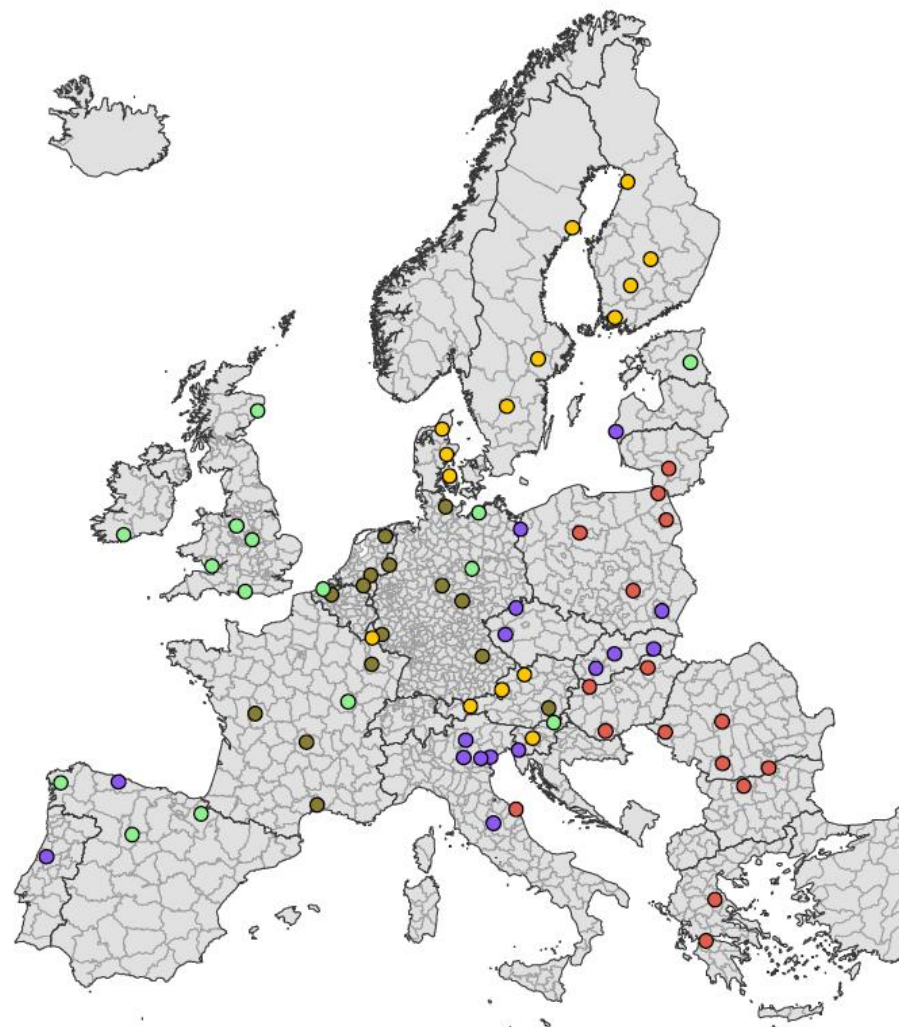


# Empirical evidence: Regional economic development 2005 - 2013

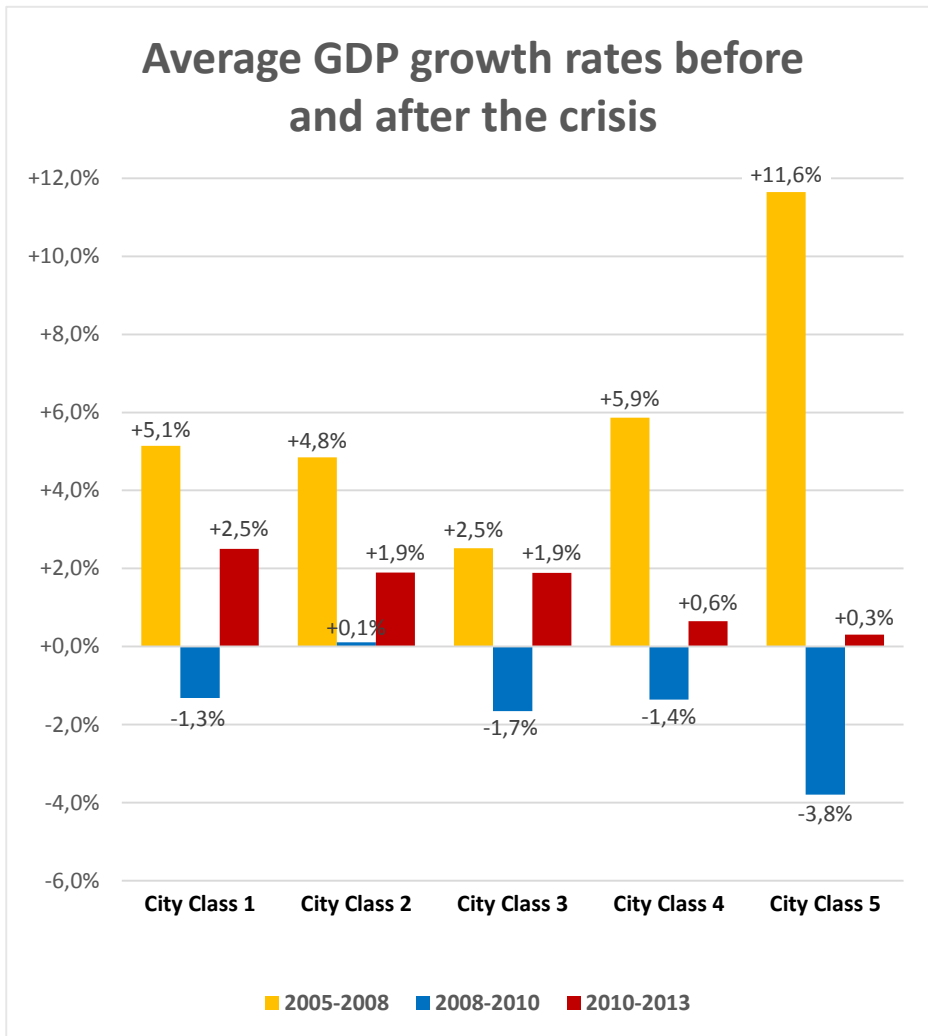
- ❑ **spatial level:** surrounding NUTS3-regions of cities included in the „European Smart Cities“-ranking (cities as development engines of the region)
- ❑ **indicators:** average yearly growth rates before (2005 - 2008) and after 2008 (2008 - 2013)
  - Gross Domestic Product (GDP) per capita at current market prices
  - employment (employed persons)
- ❑ **main questions:**
  - Are **smart cities more resilient** against the economic crisis? (→ average GDP and employment growth rates in „smart“ and „unsmart“ (5 groups) of cities)
  - Which **elements of smartness** make cities more resilient against the economic crisis? (→ correlation between different dimensions of smartness and the fall of growth rates)
  - Does a **balanced profile** of smart characteristics foster the economic resilience of cities? (→ correlation between the variance of smart characteristics and the fall of growth rates)

# Empirical evidence: Ranking of 77 European Smart Cities

<b>Austria (4)</b>	<b>Estonia (1)</b>	<b>Ireland (7)</b>	<b>Portugal (1)</b>
GRAZ	TARTU	CORK	COIMBRA
INNSBRUCK	<b>Spain (4)</b>	<b>Italy (7)</b>	<b>Romania (3)</b>
LINZ	OVIEDO	ANCONA	CRAIOVA
SALZBURG	PAMPLONA	PADOVA	SIBIU
<b>Belgium (2)</b>	VALLADOLID	PERUGIA	TIMISOARA
BRUGGE	SANTIAGO DE C.	TRENTO	<b>Sweden (3)</b>
GENT	<b>Finland (4)</b>	TRIESTE	JOENKOEPING
<b>Bulgaria (2)</b>	OULU	VENEZIA	UMEAA
PLEVEN	TAMPERE	VERONA	ESKILSTUNA
RUSE	TURKU	<b>Lithuania (1)</b>	<b>Slovenia (2)</b>
<b>Czech Rep. (2)</b>	JYVÄSKYLÄ	KAUNAS	LIUBLJANA
PLZEN	<b>France (5)</b>	<b>Luxemburg (1)</b>	MARIBOR
USTI NAD LABEM	CLERMONT-FER.	LUXEMBOURG	<b>Slovakia (3)</b>
<b>Germany (7)</b>	DIJON	<b>Latvia (1)</b>	BANSKA BYSTRICA
ERFURT	MONTPELLIER	LIEPAJA	KOSICE
GOETTINGEN	NANCY	<b>Netherlands (4)</b>	NITRA
MAGDEBURG	POITIERS	EINDHOVEN	<b>UK (5)</b>
REGENSBURG	<b>Greece (2)</b>	ENSCHEDÉ	ABERDEEN
TRIER	LARISA	GRONINGEN	CARDIFF
ROSTOCK	PATRAI	NIJMEGEN	LEICESTER
KIEL	<b>Hungary (3)</b>	<b>Poland (6)</b>	PORTSMOUTH
<b>Denmark (3)</b>	GYOR	KIELCE	STOKE-ON-TRENT
AALBORG	MISKOLC	SUWALKI	
ODENSE	PECS	SZCZECIN	
AARHUS		BIALYSTOK	
		RZESZOW	
		BYDGOSZCZ	

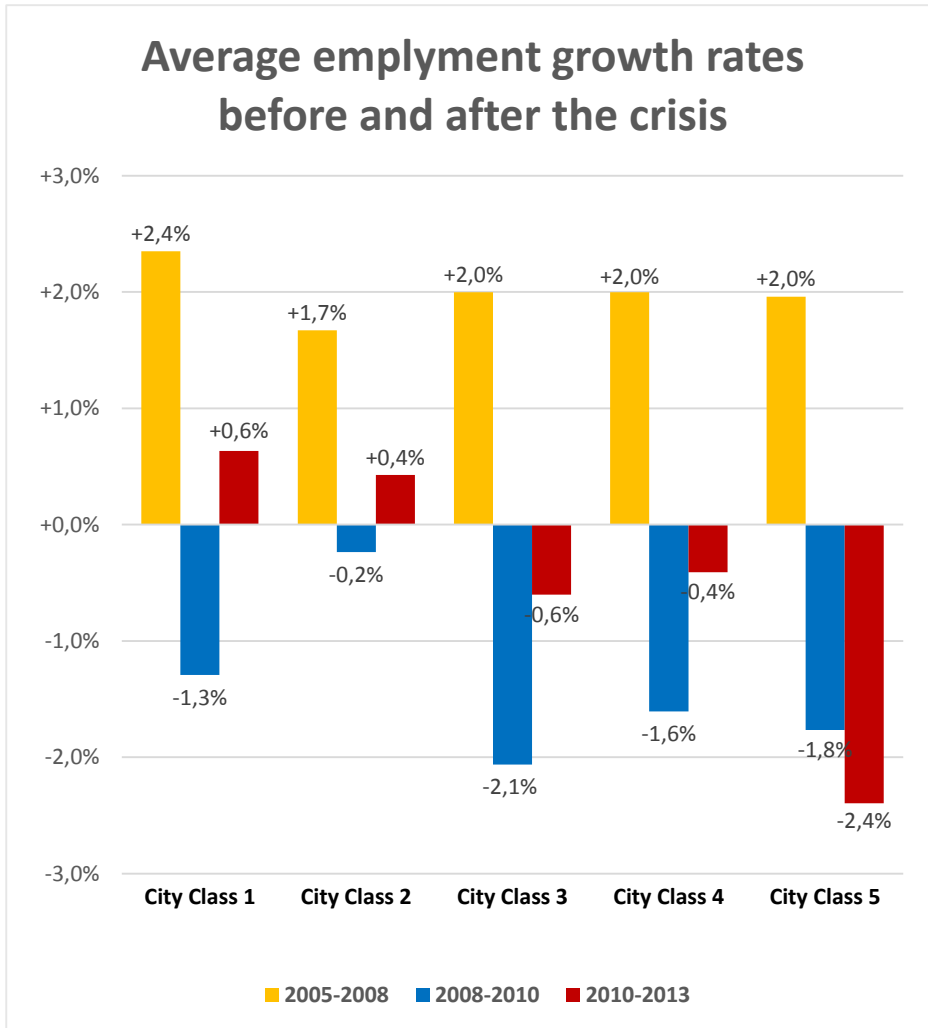


# Empirical evidence: smartness and GDP growth



- all groups of city regions are strongly affected by the crisis (slump from positive GDP growth rates before 2008 to economic recession after)
- smartest city regions (city class 1 and 2) are able to **bounce back** and **recover** pretty soon (clearly positive GDP growth rates)
- regions of **least smart cities** (city class 5) are **most heavily struck** by the crisis and **do not recover** in the following years (same for city class 4 in a softer form)

# Empirical evidence: smartness and employment growth



- employment growth rates (approximately at the same level in all groups of city regions before 2008) **totally collapsed in the first phase of the crisis** (clear reduction of employment in all groups)
- ability to **bounce back** and to achieve a **turnaround** after 2010 is significantly higher in the **regions with smart core cities** (city groups 1 and 2)
- city regions with the **lowest scores of smartness** (city group 5) continue (or even intensify) their downward trend with **increasing employment losses** after 2010

# Empirical evidence: “smart” determinants of resilience (I)

	Correlation between smartness and the slump of growth rates before / after 2008	
	GDP per capita	Employment
Smartness (in total)	-0,636**	-0,415**
Smart Economy	-0,601**	-0,343**
Smart Environment	-0,445**	-0,158
Smart Governance	-0,387**	-0,249*
Smart Living	-0,550**	-0,399**
Smart Mobility	-0,552**	-0,501**
Smart People	-0,527**	-0,327**

Slump of average annual growth rates between the period 2005 - 2008 and 2008 - 2013

\*\*Correlation is significant at the 0.01 level (2-tailed).

\* Correlation is significant at the 0.05 level (2-tailed).

**method of analysis:** correlation coefficients between a city’s scores of smartness and the slump of GDP and employment growth rates in its surrounding region before (2005 - 2008) and after (2008 - 2013) the beginning of the crisis

- ❑ correlation analysis confirms the results of the city groups: the **higher a city’s level of smartness, the lower the slump of GDP and employment growth rates** before and after the year 2008
- ❑ all 6 key fields of smartness are significantly correlated (at the 0.01 level) with the slump of GDP growth rates, 4 of them also with the fall of employment growth rates: **“smart economy”, “smart living”, “smart mobility” and “smart people”** seem to strengthen a city’s **resilience against the global crisis**, which is also partly true for **“smart governance” and “smart environment”**

# Empirical evidence: “smart” determinants of resilience (II)

	Correlation between smartness and the slump of growth rates before / after 2008	
	GDP per capita	Employment
<b>Smart Economy</b>		
Innovative spirit	-0,591**	-0,397**
Entrepreneurship	-0,325**	+0,044
Economic image	-0,138	-0,151
Productivity	-0,523**	-0,374**
Flexibility of labour market	-0,399**	-0,242*
International embeddedness	-0,205	-0,050
<b>Smart Environment</b>		
Environmental conditions	+0,129	0,235*
Air quality	-0,037	-0,061
Ecological awareness	-0,381**	-0,141
Sustainable resource management	-0,719**	-0,489**
<b>Smart Governance</b>		
Participation public life	-0,147	-0,214
Public and social services	-0,240*	-0,091

Slump of average annual growth rates between the period 2005 - 2008 and 2008 - 2013

\*\*Correlation is significant at the 0.01 level (2-tailed).

\* Correlation is significant at the 0.05 level (2-tailed).

	Correlation between smartness and the slump of growth rates before / after 2008	
	GDP per capita	Employment
<b>Smart Living</b>		
Cultural facilities	-0,190	-0,256*
Health conditions	-0,542**	-0,400**
Individual security	0,503**	0,398**
Housing quality	-0,612**	-0,201
Education facilities	-0,263*	-0,307**
Touristic attractiveness	-0,404**	-0,369**
Economic welfare	-0,449**	-0,376**
<b>Smart Mobility</b>		
Local accessibility	-0,264*	-0,093
International accessibility	-0,532**	-0,571**
Availability of IT Infrastructure	-0,378**	-0,330**
Sustainability transport system	+0,023	-0,027
<b>Smart People</b>		
Level of qualification	-0,538**	-0,346**
Lifelong learning	-0,318**	-0,198
Ethnic plurality	-0,491**	-0,341**
Open mindedness	-0,135	+0,011



# Empirical evidence: “smart” determinants of resilience (III)

- ❑ **Method of analysis:** Applying the correlation analysis to the more specific 27 “domains” of smartness shall indicate which elements of smartness make cities more resilient against the economic crisis
- ❑ The following **characteristics** (“smart domains”) of cities are significantly negatively correlated (at the 0.05 level) with the slump of GDP and employment growth rates
  - “innovative spirit, “productivity”, “flexibility of labour market” (economy)
  - “sustainable resource management” (environment)
  - “health conditions”, “education facilities”, “touristic attractiveness”, “economic welfare” (living)
  - “international accessibility”, “availability of IT infrastructure” (mobility)
  - “level of qualification”, “ethnic plurality” (people)
- ❑ The results indicate that both **“hard”** (e.g. economic competitiveness, infrastructure endowment, qualification) and **“soft”** (quality of living, plurality) **location factors** can be supposed to promote a city’s **resilience against the global economic crisis**

# Empirical evidence: diversity and resilience

**Hypothesis:** a balanced profile of smart characteristics (which stands for a city's diversity and for hidden resources) promotes a region's resilience against the crisis

Standard deviation of 27 domains of „smartness“	Correlation between smartness and the slump of growth rates before / after 2008	
	GDP per capita	Employment
Total sample (78 cities)	-0,067	-0,006
25 highest ranked cities	+0,187	+0,483*
25 lowest ranked cities	-0,121	+0,107

Slump of average annual growth rates between the period 2005 - 2008 and 2008 - 2013

\*\*Correlation is significant at the 0.01 level (2-tailed).

\* Correlation is significant at the 0.05 level (2-tailed).

- ❑ **Method of analysis:** correlation analysis between the standard deviation of the 27 domains of “smartness” and the slump of GDP and employment growth rates in its surrounding region before (2005 - 2008) and after (2008 - 2013) the beginning of the crisis
- ❑ No **empirical evidence** of a relation between a balanced profile of smart characteristics and the slump of economic growth rates before and after 2008 for the whole city sample
- ❑ In order to eliminate the size effect, the analysis was also executed for samples of highest and lowest ranked cities: **Slight** (but no significant) **indication** that **little deviations** within a city's profile might be related to a relatively **low level of economic slump in well-performing cities**

# Conclusions: Basic insights from literature

- ❑ useful **extension** and **specification** of the general approach of “**sustainability**”: well suited to describe the **ability of cities and regions to absorb external changes, disturbances and shocks** (e.g. economic crises, migration, climate change)
- ❑ problem of identifying **determinants of resilience**: external shocks hardly predictable → difficult to define determinants of a city’s or a region’s resistance against disturbances which cannot be foreseen → rather **vague and general** approaches in literature on influencing factors
  - **robustness**: reliability of protective mechanisms (only effective against predictable external disturbances)
  - **redundancy**: hidden reserves, diversity
  - **resourcefulness**: creativity, adaptability, flexibility, innovation
- ❑ **need of empirical evidence** to identify determinants of local / regional resilience

# Conclusions: Empirical evidence

- ❑ The **ability of region to resist** or, at least, to **buffer the economic crisis** seems to depend on the **level of smartness** of its core city.
- ❑ Additionally, the **smartest city regions** are more able to **bounce back** and to **recover** from the economic slump in the long run.
- ❑ **“Unsmart” city regions** are **most heavily struck by the crisis** with a rapid slump of GDP and employment growth rates and, additionally, are **less able to achieve a turnaround** from that downward trend in the following years.
- ❑ Both **“hard”** (e.g. economic competitiveness, infrastructure endowment, qualification) and **“soft”** (quality of living, plurality) **location factors** (as domains of smart city development) can be supposed to promote a city’s **resilience against the global economic crisis**.
- ❑ No clear **empirical evidence** of a relation between **balanced smart city profiles** and **resilience against the global economic crisis**.



# Thank you for your attention!

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