

Are Smart Cities more resilient to economic crises?

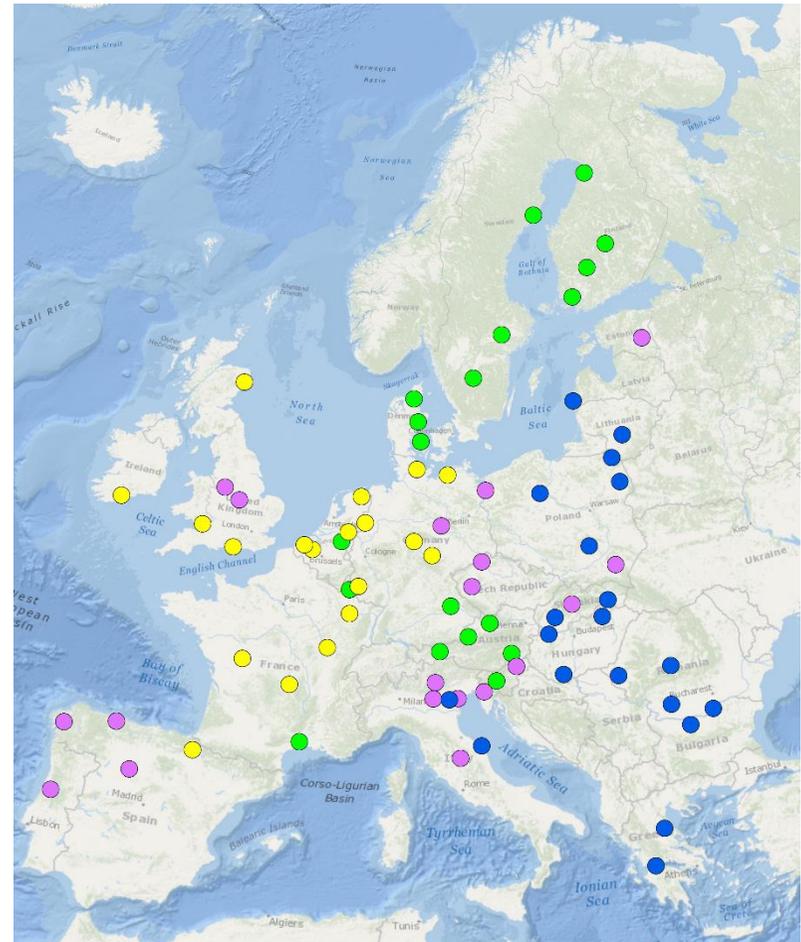
An empirical evidence of economic development in selected European medium-sized cities

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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

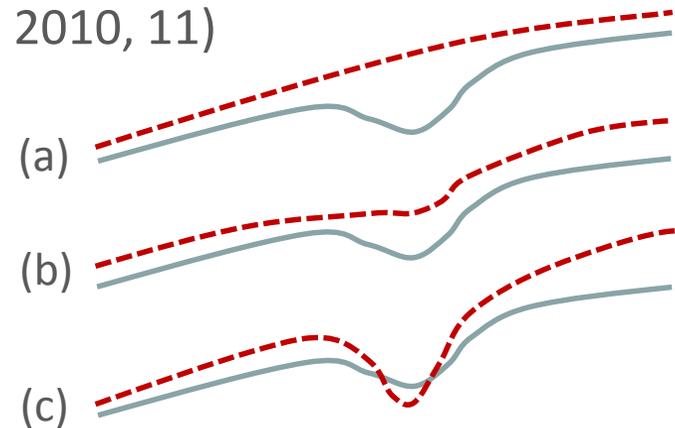
- ❑ **approaches of resilience** (Davoudi 2012, 300f)
 - **engineering resilience:** “ability of a system to return to an equilibrium or steady-state after a disturbance” (objective: speed of return to equilibrium, fail-safe system)
 - **ecological resilience:** “magnitude of the disturbance that can 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)

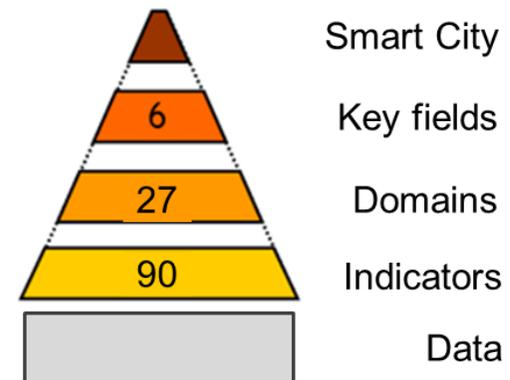


The concept of „European Smart Cities“: idea and method

- ❑ **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

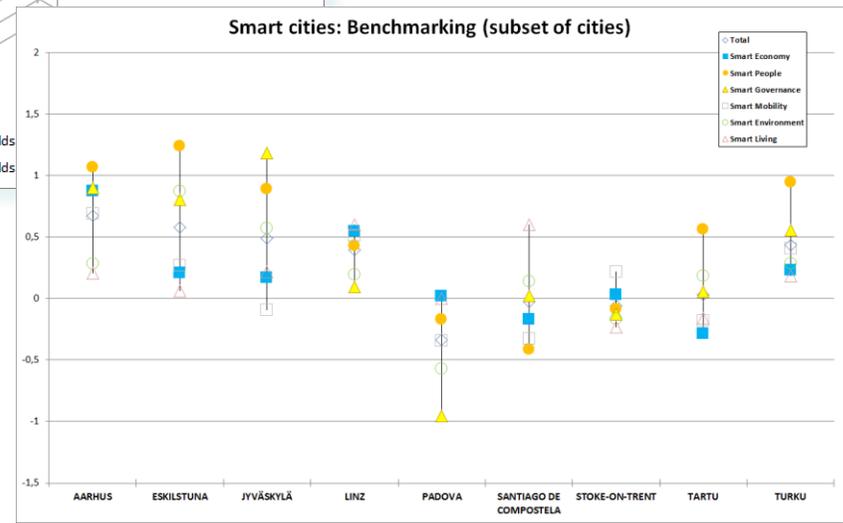
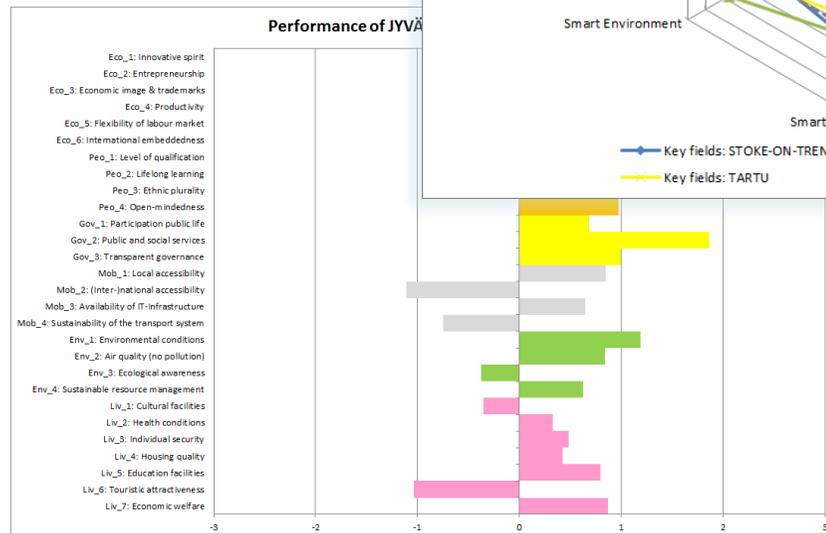
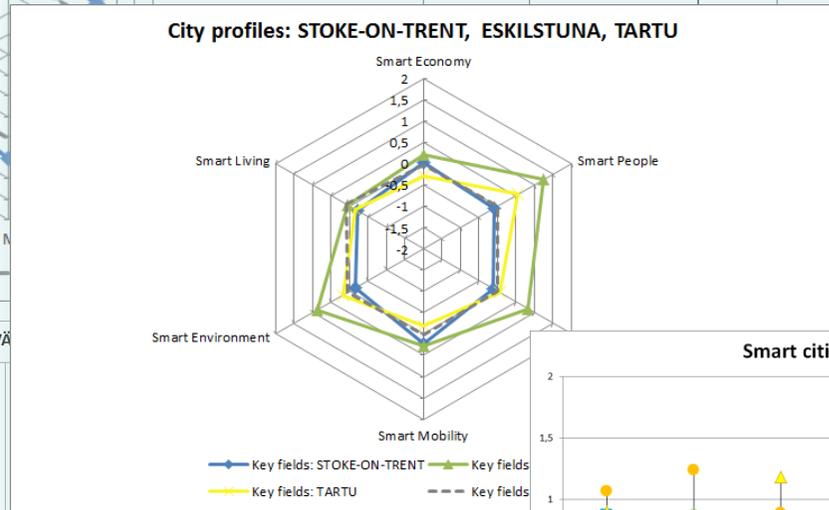
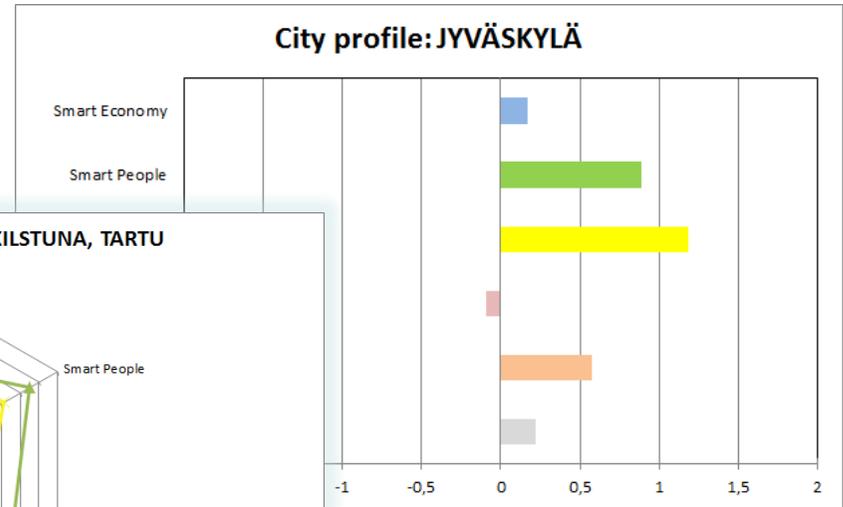
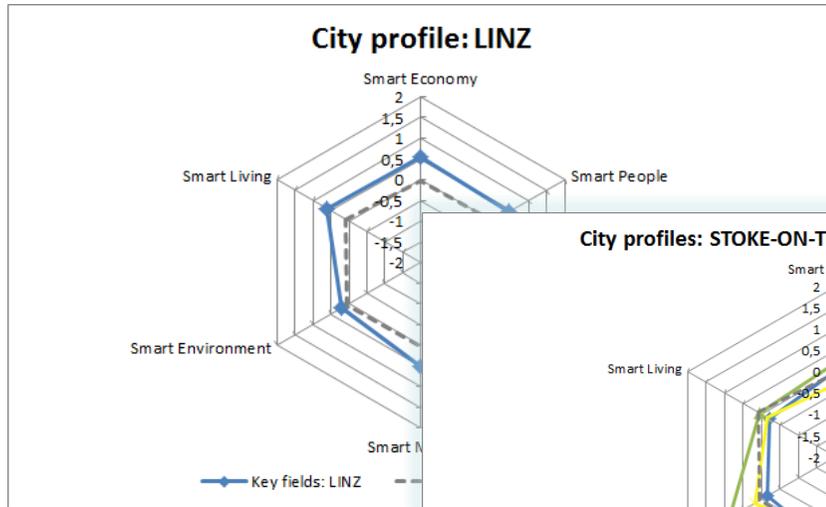
Smart Governance	
Gov_1	Political awareness
Gov_2	Public and social services
Gov_3	Efficient and transparent administration

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

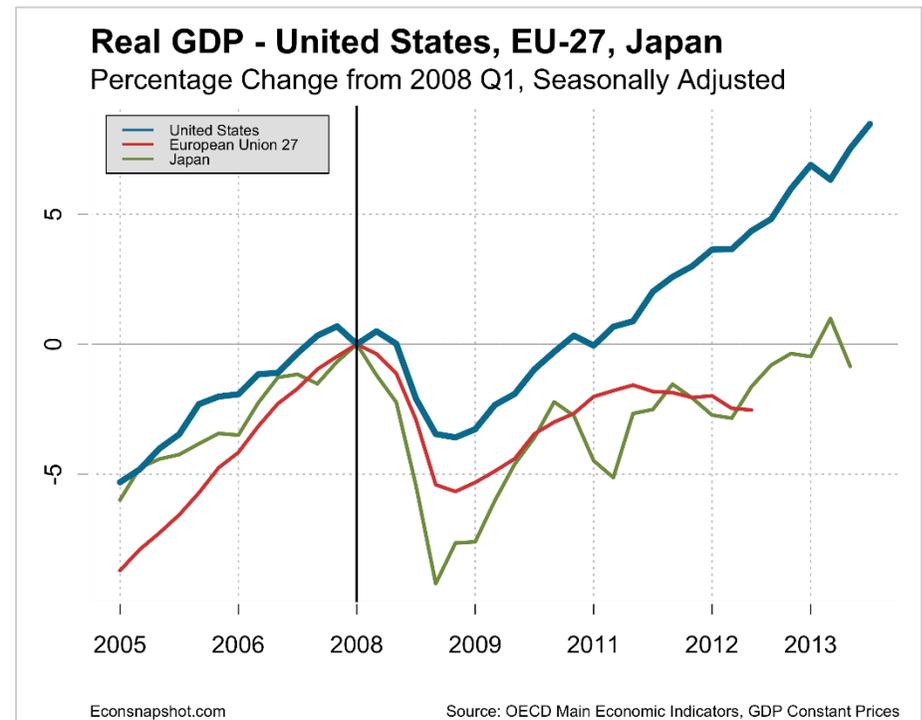
the Great Recession: ongoing global economic crisis since 2008

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

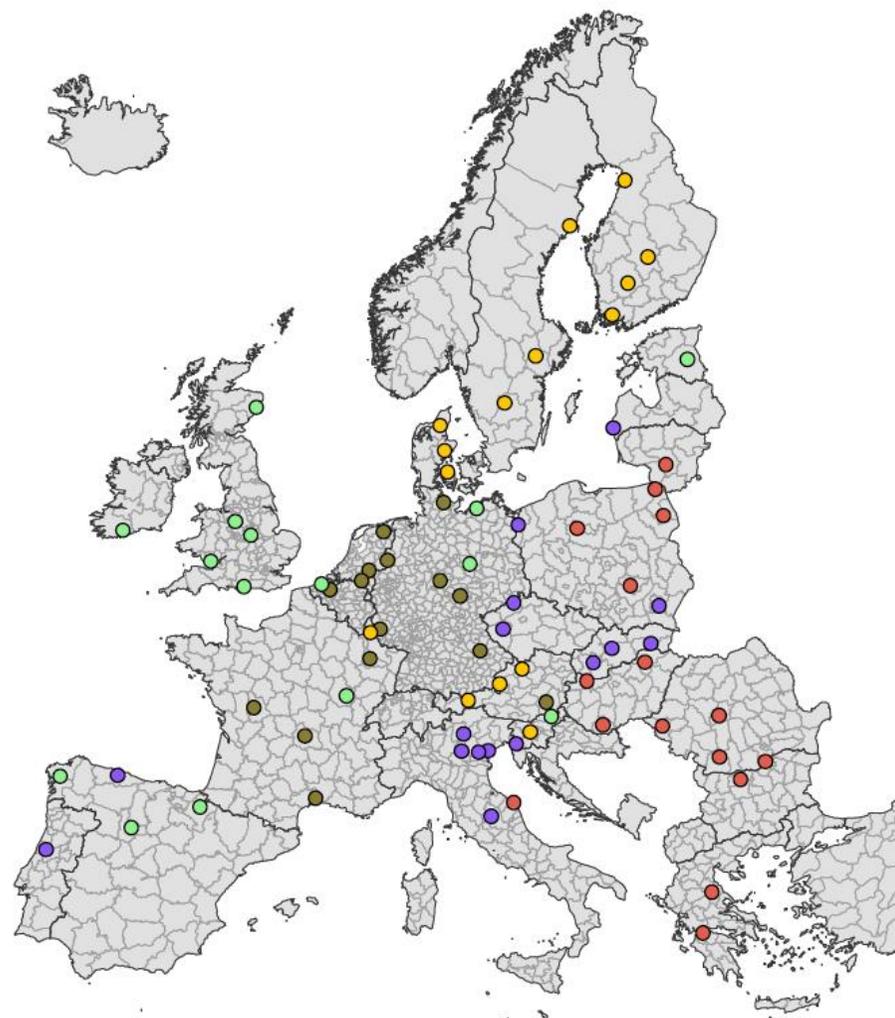


Empirical evidence: Regional economic development 2005 - 2013

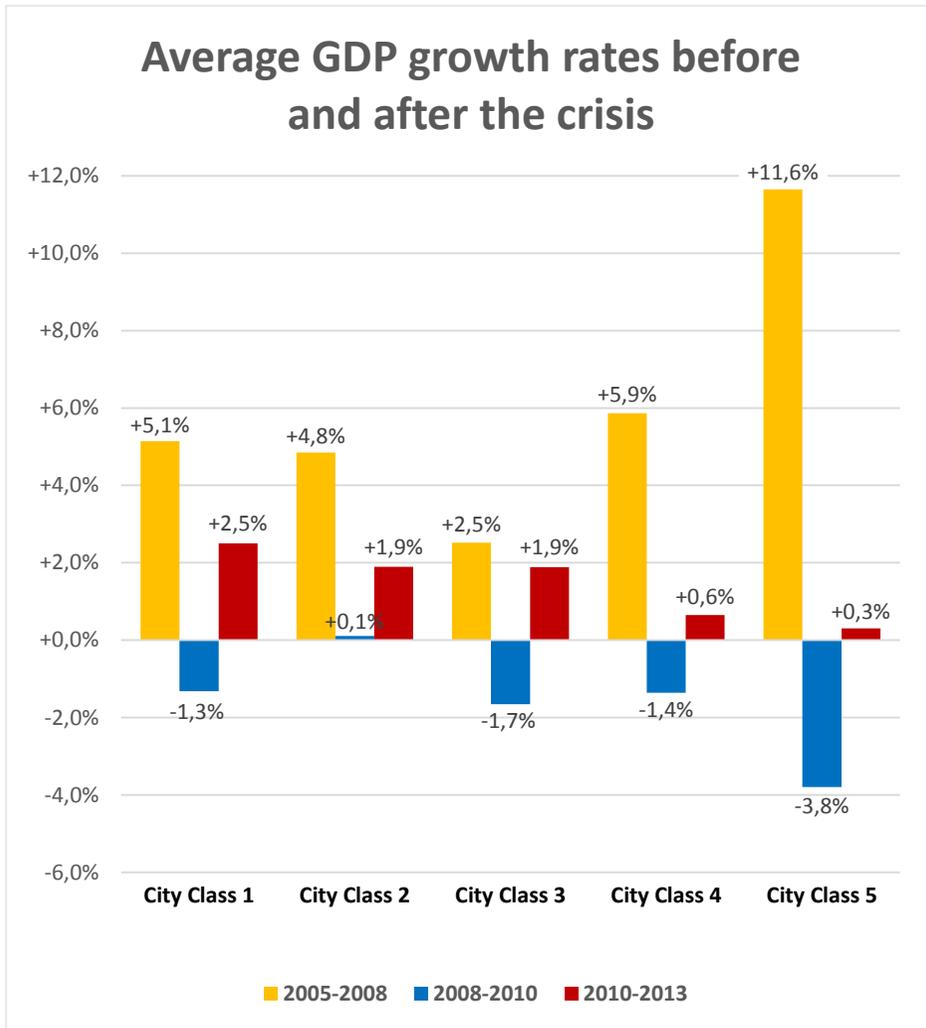
- ❑ **spatial level:** surrounding NUTS3-regions of cities included in the „European Smart Cities“-ranking (cities as development engines of the region)
- ❑ **indicators:** average yearly growth rates before (2005 - 2008) and after 2008 (2008 - 2013)
 - Gross Domestic Product (GDP) per capita at current 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

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

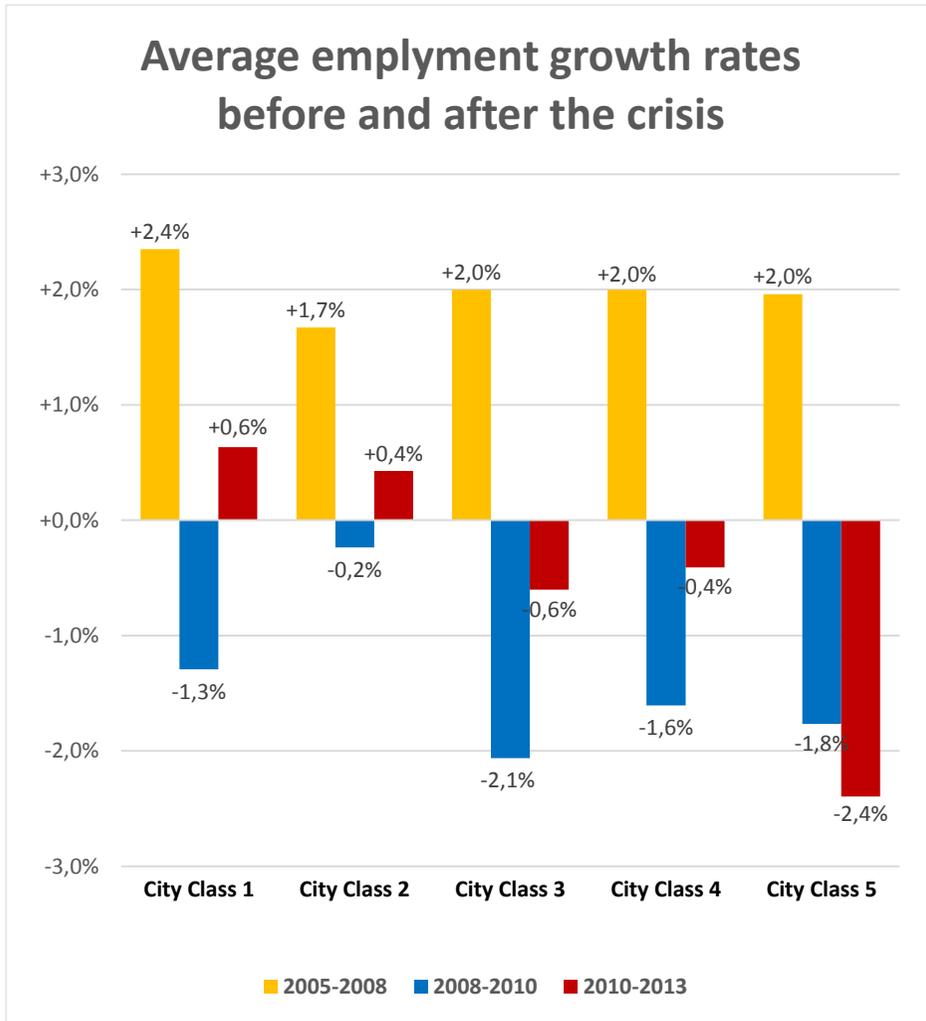


Empirical evidence: smartness and GDP growth



- 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
Smart Economy		
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
Smart Environment		
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**
Smart Governance		
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
Smart Living		
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**
Smart Mobility		
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
Smart People		
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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