POLITECNICO DI MILANO





The Economics of Smart city policies

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Setting the scene: some stylized facts (1)

- Burgeoning literature with a massive development over the last years.

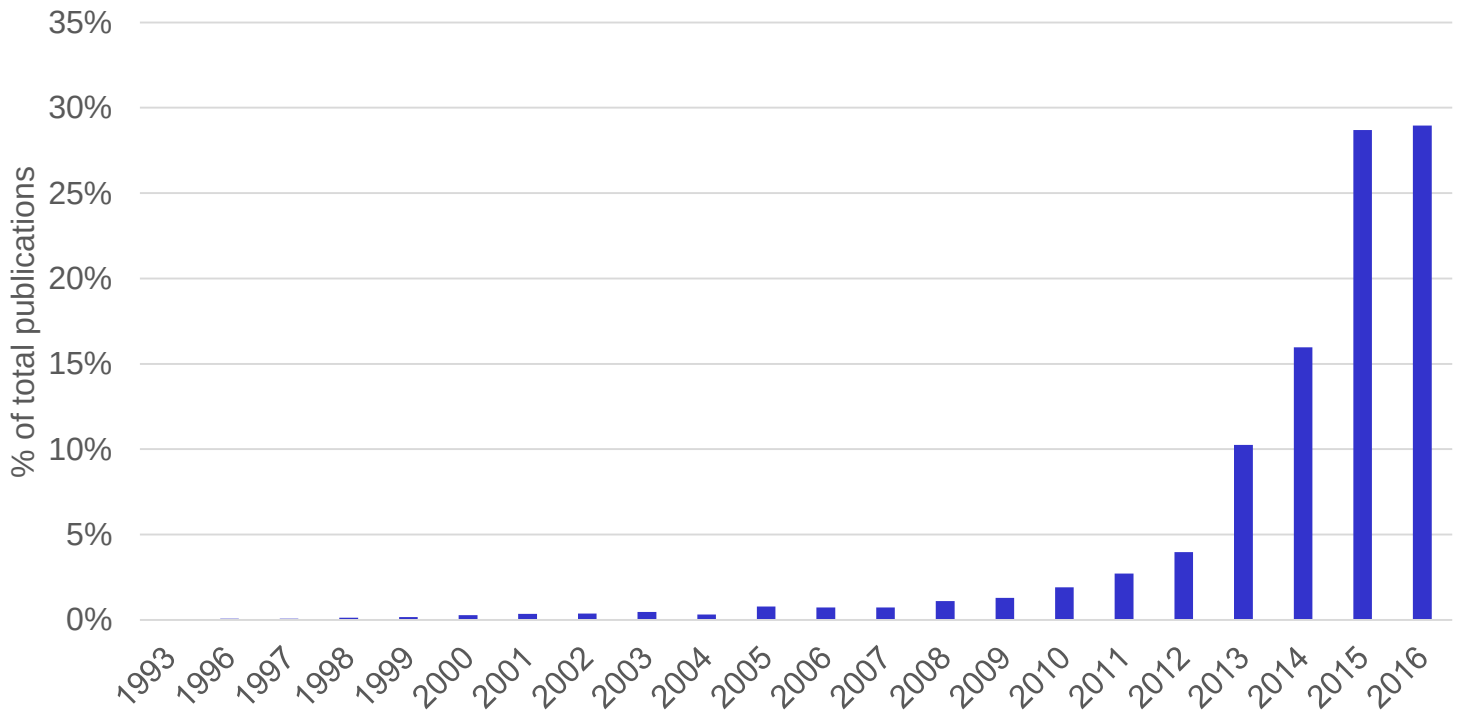
- Much heterogeneity in the type of scientific output:

Type of scientific output	Absolute numbers	%
PROCEEDINGS PAPER	1,867	55.73%
ARTICLE	1,210	36.12%
BOOK CHAPTER	107	3.19%
EDITORIAL MATERIAL	74	2.21%
REVIEW	57	1.70%
BOOK REVIEW	16	0.48%
BOOK	6	0.18%
NEWS ITEM	5	0.15%
LETTER	3	0.09%
MEETING ABSTRACT	2	0.06%
CORRECTION	2	0.06%
BIOGRAPHICAL ITEM	1	0.03%
Total	*3,350*	

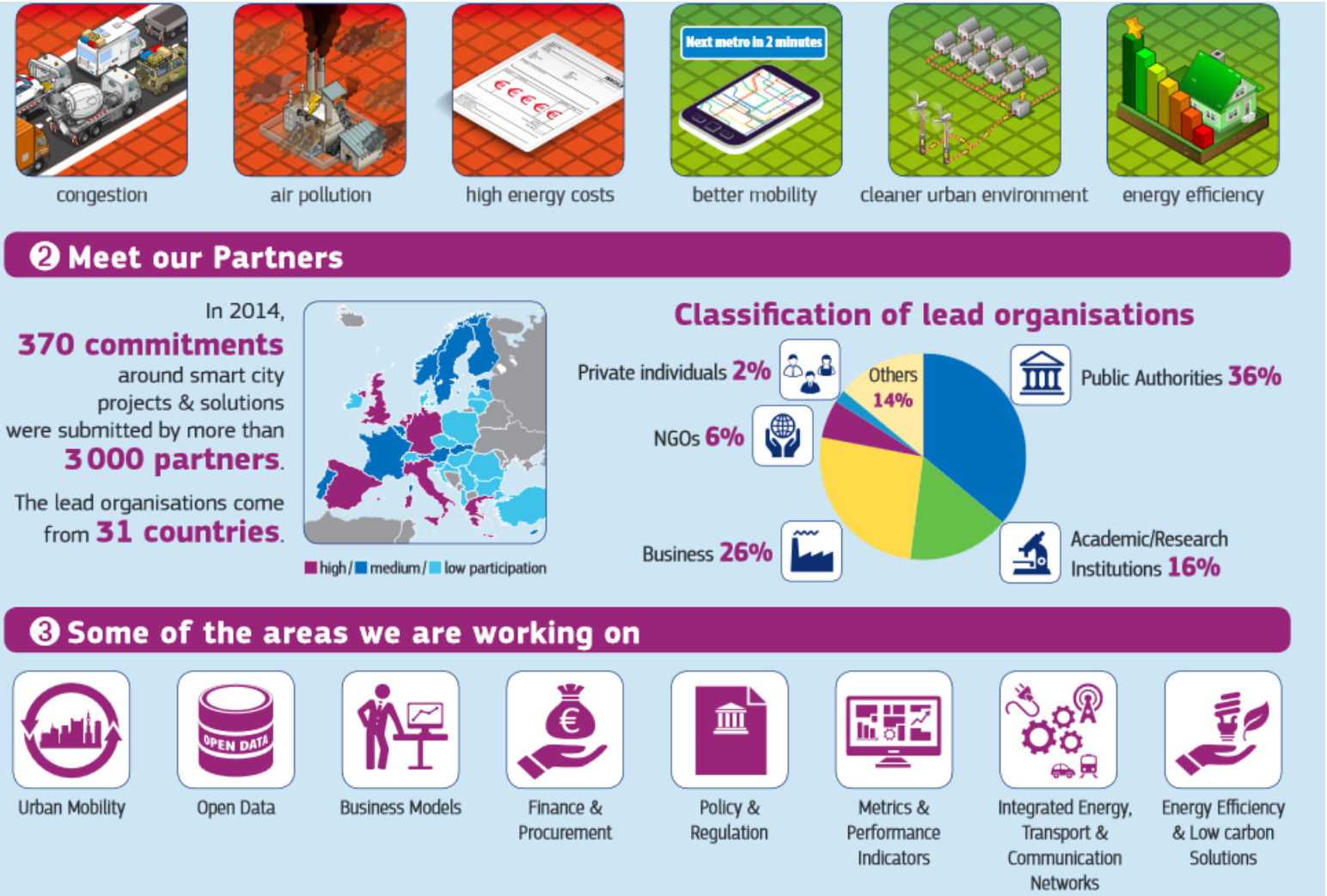
Search made on WoS, Jan. 31, 2017. Search strategy: «Smart cit»*

Setting the scene: some stylized facts (2)

- Growth of interests that does not seem to vanish:



Setting the scene: some stylized facts (3)



EU's Smart cities and communities initiative

Defining a Smart City (1)

- Because context elements should be expected to explain the success, or failure, of Smart City policies, I am mentioning only four notable definitions (in chronological order) which go truly beyond ICTs as a means to define urban smartness, highlighting the most important elements.

1. Giffinger et al. (2007) provide a classification of European medium-size cities according to six axes (Smart people, Smart governance, Smart environment, Smart economy, Smart mobility, and Smart living). Their definition reads as follows: "*A Smart City is a city well performing in a forward-looking way in these six characteristics, built on the 'smart' combination of endowments and activities of self-decisive, independent and aware citizens*" (Giffinger et al., 2007, p. 13).

Defining a Smart City (2)

2. Caragliu et al. (2011) build on the classification by Giffinger and coauthors, and provide a comprehensive and operational definition of urban smartness. In this case, cities are identified as smart when "*investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance*".

- This definition presents two main advantages.
  - Firstly, it is inspired by an urban production function approach, whereby urban smartness is defined as a precondition to urban economic performance. A clear distinction between inputs and outputs, previously not encompassed in analogous attempts, suggests that smartness can be seen as an intermediate step towards the goal of smart (viz., sustainable) urban growth.
  - Secondly, the definition decomposes the concept along six dimensions, which can be individually measured and tested, using data from official statistical sources. Therefore, this definition has been among the first ones to be empirically verified (Caragliu and Del Bo, 2012).

Defining a Smart City (3)

3. More recently, the interplay between technology and its users has been synthesized in Ratti and Townsend (2011), which simplifies the previous approach by stating that "*Truly smart cities will emerge as inhabitants and their many electronic devices are recruited as real-time sensors of daily life*".
4. Finally, De Souza (2012) concludes that "*A smart city is livable, resilient, sustainable, and designed through open and collaborative governance*". This last definition builds a bridge between previous works focusing on ICTs and context conditions as the main ingredients of urban smartness, and paves the way for future evolutions towards the resilient city.

Measuring the impact of Smart City policies (1)

- Despite the vast interest among policymakers and academics, insufficient evidence is available on the impact of Smart City policies.

- We provided two contributions to this literature.

- On a database of 309 European cities, we find that:
  - **Smart City policy intensity is associated with a better urban economic performance**, and that
  - **Smart City policy intensity is associated with higher urban innovation rates.**

- Using advanced econometric techniques, besides, suggests that the causality direction goes from policy intensity to growth and innovation, and not vice versa.

The economic rationale of Smart City policies (1)

- Despite funding available on SC policies, insufficient attention has been paid to analysising the economic rationale for Smart City policies, as well as their potential growth and innovation effects in cities.

- Two issues seem relevant for this analysis.

  - Smart City policies must show features making this type of policy different from other axes of intervention: the economic rationale for Smart urban policies must be clarified.

  - The expected impact of these policies on urban growth and innovation should be discussed.

The economic rationale of Smart City policies (2)

- What distinguishes urban smartness from other germane definitions is the interplay between tangible and intangible features.
- Each growth-enhancing factors, categorised under the six axes in the Giffinger definition, has in fact been individually linked to urban productivity growth.
  - **Human capital** has been found to play a crucial role in determining urban growth (a literature originated from the seminal work by Berry and Glaeser, 2005). More educated and more productive people tend to sort in cities (Combes et al., 2008), and the localised accumulation of human capital engenders positive externalities at the urban level not only in terms of higher productivity, but also in terms of social capital (in particular, lowering criminal participation and improving citizenship's political behaviour: Moretti, 2004).

The economic rationale of Smart City policies (3)

- Cities with higher **social capital** are also found to overperform (Glaeser and Redlick, 2009). Physical proximity enhances social interactions, thereby maximising the potential returns from social capital (Glaeser and Sacerdote, 1999).

- Efficient **transportation networks** both internal as well as external to the city make cities more productive. Duranton and Turner (2012) show that a 10 per cent increase in a city's stock of highways is in the medium run associated to a 1.5 per cent increase in employment, while Höll (2016) finds that manufacturing firms become more productive the easier their access to transportation networks.

The economic rationale of Smart City policies (4)

- The availability of **ICTs** is also associated to higher productivity. Basu et al. (2003) find overwhelming evidence that the divergence of productivity growth between the US and UK can be explained on the basis of different ICTs adoption rates.

- Urban locations are often associated with **higher quality of life**. This is evidenced both in macro (Shapiro, 2006) and micro (Lenzi and Perucca, 2016) studies.

The economic rationale of Smart City policies (5)

- A **sustainable and wise management of natural urban resources** is a necessary condition for achieving long run economic success. The depletion of natural resources can in fact seriously affect the availability of production factors for future generations (Camagni et al., 2013).

- In the Smart City literature, **participatory governance** is often found to make cities smarter and, thus, more efficient. Participated governance also means that cities that foster the co-participation of public and private institutions in Smart projects makes such projects more prone to success (Rodríguez Bolívar, 2018).

The expected impact of Smart City policies (1)

- Recent evidence shows that Smart City policies tend to be undertaken by urban areas that already score high in one or more of the axes of the definition used in this paper (Neirotti et al., 2014).
- As also documented in Caragliu and Del Bo (2016), "*Smart City policies are more likely to be designed and implemented in cities that are already endowed with smart characteristics*" (Caragliu and Del Bo, 2016, p. 657).
- The complexity of Smart City policies impact is clarified in Angelidou (2014), who provides a useful classification of Smart City policies along four main axes, i.e. whether Smart policies:
  - are undertaken at the local or the national level;
  - are applied to existing cities or geared towards the creation of brand new ones;
  - focus on hard or soft infrastructure;
  - are organised along a sector-oriented or place-specific axis.

The expected impact of Smart City policies (2)

- In turn, local context conditions are also a crucial determinant of Smart City policy effectiveness (Neirotti et al., 2014); and a shared, bottom-up approach in integrating infrastructure is often a critical factor for maximising these policies (Lee et al., 2014).
- Smart City policies work through
  - **enhancing urban efficiency** (Chourabi et al., 2012);
  - **increased citizens participation**;
  - **increased business opportunities**.
    - Evidence suggests that cities investing in Smart City policies also tend to be more proactive in attracting productive workers and firms (Bowerman et al., 2000);
    - Nam and Pardo (2011) find that technology-intensive companies involved in the application of Smart technologies engender local spillovers;
    - Actually, the widespread adoption of e-technologies, sensors, and smart technological solutions has prompted many critiques against the business-oriented nature of the notion of urban smartness (Vanolo, 2014).

The expected impact of Smart City policies (3)

- Despite the large sums invested in Smart City policies, the literature on the economic impact of Smart City policies is surprisingly scant. Mostly, it focuses on case study evidence of the impacts of the adoption of one or more type of Smart City policies on overall urban efficiency.
- Notable examples of cities that boast effective Smart City policies include Barcelona (Bakici et al., 2013), Seoul and San Francisco (Lee et al., 2014), or Louisville and Philadelphia (Shelton et al., 2015).
- A grand overview of the empirical association between Smart City policies in a cross-section of cities and urban performance is instead mostly absent; this paper aims to fill this gap, by answering the following research question:

What is the economic impact of adopting Smart City policies on urban growth and urban innovation rates?

Data and indicators (1)

- A new data set has been used for this empirical exercise, with data covering three major axes:
  - Intensity of smart urban policies;
  - Socio-economic characteristics of European cities;
  - Urban economic performance.
- In order to measure the intensity of Smart urban policies we refer to the approach developed in Caragliu and Del Bo (2016). Accordingly, four main data sources on policy intensity have been analysed:
  - cities implementing smart policies in the list prepared by European Parliament (2014);
  - cities member of the Eurocities network;
  - cities participating in Framework Programme 7 (henceforth, FP7) Smart City initiatives;
  - cities actively cooperating with a major Multinational Company offering Smart urban services http://www.eurocities.eu/

Data and indicators (2)

- **European Parliament (2014)** discusses successful case studies of cities implementing Smart City policies. In this case, being successful means enjoying an alignment between city-level policy objectives and EU2020 goals. In our data base, this information translates into a dummy variable, equal to 1 if cities are included in this study, and 0 otherwise.
- The **Eurocities** network has been created in 1986 by eleven European cities, with the goal of enhancing networking between non-capital cities. This group now encompasses 103 members, organized in forums, working goups and projects. The goal of this network is related to the view that cities are engines of smart and sustainable growth in the EU, and the network's major working group is precisely on Smart Cities. We have thus created a second indicator variable that assigns value 1 to cities belonging to this network and 0 otherwise.

Data and indicators (3)

- Using data from the factsheets on Smart City Projects and the European Commission's SCC web page, which are part of the European Commission's Digital Agenda, information on public involvement and funding of municipal offices to FP7 is collected.
- Commitments are non-binding but represent voluntary expressions of interest of public and private partners to actively and concretely support the overall objectives of the European Innovation Partnership on SCC. Commitments are expressed in different subject areas, which can be linked to the six axes of our Smart City definition, while official FP7 projects are for the most part in the field of energy efficiency, following the EU's reading of Smart Cities (Crivello, 2014).
- SCC is based on stakeholders' commitments, thereby allowing the matching of funding devoted to R&D with institutional budget of the involved actors, very much in line with the discussion about the need for a bottom up approach in delivering Smart City solutions (Schaffers et al., 2011).

Data and indicators (4)

- Since cities can be part of several EU-funded projects (EU_FP and EU_SCC, respectively) and Commitments (EU_committ), we have used a count measure of participation. The resulting variables are then standardized on a 0-1 scale, with 0 indicating cities with no participation to any of these initiatives, and 1 associated to participation in several activities.
- In order to provide a complete picture of Smart City policies, the involvement of private actors is explicitly considered. As a first step in the measurement of the inclusion of private actors in the design and implementation of Smart city policies, we have considered one of the major private players, IBM, to account for this aspect. While considering a single private actor may lead us to downsize the phenomenon, the choice was driven by the fact that IBM hosts a dedicated web site for its Smart City initiatives, listing current projects. The variable “private” takes on value 1 if this private firm is a partner of the municipal offices in the implementation of Smart City policies and 0 otherwise.

Data and indicators (5)

- The six axes selected for calculating the aggregate urban smartness indicator cover a sample of 309 EU cities for the following six dimensions:
  - Human capital;
  - Social capital;
  - Transport infrastructure;
  - ICTs;
  - Natural resources;
  - E-government.
- All remaining data are collected at the metro areas level, apart from the indicator of the urban quality of institutions, for which we use the 2010 version of the Charron et al. (2015) data base, which creates a unique indicator out of measures of the quality of governance (low corruption, impartial public services and the rule of law). These data are collected at NUTS2 level, and the value of each NUTS2 region is assigned to the metropolitan area located in the region.

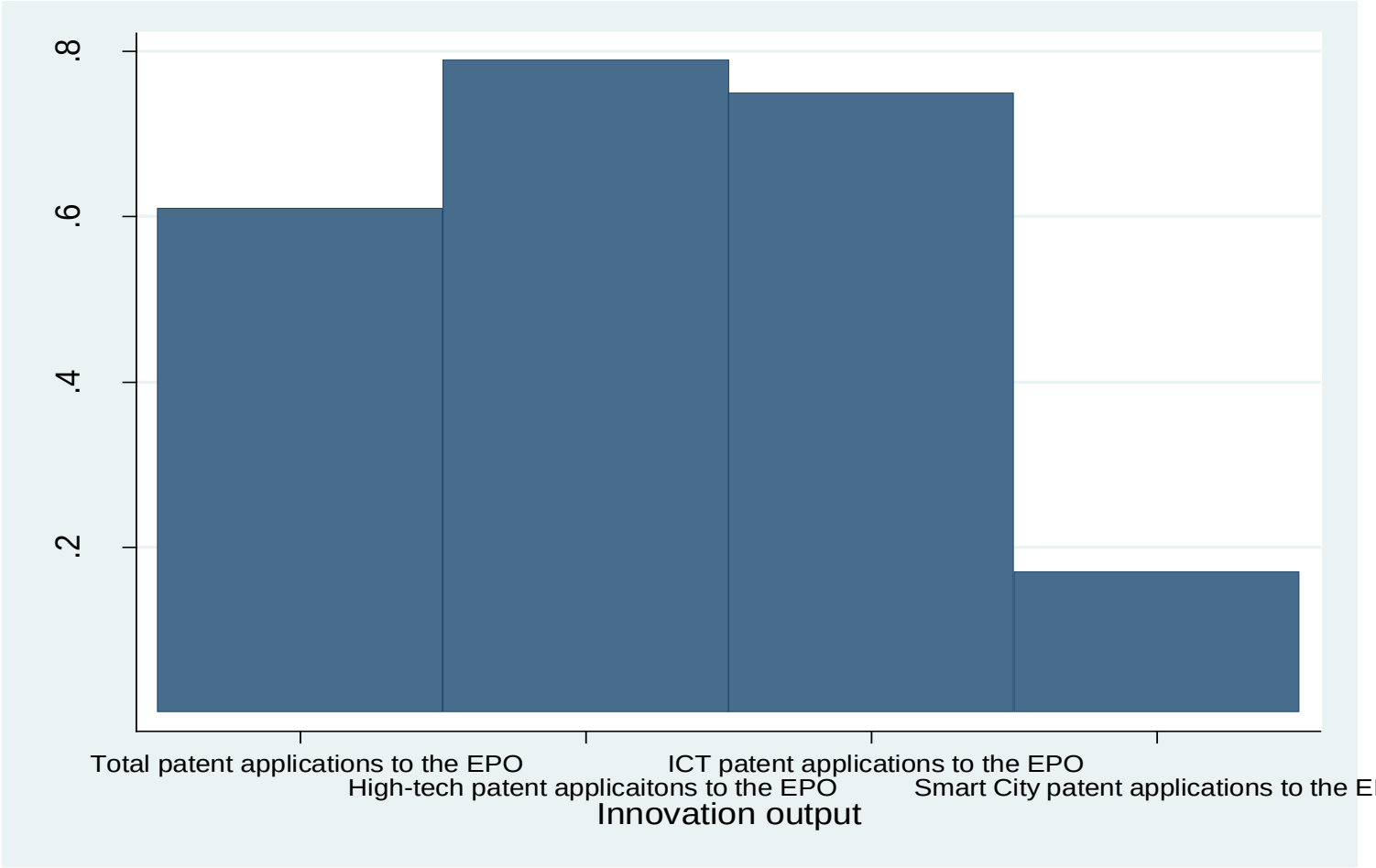
Empirical results (1): growth effects

Dependent variable	Metro area GDP growth rate, 2008-2013				
Model	(1)	(2)	(3)	(4)	(5)
Constant term	0.08***	0.10***	0.24***	0.09**	0.02
	(0.00)	(0.00)	(0.02)	(0.04)	(0.03)
Initial per capita GDP	-0.02***	-0.02***	-0.03***	-0.04***	-0.01
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Intensity of Smart City Policies	0.11***	0.23***	0.22***	0.24***	0.16***
	(0.00)	(0.00)	(0.00)	(0.06)	(0.06)
Population density	-	-0.01***	-0.01***	-0.01***	-0.01***
		(0.00)	(0.00)	(0.00)	(0.00)
R&D expenditure	-	-	0.03***	0.02***	0.02***
			(0.00)	(0.00)	(0.00)
Quality of local institutions	-	-	-	0.04***	0.04***
				(0.01)	(0.01)
Dummy New Member States	-	-	-	-	0.05***
					(0.01)
Number of obs.	309	309	309	309	309
R^2	0.26	0.28	0.28	0.29	0.32
Joint F test	51.42***	30.94***	46.43***	40.32***	56.52***
Estimation method	IV	IV	IV	IV	IV
Variable insturmented	Intensity of Smart City Policies				
Instruments used	Urban smartness; dummy, equal to 1 if the city is the Country capital				
Underidentification test (Kleibergen-Paap rk LM statistic)	46.13***	34.17***	34.03***	30.65***	21.41***
Weak identification test (Cragg-Donald Wald F statistic)	50.47***	33.23***	32.61***	31.11***	19.12***
Hansen J statistic (overidentification test of all instruments)	19.24***	6.33**	2.41	0.36	0.48

Empirical results (2): innovation effects

Variable	Sample	Treated	Controls	Difference	S.E.	T-stat
Total patent applications to the EPO	Unmatched	219.89	77.97	141.92	41.47	3.42
	ATT	180.16	70.11	110.05	39.30	2.8
High-tech patent applications to the EPO	Unmatched	48.70	9.72	38.98	10.79	3.61
	ATT	40.70	8.71	31.99	8.89	3.6
ICT patent applications to the EPO	Unmatched	66.41	16.43	49.98	14.63	3.42
	ATT	56.69	14.31	42.38	12.92	3.28
Smart City patent applications to the EPO	Unmatched	5.47	4.56	0.91	0.38	2.41
	ATT	5.37	4.45	0.92	0.49	1.88

Empirical results (3): innovation effects



Future research avenues (1)

- The debate on Smart Cities is still, unexpectedly, rather hot; if it's fad, then it's a rather long-lasting one!
- Many more research questions remain open:
  - First of all, the existence of a direct link between Smart urban features, and the possible synergic role they may play in stimulating economic growth, is yet to be inspected.
  - Ideally, this exercise would require longer time spans in the data, in order to uncover possible long run effects that the data base collected for this paper cannot capture.
  - Presently, our findings suggest that Smart City policies can play an important role in abating crisis effects, but their long run effect still calls for further empirical research.
  - Lastly, a sound conceptual classification of existing Smart City policies could also be beneficial.

Future research avenues (2)

- Presently, these policies comprise a wide range of measures, both spatially and industrially heterogeneous. A rigorous survey of their extent, main purpose and economic rationale would offer a great deal of information for those interested in identifying their real effect.

- From a policy perspective, the existence of scientific evidence on the impact of Smart City policies should not be underestimated and would ideally elicit a process of monitoring of the diffusion and intensity of these policies in European cities.

- The current landscape of Smart City policies is scattered in terms of responsibility and effectiveness, and a better coordination at the supranational scale could maximise the impact of these policies, avoiding overlapping and inefficiencies.

For your attention,

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