What makes a city "smart": Evidence from Belgian municipalities

Miguel Manjón[a] and Nathalie Crutzen[a,b]

[a]Smart City Institute, University of Liège
[b]HEC, University of Liège

Local governments and the “smart city”: Which socioeconomic factors make a territory ”smart”?

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SC statistics

- Importance of smart city (SC) initiatives:
  - ✓ 240 of the 486 EU cities with a population above 100,000 inhabitants (Manville *et al.* 2014).
  - ✓ 700 cities from 150 countries represented at the 2018 Smart City Expo World Congress in Barcelona.
  - ✓ In monetary terms, it is estimated "that the global smart city market will grow by 14% annually, from US$ 506.8 billion in 2012 to US$ 1.3 trillion in 2019" (*2016 World Cities Report*, UN Human Settlements Programme).

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→ follow a top-down approach, i.e., local governments typically lead these SC initiatives (Estevez *et al.* 2016, Mora *et al.* 2019).

Illustrative examples of this process: Amsterdam (Mora and Bolici 2017), Kansas City (Sarma and Sunny 2017) and Gothenburg (Brorström *et al.* 2018).

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$\Downarrow$

For local governments affected by these trends, a major question is which factors should be targeted in order to succeed (i.e., become "smart").

Goal of the paper

There is limited evidence guiding such decisions.

$\Rightarrow$ Some case studies (Angelidou 2017, Freitas-Camboim *et al.* 2019), one large sample study on 70 cities from all over the world (Neirotti *et al.* 2014).

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This paper presents results from log-linear and ordered regression models in which a set of SC indicators (i.e., socioeconomic factors) explain variations in the "smartness" of cities.

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These results may provide good guidelines for local governments.

(Ideally, results from an experimental research design, but this is challenging; leave for future research).

Dependent Variable and Sample

Dependent Variable and Sample

A key issue is the availability of a (dependent) variable that proxies for the "smartness" of a large sample of territories.

We use an assessment from a local public official that "is responsible for the projects associated with the phenomenon of the smart city in the municipality".

In particular, our dependent variable was obtained from a survey carried out in 2017 by the Smart City Institute of the University of Liège on the Belgian municipalities.

Dependent Variable and Sample

The survey

The survey targeted all 589 Belgian municipalities and obtained a response rate of nearly 21%.

The final sample of 123 municipalities is statistically representative of Belgian territorial and institutional realities: size of the municipalities, geographical dispersion, and urban/rural areas (Bounazef *et al.* 2018, Desdemoustier *et al.* 2019).

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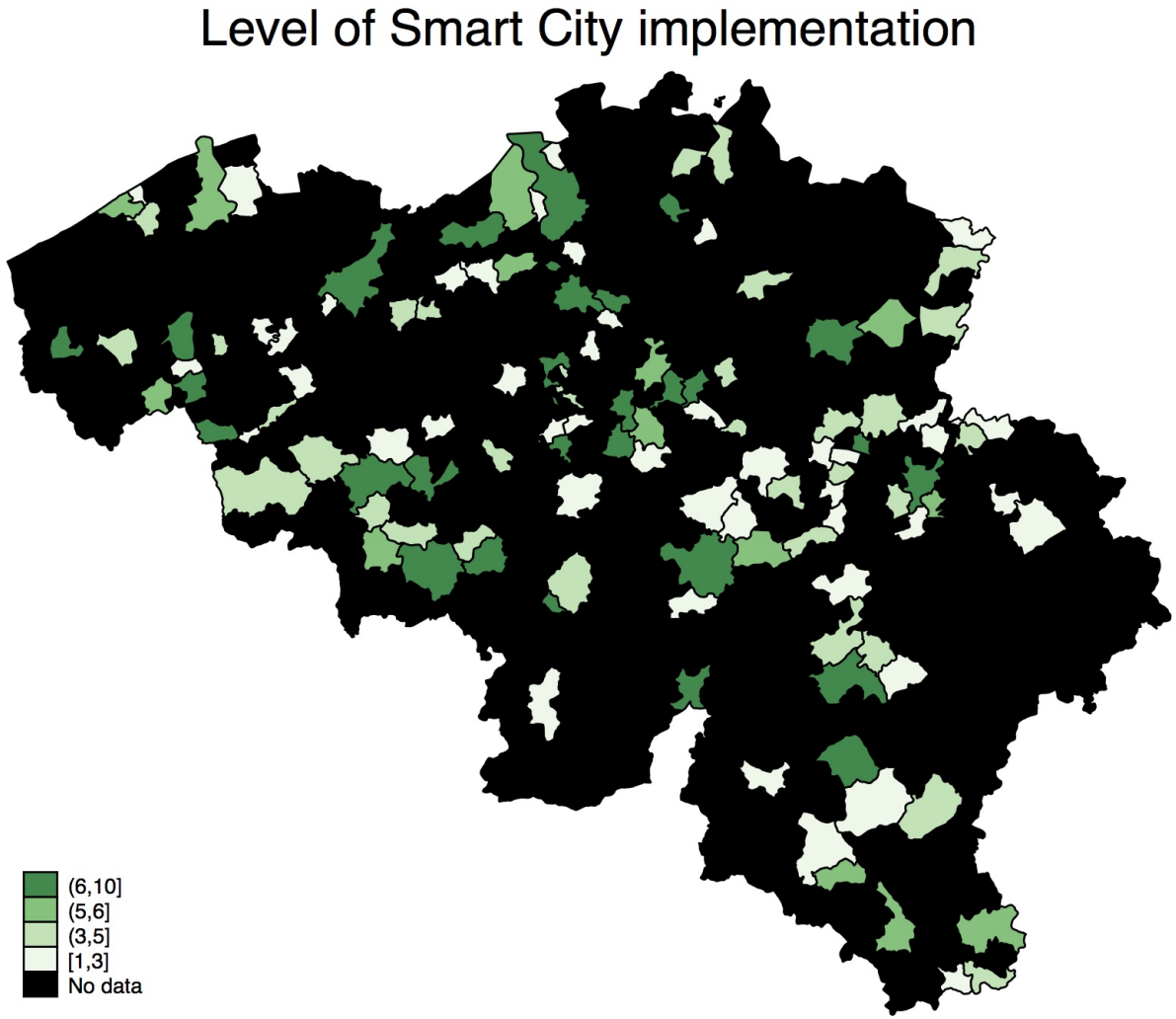
Officials "responsible for the projects associated with the phenomenon of the smart city in the municipality" were asked to provide an assessment about their municipalities' degree of smartness using the question "Please indicate the level of evolution of your municipality in the process of Smart City implementation".

We interpret this measure as the level of SC implementation in each municipality, or simply the (degree of) "smartness" of a municipality.

Dependent Variable and Sample



Note: Integer scale between 1 ("Our municipality is not a SC") and 10 ("We are a SC").

Explanatory Variables: SC Indicators

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Most of the SC literature has a normative and descriptive aim (Nam and Pardo 2011, Kourtit *et al.* 2012).

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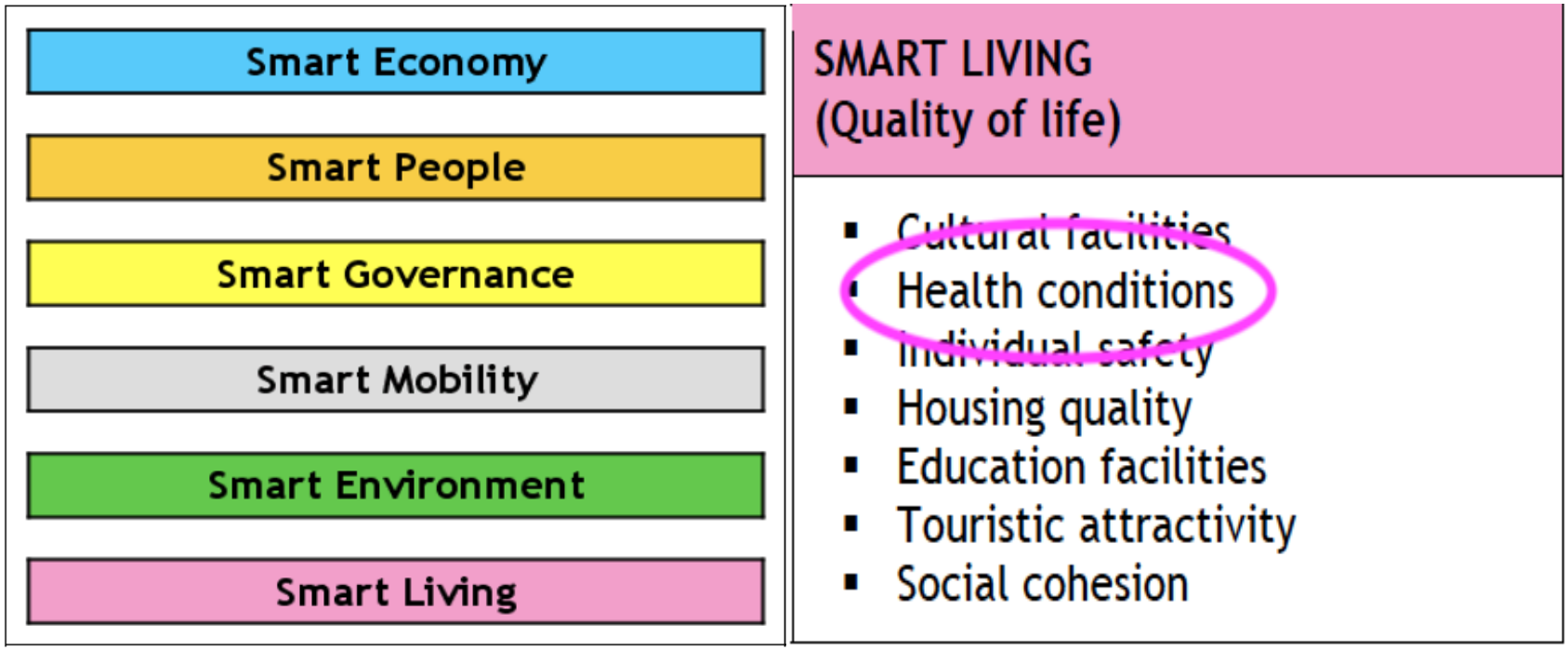
Giffinger *et al.* (2007) and ISO (2014) provide the main benchmark for constructing SC indicators.

In essence, both define a set of socieconomic factors (characteristics, themes) that define an SC and then a set of indicators for each factor.

Explanatory Variables: SC Indicators

Smart City Model of Giffinger *et al* (2007):
Illustrative example of indicators.



Health conditions indicators include: life expectancy, hospital beds per inhabitant, doctors per inhabitant and satisfaction with quality of health system.

Explanatory Variables: SC Indicators

We construct a set of common "factors" (i.e., characteristics and/or themes) in these reports:

- ✓ Economy
- ✓ Social and Human capital (Education)
- ✓ Governance-participation
- ✓ Transport-ICT-Innovation
- ✓ Environment (Energy and Wastewater)
- ✓ Quality of life (Health-Safety-Recreation)

Explanatory Variables: SC Indicators

Note that:

- there are four themes of the ISO (2014) not covered by the characteristic of Giffinger *et al.* (2007): Finance, Fire and emergency response, Solid waste, and Water and sanitation.
- there is a number of common indicators in the common factors (e.g., the unemployment rate and the share of green areas), particularly in Governance-participation and Quality of life.
- most of the indicators proposed differ, which allows most SC factors to be proxied using the indicators of either Giffinger *et al.* (2007) or the ISO (2014).

Explanatory Variables: SC Indicators

Socieconomic Factors and Associated Explanatory variables

Factors	Explanatory Variables
Economy	Unemployment rate
	# Businesses per Population
	# New Businesses
Social and Human Capital	Pop. with Primary Education
	Pop. with Secondary Education
	Pop. with HE degree
	Pop. with University degree
	Pop. Enrolled in Primary School
	Pop. Enrolled in Secondary School
	Pop. from EU Countries
	Pop. from non-EU Countries
Governance	% of Female City Representatives
	Voters' Turnout (%)
	Share of children in day care
Transportation	Motorways per Inhabitant
	Inter-city Trains
	# Private Vehicles per Household
Environment	Share of Woodland
	Share of parks and gardens
Quality of life	Rate of Criminality
	Living Area in Private Houses per Inhabitant
	Overnights per Inhabitant
	Sport areas per inhabitant

Additional controls: Provincial dummies and dummies distinguishing the professional category of the respondent.

Data sources: Belfius (2007, 2017), Bel-first (Bureau van Dijk), NMBS/SNCB and offical web pages of the regional governments of Brussels, Flanders and Wallonia.

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- Specification I: Wald tests on the joint significance of the variables associated with each of the considered socieconomic factors (recall previous table).

  We interpret the statistical significance of each Wald test as evidence that the associated factor (Economy, Social and Human Capital, Governance, Transportation, Environment and Quality of Life) is correlated with the level of SC implementation.

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- Specification II: coefficient estimates from an econometric specification that uses as explanatory variables the largest principal component (i.e., eigenvector) of the indicators that compose each factor.

  We interpret the statistical significance of the largest principal components as evidence that the associated factor (Economy, Social and Human Capital, Governance, Transportation, Environment and Quality of Life) is correlated with the level of SC implementation.

Estimates

Specification I: Result from Wald Tests

	OLS	Ordered probit
Economy	1.55	7.99**
Social and Human Capital	2.42**	22.16***
Governance	0.93	5.44
Transportation	0.77	2.72
Environment	0.09	0.75
Quality of Life	0.71	4.49

Note: Asterisks denote jointly statistically significant coefficients at the 1% level (***), 5% level (**) and 1% level (*).

Estimates

Specification II: Result from Largest Principal Components

	OLS	Ordered probit
Economy	0.0924*	0.1925**
	(0.0533)	(0.0978)
Social and Human Capital	-0.0156	-0.0065
	(0.0356)	(0.0646)
Capital		
Governance	0.0007	0.0037
	(0.0539)	(0.0977)
Transportation	-0.0089	-0.0157
	(0.0165)	(0.0300)
Environment	-0.0386	-0.0590
	(0.0693)	(0.1258)
Quality of Life	-0.0370	-0.0266
	(0.0623)	(0.1134)

Note: Asterisks denote statistically significant coefficients at the 1% level (***), 5% level (**) and 1% level (*).

Estimates

Economy and Social and Human capital are socieconomic factors that seem to be positively correlated with the degree of smartness of a municipality.

Robustness tests

- ✓ Replaced some of the indicators (the unemployment rate, the share of woodland and the share of parks and gardens, living area in private houses per inhabitant, and surface of sport areas per inhabitant) with their values in 2007.
- ✓ Included additional indicators such as taxable income over total population in 2015 (to proxy for the GDP per employed person), the log of the difference between the third and first quartile of the income distribution in 2015 (to proxy for the poverty rate) and density of population square to control for negative agglomeration effects (noise, pollution, etc.).
- ✓ Dropped the municipalities in which the public official responding the survey was an SCI manager ("Other respondents" being then the residual category).
- ✓ Replaced the dummy provinces for regional dummies (being Flanders the residual category).
- ✓ Replaced the principal components initially used by a set of components accounting for at least 70% of the variance of the variable.
- ✓ Included an ICT variable (% of jobs in high-tech industries, only available for Wallonia).

Estimates

+ Our findings indicate that the stakeholders involved in SC initiatives should pay particular attention to economic and social-human indicators (see also Freitas-Camboim *et al.* 2019) when making their decisions (and perhaps be less concerned about other indicators).

– These results cast doubts on the role played by certain socieconomic factors, such as governance-participation and ICT-transportation, identified as critical in the public management and smart city literatures.

Conclusions

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Cities all over the world seek to become "smart", i.e., they launch projects associated with the mobility of citizens and vehicles, the role of big data and its technologies, the long-term sustainability of the urban environment and/or the increase of citizen's political participation.

Importantly, these projects do not come cheap and usually involve substantial amounts of public and private resources. Yet empirical assessments on what socieconomic factors make a city "smart" are scarce.

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This paper analyses the link between the assessment made by informed public officers on how "smart" their city is and a list of factors generally considered in the literature to make a city "smart". Results were obtained for a sample of Belgian municipalities.

Conclusions

Our findings may provide guidelines for policy makers and local governments aiming at launching and/or investing in SC initiatives.

In particular, the message that arises from our results is that initiatives that improve economic and social-human capital factors will probably pay off.

Results are robust to the use of alternative sets of explanatory variables, different model specifications, and several controls on the respondents to the survey used to construct our dependent variable.

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