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SMART CITIES AND HOUSING MARKETS: EVIDENCE FROM ITALY

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ABSTRACT

Smart cities are widely recognized as the most pleasing and liveable ones, thus drawing the attention of both scholars and policy-makers. Specifically, urban "smartness" has been identified by plenty of characteristics that can be grouped into six dimensions (Giffinger *et al.* 2007): smart economy (competitiveness); smart people (social and human capital); smart governance (participation); smart mobility (both ICTs and transport); smart environment (natural resources) and smart living (quality of life).

According to this analytical framework, in this paper the relation between urban performance and smartness characteristics has been investigated in the 103 Italian NUTS3 province capitals in the year 2011. To this aim, a descriptive statistics has been followed by a regression analysis (OLS), where the dependent variable urban performance has been proxied by housing market prices. Besides, a Cluster Analysis (CA) has been developed in order to find differences and commonalities among the province capitals.

The OLS results indicate that living, people and economy are the key drivers for achieving a better urban performance. Environment, instead, keeps on playing a minor role. Besides, the AC groups the province capitals according to the smart features.

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1 Introduction

Understanding which are the determinants of urban wealth and liveability is crucially important, since the most of the world population lives in urban contexts. In particular, among the many definitions and characteristics of the "successful" city, the label of "smart city" has recently got the upper hand. The notion of "urban smartness" is thus attracting the attention of both policy-makers and academicians (i.e. European Commission, 2010; Barca and McCann, 2011). According to the "Vienna model" by Giffinger *et al.* 2007, the drivers of urban smartness can be grouped into six dimensions: economy, people, governance, mobility, environment, and living.

In this context, the present paper aims at investigating the role played by smart characteristics on urban performance within the 103 Italian province capitals[4] in 2011, by means of descriptive statistics, and econometric analysis (OLS), where urban performance, defined as the result of different growth-enhancing factors (Caragliu and Dal BO, 2012) has been proxied by housing market prices (hereafter HMPs). Besides, differences and commonalities among the cities are explored by means of a cluster analysis.

The explanatory variables have been grouped according to the Vienna model's six "smart" dimensions (economy, people, governance, mobility, environment, living). The choice to run two different models has been suggested by the fact that real estate market suffers from a lot of specific features (i.e. cyclical trends, speculation, separation of the markets, influence by planning decisions and migration flows, supply rigidity), therefore, second regression with average taxable income as dependent variable has been carried out.

Data on housing market prices come from the Scenari Immobiliari database, which records data at municipality level, in Italy, since the year 1993. The smart characteristics used as explanatory variables have been gathered from primary and secondary data, collected by various sources.

The results of the econometric analysis underlines that living, people and economy are the key drivers for achieving a better urban performance while environmental issue stays on the backdrop.

Besides, the AC showed that the most performing cluster is composed by larger "competitive" cities with excellent results in economy, governance, mobility and living. The second best performing group, is composed by large "attractive" cities mainly located in the North, which present the same characteristics of the first cluster, even to a lower level. Cluster 4, composed by the "liveable" cities, instead, includes medium-sized cities all over the country with all the variables over the average, except for unemployment. Finally, Cluster 2 concerns cities

[4] A complete list is available in the Appendix (Table A).

located in the South and some others in the peripheral areas of the regions they belong to. These smaller cities have on average the worst scores in all the selected variable, but many of them presents results over the cluster average for one of the dimension.
The paper is structured into seven sections. After the introduction, the paper focuses on the literature review of the concept of Smart Cities, and the related variables and indicators adopted to measure "smartness". Data and methodology are then described in section three, while descriptive statistics is presented in the fourth one. Sections five and six are dedicated to the results of the OLS and cluster analyses. Conclusions follow in the section seven, which puts forward new research questions.

2 Literature review

The contemporary city is often defined: "smart", intelligent, innovative, wired, digital, creative, and cultural, thus linking together technological informational transformations with economic, political and socio-cultural change (Hollands, 2008). Table 1 provides a first attempt to classify some of the many contributes on the subject.

Table 1 - Main contributes on the"successful cities"in the last two decades

	Authors	*Focus*	*Label*	*Aim*
90s	Mitchell 1995; Eger J. 1997; Graham and Marvin 1996 Komninos 2002; Talbot and Newman, 1998	ICTs, digital networks	Intelligent, digital, wired	Efficiency
2000s	Shapiro 2006; Berry&Glaeser 2005; Rappaport 2008; Wood 2006	Human capital: education	Cultural	Efficiency
	Florida 2002, 2005; Eger 2003a	Human capital: creativity	Creative	Quality of life
	Komninos 2006, 2009; Eger 2003b, Besselaar and Koizumi 2005; Coe *et al*. 2000, Anthopoulos and Fitsilis 2010, Moon 2002; Carley et al. 2001; EU 2012; Van der Meer and Van Winden, 2003	Social capital: participation and e-governance	Smart	Quality of life
2012	Ratti 2012 (MIT)	Social capital: sensitiveness, adaptability	Senseable	Quality of life/ Efficiency

Source: authors'elaboration

Specifically, after the many contributes on the "intelligent city" in the 90s, mainly dealing with ICTs as a key driver, the focus has been shifted to the "social" aspects of urban development: from the higher productivity of a more educated human capital (Shapiro, 2006; Winters, 2011), and skilled workforces (Berry and Glaeser, 2005; Glaeser and Berry, 2006), through the triple-featured (tolerance, talent, technology) "creative city" (Florida, 2002, 2005), to the sustainable approach to growth, in both environmental and social fields (Inoguchi *et al.,* 1999; Hollands, 2008; O'Grady and O'Hare, 2012).

In the last few years, chiefly due to the global crisis, the third component of the sustainability - the economic one - has been heavily involved; thus, in a SC, economic growth, social and environmental sustainability are supposed to be compatible with one another.
Even in the most recent definition of "senseable city", the MIT suggests a new path towards urban sustainability, which entails a deep use of new technologies for the everyday life of everyone (Ratti, 2012), thus involving not only intelligence and innovation as means, but also inclusion and liveability as goals (Mitchell, 2007, Sassen, 2011).

2.1 Theoretical studies on Smart Cities

In order to find a more clear-cut definition of SC, a wide range of theoretical studies have been identified. According to IBM (2009), cities can be seen as complex networks of components: citizens, businesses, transport, communications, infrastructures and services; therefore, SCs are those which better manage with their stock of instrumentation, interconnection and intelligence (*ibidem)*. Hollands (2008) also indicates some key elements for a SC, which is supposed to: (i) utilize a networked infrastructures to improve economic and political efficiency and enable social, cultural and urban development (Komninos, 2002, 2006; Eger, 1997; Graham and Marvin, 1996); (ii) follow an emphasis on business-led urban development (Brenner and Theodore, 2002; Quilley, 2000; Harvey, 1989, Gottdiener, 2001; Monbiot, 2000); (iii) be linked to particular high-tech and creative industries and 'soft infrastructure' (Florida, 2005; Eger, 2003a; Hall, 2000; Scott, 2000; Landry and Bianchini, 1995).
It appears quite clear that a strict definition of SC is not easy, however, an operational one is anyhow available: a city is 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" (Caragliu *et al.*, 2011). Indeed, sustainability seems the only common feature to all the possible definitions of SC (ABB, 2012), together with a large – maybe too large? – target of "quality of life" (Legambiente, 2012).
As a conclusion, whatever the disciplinary approach or the research background (institutional, academic or entrepreneurial), it is possible to state that a SC has two main goals: full general sustainability and quality of life, which may be summed up in the concept of "smartness".
Last but not least, due to their "wired" nature, which provides a great stock of data, SCs are easier to analyse (Batty, 2012).
As a consequence, many empirical analysis on SC have been carried on, not only by universities and private companies, but also by governmental institutions[5].

[5] Among the others, see, as examples, European Commission (2012) and for Italy, MIUR (2012).

The most of them end up choosing indicators for their many dimensions, but in some cases useful research tool-frames have also been provided.

A first example is represented by the Nijkamp Hexagon, which identifies six typologies of urban capitals (natural and handmade, financial and institutional, human and social) while analysing the level of urban sustainability for a United Nations survey (Nijkamp *et al.*, 1993). Similarly, IBM, in a different business perspective, suggests a research frame for studying the SC's investments based on seven dimensions (water and energy, transport, businesses, citizens, city services and systems, communications) (IBM, 2009).

Finally, the most valued description of SC characteristics has been provided by a joint research by the Technology Universities of Wien and Delft with the Ljubljana University (from now on defined "The Vienna model"), which focuses on six axes of the urban area (economy and governance, mobility and environment, people and living) (Giffinger *et al.*, 2007)[6].

It is worth noting that, although with small differences, the observed categories are quite similar, regardless of the field of study.

Furthermore, in the Vienna model, a definition of SC is also provided, according to which a Smart City is "well performing in a forward-looking way in six characteristics, built on the 'smart' combination of endowments and activities of self- decisive, independent and aware citizens"(*ibidem, p. 11*). Thus, smart economy mainly concerns competitiveness; smart people is about social and human capital; smart governance refers to participation; smart mobility affects ICTs and transport; smart environment involves natural resources; smart living is a synonymous of quality of life.

2.2 Empirical studies on Smart Cities

As concerns the empirical analysis on SCs, several studies have been conducted at both European and national scales, as presented in the following Table 2.

Apart from some case-study oriented works, concerning one or more cities whose features are well described and analysed in order to discuss the specific context or the policies which have been adopted, these studies can be grouped into two categories: in the first one, they have used the ranking analysis, which classifies cities according to selected indicators depending on a general or particular perspective of sustainability while the second one includes other analysis like hedonic prices method, correlation analysis, econometric models, and cluster analysis.

[6] Since this model has been adopted for the current research, it will be further investigated in the next methodology paragraph.

Table 2- Main recent empirical research on SCs

Who	*Year*	*Spatial scope*	*Sample*	*(stated) Issue*	*Methodology*	*Sources**
Ranking studies						
Euromobility	2013	Italy	50 Cities	Sustainable mobility	Ranking	Istat and various sources
ICityRate (Forum PA, 2012)	2012	Italy	103 province capitals	Intelligent Cities	Ranking	Various sources
Ecosistema Urbano (Legambiente, 2012)	2012	Italy	104 province capitals	Environmental quality	Ranking	Istat, Cities
Scenari Immobiliari	2012	Europe	20 Cities	Intelligent Cities	Ranking	Not available
ABB-Ambrosetti	2012	Italy	13 Cities	Smartness	Ranking	CERTeT
Sole24 Ore	2012	Italy	107 provinces	Quality of life	Ranking	Various sources
Giffinger et al.	2007	Europe	70 middle-sized cities	Smartness	Ranking	Eurostat, UA[7], Espon, etc..
CERTeT	2005	Europe	12 cities	Competitiveness	Ranking	UA, etc…
Other studies						
Siemens	2012	Italy	54 Cities	Efficiency	Principal component, Cluster	ANCI[8]
Caragliu and Dal Bo	2012	Europe	94 cities	Smartness	OLS	UA
Cittalia	2011	World	12 cities	Smartness	Case study	City webs
Caragliu et al.	2011	Europe	250 cities	Smartness	Correlation	UA
Colombo et al.	2012a	Italia	103 province capitals	QoL – house values, wages	Hedonic prices + ranking	OMI[9], INPS[10] and various sources
Berger et al.	2007	Russia	39 cities	QoL – house values, wages	Hedonic prices	RLM[11] survey

*of the dependent variables

Source: authors'elaboration

Focusing on the first group, in 2012 many studies have been carried out on Italian specific cities, that is the object of the present paper.

[7] Urban Audit.
[8] National Association of Italian Municipalities (Associazione Nazionale Comuni Italiani).
[9] Italian Real Estate Observatory (Osservatorio Immobiliare Italiano).
[10] National Institute of Social Welfare (Istituto Nazionale di Previdenza Sociale).
[11] Russian Longitudinal Monitoring.

Some of these studies, based on rankings, do not consider all the cities, but only a particular group of them, according to various dimensional criteria: ABB-Ambrosetti (2012) has ranked the 13 most populous Italian cities, while the Euromobility Report (2013) considers 50 municipalities where over 100.000 people live in order to analyse and discuss the level of sustainable mobility in Italy.

Rankings are definitively very popular and in some cases they consider the whole sample of the 103[12] NUTS3 Provinces (Sole 24 Ore, 2012) or capital provinces. Specifically, the ICity Rate report (Forum PA , 2012) analyses the "intelligent cities"[13], while "La Dolce Vita" (Colombo *et al.,* 2012a) ranks cities according to their level of quality of life. Finally, the Ecosistema Urbano edited by Legambiente (2012) focuses on the environmental quality issue. The following Table 3 shows the first ten cities (the best and the worst) according to the wider urban rankings, above mentioned.

Table 3 - The first best and worst 10 Italian cities (according to different ranking studies).

ICityRate (Forum PA, 2012)		*La dolce vita (Colombo et al. 2012a)*		*Ecosistema Urbano (Legambiente, 2012)*	
BEST	**WORST**	**BEST**	**WORST**	**BEST**	**WORST**
Bologna	**Enna**	**Pisa**	**Enna**	**Verbania**	**Catania**
Parma	**Crotone**	**Trieste**	**Caltanissetta**	**Belluno**	**Enna**
Trento	**Caltanissetta**	**Ancona**	**Potenza**	**Trento**	**Frosinone**
Firenze	**Siracusa**	**Bologna**	**Crotone**	**Bolzano**	**Siracusa**
Milano	**Vibo valentia**	**Firenze**	**Foggia**	**La Spezia**	**Trapani**
Ravenna	**Agrigento**	**Pesaro**	**Campobasso**	**Venezia**	**Palermo**
Genova	**Brindisi**	**Venezia**	**Vibo valentia**	**Pordenone**	**Crotone**
Reggio Emilia	**Oristano**	**Ferrara**	**Cosenza**	**Parma**	**Reggio Calabria**
Venezia	**Catanzaro**	**Imperia**	**Torino**	**Perugia**	**Vibo Valentia**
Pisa	**Catania**	**Siena**	**Agrigento**	**Reggio Emilia**	**Messina**

Source: authors'elaboration

As it is possible to note, looking both at the top rankings and at the tail-ends of the "placement", the results are quite different; for example, nly one city, Venezia, is always a best performer. Furthermore, the most of the best cities are in the North, with some few exceptions in the Center (Perugia, Ancona, Pesaro, Firenze, Siena and Pisa). By contrast, Southern cities are much more frequently in the last positions, with three of them always present far behind the front line (Enna, Vibo Valentia and Crotone).

A more in-depth analysis of these three studies appears thus worthwhile. The ICity Rate (Forum PA, 2012) classifies the cities according to the Vienna model dimensions, using about one hundred indicators at the local and provincial scales.

[12] In the most of the studies, although using current information, due to the lack of data provoked by frequent administrative borders changes, the number of provinces is still 103, despite the fact that they are 107 since 2005 (adding four provinces in Sardinia) and 110 since 2009 (with Monza, Fermo and Barletta-Andria-Trani).

13 The "I" in the title of the report stands not only for intelligent, but also for innovative, inclusive and interacting (Forum PA, 2012).

The most "intelligent" city is Bologna, which, save for the environmental dimension with a low score (42nd position), awarded one of the first six positions in all the other dimensions. Parma follows, with a good position in four out of the six dimensions; even in this case, the environment is less smart than that in the other cities (only 41st), together with the living quality (13$^{th)}$.

According to the Dolce Vita report (Colombo *et al.,* 2012a, b), whose framework dimensions are five (climate, environment, services, society and economy), the best performers show better results mainly in the economy and services dimensions, more than in those linked to environment or society, and climate, which obviously favours southern cities.

Finally, focusing on the environmental quality in the province capitals, the XIX Ecosistema Urbano considers 25 indexes (over about 70 indicators) measuring the urban performances regarding air, water, energy and waste management, transports and mobility, green areas, environmental, and mobility policies. The best cities present good results in the most of the indicators, among the others in waste management (share of recycled wastes) for middle-sized or little cities[14], in the ciclability index, which considers the urban "bike-friendliness" level such as in sustainable mobility index, which encompasses broader and different aspects of urban mobility, and in the willingness to reply to the questionnaire.

Moving to the studies based on econometric or cluster analysis (Table 4), Caragliu and Dal Bo (2012) focus on the impact of smart characteristics on urban performance – measured by per capita GDP – and investigate this impact at the local level for a sample of 94 cities in 14 EU countries between 1999 and 2006. They find that urban density is negatively associated to urban performance[15], while the smartness indicator, measured as the mean urban value for the number of visitors to museums per resident, the length of public transportation (in logs) and the number of administrative forms available for download from official web site (in logs), is always positive and significant. Besides, cities specialized in industries with high-tech content[16] (knowledge intensive services – KIS[17]), with higher amenities, and more attractive as concerns tourist inflows are better performing.

[14] Italian cities are first classified by dimension: big cities have more than 200.000 inhabitants, middle-sized cities are in the range 80.000 – 200.000, little cities have no more than 80.000 citizens (Legambiente, 2012).

[15] This may suggest that cities in the sample are experiencing the right-hand side of the optimal city structure, where costs exceed benefits (Caragliu and Dal Bo, 2012).

[16] These cities are expected to outperform those with more traditional and lower value-added sectors.

[17] See Organization for Economic Cooperation and Development (2005) for further details.

Table 4 – Econometric studies investigating Italian Smart Cities

Who	*Sample*	*Methodology*	*Dependent variable*	*Independent variables*
Caragliu and Dal Bo (2012)	94 EU cities	OLS	GDP pc (log 1999-2002 e 2003-2006)	Human capital, density, Industry mix, Urban Amenities, Attractiveness and Smartness*
Colombo *et al.* (2012a, b)	103 Italian province capitals	Hedonic prices	Real estate market prices, wages 2001-2009	Climate, Environment, Services, Society, Economy
Siemens – Cittalia (2012)	**54 major cities in Italy**	**Principal components and Cluster analysis**	**Variables**	**Environment, Housing stock, Mobility and logistics, Energy, Health supply .**

* Smartness is measured as the average score for the number of visitors to museums per resident, the length of public transport and the number of administrative forms available for download from official web site (Caragliu and Dal Bo, 2012).
Source: authors'elaboration

Colombo *et al.* (2012 a,b) analyse, on one side, the relationship between quality of life and housing prices, on the other side, the link between quality of life and wages within the Italian province capitals in the 2001-2009 period, where quality of life is defined as the weighted average of a set of local amenities, branched into five main domains: climate, environment, services, society and economy (Table 4). The result is that housing prices are higher in cities with less pollution, more green areas, and located on the coast. As concerns services, positive differentials are observed in cities with higher teacher-pupil ratio, better transport and cultural infrastructures. Regarding social conditions, housing prices are lower in cities with higher crime rates and shares of foreigners, while they are positively related to civic-ness and university enrolment. Finally, housing prices are higher in cities with higher value added per capita and lower unemployment rate. As far as the geographical composition is concerned, quality of life is highest in medium-sized towns in the Centre-North of Italy.

Finally, it is worth mentioning the recent analysis conducted by Siemens-Anci on 54 out of the 110 Italian province capitals, identified according to the size: cities with more than 90.000 inhabitants. These province capitals have been grouped by means of a Cluster Analysis on the basis of five synthetic indexes developed by means of principal components analysis. The five indexes represent: urban environment (air quality, urban green, water and waste managements), real estate stock, energy management, mobility, and health service supply.
It results six clusters (Table 5), of which five (1,2,3,4,6) are rough in adapting to the five proposed measures and present the highest scores for specific features. The "becoming cities" (cluster 5) has got below average scores in every measure, but the commonality among the 10 cities of this group[18] seems to be the growing specialization in one specific sector.

[18] These cities are mainly small-sized and in the South of the country.

Table 5- A cluster analysis on Italian major cities (Siemens, 2012)

FINAL CLUSTERS							
KIND OF MEASURES	1 Environmental cities	2 Wealth cities	3 Ideal cities	4 Good Living & Moving cities	5 Becoming cities	6 Energy cities	Average values
Environmental	84	75	88	74	35	50	68
Real estate	36	57	43	80	35	25	44
Mobility	38	40	74	76	30	15	40
Energy	49	19	58	10	18	59	36
Health service	16	70	84	37	20	5	32
Nr of cities	***17***	***8***	***4***	***7***	***10***	***8***	

Source: authors'elaboration

The best cluster is the "Ideal Cities" (cluster 3), which is composed by four medium sized cities in the North-East of the country, with the best scores in all the measures. It is followed by a small group of big cities (7) belonging to "good living and moving cities" cluster (4) where mobility and real estate stock are excellent if compared to the average values.
If Cluster 4 presents low scores in the environmental measure, in the "ideal cities" cluster 3 environment proves instead to be well taken into account.
Two other groups (environmental and energy clusters), which account for 25% of the cities sample, seem concentrated only on the environmental topic, while the wealth cities, a geographically diffused group, show good results referring to the real estate stock and the health service supply as well.

3 Data and methodology

The aim of the present paper is twofold. First, it aims at investigating the impact of smart characteristics on urban performance of the 103 Italian province (NUTS3) capitals in 2011, where urban performance is measured by housing market. Subsequently, differences and commonalities among the cities are explored by means of a cluster analysis.
Data on housing market prices come from the Scenari Immobiliari database, which records data at municipality level, in Italy, since the year 1993.
Smart characteristics, suggested by the Vienna model (Giffinger *et al,* 2007), come from various sources, as explained later, and have been grouped into six axes (the first column of Table 6).
The multiple definition of smartness is mainly based on the theories of regional competitiveness, thus considering the whole "infrastructural endowment" of the city, both the physical and the immaterial ones.

As a consequence, not only the "hard" factors, which account for efficiency like transport and ICT and natural resources, have to be taken into account, but also the "soft" ones, like human and social capital, quality of life, citizens' and stakeholders' participation must be considered. According to this model, a city can be considered "smart" if these dimensions are "smart" in turn: SMART environment (natural resources); SMART mobility (Transport and ICTs); SMART economy (competitiveness); SMART governance (participation); SMART people (social and human capital) and SMART living (quality of life).
According to the large multitude of rankings and empirical investigations presented in section 2, and adding some tweaks, the following variables for each dimension have been chosen for the empirical analysis (Table 6).

Table 6 - Dimensions, factors and variables

DIMENSIONS	*FACTORS*	*VARIABLES*
SMART Environment	**natural resources**	Waste management; Water and energy consumption; Green spaces; Air pollution; Climate
SMART Mobility	**transport**	Local Public Transport; Accessibility and parking; Bike-mobility; Car free areas; Low – emission vehicles; Traffic safety
SMART Economy	**competitiveness**	Innovation; Employment; Business vitality; Productivity; FDIs; Infrastructural endowment (transport and ICTs); Specialization
SMART Governance	**participation and sensitizing toward sustainability**	Local expenditures; Networks; Planning; Eco-management; Institutional role and (inter)national centrality; E-government;
SMART People	**social and human capital**	Digitalization; Voters; Foreigners; Long-life learning; Volunteers
SMART Living	**quality of life**	Infrastructural endowment (other than transport and ICTs); Cultural vitality; Social cohesion; Crime rates; Attractiveness; rankings?

It is worth saying that some changes occurred in choosing the variables if compared to the ones used by Giffinger *et al.*, as to better differentiate the six dimensions, as to cope with data availability. In fact, since it has been very important to find as many data as possible on the city-sample, the local scale (province capital) has been strongly preferred to the larger ones. Furthermore, unlike the Vienna model, no regional or national level data have been considered. In some cases, data related to the whole province has been collected instead of those for the province capital itself: this was due to lack of data but also to be able to analyse a higher impact scale.
Data were collected in desk research, by analysing primary and secondary data.
Despite the huge availability of data, a high correlation between couples of them suggested to reduce the number of selected variables to 14[19].

[19] A final correlation matrix is presented in the Appendix (Figure 4).

3.1 OLS estimation

The urban performance of the 103 NUTS3 province capitals is modelled by means of an OLS regression, where the dependent variable is $PRICE_c^{11}$, and the explanatory variables[20] are the following.

- $PRICE_c^{11}$ (€/sqm): market real estate price of the residential units in the semi-central area in 2011 (Scenari Immobiliari) (only for the OLS_2) ;
- $Tax\,Income_c^{10}$ (€): average taxable income per taxpayer, for each Italian province capital in 2010 (http://www. comuni-italiani.it) (only for the OLS_1);
- $JKsh_p^{10}$ (%) : is the share of firms in the J and K sectors[21] over the total, by province in 2010 (CNEL), and represents the innovation level of the province the capital city belongs to;
- $UnemplSh_p^{11}$ (%): is the share of unemployed people over the total in each province the capital city belongs to, in the year 2011 (Sole24Ore);
- $\mathrm{Im}mIntegrSh_p^{11}$: is a Cnel index measuring the immigrants integration level[22] in the province the capital city belongs to, in the year 2009 (CNEL);
- $Networks_c^{12}$: is the number of networks and associations the province capital belongs to on the total number of existing associations in the year 2012 (Ancitel);
- $\mathrm{Re}sponseRate_c^{12}$: is the administrative local institutions' replyness level, measured by the number of answers given to the Legambiente questionnaire in 2012 (Legambiente) (see section 2);
- $Uni\,\mathrm{Re}search_p^{12}$: is the number of universities and research centres in the city, year 2012 (Ancitel);
- $Pollution_p^{11}$: is the maximum number of times Particulate Matter (PM10) exceeded the limit level in the province capitals in the year 2009 (ISTAT);
- $PopWasteSh_c^{11}$ (%): is the share of inhabitants making separate collection of rubbish over the total at province capital level in the year 2011 (ISTAT);
- $BykeIndex_c^{11}$: is a complex ciclability index within the province capitals in 2011 (Legambiente);
- $Rain_p^{09}$ (mm): is the average of rainfall occurred in 2000-2009, at provincial level (ISTAT);
- $ElderlyFacSh_p^{08}$: share of facilities for elderly people over 1000 elderly in 2008 at provincial level (Ministry of Interior);

[20] For each variable the year of data collection is indicated in the superscript while c or p in the subscript stands for (province) capital or province itself, respectively.
[21] According to NACE (Nomenclature statistique des activite´s e´conomiques dans la communauté européenne) J and K are: Financial intermediation; real estate; renting, and business activities.
[22] In the index, Cnel considers the ability to gain access to local services (real estate market, education), and to be locally embedded (deviant behavior; naturalization – citizenship achievement – family reunification) .

- $InstitCult_c^{12}$: number of institutions and cultural goods in the province capital level in the year 2012 (Ancitel);
- $TouristsSh_p^{10}$: share of tourists staying overnight over the total inhabitants at the province level in 2010 (Sole24Ore).

Besides, region-capital dummy and macro-area dummy have been included in the model, in order to control for fixed effects. The equations suggest that urban performance defined as real estate prices is explained by the explanatory variables as defined above.

3.2 Cluster analysis

Once urban performance has been investigated, a cluster analysis is carried out in order to analyse similarities and differences of the province capitals in terms of smartness and urban performance. As concerns the k-means[23] Cluster Analysis, only 8 out of the 14 previous variables have been considered:

$PRICE_c^{11}$ (€/sqm $Tax\ Income_c^{10}$ (€): $JKsh_p^{10}$ (%) : $UnemplSh_p^{11}$ (%): $\mathrm{Im}mIntegrSh_p^{11}$: $Networks_c^{12}$: $Pollution_p^{11}$: $BykeIndex_c^{11}$: $TouristsSh_p^{10}$:

Besides, the size variable (population), as classified by Legambiente (2012)[24], has been added to the analysis.

4 Descriptive statistics

As concerns the geographical distribution of the 103 NUTS3 province capitals, they are located in the northern areas (45.2%), South and Islands (34.3%) and Centre (20.4%) (Figure 1).

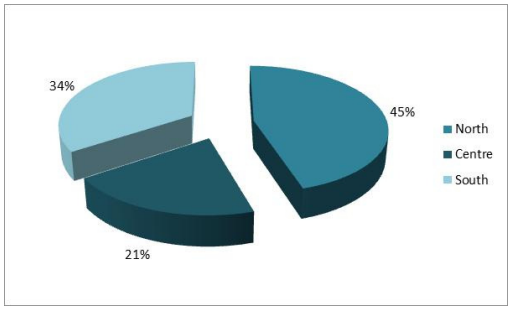

Figure 1 – Geographical distribution of the Italian province (NUTS3) capitals
Source: authors'elaboration

[23] In this kind of Cluster Analysis, each observation is placed in the group where it is closest to the means which represents the cluster itself.
[24] See footnote 14.

Focusing on the size of the province capitals, in the next Figure 2, it is possible to note that the most of the cities are medium-sized, while a third of the sample is composed by small cities. Only about 20% are big cities (more than 200,000 inhabitants) with only four of them above 1,000,000 people.

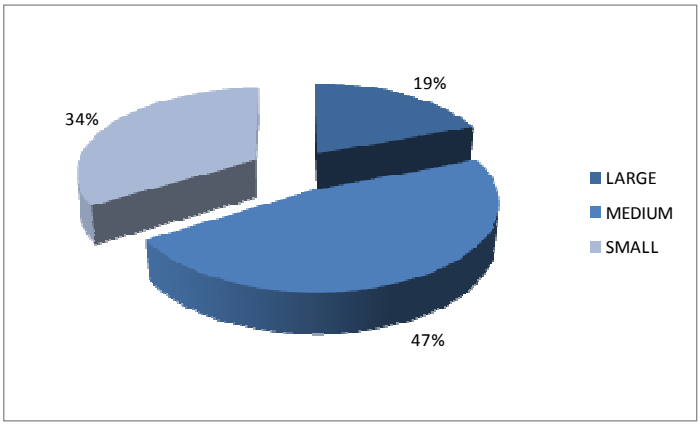

Figure 2 – Size of the Italian province (NUTS3) capitals
Source: authors'elaboration

Looking at the housing prices distribution among the capital cities, it results that about 10% show housing average prices ranging from 2,551€ and 4,550€ (cat.1 and 2), while the rest of the sample is almost equally subdivided into the left three categories (Table 12 in Appendix).
The housing prices of the first two categories (4,550-2,551) mainly refer to cities in the northern (7 out of 10) and central macro-areas (2 out of 10), while 88% of the southern cities belong to the lowest prices categories (4 and 5).

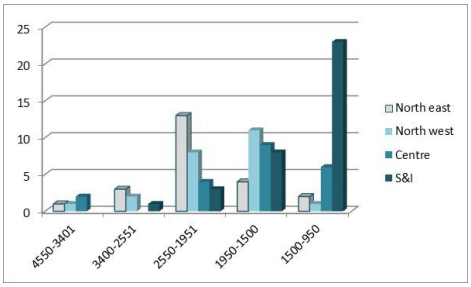

Figure 3 - Price-class distribution by Macroarea
Source: authors'elaboration

These first impressions are confirmed by the rankings of the first and the last ten cities in terms of housing prices (Table 7), with Rome, Milan, Venice and Florence in the first positions with the highest housing prices, followed by Bologna, Verona, Bolzano, Genoa, Naples and Turin characterised by housing prices in the second category. Conversely, the last 10 positions of the ranking mainly concern southern cities, with the exception of Rovigo and Gorizia in the less developed areas of the north east.

Table 7 - The first and last ten capital provinces – housing price

First ten	Price €/sqm	Last ten	Price €/sqm
ROMA	4550	ROVIGO	1250
MILANO	4300	AVELLINO	1200
VENEZIA	3950	CATANZARO	1200
FIRENZE	3850	TERAMO	1200
BOLOGNA	3400	GORIZIA	1150
VERONA	3150	LECCE	1150
BOLZANO	3100	VIBO VALENTIA	1150
GENOVA	2900	CALTANISSETTA	1100
NAPOLI	2800	CROTONE	1100
TORINO	2700	ORISTANO	950

Source: authors'elaboration

As concerns the wealth of the cities, a good proxy of the GDP[25] is the average taxable income per taxpayer in 2010 (Table 8). Despite high housing market prices, Florence and Venice seem to be less "rich" than other cities: they are only 15th and 41st respectively. Southern cities, as expected, have a minor part in building the internal revenue: the first in this ranking is Caserta, in 19th place.

Table 8 - The first and last ten capital provinces – average taxable income (IRPEF) per taxpayer – 2010

First ten	IRPEF 2010 (€)	Last ten	IRPEF 2010 (€)
MILANO	35.751	MATERA	22.805
BERGAMO	31.920	BRINDISI	22.645
ROMA	30.284	VERBANIA	22.601
PAVIA	29.987	FOGGIA	22.504
PADOVA	29.717	PRATO	22.381
TREVISO	29.465	RIMINI	22.275
SIENA	29.105	TRAPANI	21.853
ASCOLI PICENO	28.899	CROTONE	21.678
VARESE	28.807	MASSA – CARRARA	21.624
BOLOGNA	28.719	RAGUSA	21.102

Source: authors'elaboration

The housing prices are correlated with the other economy's variables, as expected. Indeed, cities with a more expensive housing stock are those with higher tax income, higher share of firms with high tech content (Knowledge intensive services), and with higher employment rate. Then better performing cities are expected to host universities and research centres, have higher amenities, attract inflows of tourists. Besides, according to Colombo et al. (2012a), housing prices are supposed to be higher in cities with less pollution, more green areas, located on the coast.

[25] GDP is not available at urban scale after 2004.

5 Results of the OLS estimations

The equation presented in section 3 suggests that the real estate price of the residential units and the taxable income in the 103 province capitals in 2011 is related to a list of smartness' characteristics belonging to six dimensions (Table 6; Table 9).

The results of the OLS regression, having real estate prices as dependent variable, are presented in the following Table 9[26] where four models have been run in order to control for the correlation between two variables (JKshare and UniResearchSh)[27], and to control for fixed effects.

It results that the Economy indicators are positive and significant, suggesting, as expected, that province capitals exhibiting higher tax income and specialised in industries with high-tech content are more willing to experience higher housing prices; conversely, cities with higher unemployment rates have a lower performance.

The cities specialised in high-tech industries are, therefore, expected to outperform those with more traditional, and lower value-added, sectors.

As concerns the "smart people" dimension, the availability of universities and research institutes is significant and positive suggesting that a city supplying this kind of services is better performing; conversely the index measuring the immigrants integration level at provincial level shows a negative and significant sign, thus stressing that the presence of immigrants, although well integrated, is still not positive for the housing market, by lowering average prices.

The results are not so steady for the Governance and Mobility dimensions, since they gain and lose significance within the models, while the Environment dimension seem not to have any impact on the housing prices.

Interesting results are then provided by two out of the three variables related to the Living dimension: tourism and cultural heritage, which influence positively the housing prices.

Both the variables proxy the city's attractiveness, thus underlying that higher tourist inflows are positively associated with urban wealth and economic performance (Caragliu and Dal Bo, 2011).

Finally, the geographical location of the province capitals play a role: being located in the North of the countries increases the probability to have higher prices. By contrast being the capital city of a region is not relevant.

[26] Descriptive statistics table of the explanatory variables is in Appendix (Table 12).
[27] Correlation matrix is available in Appendix (Figure 4).

Table 9 –OLS1

Dimension	Variable	Price_c^{11}	Price_c^{11}	Price_c^{11}	Price_c^{11}
		(1)	(2)	(3)	(4)
Economy	$Tax\ Income_c^{10}$	0.051921***	0.051358***	0.053748***	0.053188***
	$JKsh_p^{10}$	240.987***	237.2623***		
	$UnemplSh_p^{11}$	-31.5808***	-23.2098	-56.223***	-43.0048***
People	$\mathrm{Im}\,mIntegrSh_p^{11}$	-16.9526***	-16.2596***	-16.5274***	-16.0254***
	$Uni\,\mathrm{Re}\,search_p^{12}$			24.17474***	23.89541***
Governance	$Networks_c^{12}$	37.23117***	42.66081***	16.72397	22.48166*
	$\mathrm{Re}\,sponseRate_c^{12}$	-2.90944	-3.40445*	-1.40335	-43.0048
Environment	$Pollution_p^{11}$	-0.68757	-0.87854	-0.10184	-0.35077
	$PopWasteSh_c^{11}$	-5.98467	-6.82482	-4.10813	-5.10405
	$Rain_p^{0009}$	-0.32615	-0.35856	-0.0176	-0.09593
Mobility	$BykeIndex_c^{11}$	2.971613*	3.42406*	2.409295	2.732871
Living	$ElderlyFacSh_p^{08}$	0.550445	0.413728	0.22831	0.079027
	$InstitCult_c^{12}$	15.65109***	15.06742***	19.43383***	18.44719***
	$TouristsSh_p^{10}$	16.76364***	17.45921***	13.6985***	14.1261***
	_cons	1377.517***	1404.84***	1853.976***	1916.689***
	DummyRegion Capital	Yes	Yes	Yes	Yes
	Dummy macroarea	No	Yes	No	Yes
	Obs.	97	97	97	97
	P-value	0.0000	0.0000	0.0000	0.0000
	R-2 – adj	0.7957	0.7942	0.7942	0.8000

Significant at the 90% level; ** significant at the 95% level; *** significant at the 99% level.

6 Results of the Cluster analysis

A first attempt to cluster the 103 cities according to 11 variables[28] by means of a k-means CA has identified four clusters of homogeneous cities (Table 11).

The best performing cities are in the "Competitive Cities" Cluster (1): Roma, Milano, Venezia and Firenze. These are the largest cities, hosting high added-values activities (JK share), a good network of administrations and institutions (Networks), and various amenities attracting tourists (Tourist-share). On the contrary, despite a good sustainable mobility, pollution in these metropolis is very high. Housing market prices are also the highest.

[28] The selected variables (8 from the analytical framework, 1 clustered variable – density to control for the city dimension and two dummies, for macro-area and population) are described in Section 3.

Table 10 – Final clusters centroids

	Clusters				Average	Sign.
	1 Competitive cities	2 Specializing cities	3 Attractive cities	4 Liveable cities		
Price11	4163	1458	3008	2159	1895.59	.000
clustDensity	2.50	2.69	1.83	2.54	-	.168
JK_Sh	5.3	3.1	4.1	3.6	3.426	.000
ImmIntegr_Sh	45	54	49	55	52.599029	.041
BykeIndex	53.6225	20.4891	41.0433	39.8560	29.920404	.000
Unempl_Sh	7	10	8	6	8.51	.000
Pollution	38.9750	29.5071	34.5200	33.8969	31.957831	.022
Networks	17	5	11	8	7.01	.000
Tourists_Sh	15	5	14	9	7.14	.017
Centre	1	0	0	0	-	.303
North West	0	0	0	0	-	.126
North East	0	0	1	0	-	.007
South	0	1	0	0	-	.000
Small	*0*	*1*	*0*	*0*	-	-
Medium	*0*	*0*	*0*	*1*	-	-
Large	*1*	*0*	*1*	*0*	-	-
Number of cities	**4**	**58**	**6**	**35**	-	-

The second best performing group is the third one of the attractive cities, composed by 6 large Attractive cities mainly located in the North, which presents the same characteristics of the first cluster, even to a lower level.

Cluster 4, composed by the "liveable" cities, instead, includes 35 medium-sized cities all over the country with all the variables over the average, except for unemployment. They do appear as good cities to live in.

The tail end is Cluster 2, with the most of the cities located in the South and some other cities in the peripheral areas of the regions they belong to. These smaller cities have on average the worst scores in all the selected variable, but many of them presents results over the cluster average for one of the dimension, suggesting a possible future smart specialization which could help in improving the current situation.

Furthermore, considering both the results of OLS and Cluster Analysis in terms of the different dimensions, Economy proves to have a strong impact on housing prices (both unemployment and skilled employees are significant for the CA), together with Living.

Governance and Mobility, whose impact was undefined according to the OLS, have high scores in the cities with highest prices. In the CA the people dimension is represented by the measure of the level of social integration of immigrates, which seems to lower housing market prices. Pollution as well, for the Environment dimension, is higher in the richest cities.

7 Conclusions

The OLS analysis underlines the key role played by the Economy, People and Living dimensions. Indeed, it results that better performing cities are "richer", show high employment rates, are specialised in high technology sectors, host universities and research institutes, belong to a high number of networks, and are more attractive to tourists. These cities are, then, more likely to be located in the north of the country. On the other hand, better climate, lower pollution levels (Environment dimension), and better mobility (Mobility dimension) do not seem to significantly impact housing prices.
Similarly, the groups of the competitive and attractive cities, as defined by the CA, present good results in the economy, living, mobility and governance dimensions. Besides, they are located in centre-north.
In both the analyses, on the contrary, Environment doesn't seem to play a key role, as already highlighted by the empirical contributes quoted in Section 2.2 (Caragliu and Dal Bo, 2012; Colombo *et al*., 2012a and b; Siemens, 2012). Mobility, as well as density, is worth to be better and deeper analysed because their result is not univocal.

Focusing on the "specializing cities" of Cluster 2, it is worthwhile to select ''in each region a limited number of sectors in which innovation can most readily occur and a knowledge base built up. [This] approach [is] defined in the current policy debate as 'smart specialization''' (Barca 2009, p. XVII). Smart cities could have the best scores in many dimensions, but, since there is not "one-size-fits-all" strategy, for some cities the smart specialization could be the "therapy". Besides, this also implies that the success of an area or region is largely affected by the set of local institutions that are, in turn, path-dependent and rely upon the local characteristics.
Actually, if place-based policies matters on the way to smartness, they should be implemented, within a set of general priorities, by local actors with specific knowledge of the spatial dimension and characteristics of the area. It is, therefore, important to take into account both material and immaterial factors in framing specific place-based policies, both at the top-down and bottom up levels, aimed at achieving better urban performance through smart components.
Furthermore, fixed/geographical effects in both OLS and CA also suggest that differentiated policies are expected to be successful, thus depending on the regions they will be adopted.

Last but not least, smart cities – with their high level of data availability – will be faster and more effective in adopting strategies and policies.

Finally, further research needs to focus on the potential omitted variables issue, thus trying to better investigate the variables and dimensions that did not play a significant role in the present analysis.

A different investigation could involve Quality of life instead of Urban Performance as dependent variable, while spatial econometrics models could be profitably used to better analyse the topic.

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Appendix

Table A – Sample*

REGIONE (NUTS2)	PROVINCE (NUTS3)	Province CAPITAL	REGIONE	PROVINCE	CAPITAL
ABRUZZO	Chieti	Chieti	MARCHE	Ancona	**Ancona**
	L'Aquila	**L'Aquila**		Ascoli Piceno	Ascoli Piceno
	Pescara	Pescara		Macerata	Macerata
	Teramo	Teramo		Pesaro - Urbino	Pesaro e Urbino
BASILICATA	Matera	Matera	MOLISE	Campobasso	**Campobasso**
	Potenza	**Potenza**		Isernia	Isernia
CALABRIA	Catanzaro	**Catanzaro**	PIEMONTE	Alessandria	Alessandria
	Cosenza	Cosenza		Asti	Asti
	Crotone	Crotone		Biella	Biella
	Reggio Calabria	Reggio Calabria		Cuneo	Cuneo
	Vibo Valentia	Vibo Valentia		Novara	Novara
CAMPANIA	Avellino	Avellino		Torino	**Torino**
	Benevento	Benevento		Verbania	Verbania
	Caserta	Caserta		Vercelli	Vercelli
	Napoli	**Napoli**	PUGLIA	Bari	**Bari**
	Salerno	Salerno		Brindisi	Brindisi
EMILIA ROMAGNA	Bologna	**Bologna**		Foggia	Foggia
	Ferrara	Ferrara		Lecce	Lecce
	Forli - Cesena	Forlì		Taranto	Taranto
	Modena	Modena	SARDEGNA	Cagliari	**Cagliari**
	Parma	Parma		Nuoro	Nuoro
	Piacenza	Piacenza		Oristano	Oristano
	Ravenna	Ravenna		Sassari	Sassari
	Reggio Emilia	Reggio Emilia	SICILIA	Agrigento	Agrigento
	Rimini	Rimini		Caltanissetta	Caltanissetta
FRIULI VENEZIA GIULIA	Gorizia	Gorizia		Catania	Catania
	Pordenone	Pordenone		Enna	Enna
	Trieste	**Trieste**		Messina	Messina
	Udine	Udine		Palermo	**Palermo**
LAZIO	Frosinone	Frosinone		Ragusa	Ragusa
	Latina	Latina		Siracusa	Siracusa
	Rieti	Rieti		Trapani	Trapani
	Roma	**Roma**	TRENTINO ALTO ADIGE	Bolzano	Bolzano
	Viterbo	Viterbo		Trento	**Trento**
LIGURIA	Genova	**Genova**	TOSCANA	Arezzo	Arezzo
	Imperia	Imperia		Firenze	**Firenze**
	La Spezia	La Spezia		Grosseto	Grosseto
	Savona	Savona		Livorno	Livorno
LOMBARDIA	Bergamo	Bergamo		Lucca	Lucca
	Brescia	Brescia		Massa - Carrara	Massa
	Como	Como		Pisa	Pisa
	Cremona	Cremona		Pistoia	Pistoia
	Lecco	Lecco		Prato	Prato
	Lodi	Lodi		Siena	Siena
	Mantova	Mantova	UMBRIA	Perugia	**Perugia**
	Milano	**Milano**		Terni	Terni
	Pavia	Pavia	VALLE d'AOSTA	Aosta	**Aosta**
	Sondrio	Sondrio	VENETO	Belluno	Belluno
	Varese	Varese		Padova	Padova
				Rovigo	Rovigo
				Treviso	Treviso
				Venezia	**Venezia**
				Verona	Verona
				Vicenza	Vicenza

**Bold cities are also region capitals*

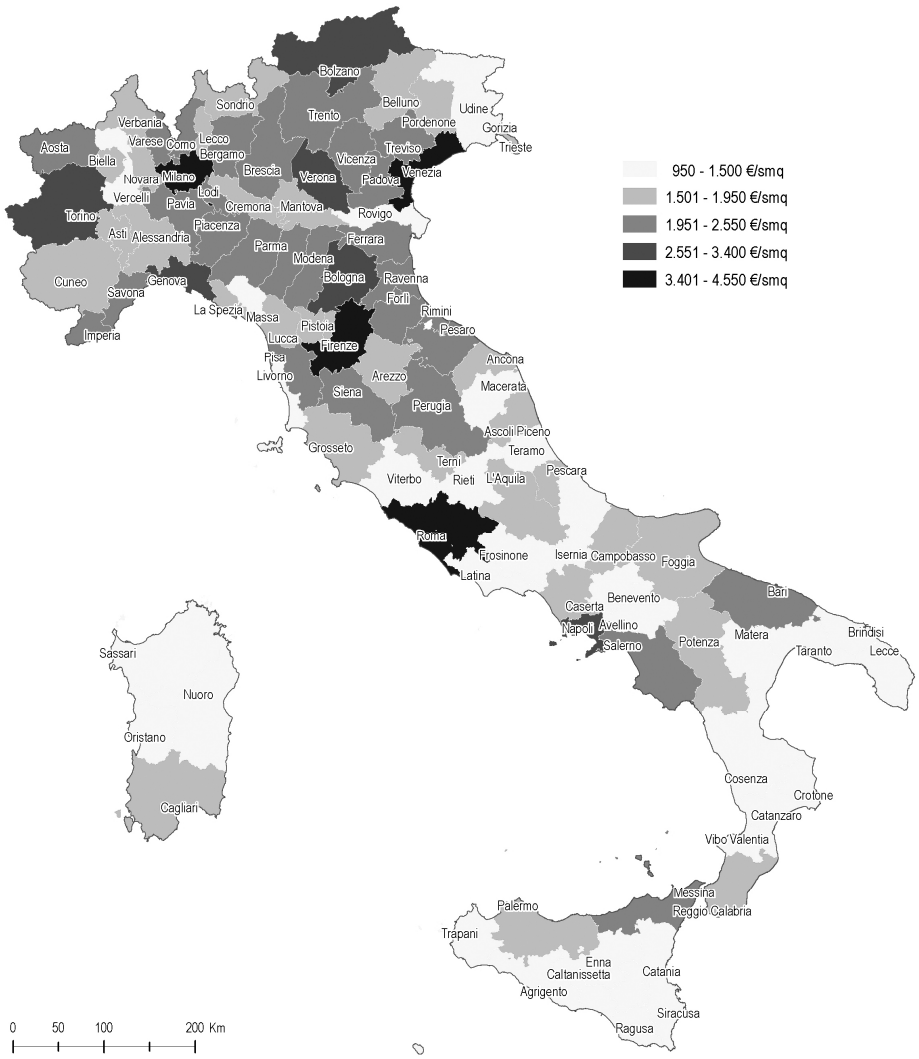

Figure 4 *- Housing prices in the 103 Italian province (NUTS3) capitals (semicentral) – year 2011*

Source: authors' elaboration on Scenari Immobiliari database.

	creat	p11	irpefcap	JKshperc	uniric~a	disocc11	insers~m	retias~c	indexr~c	smog	raccdi~c	indexc~b
creat	1.0000											
p11	0.6425	1.0000										
irpefcap	0.1613	0.3650	1.0000									
JKshperc	0.5064	0.6222	0.4504	1.0000								
uniricerca	0.3279	0.6411	0.3567	0.6165	1.0000							
disocc11	-0.5331	-0.3781	-0.2206	-0.3670	0.0879	1.0000						
insersocimm	0.1606	-0.2130	-0.1393	0.0863	-0.2424	-0.3559	1.0000					
retiassoc	0.4602	0.6517	0.1734	0.3373	0.5603	-0.1837	-0.1960	1.0000				
indexrispp~c	0.3410	0.1747	0.2566	0.2297	0.0223	-0.3463	0.1598	0.2522	1.0000			
smog	0.0980	0.2303	0.2195	0.2785	0.2039	0.0112	-0.0750	0.2598	0.0110	1.0000		
raccdiffperc	0.1301	0.1918	0.0952	0.2427	0.1214	-0.2431	0.0984	0.2549	0.0948	0.0290	1.0000	
indexciclab	0.4503	0.4519	0.2519	0.2926	0.1514	-0.4869	0.0685	0.3358	0.3763	0.2290	0.2076	1.0000
precipit	0.2732	0.1618	0.2396	0.4289	-0.0185	-0.5236	0.2541	-0.0318	0.1801	0.0369	0.1922	0.2109
anzaccstrut	0.4172	0.5747	0.3905	0.5252	0.6530	-0.1170	-0.1282	0.4275	0.1498	0.2746	0.0927	0.3096
istituzben~t	0.5037	0.5311	-0.2836	0.3124	0.3135	-0.0639	0.0452	0.4774	0.0313	0.2491	0.1382	0.2309
tourist10	0.3748	0.3108	-0.2996	-0.1158	-0.0686	-0.2897	0.0050	0.1636	-0.0254	-0.2296	0.1155	0.1205

	precipit	anzacc~t	istitu~t	touri~10
precipit	1.0000			
anzaccstrut	0.0511	1.0000		
istituzben~t	-0.0413	0.2739	1.0000	
tourist10	0.0510	-0.0297	0.3300	1.0000

Figure 5 *– Correlation matrix*

Table 11 - Average housing market prices (€/sqm) – macroarea

	Cat.1	***Cat.2***	***Cat.3***	***Cat.4***	***Cat.5***			
	4550-3401	3400-2551	2550-1951	1950-1500	1500-950	Tot	Tot (%)	Average price
North east	1	3	13	4	2	23	22.6	2245.7
North west	1	2	8	11	1	23	22.6	2087.0
Centre	2		4	9	6	21	20.4	1966.7
S&I		1	3	8	23	35	34.3	1497.1
Tot	**4**	**6**	**28**	**32**	**32**	**102***	**100**	1895.6
Tot(%)	**3.9**	**5.9**	**27.5**	**31.4**	**31.4**	**100***		

** data on the housing prices for L'Aquila are not available in 2011*

Table 12 - Descriptive statistics – explanatory variables

Dimension	**Variable**	**Obs.**	**Mean**	**Std. Dev.**	**Min**	**Max**
	$PRICE_c^{11}$	102	1895.588	676.9582	950	4550
Economy	$Tax\ Income_c^{10}$	103	25120.09	3293.3	2275	35751
	$JKsh_p^{10}$	103	3.418486	0.829671	1.89887	6.576933
	$UnemplSh_p^{11}$	103	8.495728	3.798464	3.34	17.84
People	$Uni\,\mathrm{Re}\,search_p^{12}$	103	4.38835	8.638983	0	67
	$\mathrm{Im}\,mIntegrSh_p^{11}$	103	53.76311	7.614215	30.5	69.9
Governance	$Networks_c^{12}$	103	7.009709	4.052342	1	20
	$\mathrm{Re}\,sponseRate_c^{12}$	103	81.54369	20.9985	0	100
Environment	$Pollution_p^{11}$	101	53.9802	44.75265	0	309
	$PopWasteSh_c^{11}$	103	97.32039	7.316666	60	100
	$Rain_p^{0009}$	103	782.0485	118.3673	465	1104
Mobility	$BykeIndex_c^{11}$	99	29.9204	25.47796	0	85
Living	$ElderlyFacSh_p^{08}$	103	132.3204	113.0368	20	767
	$InstitCult_c^{12}$	103	7.543689	11.52812	0	81
	$TouristsSh_p^{10}$	103	7.149417	9.338373	0.45	56.75