

**an analysis framework at the metropolitan level.**

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**Introduction**

The main metropolitan conurbations are, in every country of the global economy, the central engine of development. With the foundation of metropolitan cities, we witnessed a highly positive transition, in line with the best practices, which implemented in the big cities the change and innovation drivers, the internationalization gateways of national economies, as well as the preferred centers for the production of knowledge and all the necessary resources in order to face the international competition and overcome possible structural crises on a territorial basis.

**Methods**

We propose an analysis framework for the Real Estate profile on a metropolitan scale trying to depict the possible changes in the perception of Real Estate values by the market as a consequence of the new established Metropolitan Cities. Focus on data from the Real Estate Market Observatory (OMI – Osservatorio del Mercato Immobiliare), accessed on the basis of a partnership deal between Italian IRS. Our proposal for the analysis framework originates from the development of an index specifically created, the Correlation index. This index combine two indices created for NTN (Normalized Transaction Number) and GCR (Gross Capitalization Rate) and make them available in a Treemap graphic format. Thanks to the use of special analytical softwares and specific calculation algorithms, it is possible to show in a single image data in hierarchical scale, in this case NTN and GCR.

To develop this path, described and explained in this work, we have used as a starting point the OMI database. The OMI database uses the method of average prices and homogeneous zones and is categorized as follows:  
property prices; rents; volumes of trading in the semester.  
The volumes of trading represent the volumes of real estate traded during the sixmonth periods of each year and the dynamism of the homogeneous zones through the Normalized Transaction Numbers (NTN) and the Real Estate Market Indicators (IMI).

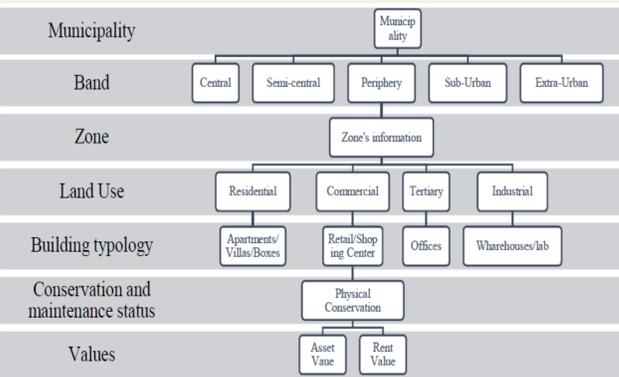


Figure 1: OMI's data structure about property prices

**Analisis of real estate dynamics by the OMI data**

The sales and rents used to calculate the minimum and maximum quotations for each OMI zone, contain samples of transactions and offers of sale/rental provided by legal documents or by real estate agency announcements. Each sale or lease has: cadastral data, date of acquisition, municipality, intended use, type, location and intrinsic and extrinsic features of the unit sold such as vicinity to public transport, amenities, commercial center, architectural features, types of finishing, etc.

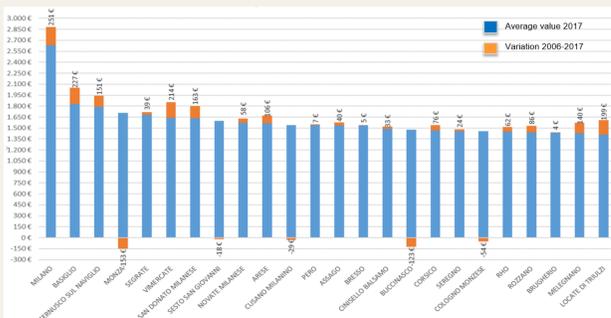


Figure 2: Real estate trends of the first twenty-four municipalities of the Metropolitan City of Milan.

Moreover we adopt an index to monitor the correlation of six-months variations in GCR (gross capitalization rate) for each of the 134 municipalities of the Metropolitan City. The calculation of the profitability rate, it was preferred to omit the estimate of the expense components, thus determining Gross Capitalization Rates (GCR):

$$GCR = \text{Gross Annual Rent} / \text{Gross Property Value}$$

**Results**

**NTN-GCR Treemaps**

We decided to carry out a further analysis, providing in a new graphic layout two types of data analyzed so far, the number of transactions NTN in the Metropolitan City of Milan and the gross capitalization rates GCR, data divided into 4 analysis sectors for all 134 municipalities of the metropolitan city. To do this, we had to choose a graphic capable of rendering, in an overall view, two values linked to each individual municipality, making it possible to read 134 municipalities as a whole. We have used Microsoft's Power BI software to do this.

**•Correlation Matrix in R environment**

To visualize the correlation model in terms of signs and magnitudes using visual dimming and variable sorting and we integrated these methods within a coherent framework based on the principles of correlation and correlation order, with various details and comparisons. The method chosen is useful for visually coding a correlation value to show both its sign and its magnitude, with the aim of representing the model of relationships between variables in a potentially wide matrix of correlations.



Figure 3: Correlation Matrix 2017\_1 for the 10 selected municipalities with alphabetical ordering

**Correlation Map in GIS environment**

In support of these index we have proposed and developed, Correlation Matrices and Georeferentiation based GIS Technology (Geographic Information System), which form and complete the framework of analysis with more dynamic and interactive data visualization tools and indicate the reciprocal behavior. Using the distributed calculation package in collaboration with ESRI, a leading company in the GIS sector through ArcGIS, we were able to create the graphics shown in the following figures.

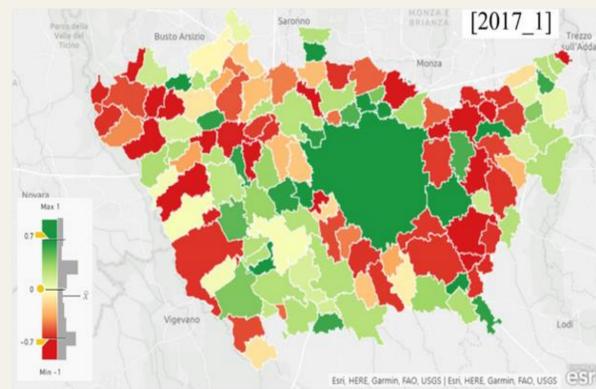


Figure 4: GIS Correlation Map 2017\_first semester

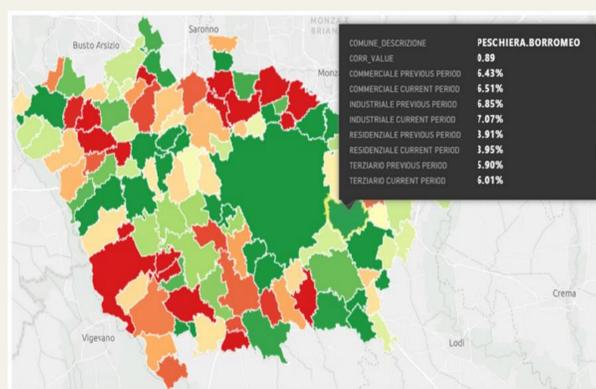


Figure 5: Dynamic, representative and intuitive GIS Correlation Map

**Literature Background**

**The concept of correlation**

The three concepts are popular: scatter plot, regression and correlation. It is possible to think that two characteristics are linked by a linear equation of the type  $y = ax + b$ , where a and b are respectively slope and intercept. This relation is called linear regression of y on x; obviously, many relations are not necessarily so simple as they can depend also on other factors; moreover, possible inconsistencies in the equation can be modelled as additive or residual errors. Galton-Pearson's theory of linear regression includes a useful and very popular parameter called the correlation coefficient. This coefficient shows the extension of the linearity in the relation between the two characteristics while its square, indicated as a coefficient of determination, can be used for a quick check of the validity of the regression in fact it shows the proportion of the variance of y that is taken into account by the regression. The correlation coefficient, in general, is between -1 and 1 and a value close to 1 or -1 indicates a high extension of the linear dependence between the characteristics; a low or zero value of the correlation coefficient does not necessarily mean no relation, but rather no linear relation.

**Conclusion**

This approach, however, are reproducible outside the Italian borders, and even on territorial scales different from the Metropolitan City. In fact, single municipalities divided by their homogenous zones could be analyzed, they could be analyzed without confinement in an entity such as a City or a Region, even areas in different Countries. Following our approach, the calculated Treemaps provide easy reading and recognition of the predominant zone in the industry, which does not always have to be the apparently most obvious zone. Then, the analysis of the correlation indicates the boundaries of the other zones' behavior with respect to the predominant area highlighted, and this, in our opinion, has excellent applicability on several territorial scales. Sure of the modernity and innovation in the use of data that could help in many tasks related to the real estate industry.

**References**

- Baiardi L, Morena M (2009) La globalizzazione e i cambiamenti delle aree urbane Marketing territoriale eds. - Milano: Il sole 24 Ore;
- Caragliu A, Del Bo C and Nijkamp P (2011) Smart cities in Europe Journal of Urban Technology 18, 65-82
- Kitchin R, Laurialt T P and McArdle G (2015) Knowing and governing cities through urban indicators, city benchmarking and real-time dashboards Regional Studies, Regional Science 6-28.
- Vanolo A 2014 Smartmentality: The smart city as disciplinary strategy Urban Studie 51, 883-898
- ARUP (2013) Smart actions in Italian metropolitan cities [Online] Available at: <https://www.arup.com/publications/research/section/smart-actions-in-italianmetropolitancities>
- OMI (2018) Manuale della Banca Dati Quotazioni dell'Osservatorio del Mercato Immobiliare.
- OECD 2017 OECD Economic Surveys: Italy 2017 (Paris)

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