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IMPACT OF SOCIO-ECONOMIC VARIABLES ON PROPERTY CONSTRUCTION COST: EVIDENCE FROM ITALY

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Abstract: *For an accurate real estate cost evaluation, it is important to break down and analyze its various technical and socio-economic cost components. Carefully examining the factors coming to bear on the final cost of a property enables a more effective project management and a greater control over the feasibility of the project concerned. In the present study, we analyze a sample of 70 new residential properties built in Italy with the aid of an interpretative model. The approach takes the strictly technical characteristics of the building sector into account, but also identifies the close correlation (little studied in the sector's scientific literature) between the trend of construction costs and socio-economic conditions of the reference setting such as the workforce's mean years of schooling, the housing market trends, and the average per capita income.*

Keywords*: real estate, externalities, construction cost, education index, human capital*

1. INTRODUCTION

Numerous studies have been conducted on the relationship between the size of a town or city and the value of its real estate asset, but much less has been done to correlate the production costs of a modern city with the variability in these costs from one city to another. Transformations undertaken by private entrepreneurs is a fundamental aspect to our understanding of how contemporary cities are evolving. Just as the *smart specialization* (McCann and Ortega-Argilès, 2015) of a city correlates with the value of its real estate, so too is its cost structure influenced by the relational dynamics between agents operating on the market.

The aim of the present study is to identify and validate which socio-economic factors influence the production cost in a given city. Although our discussion is based on an empirical and statistically well-founded analysis. The main goal of the paper is to shed light on those factors that are not merely technical, but typical of different urban economies, and capable of engendering differences in the cost of planning and developing new buildings.

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The article is organized as follows. The first section describes the state of the art as concerns research on city production costs, identifying some weaknesses in the literature on this topic. The second section outlines our hypothesis that the local population's education index clearly correlates with the cost of urban development. The third section describes the framework and outcomes of our statistical analysis. The last section summarizes our conclusions in the light of our findings and suggests new lines of future research on the topic.

2. REAL ESTATE CONSTRUCTION COST

Construction costs: performance, externalities and urban context

A proper *ex ante* assessment of the cost of any proposed construction is essential in order to establish the project's feasibility. This is particularly true in the case, for instance, of brownfield requalification within a densely-built urban fabric because the variables involved in the completion of such large-scale projects are numerous and difficult to predict.

It is important to arrive at a precise assessment of the transformation and implementation costs of a given project, both for the developer and project manager, and also for the construction company. The ability to accurately calculate the cost performance is a factor that contributes to reducing the global risk inherent in the completion of the works (Baloi and Price, 2003). Hence the abundance of literature focusing on the effective prediction of city construction costs, which can be roughly divided into three main areas of investigation. Though they partly overlap and are certainly interconnected, these areas nonetheless feature certain important specificities relating to: the identification and definition of the most effective statistical models for accurate cost prediction; the analysis of the single, technical and organizational factors that influence and engender construction costs; and the elucidation of the reasons for the so-called *cost overrun* (D'Alpaos and Canesi, 2014), i.e. the systematic increase in the cost of completion of a building project with respect to the *ex-ante* prediction.

In the first of these three areas, the literature has focused on developing statistical models for predicting construction costs, i.e. for estimating the *ex ante* cost of development project by a set of variables judged to be the most relevant (Calabro e Dalla Spina, 2014; Camagni *et al.*, 2014). The statistical models most often used in this setting are regression analyses, fuzzy methods and artificial neural networks (Hwang, 2009; Lowe *et al.*, 2006). While regressions mainly use quantitative data, factor analysis investigates the relationship of dependence between the cost and the quantitative and qualitative factors influencing it, such as jobsite organization, the construction company's experience, and the professional expertise of the skilled workers employed (Akintoye, 2000; Chan and Park, 2005; Trost and Oberlender, 2003). Fuzzy set theory and fuzzy logic are used, on the

other hand, to orient and support decision-making processes in conditions of uncertainty, and when the information available is only partial or incomplete (Zimmermann, 2001); they are particularly useful for managing global risk (Carr and Tah, 2001; Morote and Ruz-Vila, 2011). The use of fuzzy logic therefore places the emphasis on the intrinsically aleatory nature of the information available for use in estimating the cost of completing a project. Similarly, the use of neural networks enables a more accurate prediction of construction costs than can be achieved by means of regression analyses (Hegazy and Ayed, 1998; Kim *et al.*, 2004), especially in the preliminary design stage, when the information available are limited and liable to change during the conceptual building development (Baloi and Price, 2003).

Although they are hugely important from the technical and scientific standpoint, cost prediction models alone are unable to investigate which variables are the most significant in influencing the structure of the cost of a given construction; they have to rely instead on those already established in the literature. It would seem to be of considerable interest, however, to examine which components of a project or jobsite are particularly important in influencing the accurate prediction of the planned construction cost.

We can identify several fundamental features involved in the assessment of these costs, including the quality of the design work, the technical and engineering elements, the construction site setup, the quality and location of the works (Kousloulas and Koehn, 1974), the construction company profile, and the type of contract adopted for the building works.

The characteristics of a project believed to correlate most strongly, by the literature, with the construction cost are the height of the building, the number of floors, the structural solutions adopted, and the building technology employed (Brandon, 1978; Karshenas, 1984). Some studies have suggested other influential characteristics to consider, such as the shape of the building - partly because of the potential increase in the construction cost in the case of projects demanding advanced technologies (Belniak *et al.*, 2013), or featuring typically high-density typologies with elements of risk and a financial exposure that are difficult to quantify in advance (Antoniucci and Marella, 2014 and 2016; Kaming *et al.*, 1997). Other authors have mentioned the importance of jobsite organizational aspects (Lessard and Miller, 2001), underscoring how project management issues can influence not only the accurate estimation of the construction costs, but also and more importantly the containment of the overall risk related to the completion of the works (Baloi and Price, 2003; Canesi *et al.*, 2016).

Despite the vast body of literature on the topic of construction costs, the debate has always concentrated on the strictly technical aspects, which certainly is important and necessary, but fail to cover all the facets of this highly complex matter. There are socio-economic and cultural elements that influence not only

construction costs *per se*, but also and particularly the territorial variations of these costs. Factors such as the incomes of families and businesses, and the population's mean years of schooling (or level of formal education) have been amply investigated in urban economics, but placed exclusively in relation to property purchase prices and values.

The relationship between local culture, enterprising spirit, advanced services, and the growth of a city has now been well established and shared by scholars of the economies of agglomeration (Florida, 2005). Several studies have demonstrated the correlation between property prices in metropolitan areas and the presence of university institutes and districts with advanced services, identifying the importance of the *creative class* (Glaeser, 2012). But the topic of the *skilled city* (Glaeser *et al.*, 2004) only deals with how better levels of formal education, an enterprising culture, and higher incomes are associated with rising property prices. What is completely ignored is the important influence that these socio-economic aspects can have on construction costs too, which are a core contributor to properties' value.

Family incomes and construction costs are recognized as influential factors in the formation of real estate values (Potepan, 1996), but there is a paucity of studies to identify the relationships between property values, construction costs, and income-related and cultural aspects. The link between human capital and industrial production costs cannot be taken for granted, although some scholars have found a positive correlation between a better formal education and a higher income for all types of worker (Moretti, 2013; Moretti and Thulin, 2013). In Italy, production costs in the building sector unquestionably depend largely on the income levels of the workforce. It is therefore important to examine the potential correlations between levels of formal education and the costs of building works.

Socio-economic factors and construction cost performance

This study thus aims to shed light on the possible links between the cost of building residential properties and the pertinent socio-economic aspects. To grasp the fundamental factors involved, a first step necessarily entails selecting which variables are the most representative from the cultural and economic standpoint. To do so, it is best to start from studies that have placed the performance of real estate values in relation to the size of the *skilled city* (Glaeser *et al.*, 2004). Studies on the economic structure of innovation hubs have emphasized the importance of human capital. The link between the diffusion and high output of advanced technologies and the increase in employment levels and individual and global incomes gives rise to "a new geography of jobs" (Moretti, 2013).

Studies conducted by Lucas (1988) and Glaeser (Glaeser *et al.*, 2005; Glaeser and Ressenger, 2010) showed that per capita income correlates with the presence of qualified and well-learned workers in a given territory due to cognitive

interaction processes, complementarity, creativity and development. These social structures constitute what the economists call externalities of human capital: interaction and knowledge sharing generate new ideas, with a consequently greater productivity and economic growth, which are translated into a generalized rise in salaries. This first affects the better-educated, skilled workers (the so-called creative class), and then has a cascading effect on all the other, less specialized workers.

So the value of real estate is strongly influenced by specific factors in a given population, such as family and company incomes, and levels of formal education. Innovation influences not only the job market, but the property market too. Briefly every aspect that makes a city attractive ends up being at least partly capitalized in an increase in the value of its real estate (Moretti, 2013). We therefore tested the link existing between the diffusion of higher education and the average income of the workforce as a whole. If these factors influence property values, they may be important in determining construction costs as well.

It is well known that, in the breakdown of construction costs, the item of expenditure with the greatest influence is the cost of labor. In 2015, the construction cost index calculated by the Italian Statistics Institute (ISTAT) attributed a weight of 52.6% to the cost of labor (up 1% from the figure calculated in 2014). This incidence makes construction costs highly sensitive to variations in workers' incomes. That is why it seemed worthwhile to test whether and how families' per capita incomes can have a proportional influence on the composition of the cost of constructing a city today. Since the literature has also established the correlation existing between incomes (salaries) and the level of formal education in the American metropolis (Moretti, 2013), it is worth testing for this potential relationship in the Italian setting too. To do so, in the model proposed in the following section, we include several socio-economic variables for testing possible correlations between income, level of formal education, and the cost of building residential properties on the Italian market.

3. MATERIALS AND METHODS

Research objectives

The aim of our analysis is to test for potential relationships existing between city construction cost performance and several variables capable of representing the socio-economic and cultural aspects characterizing a given territory, without neglecting some of the relevant technical characteristics, used as a tool to control for any variance.

Data and classification

It has to be said that it is more difficult to find data on the Italian context than elsewhere on the international scene. Being well aware of this difficulty, and given

the limited number of cases available, we chose to restrict our analysis and sample new builds in a limited area (rather than the whole country) in order to remove several variables relating to purely territorial dynamics. The sample analyzed consisted of 70 new residential properties built in north-eastern Italy between 2006 and 2015. Our data were collected from qualified sources, i.e. operators in the building sector active in the reference area. To be able to compare the cases in our sample without having to introduce too many variables in the subsequent development and validation of our analysis, it was necessary to establish that certain basic characteristics were shared by all the selected development projects. This ensured some degree of homogeneity in aspects that were of limited interest for the purposes of the present study. The homogeneous characteristics chosen for our sample were:

- type of construction: residential apartment block;
- type of development: new build;
- time of construction: from 2006 to 2015;
- location: in the regions of Veneto (municipalities located in all provinces) and Lombardy (municipalities in the provinces of Milan, Monza and Bergamo).

The data collected were divided into independent input variables and a dependent output variable. The dependent variable was the construction cost (*CC* in €/m^3) of the building project analyzed. The independent variables included some chosen from among those considered in the literature, plus several others judged to be capable of better interpreting the socio-economic and cultural characteristics of the local populations. In addition, the developers involved in the survey were asked to complete a chart in order to sample the different types of building in the database. After compiling and completing the full database with all the data collected, the number of independent variables was reduced to 9: any variables mutually and exclusively correlated with one another were removed first, then those less meaningful for the purposes of the present study. Then the selected variables were clustered together as shown in Table 1.

Table 1
Independent variables of the model.

Building Characteristics	*Development Characteristics*	*Real Estate Market*	*Socio-economic Characteristics*
• Volume (Vol) • Number of Floors (NF) • Building Quality (Qu)	• Duration of construction (Du) • Company size (CS)	• Planning Permission (PP) • Market Value (Val)	• Incomes (Inc) • Numbers of graduate (NGr)

The first two categories (*Characteristics of the building*, and *Characteristics of the building process*) were used as control variables, to analyze the variability of the physical and technical features of the buildings considered. The last two categories (*Characteristics of the local real-estate market*, and *Socio-economic characteristics*) represent the core aspects of the present investigation. The selected inputs are described below:

- *Characteristics of the building*. To describe the building in physical terms, we chose three variables that intrinsically represent the physical characteristics of an apartment block, i.e.
  - Volume (Vol) of the building in m^3 for town-planning purposes, which includes all interior volumes above ground plus 60% of those below ground;
  - Number of Floors (NF), to investigate the relationship existing between the height and density of a building and the construction cost per m^3;
  - Quality (Qu) of the building, as a control variable with a view to explaining the model, given that the quality of the design work and of the materials employed explain a significant part of the cost level of a piece of real estate.
- *Characteristics of the building process*. Two types of variable were chosen as significant indicators of the building process, investigating the methods used to complete the process and the stakeholders involved:
  - Duration of the building site (Du), in months, to test for any presence and preponderance of economies of scale due to the dilution of the fixed costs, or the prevalence of an increase in the overrun costs with any prolonged duration of the building site;
  - Size of the construction Company (CS), to test the dependence of the costs on the size of the firm, considering two possible interpretations, i.e. the existence of economies of scale or a competitive advantage for the smaller-sized companies.
- *Characteristics of the local real-estate market*. To seek any correlations between construction costs and local real-estate markets, we chose two variables that reflect different aspects and formalizations of the sector:
  - Building Permits (PP), which represent the liveliness of the property market in a given area;
  - Unit market Value (Val), expressed in €/m^2, deduced from the market prices quoted in the database of the *Consulente Immobiliare* journal published by the *Sole24Ore* daily newspaper. Each item included in the database refers to the corresponding market sector, the location and the time of construction, subsequently actualized by means of the ISTAT index.

This input was used to identify any correlations between construction cost, attractiveness of a particular market, and the balance between supply and demand.

- *Socio-economic characteristics.* As mentioned in the previous sections, construction costs are influenced by the physical and technical characteristics of development project, but the local population's level of income and formal education can also significantly affect the trend of the property market. The variables chosen in this category to reflect the latter influence were consequently:
  - Mean gross Income (Inc) of the population in the municipality taken for reference;
  - Number of university Graduates (NGr) in the population of the municipality where the property is to be built, to see if any correlation exists between the level of the population's formal education and the construction costs of residential properties on the Italian market.

As for the output of our model, the unit cost of the completed building (€/m^3), it is important to note that the resulting value was actualized by applying the ISTAT index to the whole sample in order to avoid any temporal bias.

The interpretative model

To identify any correlations between construction cost performance and the socio-economic context in a sample of Italian cities, we conducted a descriptive statistical analysis on the sample collected (Fig. 1).

The results identified a mean construction cost of 348.62 €/ m^3, with a near-Gaussian distribution where 75% of the properties incurred unit costs below 380 €/ m^3. A slight positive asymmetry emerged, due to the median value being lower than the mean, pointing to the presence of a slight preponderance of properties with construction costs below the median (Fig. 2).

Variable	Mean	SE Mean	StDev	Variance	Minimum	Q1	Median	Q3
Vol	9861	630	5235	27407246	525	6510	8634	14136
NF	5,058	0,278	2,313	5,350	2,000	3,000	5,000	6,000
Du	23,536	0,742	6,163	37,988	9,000	19,000	25,000	28,000
CS	3,290	0,101	0,842	0,709	1,000	3,000	3,000	4,000
Qu	3,043	0,125	1,035	1,072	1,000	2,000	3,000	4,000
Inc	18099	397	3297	10867939	11216	15720	17741	18686
PP	256519	16421	136405	18606239571	44638	166362	185517	454327
Val	2071	102	848	719655	1075	1500	1825	2450
NGr	3146	398	3305	10924104	99,0	495	2896	4783
CC	348,6	12,3	102,2	10447,9	169,0	307,2	343,7	380,0

Figure 1: Sample's descriptive statistic

Concerning the physical characteristics of the buildings, they had a mean volume of 9,861 m^3, which roughly corresponds to apartment blocks consisting of approximately 30 apartments on five floors above ground (Fig. 1). The quality of the buildings (which was usually good) and the size of the construction companies involved were both perfectly consistent with the median of the reference sample, showing a Gaussian distribution indicative of typical quality levels and entrepreneurs (Fig. 2). When it came to construction times, on the other hand, the

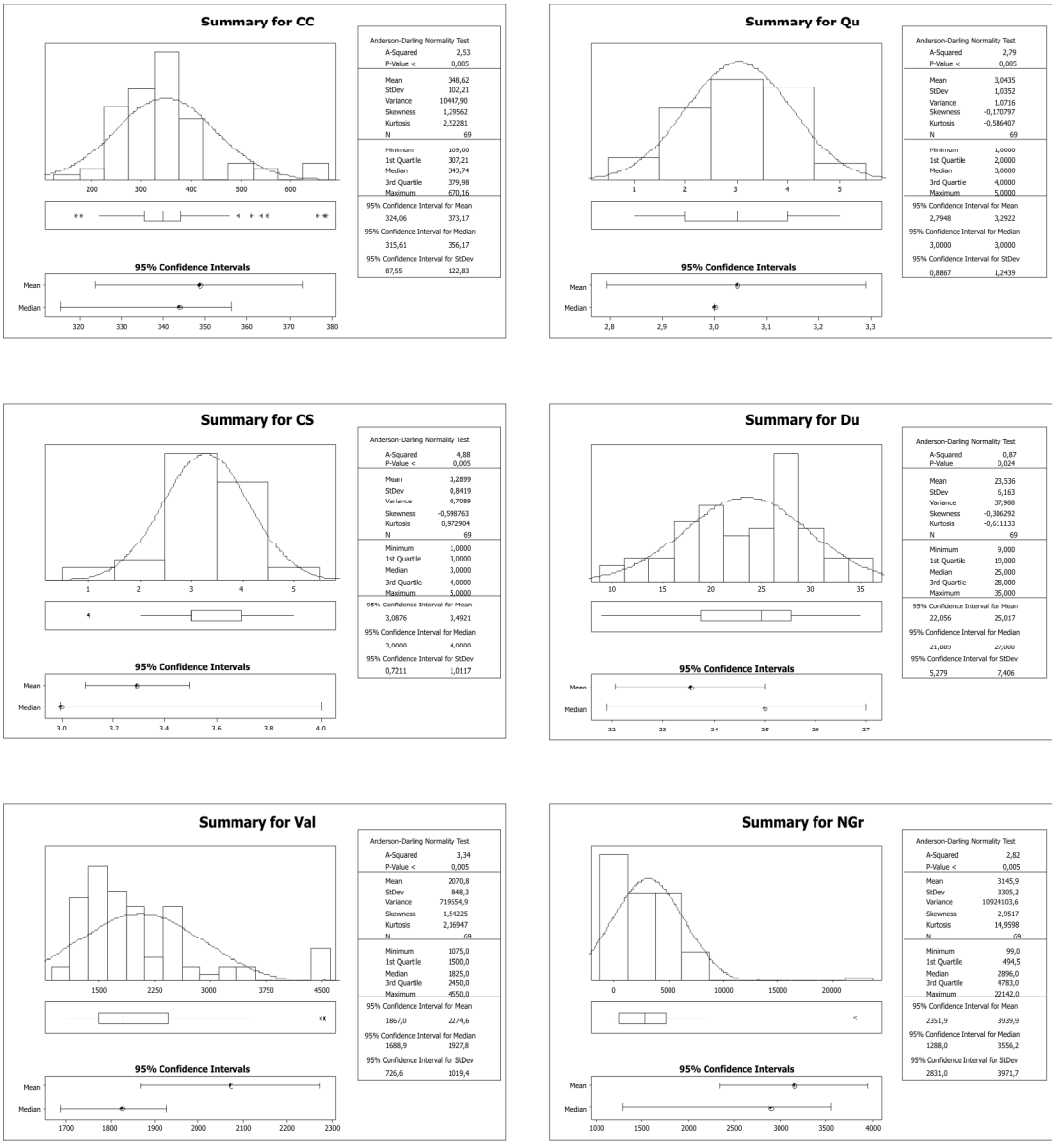

Figure 2: Descriptive statistics for CC, Qu, CS, Du, Val and NGr variables

mean duration of the jobsites for our sample was 23.5 months, with a distinctly platykurtic distribution indicative of a marked variability due to the high standard deviation and a modal value of approximately 27.5 months, a considerable rightward shift with respect to the mean value identified (Fig. 2).

The characteristics used to describe the reference property market and the socio-economic characteristics identify new buildings' development located mainly in provinces/municipalities where the mean per capita income (€18,107) is higher than the average for the surrounding region (€14,537). It should be noted, however, that there was a considerable scatter of our data, with a high standard deviation. As for location, the municipalities considered issued a high mean number of building permits (258,519) due to a very marked positive asymmetry that reveals a conservative new-build strategy in municipalities already active from the real-estate and entrepreneurial standpoints.

The markets with the largest number of new buildings were also those with price quotations ranging from 1,500 (first quartile) to 2,450 €/m^3 (third quartile), although the mean for the sample was 2,070.8 €/ m^3. This was due to an evident positive distribution that confirms an inertial tendency to build in markets that are already active and economically receptive on the one hand, and on the other a tendency to build in markets where the demand settles around more modest selling prices but the number of sales completed is higher (Fig. 2). Concluding our descriptive analysis of the sample of new residential buildings considered, we identified a mean 3,146 graduates in the reference municipality, but the first quartile (with approximately 500 graduates) gave rise to an evident positive asymmetrical distribution, and consequently to a preponderance of the properties in our sample being built in municipalities with fewer graduates (Fig. 2).

The correlations identified by the scatter plots (Fig. 3) reveal the types of association existing between the construction cost output and the different independent variables considered.

The variables in the category *Characteristics of the building* confirmed the economies of scale on the volume of the buildings, validating (as expected) an inverse linear dependence in relation to the construction cost of the building. This reflects the peculiarities and practices of the model of Italian residential properties, with a purely extensive, flat market rather than an intensive, high-density one.

The *CC* variable revealed a positive dependence on *quality* (Qu), as was to be expected because this characteristic was included in the model as a control variable.

As for the *Characteristics of the building process*, the *duration of the building site (Du)* variable was found positively correlated, validating the assumption that any prolongation of the construction works coincides, *ceteris paribus*, with a more than proportional increase in the fixed jobsite costs that would override any potential

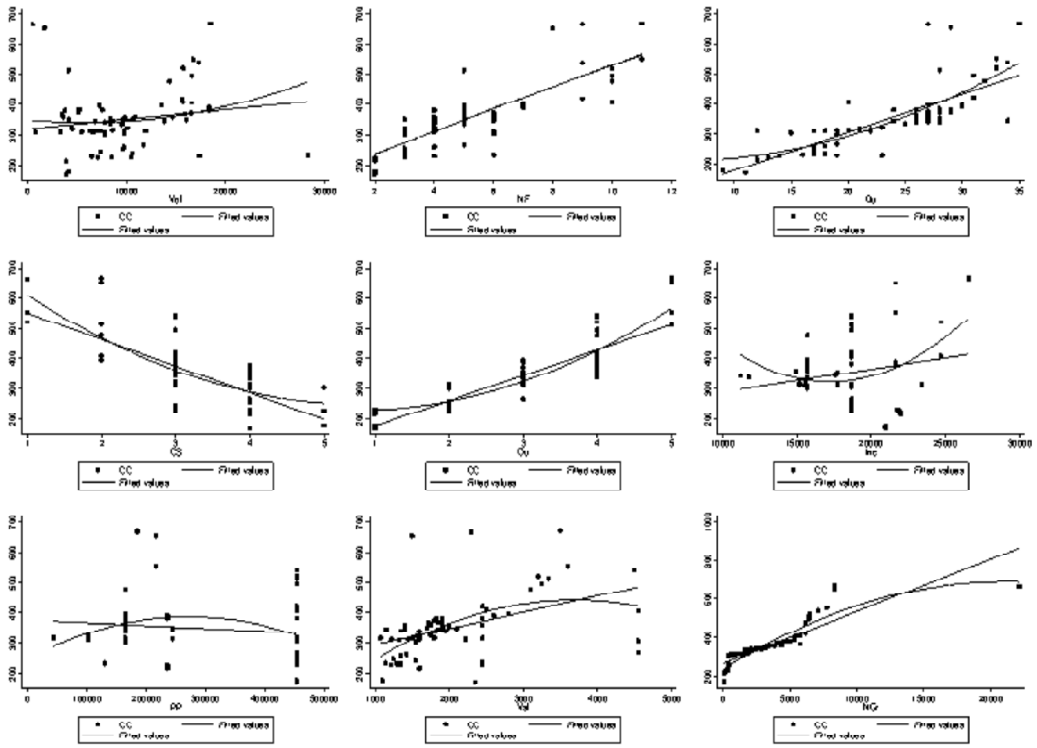

Figure 3: Scatterplots with independent variables and the CC dependent variable

advantages achievable from economies of scale deriving from the simultaneous operation of several jobsites. The mean size of the construction company in the sample represents mid-size enterprise.

The characteristics referring to the category of the real-estate market predictably confirmed a positive association between construction costs and the market values recorded.

As regards the group of *Socio-economic characteristics*, it is worth emphasizing that both the variables considered (*Income* and *Number of graduates*) were found positively correlated with the dependent variable, identifying a tendency for higher modern city construction costs in provinces with higher incomes and a better formal education. These correlations suggest that higher levels of economic and cultural activity and dynamism coincide with proportionally higher levels of market supply and demand, consequently influencing the quality and the cost of properties, which is interpreted in economic terms as the point of equilibrium between supply and demand. This result is well-established in the literature on prices, but novel when applied to the field of new urbanizations and the modern city building sector.

Our analysis thus confirms dependences already known in the international literature, but hitherto not tested and validated in the Italian scene. It also identifies strong associations between the socio-economic fabric of an urbanized territory and the cost of new buildings, and therefore - more in general - the encounter between supply and demand in the residential property market.

Our investigation aimed to consider not only the construction phase proper, but also and especially the earlier stages, as a tool for supporting decision-making in the design stages and even earlier, in urban planning. Making the right choices early on is fundamentally important to the future success and marketability of any building project.

4. CONCLUDING REMARKS

Our empirical investigation conducted on 70 building projects completed in northern Italy identified a strong correlation between construction costs and the local population's level of formal education and per capita income. The relationship that emerged was by no means obvious, especially in such a traditionally static context like the Italian one, where cost component analysis is usually done by technical features which rarely grasp the correlation with urban dynamics.

Finding higher construction costs with rising numbers of graduates and higher per capita incomes points to an evolution in the Italian urban domain that has something in common with the cities of North America, particularly as regards the fallout of economies of agglomeration. It is important to underscore this aspect in an effort to predict the evolutionary dynamics of our cities in terms of private investments. City expansion and regeneration are not only a matter of real-estate markets, in terms of property purchases and sales; they also depend on the trend and variation of construction costs for urban transformations, a large proportion of which concerns the cost of the manpower involved.

The concentration of service industry economies, research centers and creative entrepreneurships in the main urban centers generates a generalized increase in per capita incomes on all professional levels, with an evident echo in the building industry.

Our analysis should pave the way to further research on the topic. Enlarging the sample investigated would enable us to test whether significant differences exist, in terms of costs, between cities with different vocations and of different sizes. Finally, a more specific and detailed breakdown of the production costs, separating the labor component, would enable us to shed more light on the relationship identified between an urban population's higher incomes and years of formal education.

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