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Domenico Enrico Massimo

Dipartimento Patrimonio Architettonico e Urbanistico (PAU)
Università degli Studi Mediterranea di Reggio Calabria
E-mail: *massmo@unirc.it*

Emerging Issues in Real Estate Appraisal: Market Premium for Building Sustainability

In international and metropolitan real estate markets, it has been detected, for the first time, the growing relevance of green buildings with respect to non-green building. Also, it has been singled out and then quantified through regression analysis a green premium, i.e. a differential in terms of price toward sold real estate units having ecological characteristics along with an energy value (more efficient behavior). The incipient international studies recommend to extend the analysis to unexplored middle-size non-metropolitan (marginal) real estate markets. One of this areas has been studied detecting the first sale of an apartment with energy certification belonging to class B in a building with ecological characteristics. The assessment analysis performed through Market Comparison Approach, MCA, made it possible to detect and then appraise the green premium that is in line with the outcomes of the first and pioneer international studies performed in metropolitan areas.

Key words: *Real Estate Market Appraisal; Market Comparison Approach (MCA); Green Premium*

1. Introduction to research

The construction of human settlements and the thermo-climatic management of architecture and buildings have assumed, in recent times, a wide relevance as documented in local and global economies, involving different aspects:

- manpower;
- land use;
- use of raw materials and semi-finished products;
- energy consumption;
- emissions of pollutants.

Pollutant emissions, as one of the final outputs of the settlement process, are among the major cause of global warming on the planet according to the Intergovernmental Panel on Climate Change, IPCC (1990, 1995, 2001, 2007). Given this ecological crisis, an important fact in any mitigation strategy and solution is the desirable convergence of the private real estate economies (investors, realtors, owners, users) to award a prize to sustainable settlements. Research investigates the possible existence of such a virtuous convergence.

In the construction sector there is a growing awareness on the role that the housing market may actually play in reducing the negative effects of urbanization on the global environment, especially in the long run. This can also be achieved by intervening in the climate management of buildings and in their life cycle.

It is a disputed question whether the mitigation of global emissions of carbon dioxide, due to the management of the buildings stock, can be effectively reduced by one of the following alternative scenario:

- a "pure" real estate market without any government or rule;
- a public regulatory system imposed by national and international governments or intergovernmental organizations.

As anticipated, it is crucial that the private housing sector (investors, developers, realtors, builders, owners) is converging towards the goal of improving the environmental management of buildings.

In fact, it is possible and interesting to see the watermark of what is emerging significantly in the global real estate industry as an innovative combination of:

- environmental standards voluntarily adopted by construction companies, industries and investors;
- incentives and public stimuli combined with mandatory government regulations.

In particular, regarding the energy characteristics, owners, managers and tenants of properties pay and support the consumption of energy for as much as thirty percent (RICS, 2004, 2005a, 2005b, 2005c, 2006, 2009a, 2009b, 2010 ; Kats, 2003a, 2003b) of the total cost of building management. This is the most significant category in terms of operational costs of a building, and it is even more expensive for the commercial and industrial sectors.

In addition, the same overall operational management of buildings is responsible for over one third (RICS, 2004, 2005a, 2005b, 2005c, 2006, 2009a, 2009b, 2010; UNEP, 2007; Kats, 2003a, 2003b) of the emissions of pollutants that represent one of the most serious threats to the survival of the planet.

Given the vast resources (which quantification have started only in recent years) consumed for climate and energy management of settlements and buildings, and taking into account the worrying environmental impacts of over-consumption and waste in the building sector, the developed countries have started building energy-saving actions to achieve overall sustainability of buildings and reduce the operating costs for building management. These actions allow to anticipate the adjustment that might be, with high probability, required in the near future due to:

- better environmental standards independently selected from private industry;
- more restrictive environmental regulations approved by the local, regional, and national institutions as well as by federal and international organizations.

To this end, green building practices have been issued to attain energy efficiency in architecture. According to Wikipedia's definition, green building refers to:

> *"a structure and using process that is environmentally responsible and resource-efficient throughout a building's life-cycle. This practice expands and complements the classical building design concerns of utility, durability, comfort, beauty and economy. Synonymous are: sustainable building or green construction".*

A second definition of a Kats (2003b) introduces the "rating system for green building" in order to measure the sustainability of the architecture:

> *"Green or sustainable buildings use key resources like energy […] more efficiently than buildings there are just built to code. […] Green buildings typically contribute to improve employee and student health, comfort, and productivity. The United States Green Building Council (USGBC) developed […] guideline and rating system for green buildings".*

As stated above, parallel procedures of measurement\certification have been developed to assess the energy efficiency of buildings and provide the eco-labeling. Among the most known it is possible to enlist: Breeam: Netherlands; Cepheus: Germany; Estidama: United Arab Emirates; Casbee: Japan, by Japan Sustainable Building Consortium, Green Star: Australia, New Zealand, South Africa; GBAS: China; Green Globes U.S.; Mark Green: Singapore; Leed: Brazil, Canada, Mexico, Usa.

A key point is to be able to identify and single-out the different impacts resulting from investments in green building (designed primarily for energy efficiency), starting with the costs (monetary, physical and ecological-environmental), or the specific impacts on:

- initial monetary costs to build a green building, presumably higher than those needed to create a brown building ("just built to code");
- physical quantities of energy consumption and associated pollutant emissions (likely much lower for green buildings) with an "avoided consumption" sometimes referred to as thermal premium, or the "eco-energy footprint of architecture and individual buildings", with the connection between consumption and pollution;
- monetary costs of property management, especially climate, in the life-cycle (*i.e.* constant and permanent); much lower cost, probably, in a green building than a brown building.

The higher initial costs to build a green building is sometimes called first-cost premium.

2. Green premium in sustainable architecture

It is possible to perform valuations concerning the three disentangled impacts (monetary costs of initial investment; physical and environmental costs; operating costs, especially climate, in the life cycle) because the relative quantification are quite convergent, and consolidated and feasible approaches are today available (Kats, 2003a, 2003b).

The estimates found in literature (and recalled in: Massimo, 2009; Massimo, Barbalace, 2010; Massimo, Musolino, Barbalace, 2009) have provided reliable indicators and evidence on the effectiveness of green building to produce substantial

savings in fuel consumption and significant proportional cut-off in its emissions. Savings represent the first repayment (pay back) of the higher initial investment. Energy savings can be defined and summarized as: green building thermal or engineering or technical premium (Kats, 2003a, 2003b).

Partly as a result of thermal engineering or technical premium, and their estimates, the approach of green building is one of the most important and leading innovations in:

- construction;
- housing market;
- public regulation for settlements;
- university research and related educational training.

Despite the innovative implementation, the number of certified sustainable buildings is still small if compared to the overall number of existing buildings built after World War II.

To the awareness of entrepreneurs, not only intuitive and anecdotal, regarding the large positive and convenient operational cost of green building practices (Kats, 2003a, 2003b), did not correspond concrete achievements in terms of number of new sustainable buildings that met the expectations of investors, developers, builders, tenants, and occupants.

One reason is that entrepreneurs require more data and less uncertainty about the pay-back period of investment in green building in the real estate market. Investigations have shown that not enough assessment have been performed to give empirical evidence about these aspects.

It is essential to highlight that the pay-back of the green investment may be determined not only with thermal or engineering or technical premium but also by a second and additional premium in the market for real estate investments referred to as economic premium (Quigley, 2009) or rental and selling price market premium. The sum of both of these premia is the green building premia that can be expressed as follows:

thermal or engineering or technical premium + rental and selling price market premium = green building premia.

It is confirmed a strong demand from investors for specific estimates about the appreciation or premium that concretely expresses the market for green buildings: the market premium or economic premium.

These estimates should quantify directly on the marketplace and on the basis of empirical evidence the times of offset, pay-back, of the higher investment costs (or first cost) determined by the sum of both rewards (market premium, added to the technical premium) incurred by promoters and manufacturers to make energy efficient and sustainable buildings.

The research about the existence in specific markets of the economic premium *i.e.* the rental and selling price market premium encompasses two sub-sectors: commercial buildings *versus* residential buildings; metropolis *versus* smaller

settlements. The state-of-the-art shows the start-up of investigations concerning the economic premium due to sustainability and referred to certified commercial buildings in wide urban areas, with details about the valuation of:

- expectations (*i.e.* premium for an economic premium or selling price market premium) of private developers and institutional investors that link quantity, degree and intensity of green practices and Corporate Social-Ecological Responsibility (CSR) to the pay-back of the higher initial investment seen in its financial dynamic (Ellison, Sayce, Smith, 2007);
- The Willingness To Pay (WTP) declared but not observed (GVA Grimley, 2007; McGraw Hill Construction, 2006, 2010; Green Building Smart Market Report, 2006) of potential buyers and tenants;
- empirical evidence of a better percentage of occupation of commercial offices ("An Investigation of the Effect of Eco-Labeling on Office Occupancy Rates", Fuerst, McAllister, 2009) proportional to the rental price market premium.

In parallel, the analysis of the state-of-the-art detects the lack of geographical and typological assessments in unexplored areas and become a priority interest such as:

- segment of the housing market;
- marginal economic regions;
- peripheral parts of urban areas, *i.e.*
- real estate markets of small to medium sized settlements.

This is to investigate whether there are any signs of green buildings, and if so intercept (detect) them.

Research develops a first attempt, or Case Study, to intercept the phenomena of green building in areas hitherto unexplored, such as:

- Mediterranean marginal economic regions such as Calabria;
- a non-metropolitan city, such as Reggio Calabria with about 180,000 residents;
- a small to medium size real estate market;
- a sub-segment of newly built residential buildings in semi-peripheral areas.

3. Energy certification and perspectives for green buildings

It is assumed that in economic analysis and estimation, the following expressions can be considered equivalent: common building; non-green building; brown building; constructions built just to code.

The result has already been proved in numerous geo-economic areas revealing that industry, real estate markets, and companies have made their own internal autonomous voluntary standards more stringent in terms of quality, safety and environmental and climatic characteristics of the buildings. This results in the above-mentioned green buildings, *i.e.* energy efficient buildings with low environmental impact.

The next value added is to support sustainability of constructions by starting with technical measurement to give empirical evidence of the energy efficiency of buildings by using specific tools, that are becoming increasingly common at world level.

To estimate quantitatively and financially the effective degree of efficiency, voluntary and mandatory "energy certificates" are gradually being introduced. Approaches and procedures for measuring efficiency classes contribute and are a fundamental step in the broader integrated analysis (physical estimation) of the sustainability of the settlement.

An illustration of this. In most jurisdictions located in different continents, it is compulsory to exhibit on new or retrofitted buildings the Energy Performance Certificate.

In geo-economic European Union, the certificates affixed to the green buildings in the implementation of European Union Directive of 2003 on "Energy Certification of Buildings", are comparable to EPA SEP, Statement of Energy Performance of the U.S. Environmental Protection Agency (EPA), and non-governmental parallel rating systems such as the LEED system:

> *"The United States Green Building Council (USGBC), a national non-profit membership organization developed the Leadership in Energy and Environmental Design (LEED) to provide a guideline and rating system for green building". (Kats, 2003b)*

One of the most significant events of the last decade, covers the same real estate markets, which voluntarily and privately without government intervention, have expressed more comprehensive "Environmental Certification for Buildings" (Table 1), similar or parallel to the aforementioned LEED System.

Table 1. Key assessment tools and environmental certification of buildings in different countries.

Country	Tool
Europe	
Finland	PromisE
France	Hqe
Germany	Dgnb; Cepheus
Netherlands	Breeam NL
Portugal	Lider A
Spain	Verde
Switzerland	Minergie
Uk	Breeam

Country	Tool
Asia	
China	Gbas
Hong Kong	Hkbeam
India	Griha
Japan	Casbee
Philippines	Berde
Singapore	*Green* Mark
United Arab Emirates	Estidama
Africa	
South Africa	*Green* Star SA

Country	Tool
Australia	
Australia	Nabers; *Green* Star
New Zealand	*Green* Star NZ
America	
United States	Leed; *Green* Globes
Canada	Leed Canada;Green Globes
Mexico	Leed Mexico
Brazil	Aqua; Leed Brasil

As with other products, even in more mature real estate markets is emerged the trend of private companies to self-adopt "energy and environmental certification systems". The news is that certification can now be applied both for new construction, and more recently for the retrofitting and refurbishment of existing buildings (2009 Massimo, Massimo Barbalace, 2010; Massimo, Barbalace, Malerba, 2010).

The actual incidence of such "voluntary certification systems" is asymmetrical: on the one hand an increasingly important impact in terms of quality media, promotion, advertising, image, mission, and secondly a minor quantitative impact in terms of percentage of green buildings compared to the overall existing housing stock.

Despite this small quantitative impact of green building, all the projections foresee a growing significance and importance, especially the "systems of voluntary certification of buildings" in the future of real estate markets.

Specifically, it seems founded the future expectation (Fuerst, McAllister, 2009) for which the owners of green buildings (including commercial) will have the same lower vacancy rates and lower costs in marketing, in addition to the more economic management of their climate and energy stocks to be rent, for several reasons:

- greater attractiveness of the property market;
- better living conditions (residence);
- better working environment and productivity (non-resident);
- future potential and possible tax breaks and government incentives.

From an investor's viewpoint this can result in increased profitability due to:

- enhanced reputation;
- increased demand for potential conductor;
- pre-adaptation to future more restrictive environmental regulations (carbon tax);
- lower cost of ownership in case of urban equalization or an ecological premium through local taxation.

Parallel to the observed increase in ecological awareness (private and non-governmental), also grows the incidence of international environmental regulations, as well as national and regional. Local governments broaden the scope of application of ecological interventions by placing them in the urban planning that directly affects the construction of residential and non-residential buildings.

In metropolitan markets are emerging signs of price differentials relative to environmental and energy aspects of real estate markets. The green building, specially commercial, are starting to differentiate from brown buildings, or built to code, and it is observed a gradual increase in their profitability.

From this considerations starts the research aiming to:

- first, detect the possible presence of corporate responsibility towards the environment and correlated response in the market in terms of price differentials and real estate income;
- then, possibly investigate the causal relationship of price differentials with the environmental characteristics (general: health and ecological) and energy (physical and engineering specifications of efficiency and cost management) of green buildings *versus* brown buildings or just built to code.

As first step, it is examined the new environmental corporate responsibility.

4. Environmental responsibility of private companies and sustainability of commercial buildings

4.1. Corporate social performance. Environmental responsibility

In Western and Asian economies, companies promoting real estate and commercial enterprises and industrial users of commercial buildings are beginning to

address within a new conception of "corporate social responsibility" (CSR: Lyon, Maxwell, 2004, 2008, 2009; in a different perspective: Friedman, 1971) the theme of conservation and energy savings in their buildings:

- both as new and innovative environmental responsibility declined in specific terms to a brand new "corporate ecological responsibility";
- both as a great opportunity to reduce their perpetual operating costs.

Over the past twenty years, the assessments of the production processes have introduced and gradually internalized some environmental and energy aspects. As a result, even companies are valuated taking into account their performance and responsibilities also compared to ecology, environment and energy.

In this new context, in recent years private companies have strengthened the process of their acceptance of responsibility, *i.e.* of their "corporate performance". The assessment of private enterprises tends to include some stable "assessment criteria" which describe in an objective, clear and unambiguous way the industrial choices concerning:

- sustainability of inputs and source of raw and natural materials;
- how to use energy;
- treatment of employees in the manufacturing process;
- non-misleading advertising and relationships with the global society and local communities.

The global financial crisis of 2009 has suggested speeding up and strengthening the slow process that was in place since 1990 (Waddock, Graves, 1997) of social and environmental responsibility.

As happened with the case of macro-scale processes, consultants and appraisers take industrial investment and use the "degree of real ecological responsibility" (Social Investment Forum, 2007) as a criterion for evaluation at micro scale also for individual companies. There is empirical evidence that companies that have specific features of ecological production have lower vulnerability and sensitivity due to the foreseeable future and more restrictive environmental regulations that may be issued (Lyon, Maxwell, 2006, 2008, 2009).

4.2. Companies and building sustainability: the economic expectations

Businesses have the expectation (SVA Grimley, 2010) that infrastructures and commercial buildings with sustainable characteristics may bring to a higher productivity of both manpower (Kats, 2003b), thanks to the better livability and indoor quality, and also in their capital factor thanks to the sizeable energy saving (Kats 2003a, 2003b). Positive effect is the reduction of pollutant emissions subject in the future to expensive internalizations with corporate economic burden because of the disadvantages currently socialized and outsourced.

The point is to verify with economic and appraisal analysis: the real estate market; the actual financial results; the operational results achievable with eco-

logical buildings. This has been recently started by: Quigley (2009) and Fuerst and McAllister (2009).

Some of the intuitive expectations of enterprises related to investments in green building, are below reported (Quigley, 2009).

Expectation 1. "Cost-effective in green building" investment with future saving in operative costs

The initial investment, which is higher for green building (first cost premium), should lead to the following savings (EPA, 2008, Energy Star, Kats, 2003a; Quigley, 1991; RICS, 2004, 2005a, 2005b, 2005c, 2006, 2009a, 2009b, 2010) lasting for the entire life cycle:

- savings in energy inputs;
- decrease in other costs associated with operating systems and proportional to the consumption of energy (*e.g.* motors for air conditioning and ventilation);
- insurance against future increases in energy costs;
- reduction of pollutant emissions and insurance on future carbon tax.

It is evident the intuitive agreement of businesses about effectiveness of green building in lowering operating costs. This is because physical savings (kWh, joules; CO_2) can be estimated with sufficient reliability.

At the same time there is a lack of physical transformation of these savings in multi-paradigmatic financial analysis that can accurately quantify the economic savings and support similar investments.

Expectation 2. Investment in green building as a higher labor productivity

The higher initial investment for green building features, should lead to better conditions for employees or higher labor productivity.

This specific impact is not yet sufficiently disentangled by the economic analysis because the relationship between good bio-climatic design and labor productivity is difficult to quantify and assess. Sometimes it is adopted the proxy of the declared Willingness to Pay (WTP) of potential users, tenants, and occupants of commercial real estate buildings.

There is also a lack of economic analysis and estimation about the possible economics premium intended as both rental and selling market premium. They would express and recognize the impact on the price of ecological characteristics that promote productivity.

Introductory analysis of this issue have been found in: Gat (1998).

Expectation 3. Investment in green building with greater durability and lower risk of "obsolescence"

Element of investment in green building is the already reported higher initial cost (first cost premium). This factor seems daunting, but actually crucial in two aspects. The first is induced by the greater durability of materials and better intrinsic quality of the architectural results, that explain the higher initial unit cost of production. The second is the result of a longer, safer, extended and stable life-

cycle of the output and therefore a greater total duration of the construction.

Recalling the analysis of risk enterprises that have ecological performance of corporate responsibility (Orlitzky, Benjamin, 2001), the synergy between environmental characteristics and longer life cycle of the investment makes, with high probability, the building more desirable in the real estate market and less exposed to ecological and energy-related risks.

This implies a significant reduction in the risk premium insurance, and above all a higher estimate of the total value of the property (monetary and intrinsic).

In some real estate business risk analysis, it is reported the empirical evidence that the characteristics of the corporate capital expressing ecological responsibility have produced a better industrial reputation and a lower volatility in the market of both subjective and objective values. The mechanism occurs in the financial analysis of the property where the ecological buildings is accounted with a higher value for the balance sheet and results in an increased capital value of the entire complex for the budget business.

Even in this field is confirmed the lack of analysis and Case Studies concerning the possible selling price market premium, which recognizes the mitigation of future business risks thanks to the ecological characteristics of the capital.

Expectation 4. Green building investment as prestige, improved image and better marketing of companies

The choice of a green building has the impact of increasing the prestige of the businesses, with important observed consequences (Fuerst, McAllister, 2009; Quigley, 1991, 2009):

- improved global reputation as a company with a high "corporate ecological responsibility";
- attraction of the most motivated and best talented employees;
- greater attractiveness to investors, customers, sponsors, information;
- impact on the brand and products or services bearing the name of the company.

To estimate this impact is sometimes adopted the proxy of the greater and declared Willingness To Pay (WTP) of potential tenants of commercial property.

In this field it is noted the scarcity of economic analysis and estimation of potential selling price market premium recognizing in the market the impact on the total price for the sale of environmental attributes bearing greater prestige to the company.

Below are examined the possible responses of the real estate market to corporate ecological responsibility.

5. Commercial buildings and green premium. Case Studies

5.1. Introductory aspects

International research (Quigley, 1991, 2009, Fuerst, McAllister, 2009) suggests that a green building actually provides a "whole-family benefits" including:

- lower running management costs;
- better quality of life (residence); better and higher labor productivity (non-resident);
- possible tax deductions;
- government incentives and possible benefits.

In the study of real estate markets have been adopted partial equilibrium models to analyze the effects in the short term (the market premium) on the occupancy or rental rate of a property ("the green market rental premium") of its own technical and architectural characteristics with "ecological-energy value added".

It is assumed that an overrun (and repayment) of higher initial costs by the ecological "family benefits" is determined by the decline in demand for alternative non-environmentally buildings. It follows an increase in the demand curve for green buildings.

The research assumes that persists in the long-term in favor of sustainability a first and distinct "market premium on rent" in proportion to: the constancy of behaviors and preferences of the actors to maintain the standards that support the described real estate features; scientific innovation that can increase the effectiveness of green measures; the technological innovation that helps to reduce the ecological costs of construction projects.

It is assumed that the second and distinct "market premium on the sale price" is in turn a reflection of the combination of a higher rent obtained from green buildings for reasons of prestige and appeal, and the reflection of its intrinsic characteristics of capital goods such as:

- lower energy costs;
- advance and adaptation to future environmental regulations;
- reduced risk of having to bear the consequences of a carbon tax;
- reduced risk of achieving the "negative premium" from the market, in case of a growth of preferences toward the "green house".

5.2. Empirical evidence for the commercial real estate

The empirical analysis carried out so far in metropolitan areas have begun to measure the effects of technical-architectural features with "high ecological value-added" that commercial buildings unfold on:

- "market premium on the sale price" (Quigley, 2009);
- "market premium on the occupancy or rental rates" (Fuerst, McAllister, 2009).

For large sample size adopted for the study of real estate markets, the dependent variable of trading price and use price are related to a set of hedonic characteristics (explanatory variables) of the buildings such as: size and surface; age of the property; quality and value; floor level; condition; location; existence of dichotomous characteristics. The model is adopted to measure the "price differential" between green buildings and brown buildings.

Both subsets, or estimative sub-samples, belong to the same market segment and the same real estate sub-area.

An early study (Fuerst, McAllister, 2009) analyzes rents on 16,488 properties of which 1,031 are green buildings, and compares them with the remaining 15,457 units with common environmental, energy, and thermal conditions. The results measured for green buildings a "premium on the rental rate" of 4-5% higher than the common property units.

A second study (Quigley, 2009) examines sales on 6,157 properties of which 686 green buildings and compares them with the remaining 5,471 units with common environmental, energy, and thermal conditions. The results measured for green buildings a "premium on the sale price" of 25-26% higher than the common property units.

5.3. Considerations

The analysis reported in metropolitan urban areas, provide empirical evidence of a diachronic "price differential" in a precise and limited period of time. There is an expectation that this theoretical "price differential" is affected by future changes and between buildings of the same type.

Particular attention should be devoted to get accurate information including visual and documentary data about each individual property units and analyzed with the help of a "Real Estate Market Geodatabase", hereinafter referred to as "Geodatabase".

6. Green buildings residential market in a middle-small marginal real estate market. Case Study

From the survey conducted, it emerged the need for further estimation analysis involving Case Studies located in small to medium size markets and also for investigation about the price differential between green building and brown buildings, with the possible support of a Geodatabase (Simonotti, 2006).

To investigate the possible presence of a nascent phenomenon of green building in non-metropolitan areas, the data are analyzed in a small to medium size real estate market located in the Calabria region, in the Municipality of Reggio Calabria, with about 180,000 residents.

The Case Study (Massimo, 2006, 2007) is configured as a constant and continuous observation of a sample of 50 sales per year, from 1986 to 2006, examining:

- characteristics of buildings, classified with the aid of databases or spatial Geodatabase;
- the "actual prices" for individual sales (Simonotti, 2005).

In the search of each individual observation data are collected through interviews with buyers, sellers, brokers, agencies, and technical experts, producing a

twofold knowledge of real estate prices and their technical characteristics and localization.

The study area has been divided into "real estate areas", according to a first hypothesis derived from the implementation of analytical models of Multi Dimensional Scaling (MDS). These areas were then introduced in the classical real estate analytical model of Multiple Regression Analysis (MRA) as an independent variable parametric Zone.

As is well known:

> *"MRA models [...] seek to explain the relations of cause and effect between [...] real estate features [...] and the market price. The MRA in the last thirty years has become part of the method as a tool for estimating in the presence of numerous data." (Simonotti, 1997, p. 237)*

In Case Study, the variable Zone has been tested using spatial tools *i.e.* georeferencing procedures that facilitate and support data building. The Geodatabase makes available continuously and in a coordinated way the collection of individual real estate documents relating to each observation, even with remote systems thanks to the further integration with WebGIS tools.

The entire data set is finally analyzed under the economic and spatial pattern thanks to the Multiple Regression Analysis (MRA), which verifies the independent variables, including the variable "Zone". The observation is in the process of expansion and extension to 2010.

The sample size, recently increased (and ever-widening), and data control improved the significance of the explanatory variables because they all pass the test (t). The most recent data set consists of 1,000 sales of which 500 have already been verified in the field, photographed, full of detailed documentation, geo-referenced and entered into the Geodatabase. The data set formed the input for the most recent performance of the model adopted, as described in Table 2 (Massimo, Barbalace, Malerba, 2010).

Table 2. Case Study of Reggio Calabria. Analysis of the real estate market. Extension of the observations from 2001 to 2010. Multiple Regression Analysis (MRA). Geographical areas and number of observations.

Regression	Name	Geographical area	Obs 2010 (5)	Obs 2007 (4)	Obs 2006 (3)	Obs 2005 (2)	Obs 2001 (1)
Mra1.000	Reggio C.	Municipality	1.000	835	647	526	-
Mra500	Reggio C.	Center	500	444	415	370	106
Mra1.000	Adjusted R^2	Municipality	0.510	0.614	0.706	0.751	-
Mra500	Adujsted R^2	City center	0.894	0.903	0.908	0.923	0.920
Mra500	Var. sign.	City center	7\7	6\7	6\7	5\7	4\7

Obs = number of transactions recorded, and year of the study.

The synthesis of observation of the real estate market of Reggio Calabria is expressed with the main output of the algorithm: Adjusted $R^2 = 0.894$, significant variables 7 \ 7.

All 7 variables are significative, both pervasive (Zone: regressive, from 1 to 6; Conservation: regressive, 1 to 4; Surface: cardinal continues progressive), and all the others as: Floor Level, progressive integers; Date of Purchase, regressive in retrospective months; Services, dichotomous, 0-1; Date of Construction, regressive in years back. All are also statistically significative for [t = 0.05].

Based on tests performed, whose results are summarized in Table 2, it seems that the parsimonious models used should not be rejected and it seems to confirm the performance of the above mentioned applications. Refer to them (Massimo, 2006, 2007, Mollica, Massimo, 2002) for a more analytical definition of the primitive and original explanatory variables.

The combination of the linear function of the model with data collected and economic objective, expressed by the index of determination R^2 and by Adjusted R^2, is reliable in the first instance.

As part of this pluriannual research, for the first time it was intercepted and fully documented the sale of a green building with green features and energy certification of Class B.

A help and support is given by the Geodatabase as a module of the General Information System for the Evaluation or SGV (Massimo, Musolino, Barbalace, 2006). It manages, validates, documents, and geo-references all sales observed in the real estate market, in the case of Reggio Calabria. There, it was localized the above mentioned first reported sale of green building with ecological characteristics of Class B. For it can be investigated (detection) the existence or not, through the comparison of estimates, of a green premium or economic premium (Quigley, 2009) that may be similar to that found in urban markets first mentioned.

The Geodatabase has also allowed to identify and select two properties for comparison (Observations), contiguous and very similar to the green building (Green Subject), except for the ecological-energy feature. They helped to separate (disentangle) the ecological characteristics and its effect on the total price of sale, *i.e.* the marginal price of sustainability.

All sales (Observation; Green Subject) belong to homogeneous residential properties and have been recently built in the northern outskirts of the town of Reggio Calabria, consisting of multi-storey buildings, with their own enclosure and isolated area of service, medium structural quality, all aiming at medium-high level.

7. Results of Market Comparison Approach

In the absence of a sample size of statistical data there are of course not the conditions to apply the Multiple Regression Analysis (MRA).

In these circumstances, with little data, it is applied the analysis of marginal prices of the Market Comparison Approach (MCA). As is well known:

"The Market Comparison Approach (MCA) is a method for estimating the market price of [...], by comparing the property being valued and a set of properties recently purchased and with unknown price." (Simonotti, 1997, p. 288)

It is taken a sample size (of course very few in number) of properties with and without the green feature. Since the buildings will almost certainly differ for other characteristics (surface, floor, contract date, number of services, etc.) they are all unified under the same conditions of the green building.

The adjusted price (Table 3-4) of the Market Comparison Approach (MCA) expresses the price that the green building would have had if it had not possessed the green characteristics, that it actually possesses. Then the effect of the isolated green feature is the difference between the price of the green building and the adjusted price (without the green feature).

In other words, it answers the question: what values would have had the Observations in place but without the quality of the Green Subject? This is possible by bringing the Observations to the Subject's conditions using the marginal prices of characteristics other than the one considered. The difference between the price of the Green Subject, and the adjusted values of Observations, as results of the Market Comparison Approach (MCA), is the effect of the quality possessed by the Green Subject thanks to the green characteristic. The result is related to the sample data available, but it solves the methodological problem of estimation in restricted and specific situations. The calculations are performed analytically with the Market Comparison Approach (MCA) (Tables 3 and 4). The average of two separate green premia or the average market premium on the sale price attributable to the green characteristic of the unit sold in the market indicates the trend in the housing market of green buildings in the area of Reggio Calabria. Trend also recognizes for the first time in the time span considered, about a quarter of a century, ranging from 1986 to 2006, and recently extended and updated to 2010.

Therefore the average of the two green premia is estimated as follows:

$$(31{,}399.05 + 22{,}661.64): 2 = \mathbf{27{,}030.34}\ \text{EURO}$$

The market premium is equal to 25.50% of the market price of the Green Subject.

8. First considerations

The brief overview on trends in housing markets has noted the growing importance of green building and the lack of parallel evaluations.

Some international studies conducted in metropolitan urban areas have developed extensive analysis with detection of estimative samples studied with the help of statistical tools.

In these urban markets, results have measured for green buildings an economic premium (Quigley, 2009) over the sale price of 25-26% higher than the brown building units.

Table 3. Case Study of Reggio Calabria. Analysis of the real estate market. Estimation of Green Premium. Green Subject and Sub 48.

Variables	Um	(1)	(2)	(3)= (1)-(2)	(4)	(5) = (3) x (4)
		Green Subject	Obs Sub 48	(Δ) Difference	Unit Marginal Prices	Adjusted Price
Price	€	106,000.00	115,000.00			115,000.00
Surface	m^2	72.00	108.00	-36.00	1,029.45	-37,060.20
Date [0,02xprz]	year	2008	2006	+2	2,300.00	4,600.00
Balconies [0,20x1.029,45]	m^2	14	18.56	-4.56	205.89	-938.85
Floor Level	n	4	5	-1	3,000.00	-3,000.00
Services	n	1	2	-1	4,000.00	-4,000.00
Adjusted Price	€	74,600.95				74,600.95
Green	yes-no	YES	NO			106,000.00
Green Premium				D = +29.62		31,399.05

Sub 48: Surface 108.00 m^2; Balconies 18.56 m^2; Date of Purchase 2006; Floor Level 5; Services 2.

Table 4. Case Study of Reggio Calabria. Analysis of the real estate market. Estimation Green Premium. Green Subject and Sub 53.

Variables	Um	(1)	(2)	(3) = (1)-(2)	(4)	(5) = (3) x (4)
		Green Subject	Obs Sub 48	(Δ) Difference	Unit Marginal Prices	Adjusted Price
Price	€	106,000.00	145.000,00			145,000.00
Surface	m^2	72.00	129.82	-57.82	1,029.45	-59,522.79
Date [0,02xprz]	year	2008	2006	+2	2,900.00	5,800.00
Balconies [0,20x1.029,45]	m^2	14	18.56	-4.56	205.89	-938.85
Floor Level	n	4	5	-1	3,000.00	-3,000.00
Services	n	1	2	-1	4,000.00	-4,000.00
Adjusted Price	€	83,338.36				83,338.36
Green	yes-no	YES	NO			106,000.00
Green Premium				D = +21.37%		22,661.64

Sub 53: Surface 129.82 mq; Balconies 18.56 mq; Date of Purchase 2006; Floor Level 5; Services 2.

Table columns: *Variables*: independent variables or characteristics, explanatory of the price as dependent variable. *Um*: quantitative measure of the individual independent variables. *Green Subject*: quantitative measure of the variables of the Green Subect. *Obs* Sub 53 e 48: quantitative measure of the variables of the Observation. *Difference*: quantitative differences between Green Subject and Observations. *Unit marginal prices*: monetary contributions of each individual features to the total price. *Adjusted price*: quantitative measure of the adjusted prices.

It was developed a Case Study in Reggio Calabria where it has been intercepted for the first time, in a marginal economic area, a case of sales of green building, certified as energy class B. This local real estate market since 2001 is the subject of specific studies, estimates and systematic observation in the time span from 1986 to 2006, and recently extended and updated to 2010. The conditions of the local market characterized by scarcity and lack of sufficient information, requires the application of the methodological Market Comparison Approach (MCA) as a procedure used in the presence of limited data, in consideration that this tool applies the same logic estimation of Multiple Regression Analysis (MRA) by defining the marginal prices of real estate properties.

The estimates performed with the Market Comparison Approach (MCA) reveal an "economic premium on the sale price" of 25.50% for green building as a higher price than brown building units.

This percentage of "green premium" is in line with the order of magnitude of 25-26% emerged in the international real estate studies that have been generally focused on data samples more extended and located in metropolitan housing markets.

This first experimental prototype enhances the scope of the approach of Market Comparison Approach (MCA) in situations where it is statistically impractical, but is however needed to provide a quantitative answer.

The Market Comparison Approach (MCA) is therefore a suitable instrument to address other similar situations united by the reduced availability of data about green buildings and brown buildings, such as in small towns, and settlements, in the resorts, for the isolated valuable properties, and generally in all situations where the phenomenon of emerging green building needs of measures, that although indicative, are still quantitative and provide guidance to businesses, investors, developers and owners.

When more data are available, statistical tools such as Multiple Regression Analysis (MRA) will be used.

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Figure 1. Geographic Information System \ Real Estate Market Geodatabase. Case Study. Urban center of Reggio Calabria. Sample data. Photo of sold property. GIS display scale 1:25,000.

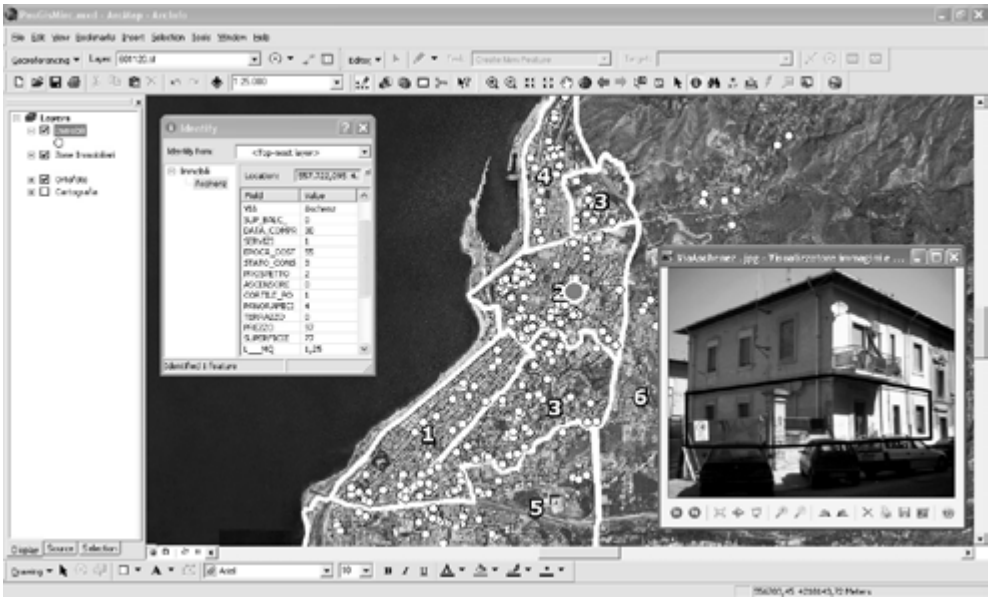

Figure 2. Geographic Information System \ Real Estate Market Geodatabase. Case Study. Urban center of Reggio Calabria. Sample data. General plan of the urban block used for stacking, scale 1:200. GIS display scale 1:25.000.

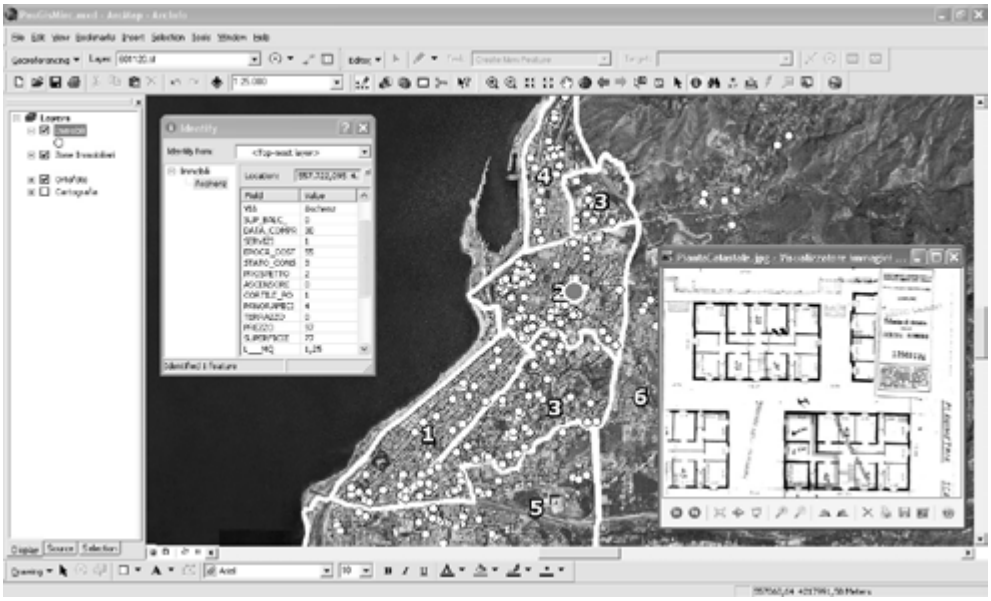

Figure 3. Case Study of Reggio Calabria. Analysis of the real estate market. Localization of Green Subject and Observations in the same real estate market segment.

Figure 4. Case Study of Reggio Calabria. Analysis of the real estate market. Green Subject intercepted in the real estate market of Reggio Calabria with Class B certification.