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A Model for the Assessment of the Economic Benefits Associated with Energy Retrofit Interventions: An Application to Existing Buildings in the Italian Territory

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Abstract: In recent decades, the issue of existing buildings' energy retrofit has played a central role in the context of international and national territorial development policies, mainly due to the obsolescence state that characterizes the housing stock. Since the current need for energy renovation collides with the widespread low spending capacity of the owners, in recent years numerous fiscal incentives have been envisaged, aimed at promoting building initiatives for the improvement of energy performance indices. With reference to the Italian fiscal measure so-called Superbonus, introduced by the "Relaunch" Law Decree No. 34/2020, in the present research, a model for evaluating the economic benefits, in terms of the convenience of the operators involved, generated by energy requalification interventions, has been proposed. The analysis has been developed with regards to the Italian territory and to the prevailing building typology, by considering 110 provincial capitals and the main urban areas into which each city is divided (central, semi-central, and peripheral). Specifically, for each urban area of the Italian capitals considered, the market value differential between the after energy and before energy intervention situations has been firstly determined. Furthermore, assuming an ordinary profit margin of a generic investor interested in this type of investment, the break-even incentive, i.e., the percentage threshold able to ensure the condition of minimum convenience for an investor, has been estimated for each urban area.

Keywords: residential properties; housing stock; fiscal incentives; refurbishment interventions; energy renovation initiatives; energy retrofit

1. Introduction

In recent decades, the issue of energy redevelopment of existing buildings has assumed, at an international level, a central role in the context of territorial development policies. With reference to the Italian territory, the residential and infrastructural stock is characterized by a growing obsolescence state: according to the 15th population and housing census developed by the National Institute of Statistics (ISTAT), in fact, over seven million (nearly 60%) of 12.2 million residential properties were built before 1980 [1]. Furthermore, approximately 42.5% of the total housing asset is over 50 years old, and only 8.7% of the houses were built in the 21st century. In addition, over 70,000 buildings (with over 500,000 housing units) are in an advanced state of decay, certifying that over 40% of buildings for residential use are in very poor conservation conditions, with low functional performance as regards the levels of energy standards, health, and safety required by the reference laws.

In the framework outlined, the construction sector is currently also the most energy-consuming one in terms of CO2 emissions (over 1/3 of atmospheric emissions derive from existing buildings), ranking among the first sectors in terms of energy quantity [2]. In this sense, the strategies for the renovation of the building stock are currently aimed at defining solutions capable of reducing emissions and energy consumption, such as the construction of n-ZEB (nearly Zero Energy Building) buildings [3–5].

According to the Goal No. 11 included in 2030 Agenda for Sustainable Development [6], the energy retrofit interventions on the existing residential property asset represent a valid solution (i) to reduce consumption in building management, (ii) to improve living comfort, and (iii) to accelerate the decarbonization process called for by the European Green Deal by 2050 as part of the process of energy transition, i.e., the passage from an energy mix centred on fossil fuels to one with low or zero carbon emissions based on renewable sources [7].

In the current financial situation, building stock rehabilitation constitutes an effective driving force for national economic recovery since it is able to generate sector investments for over 55 billion euros [8].

In the Italian territory, since the mandatory energy retrofit of existing buildings collides with the widespread low spending capacity of property owners and with the high costs necessary for the implementation of interventions, in the recent years numerous fiscal incentive policies have been envisaged to promote building initiatives for the improvement of energy-performance indices. In fact, the poor energy efficiency of the buildings has led to the proliferation of new financing schemes, subsidized loans, or tax deduction systems capable of enticing the building stock owners to carry out energy improvement operations, in terms of projects (i) on the property envelope through the replacement of fixtures, (ii) for the improvement of systems, (iii) for the installation of renewable energy systems, and (iv) for automation and efficiency control.

By taking into account the fiscal incentives spread, the investments developed using these forms of subsidies have tripled in recent years, increasing from 9.4 billion euros in 2008 to 28.1 billion euros in 2017 [9]. In particular, the number of interventions that have benefited from tax incentives aimed at energy redevelopment and, in general, at the recovery of the building stock was equal to 21 million in the period from 1998 to 2020, with a total amount of investments of over 345 billion euros. Specifically, in 2019, 28,762 million euros were spent, while the energy retrofit projects carried out in 2020 involved a capital of 25,105 million euros [10], i.e., −12.7% compared to 2019, due to the shutdown that affected the construction market in the first months of 2020 caused by the COVID-19 pandemic and the associated lockdown period [11].

Within the context mentioned, the government incentive measures allow, on the one hand, one to activate targeted interventions and, on the other, to deduct significant monetary amounts, by enabling the owners of the properties to be redeveloped to save significant costs. In terms of renovation expenses deducted, these have been equal to 12.7 billion euros in 2019 for the refurbishment interventions carried out for the 2017–2018 two-year period and to 11.3 billion euros in 2018 for the interventions carried out for the two-year period 2016–2017, with an increase from one two-year period to the next one equal to 12.1%. Furthermore, with regards exclusively to the energy requalification interventions carried out in the two-year period 2018–2019, 3.2 billion euros were deducted in 2019, and 2.8 billion euros for the interventions carried out in the 2016–2017 two-year period were written off in 2018, by attesting an increase of 14% during the last two years [8,12].

In the framework of the most recent regulations aimed at promoting the requalification of the existing building stock, the "Relaunch" Law Decree No. 34/2020 [13], converted into Law no. 77/2020, has introduced a fiscal incentive percentage equal to 110% (so-called "Superbonus"), providing for the possibility of opting for an advance contribution in the form of a discount applied by the suppliers of goods or services (so-called "discount on invoice") or for the assignment of the credit corresponding to the tax deduction due.

Among the incentive policies for the improvement of existing assets [14–20], the "Relaunch" Law Decree constitutes an important financing measure aimed at encouraging the implementation of these interventions and at supporting property owners in activating energy retrofit operations. The Law No. 178 of 30 December 2020 (Budget Law 2021) has extended the Superbonus to 30 June 2022 and in specific situations until 31 December 2022 or 30 June 2023 [21]. The provisions of the Superbonus allow for the use of the deduction equal to 110% and are added to already defined deductions between 50% and 80% for interventions of recovery of the building stock, based on the article 16-bis of the Income Tax Code (Tuir), including anti-seismic initiatives (so-called "Sismabonus") currently disciplined by the article 16 of Law Decree No. 63/2013 [22], and energy requalification of buildings (so-called "Eco-bonus"), based on the article 14 of Law Decree No. 63/2013. For these interventions, higher deductions are currently recognized when the intervention concerns common parts of the opaque enclosure for more than 25% of the dispersing surface or when the interventions are carried out on the common parts of buildings located in seismic areas "1" (high seismic intensity), "2" (medium seismic intensity), "3" (low seismic intensity), and "4" (very low seismic intensity) and are simultaneously aimed at energy redevelopment and reducing the seismic risk.

The present research aims to define a methodology for evaluating the economic benefits, in terms of the convenience of the operators involved, generated by energy requalification interventions carried out through the use of the Superbonus mechanism. Among the various advantages connected to an energy retrofit initiative (bill savings, improvement of building quality, increase of living comfort, etc.), this study is focused on the assessment of the increase in market value of the residential units in which an energy intervention is performed.

The analysis is developed with reference to the Italian territory and to the prevailing—in terms of the most common—building typology (i.e., multi-story building made of reinforced concrete), by considering the current one hundred and ten Italian provincial capitals and the main urban areas into which each city is divided (central, semi-central, and peripheral). In particular, for each urban area of the Italian provincial capitals analyzed, the market value differential between the after energy intervention (hereinafter *post-energy intervention)* situation and the before energy intervention (hereinafter *ante-energy intervention)* situation is firstly determined, comparing it with the energy requalification costs ("with" and "without" the incentive of the Superbonus); subsequently, assuming a unique profit margin of an ordinary entrepreneur interested in this type of investment, for each urban area the break-even incentive is estimated, i.e., the percentage threshold capable of ensuring the condition of minimum convenience of the initiative for the investor.

In order to define a valid support tool for public and private operators, the outputs obtained from the application of the proposed evaluation model are represented on geographical maps, to quickly identify, for each urban area of the selected provincial capitals, the most convenient areas for a potential private investor (*convenience maps*) and, then, the incentive thresholds that guarantee the feasibility of the operation (*isoprofit maps*).

Therefore, the methodology proposed constitutes a flexible tool, replicable in any territorial context (national and international) and able to elicit the different economic benefits connected to the various input variables that could integrate the evaluation model (location, technological, and economic).

2. Background

In the context of the existing literature related to the analysis of the economic benefits associated with energy efficiency interventions, several researches investigated the effects of these on the real estate market. In particular, these studies concerned the examination of the relationship between the increase in energy performance deriving from an energy improvement project and the property value differential [23–34]. With reference to different geographical contexts, the Authors have analyzed the economic returns to energy-efficient investments in the real estate market by outlying the benefits derived from energy retrofitting for the existing buildings, in line with the goal of developing sustainable cities.

It should be outlined that the present analysis is also focused on the evaluation of the effects of "generic" renovation interventions on residential market—in terms of increase in the selling prices—thus including in the category of building renovation interventions those of energy requalification and assuming that an ordinary restructuring operation also concerns technological systems refurbishment (electrical, water, heating, sewage, etc.), fixtures replacement, and insulation coating installation, aimed at improving the energy efficiency of the building.

In general terms, the energy retrofit of existing buildings represents a complex process involving various decision-making issues, relating not only to technical and technological aspects but also to environmental, social, and cultural ones [35]. The use of new construction materials and techniques and the implementation of innovative regulatory policies aimed at promoting the energy efficiency [36] of the existing assets have allowed one to raise awareness on the importance of the buildings energy aspects among all the operators involved: planners, designers, experts, and users [37]. In this sense, for example, Fuerst et al. [38] have investigated the effect of Energy Performance Certificate (EPC) ratings on residential prices in Wales, by attesting to significant positive price premiums for dwellings in EPC bands A/B (+12.8%) and C (+3.5%) compared to houses in band D, whereas lower discounts have been estimated for residential properties in bands E (−3.6%) and F (−6.5%). The existing literature related to the analysis of the energy efficiency investment measures also concerns the assessment of the empirical relevance of various barriers to their diffusion [39]; the identification of bottlenecks that hamper energy-saving investments and the definition of proposals to overcome them [40]; and the analysis of the effectiveness of different strategies for the energy retrofit, taking into account their cost efficiencies [41].

The number of studies dealing with the effects of investments in energy efficiency on the residential value is currently limited as most of the recent literature has focused on commercial properties and has analyzed the effects of energy certifications [42–44], attesting to significant impacts of certification on office properties prices and rents. According to a report developed by International Energy Agency (IEA) [45], the market operators are willing to pay a higher price to rent or to buy a property with better energy performance.

Johnson and Kaserman in 1983 [46] and subsequently Dinan and Miranowski in 1989 [47] have carried out analyses aimed at evaluating the influence of energy bills savings on selling prices, concluding that a decrease of 1 dollar on energy bills is capitalized in increases of the residential selling price in a range between 11.63 and 20.73 dollars per m^2.

Starting from data detected by the American Housing Survey from 1991 to 1996 in 30 metropolitan areas, in the research developed by Nevin and Watson [48], multiple regressions have been implemented to analyze the impact of billing expenses on housing prices, by demonstrating a relevant real estate market appreciation for energy cost savings. In particular, the Authors have proposed a hedonic model by which housing values increase by about $20 for every $1 reduction in annual utility bills. On average, for each additional kWh/[m^2] of energy consumption, the price is reduced by 0.05% of the total value, whereas a 1-euro reduction in annual energy costs is associated with an increase of 15.5 euro of the property price per m^2 [46,48]. With reference to the residential rental market, the unit rental price increase reaches 6.22 euro per 1 euro of energy costs saved. Moreover, a decrease of annual energy costs by 1 euro leads to an increase in annual rental income by approximately 0.23 euro per m^2 [49].

In general terms, in the studies aimed at determining the influence of renovation interventions on existing residential assets prices, different methodological approaches capable of evaluating the post-energy intervention economic benefits have been used [50–52]. In the context outlined, Seek [53] has highlighted that one of most relevant housing refurbishment advantages concerns the increase in value associated with intervention, assuming that the renovation costs are recovered though the property sale. Furthermore, according to Knigh et al. [54], the existing renovated properties could achieve high quality equal to a more recent or even new residential property.

Moreover, Bogin et al. [55] have analyzed the residential buildings market appreciation related to refurbishment initiatives through the creation of a House Price Index (HPI), by estimating an increase of 23% on the final price post renovation. With reference to the real estate market of the Republic of Lithuania, Kaklauskas et al. [56] have found an increase in selling price of refurbished residential units equal to 25%. In the European context, the studies carried out by Brounen and Kok [23] have analyzed the effects of the Energy Performance Certification (EPC) on the residential prices: by detected a sample of about 32,000 properties, the premiums/discounts in terms of increase/decrease in housing prices resulting from a building renovation have been estimated. In particular, by starting from a housing property characterized by an energy label "D" and by considering a sample of residential units with different energy labels and with all other similar characteristics, a rise equal to 10% for label "A", 5.5% for label "B", and 2% for label "C" has been assessed, whereas the discount on the selling price of properties with lower energy label (equal to −0.5% for label "E", −2.5% for label "F" and −5% for label "G") has been observed.

Furthermore, in a report developed by Bio Intelligence Service in 2013 [57], the economic benefits deriving from the possession of EPCs both on selling prices and on rental prices for various countries such as Austria, Belgium, France, and Ireland have been investigated. The proposed hedonic regression model has allowed one to determine an average percentage increase for each energy label: in particular, in Austria an increase of 4% for rent and 8% for selling have been observed, in Belgium a growth equal to 2.7% for rent and 4.1% for selling have been found, in France a positive change of 3.2% for leases and 4.3% for sale have been seen, and in Ireland an appreciation of 1.4% in rental market and 2.8% for the sale market have been recorded.

With regards to the context of Germany, Cajias and Piazolo [58] have defined a functional correlation between energy savings in monetary terms and the differential on the selling price. Based on a study sample of about 2600 individuals, for energy savings of 1%, an increase of 0.45% on market values has been pointed out. Analyzing the Irish real estate market, Hyland et al. [28] have found a relationship between the selling prices and the energy labels of buildings: by analyzing about 15,000 samples and compared to a property of energy label "D", increases equal to 9.3% for label "A" and to 5.2% for label "B" have been identified. At the other end of the scale, receiving an F or G rating reduces the price by 10.6% relative to "D"-rated properties, ceteris paribus. Finally, in the study, the same functional relationships with reference to rental prices have been investigated: with reference to D-rated properties, "A" properties experience rental rates that are 1.8% higher, and, counter-intuitively, the premium is even higher for B-rated properties at 3.9%. Furthermore, a decrease of 1.9% for label E and 3.2% for labels F and G has been detected.

A positive variation in selling prices in correspondence of the higher labels and a negative differential for the lower labels have been found in the United Kingdom in the study carried out by Fuerst et al. [59]. By collecting a study sample consisting of 300,000 residential units, the implementation of a hedonic model has allowed one to determine (i) positive changes equal to 5% for residential units characterized by the highest energy labels "A" and "B" and to 1.8% for housed with intermediate energy label "C" and (ii) negative variations on average equal to −0.8% for housing property with the lowest energy labels (−0.7% for energy label "E" and −0.9% for label "F").

In a study on the Swiss real estate market by Banfi et al. [60], a greater willingness to buy energy-efficient properties has been observed, by attesting a market appreciation up to 13%.

The research carried out by Evangelista et al. [61] has aimed at investigating the market appreciation energy efficiency, analyzing its impact on residential property prices in Portugal. Through a set of approximately 256,000 residential properties sold from 2009 to 2013, the results have attested to a premium equal to 13% for the most energy-efficient apartments (i.e., those of EPC labels "A" or "B") and a market price premium between 5 and 6% for single-independent houses.

In Italy, several studies on the effects of energy efficiency on property values have been carried out. Bottero and Bravi [62] have assessed the impacts of energy redevelopment interventions on the market prices by determining a positive unit variation equal to 26.44 euros per m^2 for each energy label considered. Moreover, by using an evolutionary polynomial regression model, Morano et al. [63] have revealed an increase of 27.94% for class "A" and a discount of −26.44% for class "G".

Through the implementation of a hedonic model, the Australian Bureau of Statistics [64] has analyzed the functional relationships between the Australian Capital Territory selling prices detected in the two-year period 2005–2006 and the properties energy labels. In particular, the analysis has allowed one to identify an increase correlation for each energy rating label that in Australia is defined as a score between 0 and 6: an increase equal to 1.6% for rating category 1, to 3% for score 2, to 5.9% for label 3, to 6.1% for category 4, and 6.3% for rating categories 5 and 6 have been detected.

By comparing selling prices between energy certified and non-certified properties, Bloom et al. [24] have calculated an increase equal to $85 per m^2 for properties characterized by an energy attestation, in order to demonstrate the relevance of energy aspects on real estate market. By recalling the same goal, Kahn and Kok in 2012 [65] have found that residential units with energy certification are more appreciated than non-certified buildings (+9%).

In the Singapore real estate market, Addae-Dapaah and Chieh [66] have analyzed the relationship between Green Mark Certification (GMC) and the selling prices by recording an increase equal to 9.61% for Gold Plus, to 9.64% for Gold, to 12.97% for Certified, and to 27.74% for Platinum, compared to houses without GMC.

With reference to the current incentive of interventions aimed at energy retrofit of existing housing stock, the present research intends to analyze the economic effects of these operations on the market value of Italian property assets. The work concerns a relevant issue differently investigated in the scientific literature, by proving a contribution in terms of evaluation methodology of economic benefits related to energy renovation initiatives, and points out their positive impacts on real estate sector. It should be highlighted that the analysis represents the first attempt to quantify the fiscal measure granted for buildings' energy redevelopment in order to allow private investors to achieve a fixed profit margin and public entities to define effective strategies for using public economic resources.

3. Methodology

With reference to the aims of the present research, the methodology proposed intends to provide an operational approach for the assessment of economic benefits generated by energy improvement interventions on existing residential buildings. It is articulated into six phases that are described below and are implemented with reference to the selected case study:

Phase 1—Analysis of the reference context

- Definition of the most frequent/common building typology;
- Identification of the average property internal area;
- Definition of the property constructive and functional factors.

Phase 2—Description and localization of the study samples

- Determination of the urban areas (central, semi-central, and peripheral).

Phase 3—Analysis of the unit energy retrofit costs

Phase 4—Data collection of selling prices of properties with high energy label ("A", "B", and "C") and low energy label ("E", "F", and "G")

Phase 5—Assessment of economic benefits

- Determination of the value differential between the post-energy intervention situation and ante-energy intervention situation;
- Evaluation of the break-even incentive.

Phase 6—Development of geographical maps of economic benefits

- Convenience maps;
- Isoprofit maps.

In Figure 1, a summary of the main steps for the implementation of the methodology proposed is reported.

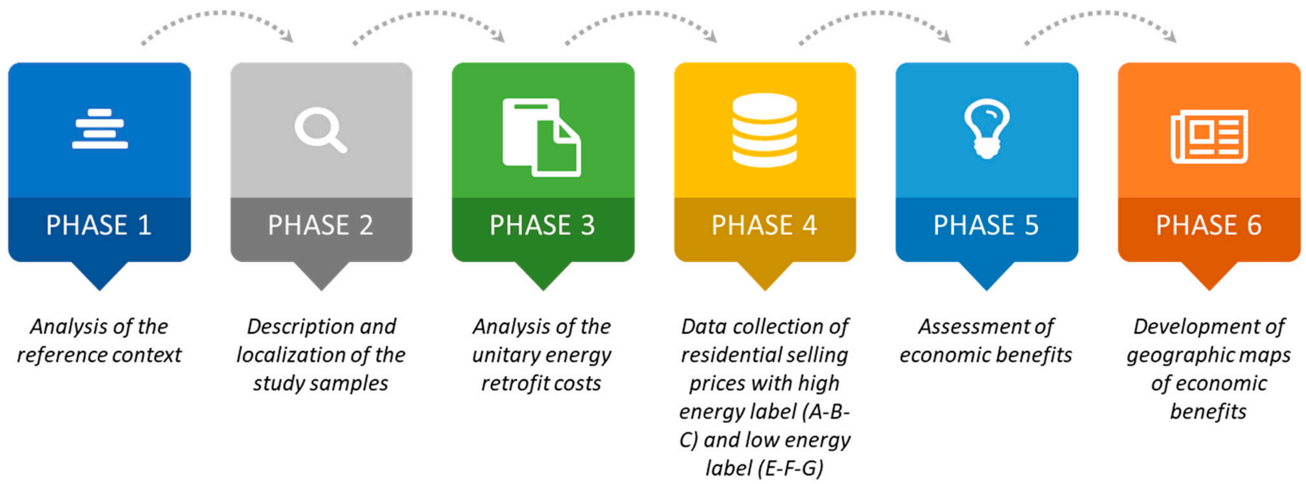

Figure 1. Main steps of the methodology proposed in the analysis.

The proposed methodology constitutes a logical procedure to be performed for the assessment of the economic benefits deriving from energy retrofit interventions. It considers the main variables that play a central role in the energy improvement initiatives on the existing property asset, such as the energy requalification costs, the housing selling prices ante-energy intervention situations and those related to the post-energy intervention one, and the value differential between the two situations. The adequacy of the methodology is pointed out by its flexibility and user-friendliness, mainly thanks to the systemic logic-operative process defined through the illustrated phases.

The case study of the present research concerns the Italian context. In particular, all the 110 provincial capitals located in the twenty regions have been considered. In order to define an evaluation model of the economic benefits, in terms of convenience of the operators involved, generated by energy improvement interventions on existing residential buildings carried out through the use of the Superbonus, the analysis has been developed with reference to the most prevalent (most common according to the ISTAT data [1]) building typology, i.e., multi-story building made of reinforced concrete, and by considering the main urban areas in which each provincial capital is divided (central, semi-central and peripheral). In particular, for each urban area of the Italian provincial capitals analyzed, the market value differential between the post-energy intervention and ante-energy intervention has been firstly determined by comparing it with the energy requalification costs (i.e., considering the situation “with” and that “without” the incentive of the Superbonus). Subsequently, by assuming a unique profit margin of an ordinary entrepreneur interested in this type of investment, for each area, the break-even incentive has been estimated, i.e., the percentage threshold able to ensure the condition of minimum convenience for the investor.

4. Results and Discussion

The results obtained by the application of the developed methodology to the case study in terms of the value gap between the post-energy intervention and ante-energy intervention situations have been represented on geographical maps in order to quickly identify, for each urban area of the selected provincial capitals, the most convenient areas for a potential private investor (convenience maps) and the incentive thresholds that guarantee the feasibility of the operation (isoprofit maps).

For each phase of the proposed methodology, the main operations carried out with reference to the case study considered are reported below.

4.1. Phase 1—Analysis of the Reference Context

4.1.1. Definition of the Most Common Building Typology

The investigation carried out in the present research has concerned all the provincial capitals located in the Italian context and has focused on the prevailing building typology, i.e., the multi-family and multi-story residential building in reinforced concrete and composed by four floors. With reference to the national context and by considering the data published by ISTAT collected for the 15th General Census of the population and housing in 2011, the number of existing buildings classified by type of intended use has been analyzed for each region. According to the data detected, the Italian building stock is mainly characterized by the residential typology, that is, 84.2% of the total built, i.e., 12.18 million of buildings compared to total 14.4 million. Moreover, by taking into account a study developed by CRESME in 2017 [67], with reference to the 15 million of buildings located on the Italian territory, 11.9 million buildings consist of residential ones, intended exclusively for housing or hosting a mix of residential and economic activities; 1.6 million are buildings entirely used for the performance of non-residential, primary, secondary, or tertiary activities; 1.5 million buildings are unused; abandoned; or intended for other uses, such as electrical substations, toll or gasoline stations, towers, fortifications, and lighthouses.

Therefore, with reference to the criteria adopted for the selection of building typology, the identification and the architectural and constructive characterization of the existing buildings have been carried out. In fact, by considering the categories detected by ISTAT (residential, commercial, office, etc.) and the available data on the housing stock in terms of structural, morphological, and functional type, the factors of the building typology to be considered in the analysis have been defined.

It should be added that the application of the proposed evaluation methodology to the case study selected represents a first implementation of the assessment tool and, in this sense, the choice of structural type has been also ruled by the available information data in terms of energy retrofit interventions defined in the Italian cities. Other practical developments of the methodology may concern different building types, such as masonry buildings, single and two-family buildings, and three and four- families buildings, as villas.

4.1.2. Identification of the Average Property Internal Area

In order to identify the average area of the residential units located on the Italian territory, the analysis has been developed by consulting the data published by ISTAT collected for the 15th General Census of the population and housing in 2011 [1,68]. From the data consulted, the average surface area of occupied Italian dwellings is equal to 99.3 m^2.

4.1.3. Definition of the Property Constructive and Functional Factors

The determination of the other constructive and functional factors that characterize the prevailing building typology to be considered in the analysis has allowed one to identify a “prototype”, i.e., an Immeuble Type, made of reinforced concrete, with three or more floor levels, without basement, equipped with a elevator, characterized by medium quality of finishes and materials, and with normal accessibility. It should be outlined that no unusual and particular factors have been selected in order to develop an analysis on an “ordinary” situation that could be detected in the Italian context. In this sense, taking the multi-story residential building as prototype, both the low-density buildings (one, two, and three floor levels) and the high-rise buildings (more than five floors) have been excluded. In addition, the common size of four-room apartments has been chosen, in accordance with the prevailing residential unit area requested by families of four people. Finally, medium build quality has been selected for the prototype by neglecting extreme situations related to high quality or very poor finishes.

The Table 1 shows the main characteristics identified for the building prototype selected in this analysis.

Table 1. Main distinctive characteristics selected for the prototype considered in the analysis.

Prototype Constructive and Functional Factors	
Building typology	Multi-story residential building
Construction typology	Reinforced concrete
Floor levels	Four
Presence of elevator	YES
Build quality	Medium
Presence of basement	NO
Accessibility	Normal

The selected characteristics have been used both for the determination of unit costs of building renovation interventions for each provincial capital and for the selling prices collection, in order to assess the market value differentials between the post-energy intervention and the ante-energy intervention.

4.2. Phase 2—Description and Localization of the Study Samples

As already mentioned, with reference to the Italian territory, the present research has focused on the evaluation of economic benefits in terms of market value differential associated with energy retrofit initiatives implemented through the use of the Superbonus. In Figure 2, the localization of the one hundred and ten Italian provincial capitals considered in the analysis in the twenty regions is reported.

Figure 2. Localization of the Italian provincial capitals considered in the analysis.

4.2.1. Determination of the Urban Areas (Central, Semi-Central, and Peripheral)

According to the geographical distribution developed by the Real Estate Market Observatory (OMI) of the Italian Revenue Agency [69–71], each Italian provincial capital considered in the analysis is divided into municipal trade areas (central, semi-central, peripheral, suburban, and extra-urban). In particular, the areas considered in this research are the central; semi-central; and, finally, the peripheral one, by excluding the suburban and extra-urban areas because the building is scarcely present or mainly rural.

4.3. Phase 3—Analysis of the Unit Energy Retrofit Costs

With regards to the different typologies of energy retrofit interventions to be implemented in a building made of reinforced concrete using the Superbonus (at least two energy labels upgrades), the main operations could concern (i) the insulation coating installation on the opaque perimeter walls, (ii) the insulation of the flat roofs with thermal insulating material or coating with reflective material, (iii) the insulation of sloping roofs, (iv) the replacement of fixtures and any subframes, and (v) the fitting of solar shading.

The determination of the unit energy requalification costs has been carried out by implementing a comparative methodological approach, by using the data collected from costs estimates developed with reference to (i) interventions aimed at improving the energy performance of buildings located on the Italian territory and (ii) official data reported by Cresme [10]. In this sense, the detected unit redevelopment costs have been appropriately adjusted through the building renovation costs reported by Cresme with regards to the "residential renewal" category and the building parameters already defined. Therefore, a sufficient number of costs estimates relating to energy retrofit initiatives to be implemented or already started on the Italian territory through the Superbonus mechanism have been consulted. Finally, for each Italian provincial capital considered, starting from these unit costs, those to be considered in the analysis have been adjusted through the parametric unit costs detected by Cresme.

4.4. Phase 4—Data Collection of Properties Selling Prices with High Energy Label ("A", "B", and "C") and Low Energy Label ("E", "F", and "G")

In order to determine the economic benefits associated with energy improvement interventions in terms of the value variations between the post-energy intervention and ante-energy intervention situations, for each provincial capital considered in the analysis, a sample of recently sold residential properties has been collected. Thus, for each city, the assessment of the market value differential has been carried out by selecting, respectively, (i) fifteen individuals in total for each provincial capital, i.e., five residential properties located respectively in each central, semi-central, and peripheral municipal trade area, and by taking into account the functional and constructive characteristics previously identified for the definition of the prototype, i.e., multi-story residential building type, in reinforced concrete, of about 100 m^2 (range considered 80 m^2—100 m^2), of three and more floor levels without basement, with elevator in the building in which the property is located, characterized by medium finish quality and by high energy label—A, B, and C—(post-energy intervention situation); and (ii) fifteen individuals with similar characteristics but with the low energy label—E, F, and G (ante-energy intervention situation).

In general terms, the energy label represents a significant characteristic for the samples collected to obtain the Superbonus, the energy requalification interventions must help to improve the energy performance of the residential property by at least two energy labels, i.e., by determining an upgrade of building energy performance.

Finally, it should be pointed out that the selection of the samples of each municipal trade area has allowed one to obtain a heterogeneously distributed sample on the territory of each provincial capital analyzed.

4.5. Phase 5—Assessment of Economic Benefits

For each Italian province capital, (i) the unit cost of redevelopment intervention, (ii) the average market value referred to residential properties characterized by the high energy high—A, B, and C—(post-energy intervention situation), and (iii) the average market value referred to residential properties characterized by the high energy label—E, F, and G—(ante-energy intervention situation) have been detected. Thus, for each urban area of the Italian provincial capitals considered, the determination of the after and before intervention value differential has been carried out. The market value variation between the post-energy and ante-energy intervention situations has been finally compared with the energy retrofit costs, in order to investigate the impact of the initiative on selling prices by considering, on the one hand, the assumption of the Superbonus incentive that provides that no cost of the intervention is borne by the property private owner and, on the other hand, the situation for which the use of the Superbonus is not provided. In this sense, the present analysis has intended to evaluate the effects of the energy efficiency intervention in terms of value differential regardless of the implementation of the Superbonus mechanism and, therefore, to verify the effects of the initiative in absolute terms.

4.6. Phase 6—Development of Geographical Maps of Economic Benefits

By recalling the aim of this research regarding the definition of the economic benefits associated with energy efficiency interventions, the outputs obtained from the application of the proposed evaluation model have been represented on geographical maps. Moreover, for each urban area of the selected provincial capitals, to quickly identify the most convenient areas for a potential private investor, convenience maps have been developed.

4.6.1. Convenience Maps

With reference to each urban area in which each provincial capital is divided—central, semi-central, and peripheral—for each Italian region the convenience maps have been developed by taking into account the value surplus between the post-energy intervention and ante-energy intervention situations detected for each urban area. In particular, the effects of the energy intervention in terms of variation on housing prices have been represented by a color gradient, where the darker shades have been used for the provincial capitals for which the highest differential has been detected and the lighter shades for the provincial capitals with the lowest differentials. For each urban area of the provincial capitals considered, in the maps the value differential is calculated without the use of the Superbonus mechanism (i.e., subtracting the costs of the project borne by the private subjects) and ~~(ii)~~ the value differential by assuming the redevelopment intervention with the Superbonus incentive (i.e., considering that all project costs are supported by public funding) is reported. Thereby, the evaluation of the convenience of the energy retrofit initiative without or with the fiscal measure has been performed. For example, in Figure 3 the convenience maps defined for the Piemonte region are shown. Furthermore, in Figures S1–S19 reported in Supplementary File, the convenience maps developed for each urban area of the Italian provincial capitals located in the remaining nineteen regions are reported.

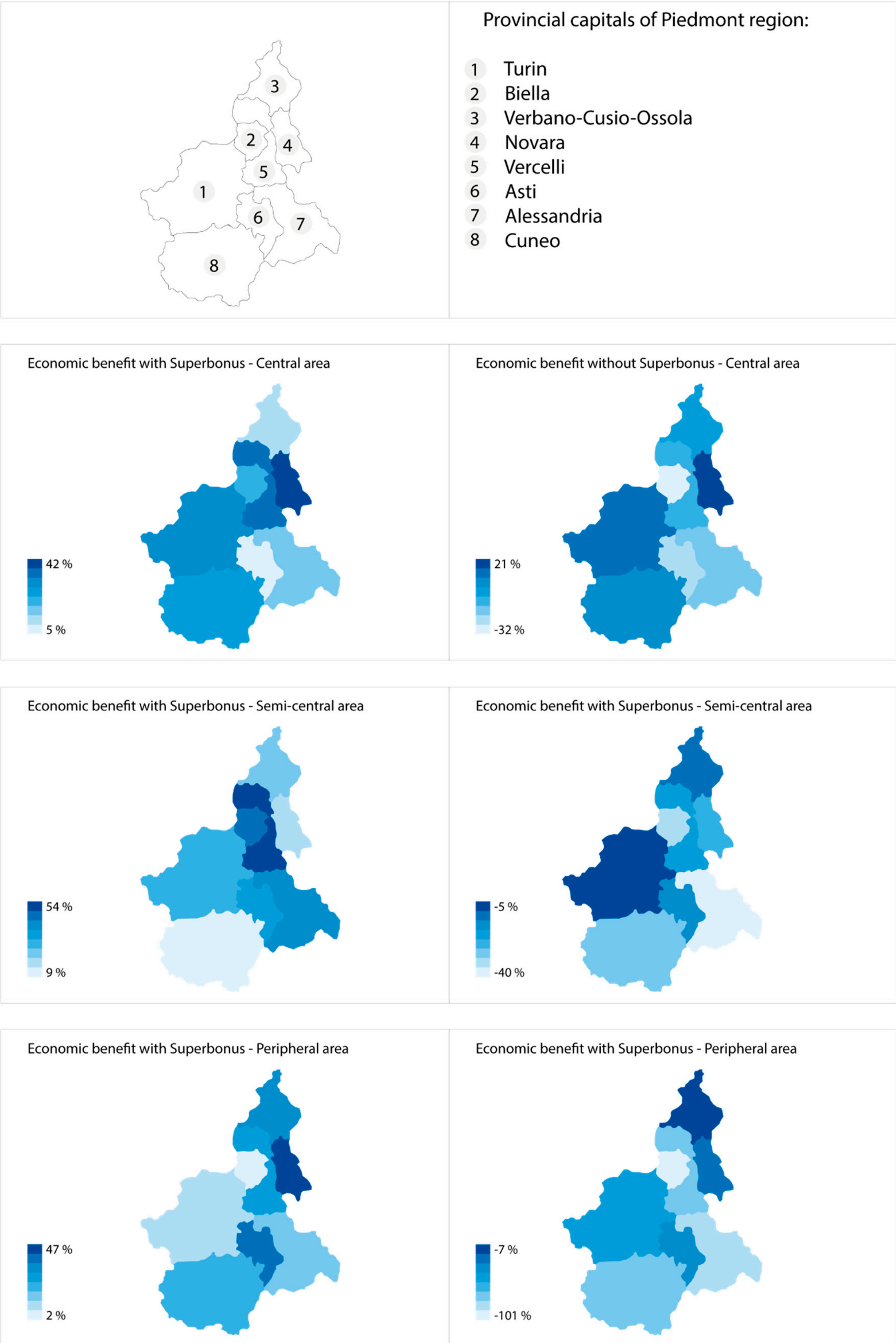

Figure 3. Convenience maps defined for the urban areas of the provincial capitals located in Piemonte region.

The goal of the proposed maps concerns the identification of the provincial capital's urban areas, for which a higher convenience for both public and private subjects to implement energy improvement intervention has been observed.

Firstly, it should be pointed out that the market value differentials calculated in the situation in which the Superbonus incentive is used, i.e., considering that all the intervention costs are supported by public funding, have attested the total convenience for private investor (=100% of the provincial capitals considered).

The results obtained have highlighted that, in the situation in which the costs of energy improvement are included in the value differential calculation and, therefore, the intervention is carried out without the Superbonus incentive, for the central areas of the provincial capitals located in the North-Western Italy macro-area (regions of Valle d'Aosta, Liguria, Lombardia, and Piemonte), a total investment convenience has been found. For the Piemonte region, for three of the eight total provincial capitals, the convenience of carrying out the investment in terms of value surplus between the ante and post-energy intervention situations has been recorded.

By analyzing the outputs for the semi-central area and by considering the costs of energy improvement, the investment is convenient for all the provincial capitals of the Valle d'Aosta region, for half of the cities located in the Liguria region (two out of four), and for eight provincial capitals of the Lombardia region, compared to twelve in total and none for the provincial capital of Piemonte.

With reference to the peripheral areas of the provincial capitals of North-Western Italy macro-area, the energy retrofit initiatives determine benefits for the private operators in all provincial capitals of the Valle d'Aosta, in only one provincial capital of the four ones located in Liguria region, in four out of twelve provincial capitals of the Lombardia region, and in none cities among those considered in Piemonte.

Within the North-East Italy macro-area (regions of Trentino Alto Adige, Friuli Venezia Giulia, Veneto, Emilia Romagna), the same analysis has allowed one to verify an almost total convenience in activating energy improvement interventions for all the regions located in this cluster: in fact, for all the central areas of the provincial capitals located in Trentino Alto Adige, Veneto, and Emilia Romagna, a positive variation in terms of property prices between the ante-energy intervention and post-energy intervention has been recorded, whereas for one provincial capital of Friuli Venezia Giulia region (city of Gorizia), a scarce convenience has been detected.

From the analysis performed for the semi-central and peripheral areas of the North-East Italy provincial capitals, a total convenience has been found for the Trentino-Alto Adige region. For the region of Friuli Venezia Giulia, a relevance convenience has been indicated for the semi-central area of all the cities considered, except for the provincial capital of Gorizia and for the peripheral area of all the provincial capitals aside from Udine and Gorizia.

Furthermore, only for three provincial capitals of the Emilia Romagna region out of the nine, there is no convenience in implementing an energy retrofit intervention on buildings located in the semi-central area, and for three out of seven provincial capitals the semi-central areas of the cities located in the Veneto region a scarce convenience has been attested. Moreover, a lower convenience to invest has been found for the peripheral areas of the provincial capitals located in regions of Veneto (for four out of seven, an absence of convenience has been revealed) and Emilia Romagna (for six out of nine, no benefits have been identified).

By analyzing the results obtained for the regions located in Central Italy (regions of Toscana, Umbria, Marche, and Lazio), an absolute convenience for all three urban areas considered has been found for the region of Toscana. For the provincial capitals of Umbria, monetary benefits deriving from the energy retrofit investments in central and semi-central areas have been observed, whereas in the peripheral area only for the city of Perugia, no convenient condition for the private investor has been recorded. For the Marche region in the peripheral urban area only for the city of Ancona and in the central and semi-central areas for the city of Ascoli Piceno, an absence of convenience to implement an energy improvement initiative has been pointed out. Finally, with regards to the Central Italy cluster, (i) a total convenience in the central areas of the Lazio region provincial capitals, (ii) significant market value differentials in the semi-central areas of the cities (only for two provincial capitals out of five there is no positive surplus) and (iii) a lower convenience in the peripheral areas of the same provincial capitals (for three cities out of five, monetary benefits in redevelopment investments have been verified) have been attested.

Within the regions located in the Southern-Italy macro-area (Campania, Abruzzo, Molise, Basilicata, Puglia, and Calabria), for the central, semi-central, and peripheral areas in which each provincial capital analyzed is divided, the percentage of those for which a convenience to invest has been observed are reported below: for the central areas, 75% (3 for 4) of the provincial capitals for the Abruzzo region, 100% for Molise (2 for 2), 80% for Campania (4 for 5), 67% for Puglia (4 for 6), 50% for Basilicata (1 for 2), and 60% for Calabria (3 for 5); for the semi-central areas, 50% of the cities for the Abruzzo (2 for 4) region, 50% for Molise (1 for 2), 80% for Campania (4 for 5), 50% for Puglia (3 for 6), 50% (1 for 2) for Basilicata, and 40% (2 for 5) for Calabria region; and for the peripheral areas, 75% (3 for 4) of the provincial capitals for the Abruzzo region, 50% (1 for 2) for the Molise region, 80% (4 for 5) for the Campania region, 50% (3 for 6) for the Puglia region, 100% (2 for 2) for Basilicata region, and 0% (0 for 5) for Calabria. In this sense, it should be outlined that for no provincial capital of the Calabria region has a convenience of intervention in the peripheral areas been expected in the hypothesis of the absence of the Superbonus implementation, i.e., by considering the intervention costs in the market value differential calculation.

Finally, by analyzing the results for the central areas of the Italian Islands (Sicilia and Sardegna), the energy retrofit investment has identified as convenient for six out of nine provincial capitals of the Sicilia region and for five out of eight provincial capitals of the Sardegna region. Similarly, for the semi-central areas, a positive value differential between the post-energy intervention situation and the ante-energy intervention situation has been recorded for five out of nine provincial capitals of the Sicilia region and three out of eight cities of the Sardegna region. For the peripheral areas of the provincial capitals located in the Island, a scarce convenience in terms of post/ante value surplus for five out of nine provincial capitals of the Sicilia region and seven out of eight of the Sardegna region has been attested.

In Table 2, the maximum and minimum value differentials between the market values detected in the post-energy intervention situation and those related to the ante-energy intervention one, determined for each macro-area, are reported. In particular, for each urban area, Table 2 shows a summary of the average value surplus expressed in percentage terms calculated without the use of the Superbonus mechanism, with the costs incurred by the investor.

Table 2. Average maximum and minimum value differentials expressed in percentage terms, calculated without the use of the Superbonus mechanism.

Maximum and Miminum Value Differentials						
Macro-area	Central Area		Semi-central Area		Peripheral Area	
	Maximum Value	Minimum Value	Maximum Value	Minimum Value	Maximum Value	Minimum Value
North-Western Italy	Imperia 56%	Biella −32%	Sondrio 33%	Alessandria −40%	Milan 37%	Biella −101%
North-East Italy	Pordenone 45%	Gorizia −18%	Pordenone 49%	Gorizia −41%	Pordenone 29%	Gorizia −56%
Central Italy	Macerata 59%	Ascoli Piceno −5%	Macerata 69%	Ascoli Piceno −6%	Pesaro e Urbino 43%	Rieti −47%

Southern Italy	Taranto 55%	Catanzaro −36%	Bari 43%	Vibo Valentia −31%	Bari 26%	Chieti −42%
Islands	Nuoro 52%	Ragusa −37%	Cagliari 38%	Trapani −47%	Palermo 23%	Medio Campidano −66%

4.6.2. Isoprofit Maps

By recalling the division of the Italian territory into five macro-areas—North-Western Italy (Valle d'Aosta, Liguria, Lombardia, Piemonte), North-Eastern Italy (Trentino-Alto Adige, Veneto, Friuli Venezia Giulia, Emilia Romagna), Central Italy (Toscana, Umbria, Marche, and Lazio), Southern Italy (Abruzzo, Molise, Campania, Puglia, Basilicata, and Calabria) and Islands (Sicilia and Sardegna)—the isoprofit maps have been defined considering the three urban areas considered (central, semi-central, and peripheral) into which each Italian provincial capital is commonly divided.

By taking into account an ordinary profit margin for the investor equal to 15%, the isoprofit maps have allowed one to graphically represent the urban areas of the different Italian provincial capitals located in the macro-areas for which the use of fiscal incentives is required, and their measure.

The isoprofit maps have allowed one to identify the provincial capitals for which a higher convenience in carrying out the intervention through the use of the Superbonus incentive has been attested. In this sense, in fact, the value higher than 110% highlights that the investor must incur additional costs to achieve the energy efficiency goal. On the other hand, in cases for which the value is negative, a very convenient condition has been found for the private subject, by confirming a lack of necessity in implementing the Superbonus measure.

For all three urban areas—central, semi-central, and peripheral—into which each Italian provincial capital is divided, the break-even incentive is capable of guaranteeing the private investor a profit margin equal to 15% on the initial investment costs, that is, the sum of the purchase of the property and eventual refurbishment costs to be burdened and not covered by the incentive has been determined. The results obtained have attested that in the central areas of forty-three provincial capitals (39% of the total number of provincial capitals analyzed), a convenient condition has occurred due to the detection of relevant benefits in implementing energy improvement interventions even in the absence of the Superbonus incentive. With reference to the semi-central area, a profitable situation for the private operator to invest using their own capital for the energy efficiency intervention has been found for 19 provincial capitals (17% of the total number), whereas for the peripheral areas, a convenience to activate an energy retrofit initiative without the use of the fiscal mechanism has been recorded only for nine provincial capitals (8% of the total number). Thus, at national level, for 21% of the urban areas in the 110 provincial capitals (71 urban areas compared to the 330 urban areas of the Italian provincial capitals), a condition of convenience to invest in the improvement of energy requalification of the residential assets has been identified.

In Figure 4, the isoprofit maps developed for Northern Italy, i.e., North-Western Italy and North-Eastern Italy macro-areas, are reported. The isoprofit maps related to the Central Italy, Southern Italy, and Islands macro-areas are reported in Figures S20 and S21 in Supplementary Files.

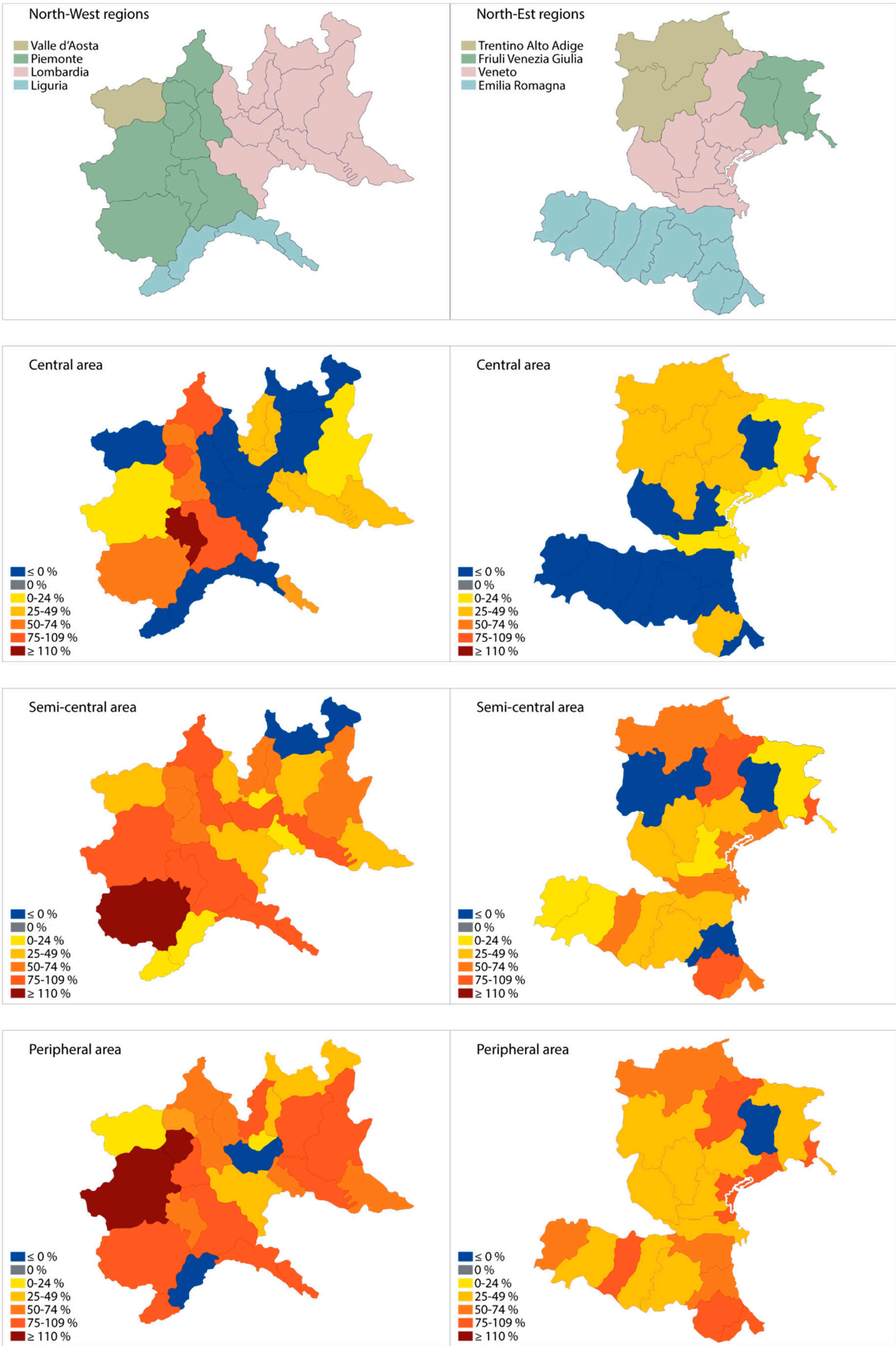

Figure 4. Isoprofit maps developed for the North-Eastern Italy and North-Western Italy macro-areas.

Finally, the isoprofit maps have been elaborated using a gradation of four colors: (i) blue for the provincial capitals for which there is no need to use any fiscal incentives (break-even threshold <0%); (ii) grey for the situations where the break-even threshold found is equal to 0%; (iii) orange for the four clusters (1–24%, 25–49%, 50–74%, and 75–110%), which indicate the provincial capitals where the incentive is necessary but with an extent lower than 110%; and (iv) red for the provincial capitals where the 110% incentive currently provided by the Superbonus is insufficient to guarantee the condition of minimum convenience for an investor. The isoprofit maps have been implemented at the macro-area level into which the Italian territory is commonly divided—North-Western Italy (regions of Valle d'Aosta, Liguria, Lombardia, and Piemonte), North-Eastern Italy (regions of Trentino-Alto Adige, Veneto, Friuli Venezia Giulia, and Emilia Romagna), Central Italy (regions of Toscana, Umbria, Marche, and Lazio), Southern Italy (regions of Abruzzo, Molise, Campania, Puglia, Basilicata, and Calabria) and Islands (regions of Sicilia and Sardegna).

Table 3 reports for each macro-area the minimum and maximum positive value, i.e., the situations for which public funds are necessary, of the break-even incentive capable of guaranteeing the private investor a profit margin equal to 15% on the initial investment costs.

Table 3. Minimum and maximum positive value of the break-even incentive for each macro-area (private investor's profit margin = 15%).

Minimum and Maximum Positive Break-even Incentive Value						
Macro-area	**Central Area**		**Semi-central Area**		**Peripheral Area**	
	Minimum Value	**Maximum Value**	**Minimum Value**	**Maximum Value**	**Minimum Value**	**Maximum Value**
North-Western Italy	La Spezia 15%	Asti 125%	Imperia 13%	Cuneo 119%	Monza e Brianza 11%	Turin 113%
North-East Italy	Venice 4%	Gorizia 65%	Piacenza 2%	Belluno 89%	Treviso 26%	Reggio Emilia 96%
Central Italy	Fermo 1%	Ascoli Piceno 78%	Fermo 4%	Ascoli Piceno 61%	ROME 10%	Rieti 97%
Southern Italy	Salerno 7%	Catanzaro 111%	Brindisi 21%	Vibo Valentia 90%	Lecce 3%	Vibo Valentia 91%
Islands	Olbia-Tempio 14%	Sassari 77%	Nuoro 7%	Trapani 102%	Agrigento 12%	Caltanissetta 122%

Furthermore, with reference to the investigation aimed at defining the percentage threshold capable of ensuring the condition of minimum convenience of the operation for an investor, a sensitivity analysis of the profit margin of a generic entrepreneur interested in this type of investment has been developed. In this sense, a fluctuation of the percentage of private profit margin within a range of variation [−5%; +5%] has been carried out, in order to verify the minimum break-even incentive able to ensure the financial feasibility of the initiative. By considering profit margins of +10%, +12%, +15%, +17%, and +20%, the sensitivity analysis performed for the different profit percentages has produced interesting considerations related to the private feasibility of the investment. First of all, by considering a profit margin of +10%, the results have attested to a convenient situation in the central area of 59 provincial capitals (54% of the total number), in the semi-central area of 34 provincial capitals (31% of the total number), and in the peripheral area of 15 provincial capitals (14% of the total). With reference to a profit margin of +12%, the results have pointed out a convenient situation in the central area of fifty-two provincial capitals (47%

of the total number), in the semi-central area of twenty-six provincial capitals (24% of the total number), and in the peripheral area of eleven provincial capitals (10% of the total). By taking into account a profit margin equal to +17%, the results have verified a convenient situation in the central area of 38 provincial capitals (35% of the total number), in the semi-central area of 17 provincial capitals (15% of the total number), and in the peripheral area of seven provincial capitals (6% of the total). By analyzing a profit margin of +20%, the results have demonstrated a profitable situation in the central area of 34 provincial capitals (31% of the total number), in the semi-central area of nine provincial capitals (8% of the total number), and in the peripheral area of five provincial capitals (4% of the total).

In brief, the results obtained can be summarized as explained below: (i) for a profit margin of 10%, for 45% of the energy retrofit interventions carried out in the central areas of the Italian provincial capitals, for 69% of the projects in the semi-central areas, and for 85% of the investments in the peripheral areas, the need for a fiscal incentive less than 110% [1–110%] able to make the initiative sustainable has been observed; (ii) for a profit margin of 12%, in 52% of the central areas, in 76% of the semi-central areas, and in 89% of the peripheral areas of the Italian provincial capitals, an incentive less than 110% [1–110%] is required for the financial sustainable intervention; (iii) for a profit margin of 15%, in 59% of the central areas, in 82% of the semi-central areas, and in 89% in the peripheral areas of the Italian provincial capitals, an incentive less than 110% [1–110%] is required for the financial sustainable intervention; (iv) for a profit margin of 17%, in 64% of the central areas, in 82% of the semi-central areas, and in 91% of the peripheral areas, a public incentive less than 110% [1–110%] has been found able to ensure the intervention convenience for the private; (v) for a profit margin of 20%, in 67% of the central areas, in 87% of the semi-central areas, and in 93% of the peripheral areas of the Italian provincial capitals analyzed, a percentage incentive less than 110% [1–110%] has been estimated to guarantee the condition of minimum operation convenience.

In Figure 5, the sensitivity analysis graph obtained in correspondence of five percentage profit margins considered—10%, 12%, 15%, 17%, and 20%—for the central area of the Italian provincial capitals considered (the same typology of graph for the semi-central and peripheral areas of the provincial capitals considered is included in Supplementary Files in Figures S22 and S23).

In particular, in the graphs, a dotted horizontal line corresponding to the current incentive provided for by the legislation equal to 110% and five dotted vertical lines corresponding to the incentive percentage equal to 0% have been included. In this sense, it should be noted that for the central urban area for one provincial capital in correspondence of the profit margin of 10%, for one provincial capital in correspondence of the profit margin of 12%, for two provincial capitals for the profit margin of 15%, for two provincial capitals in correspondence of the profit margin of 17%, and for two cities for the margin equal to 20%, an incentive percentage greater than 110% is required. In addition, assuming a profit margin of 10%, for no intervention carried out in the central areas of the provincial capitals a higher incentive compared to that currently used is needed. With reference to the number of Italian provincial capitals in which the financial convenience of the energy efficiency intervention in the central area is ensured, on the left of the vertical lines the graph shows the number of cities for which no public incentive is required to ensure the condition of minimum convenience for an investor, and on the right, the number of provincial capitals for which it is necessary to introduce a fiscal measure in terms of gradually increasing subsidy from 1% to 139%, i.e., the maximum percentage found.

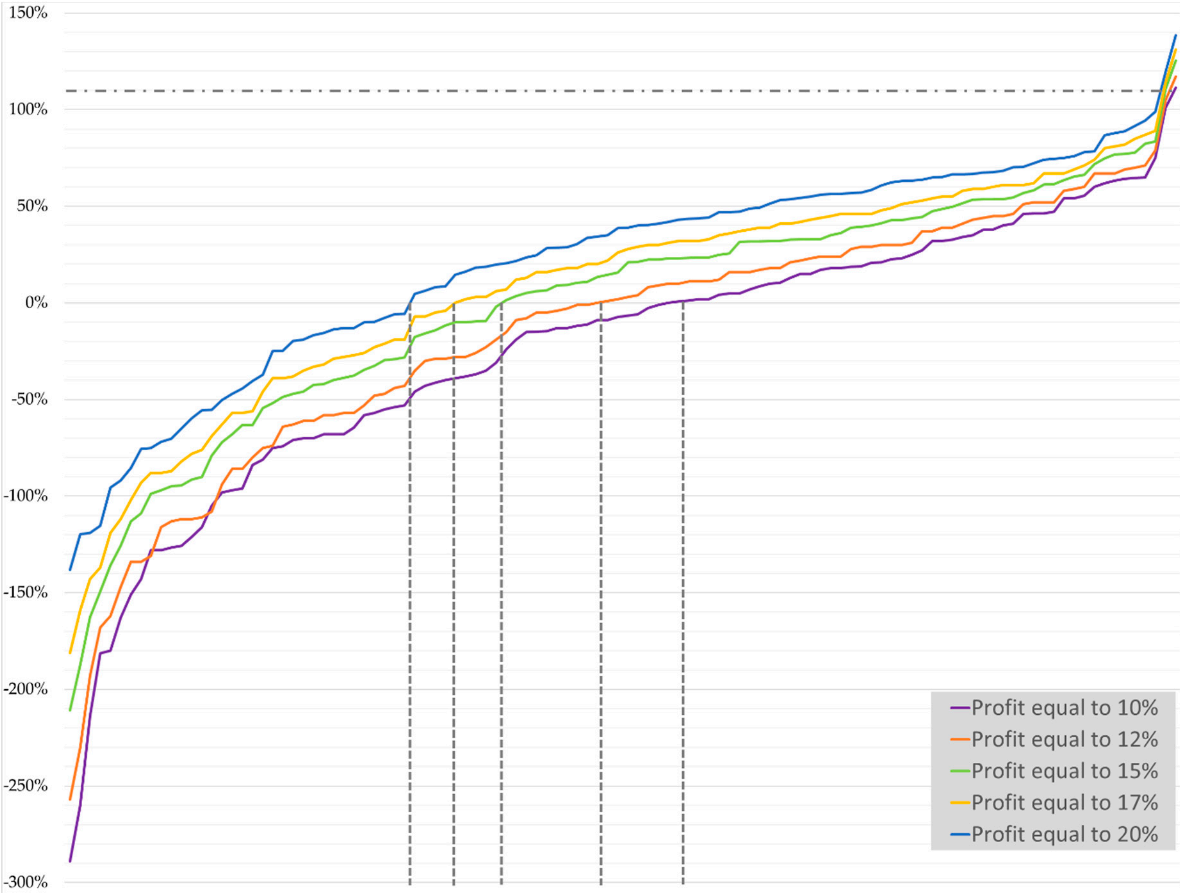

Figure 5. Sensitivity analysis obtained in correspondence of five percentage profit margins considered (10%, 12%, 15%, 17%, and 20%) for the central area of the Italian provincial capitals considered.

With reference to the central area, the number of Italian provincial capitals for which a situation of convenience has been verified without the need for the Superbonus mechanism for all ordinary profit margins of the investor from 10% to 20% is equal to two hundred and sixty out of total of five hundred (by taking into account five margin profits for 110 provincial capitals). In particular, for the defined isoprofit percentage of 10% for 59 provincial capitals, of 12% for 52 provincial capitals, of 15% for 43 provincial capitals, of 17% for 38 provincial capitals, of 20% for 34 provincial capitals, the convenience of the intervention for the private operator has been ensured. Exclusively for eight provincial capitals (by considering five margin profits for 110 provincial capitals), the financial threshold capable of guaranteeing the condition of minimum convenience higher than 110% has been detected.

For the semi-central area, the sustainability condition of the energy efficiency investment compared to the different profit margins of an ordinary entrepreneur without the need to the 110% incentive has been verified in 105 provincial capitals (with reference to five margin profits for 110 provincial capitals). In particular, in the semi-central areas of nine provincial capitals, a lack of need for any incentive (<0%) for all ordinary profit margins of the investor from 10% to 20% has been recorded, whereas the limit of 110% being exceeded has been attested to in nine cases for which it is necessary to provide a percentage of the incentive higher than that currently implemented. For 436 out of total 500 cities, the sustainability with the use of a public funds between 1% and 110% has been obtained, and for 11 provincial capitals, a higher than 110% incentive need has been determined.

Finally, for the peripheral areas of five provincial capitals, there is a financial feasibility condition to invest in an energy improvement intervention without Superbonus: specifically, the convenience has been certified even without any tax incentive (<0%) for 47 cities. Moreover, for 492 provincial capitals, the sustainability with the use of a public funds between 1% and 110% has been verified, and for 11, a higher than 110% incentive need has been determined.

Furthermore, with reference to the three urban areas considered (central, semi-central, and peripheral), the results obtained in terms of the number of provincial capitals found in correspondence of the different percentage profit margins are grouped. Therefore, seven fiscal incentive clusters necessary to guarantee the financial feasibility of the initiative (<0%, 0%, 1–24%, 25–49%, 50–74%, 75–110%, and >110%) have been considered, and, for each profit margin selected, the number of provincial capitals is reported. In particular, it should be noted that for the central area, a significant presence of cities in the cluster <0% for which no tax incentive would be activated has been defined. The graphs developed for the central areas (Figure 6), for the semi-central areas (Figure 7), and for the peripheral ones (Figure 8) of the provincial capitals analyzed have been reported below.

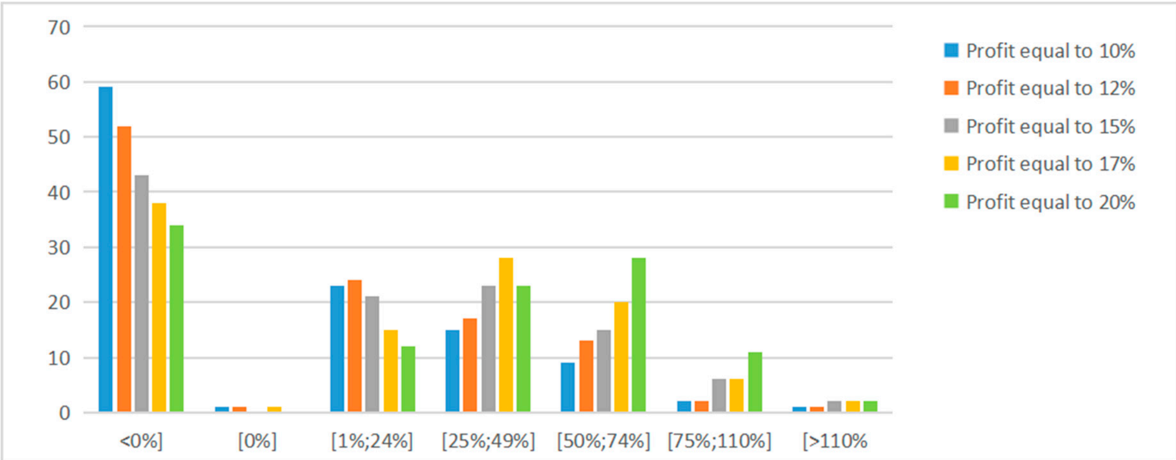

Figure 6. Distribution of the number of provincial capitals found in correspondence of the seven fiscal incentive clusters (<0%, 0%, 1–24%, 25–49%, 50–74%, 75–110%, and >110) in the central urban areas.

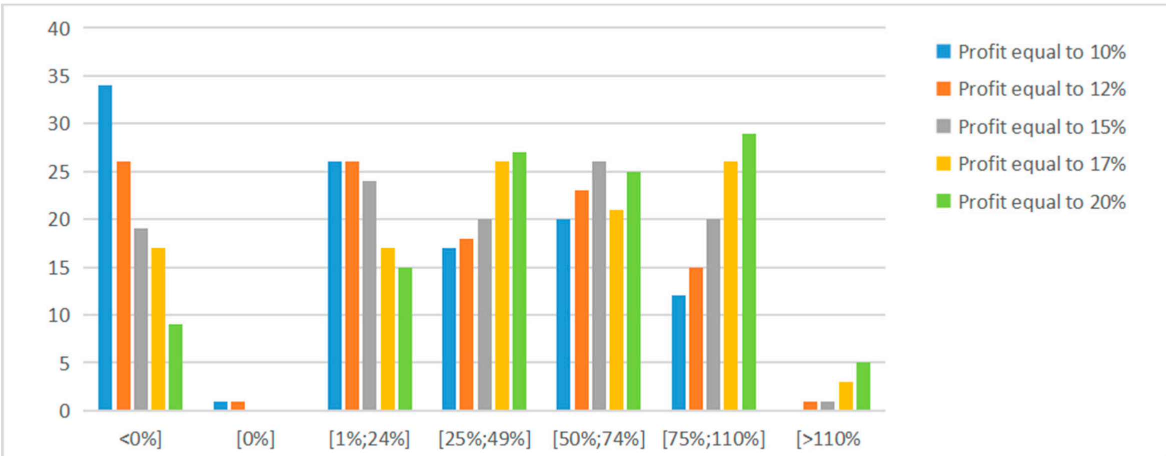

Figure 7. Distribution of the number of provincial capitals found in correspondence of the seven fiscal incentive clusters (<0%, 0%, 1–24%, 25–49%, 50–74%, 75–110%, and >110) in the semi-central urban areas.

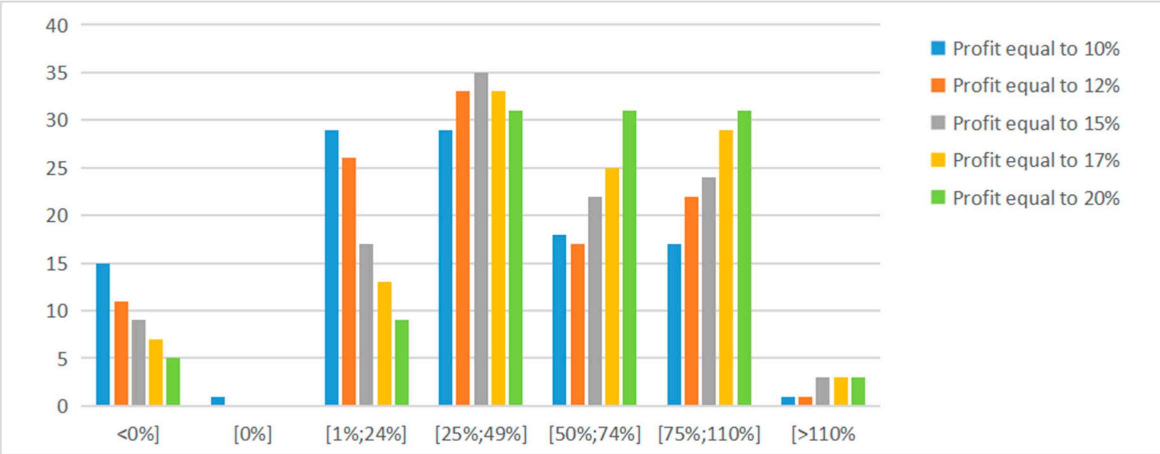

Figure 8. Distribution of the number of provincial capitals found in correspondence of the seven fiscal incentive clusters (<0%, 0%, 1–24%, 25–49%, 50–74%, 75–110%, and >110) in the peripheral urban areas.

5. Conclusions

In the context of the existing literature aimed at analyzing the effects of energy retrofit interventions on real estate market in terms of residential, commercial, or office selling prices, this study has intended to provide an innovative contribution in line with the current promotion of fiscal incentives for the energy requalification of the existing property asset.

The research has focused on the investigation of the sustainability of energy efficiency interventions on the building stock, by analyzing the Superbonus 110%. The study has aimed to develop a model organized in phase sequences able of evaluating the economic benefits, in terms of the convenience of the operators involved, generated by energy requalification initiatives carried out through the use of the Superbonus mechanism. According to the ISTAT data, the analysis has been developed with reference to the Italian territory and to the prevailing/most common building typology (multi-story building made of reinforced concrete), by considering the current 110 provincial capitals and the main urban areas into which each city is commonly divided (central, semi-central, and peripheral). In particular, the steps implemented have concerned: (i) the analysis of the reference context; (ii) the description and localization of the study samples; (iii) the examination of costs estimates related to energy efficiency interventions relating to multi-story buildings in reinforced concrete in order to define the unit costs; (iv) the data collection of property selling prices with high and low energy label, in order to determine the unit market values for each area of each provincial capital, in the ante and post-energy intervention situations; (v) the computational phase, in which the economic benefits in terms of surplus value generated by the interventions in each urban area of each provincial capital have been estimated. Furthermore, the break-even incentive, i.e., the percentage threshold of the fiscal incentive for each area of each provincial capital considered, is able to guarantee the condition of minimum convenience for an investor have been assessed; and (vii) the georeferencing of the outputs through the development of the convenience maps and isoprofit ones.

With reference to the case study analyzed, the results obtained have attested that, in the situation in which the refurbishment costs are covered by the Superbonus incentive, the investment is totally convenient for all Italian provincial capitals. On the other hand, in the situation in which the investor fully bears the energy efficiency costs, the operation would be convenient for 82% of the central areas, 63% of the semi-central areas, and 57% of the peripheral areas of the cities selected.

The investigation performed to assess the break-even incentive, i.e., the percentage threshold able to ensure the minimum convenience of the operation by assuming a unique profit margin of an ordinary entrepreneur involved in this investment type (isoprofit analysis), has allowed one to highlight that, in the hypothesis of a private expected profit equal to 15% on the investment costs, for 21.5% of the total areas analyzed (330 total areas, i.e., 110 central, 110 semi-central, and 110 peripheral), the initiative is sustainable even in the absence of a Superbonus incentive, whereas for 1.8% the need for an incentive equal to or higher than 110% has been identified, and for 76.7% of the areas incentive support of less than 110% has been found.

By observing the outputs, the most convenient situations occur in the provincial capitals of the Northern Italy and Central Italy compared to those located in Southern Italy and the Islands.

The proposed model has allowed one to provide indications related to fiscal policies: in fact, if all the funds allocated for 110% were used, the possibility of implementing the available monetary resources in alternative public uses would be precluded while guaranteeing the financial feasibility of all energy efficiency investments. The convenience and isoprofit maps constitute a useful tool for private and public subjects involved in energy retrofit processes, on the one hand, to verify the sustainability of the interventions in the various contexts considered and, on the other, to ensure a fiscal incentive only if required. The outputs obtained have shown that for more than 70% of cases considered, a Superbonus measure in the range between 1% and 75% is needed: in this sense, the measure of 110%, while attracting greater interest from investors, represents a disbursement by the State aimed at improving the existing asset.

In this sense, the research constitutes the first attempt to quantify the value surplus between the ante and post project-energy intervention situations “with” and “without” the incentive of the Superbonus. Furthermore, the present study has tried to calculate the fiscal measure granted for the buildings’ energy redevelopment in order to allow private investors to reach the financial convenience threshold and public entities to define effective strategies for using public economic resources.

The practical implications of the research are related to the multiple uses of the developed tool: (i) it has allowed private operators (local entrepreneurs, institutional and non-institutional investors, asset management companies, banks, insurance companies, real estate funds, technical consultants involved in the feasibility assessments of energy interventions, etc.) to determine the urban areas of each Italian provincial capital or, more generally, the cities for which a higher convenience in energy efficiency interventions is observed [72]. In this sense, the methodology proposed will allow one greater control of investment risk [73], providing support in the preliminary assessment of the sustainability of operations and precluding possible future insolvency situations such as unlikely to pay and non-performing loans); and (ii) public entities to define the areas and/or the provincial capitals in which the current Superbonus incentive is necessary, excessive, or insufficient and, therefore, to estimate the break-even incentive percentages capable of guaranteeing the condition of minimum convenience for the investor. In this sense, the developed model may represent a valid support tool in the negotiation phases between public and private in order to weigh the incentive thresholds according to the territorial context considered and/or to activate compensation mechanisms in the negotiation phases between public and private parties.

In this sense, the methodology could be easily retraced and implemented in any territorial context. Future insights of this research may concern the convenience assessment for an investor deriving from the refurbishment interventions carried out on properties to be restructured, in order to determine the profit margins in absolute terms achievable in each territorial context and to compare the outputs with other areas.

In addition, the outputs obtained may be implemented in the Building Information Modeling (BIM) environment, in order to allow for the automation of the proposed valuation methodology. In this sense, the model to be developed will allow an automated benefits assessment, by integrating a structured database on Excel support and geographical maps and information modeling in BIM environment. Starting from the systematized outputs in an appropriate quick-consultation abacus, the implementation of the information set in the BIM environment will make it possible to automate the entire work-flow linked to the final outputs and therefore to explicate the results simultaneously for a large number of buildings located in different territories. Furthermore, the integration of information into BIM could provide for the evaluation of the unit cost directly through the BIM authoring environment in order to monitor unit costs and market values depending on the intervention typology.

Finally, further future developments of the method are connected to the assessments of the economic benefits in terms of positive effects related, for example, to savings on the bill, appropriately considering the climatic conditions of the different territorial contexts and the different construction technologies allowed: in fact, in the model proposed, the estimated benefits relate exclusively to the increases in the housing market value connected to the energy efficiency measures. Future implementations of the methodology may also concern different "prototypes" (masonry, mixed, wood, steel, etc.), in order to draw upon a support tool that, for any type of intervention considered, could constitute a vademecum of the conveniences for an investor and of threshold incentives for Public Administrations.

Supplementary Materials: The following are available online at www.mdpi.com/article/10.3390/app12073385/s1, Figure S1: Convenience maps defined for the urban areas of the provincial capitals located in Valle d'Aosta region; Figure S2: Convenience maps defined for the urban areas of the provincial capitals located in Lombardia region; Figure S3: Convenience maps defined for the urban areas of the provincial capitals located in Liguria region; Figure S4: Convenience maps defined for the urban areas of the provincial capitals located in Trentino Alto Adige region; Figure S5: Convenience maps defined for the urban areas of the provincial capitals located in Veneto region; Figure S6: Convenience maps defined for the urban areas of the provincial capitals located in Friuli Venezia Giulia region; Figure S7: Convenience maps defined for the urban areas of the provincial capitals located in Emilia Romagna region; Figure S8: Convenience maps defined for the urban areas of the provincial capitals located in Toscana region; Figure S9: Convenience maps defined for the urban areas of the provincial capitals located in Umbria region; Figure S10: Convenience maps defined for the urban areas of the provincial capitals located in Marche region; Figure S11: Convenience maps defined for the urban areas of the provincial capitals located in Lazio region; Figure S12: Convenience maps defined for the urban areas of the provincial capitals located in Campania region; Figure S13: Convenience maps defined for the urban areas of the provincial capitals located in Abruzzo region; Figure S14: Convenience maps defined for the urban areas of the provincial capitals located in Molise region; Figure S15: Convenience maps defined for the urban areas of the provincial capitals located in Basilicata region; Figure S16: Convenience maps defined for the urban areas of the provincial capitals located in Puglia region; Figure S17: Convenience maps defined for the urban areas of the provincial capitals located in Calabria region; Figure S18: Convenience maps defined for the urban areas of the provincial capitals located in Sicilia region; Figure S19: Convenience maps defined for the urban areas of the provincial capitals located in Sardegna region; Figure S20: Isoprofit maps developed for the Central Italy and Southern Italy macro-areas; Figure S21: Isoprofit maps developed for the Italian Islands; Figure S22: Sensitivity analysis obtained in correspondence of five percentage profit margins considered [10%, 12%, 15%, 17% and 20%] for the semi-central area of the Italian provincial capitals considered; Figure S23: Sensitivity analysis obtained in correspondence of five percentage profit margins considered [10%, 12%, 15%, 17% and 20%] for the peripheral area of the Italian provincial capitals considered

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