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Green housing: Toward a new energy efficiency paradox?

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ABSTRACT

Buildings energy efficiency has occupied a prominent place on the agenda over the last decade. This study aims to assess the economic viability of improving the energy performance of residential buildings, by comparing additional costs of investment with the monetary savings achievable through reduced energy consumption.

The evaluation model relies on the methodological framework of Discounted Cash Flow analysis, from a purely financial point of view in which externalities are not considered. The assessment is applied to two case studies located in Northern Italy. For each case study, several energy improvement alternatives are investigated.

Empirical findings can be summarized as follows: at least partly, investing in buildings energy efficiency lacks economic viability; nevertheless, it can be interpreted as a hedge against a sharp rise in energy supply pricing in the coming years.

As original contribution, the achieved findings provide an empirical support to highlight a new kind of energy efficiency paradox: investing in improving the buildings energy performance should allow a reduction to both climate-altering emissions and, in an efficient market, the price of energy supplies; but a decreasing price also lowers the profitability of the self-same investment, and acts as a deterrent to further improvements.

1. Introduction

The topic of buildings energy efficiency occupies a prominent place on the agenda. Eurostat (2011) estimates that residential and tertiary buildings are responsible for 40% of energy consumption and 36% of greenhouse gas emissions. The European Union has placed an increasing emphasis on improving energy performance in the building sector, to achieve both a medium-term objective, such as a 20% reduction in energy consumption by the year 2020, and a long-term goal, namely a low-carbon economy by the year 2050.

In May 2010, the European Commission adopted the Energy Performance of Building Directive (2010/31/EU). Almost a year later, in March 2011, the Commission's Communication on "Energy Efficiency Plan" recognized that only half of the goals established for that period were achieved. A further Commission's Communication, in June 2013, stressed the lack of progress with regard to Nearly Zero-Energy Building standard, which public buildings should achieve by 2018 and all new constructions by 2020. Therefore, a considerable potential for improving energy performance is identified in the European construction sector. Nevertheless, the current situation can be summarized as a perceived dichotomy between ambitious goals and partly unsatisfactory outcomes.

In the Italian context, European targets are put forward in the so-called national energy strategy. Among the tools for its implementation, there are performance requirements, energy efficiency certificates, tax rebates and labelling schemes, both compulsory and voluntary. Hence, several innovations aiming to improve energy efficiency have been experimented with in the building sector. A first branch of research concerns design solutions aimed at reducing energy losses (Albatici & Passerini, 2011), for example through the removal of thermal bridges (Boeri & Longo, 2011; Rossetti & Pepe, 2015). Similarly, other studies have delved into the performance of construction materials, in order to reduce heat exchanges through the building envelope (Albatici, 2009; Antonini, Longo, & Gianfrate, 2014; Becchio, Corgnati, Kindinis, & Pagliolico, 2009). Finally, a number of studies have focused on the reduction of energy demand for heating and cooling by means of high-efficiency systems (Causone, Baldin, Olesen, & Corgnati, 2010; Fabrizio, Seguro, & Filippi, 2014). A broad range of intervention strategies and related experiences have recently been discussed by Ferrante (2014), stressing their relevance for cities falling within the Mediterranean climate. The energy efficiency index ODEX, developed within the framework of the European

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project ODYSSEE-MURE (Bosseboeuf, Chateau, & Lapillonne, 1997), estimated that energy performance of the Italian residential real estate sector has increased by almost 30% between 1990 and 2011 (Enea, 2012a, 2014). The greatest change was observed during the period 1997–2004, however since 2007 the residential sector has shown negligible variation.

In search of further improvements, urban policies and governance practices are considered precious tools in order to foster the diffusion of energy-efficient solutions (Dowling, McGuirk, & Bulkeley, 2014). In Italy, regional governments and provincial authorities are entitled to lawmaking with regard to both buildings performance and town planning. During the last few years, they have striven to pursue a tighter integration between building-related energy concerns and planning. A worthwhile approach is provided by the Trento Province, which has included building regulations concerning energy performance in its Urban Planning Act (Provincial Law 1/2008). An interesting innovation consists in granting both additional gross floor area and rebates on local construction taxes, commensurate to energy label, if higher than the standard required (s. 86). Moreover, computation of buildability index does not account for the volume of elements designed to improve energy efficiency. The underlying assumption is that a lot of measures are not fully self-sustainable from an economic and financial perspective, so they deserve to be subsidized. Indeed, there is still an unresolved question: is the higher cost incurred during construction of energy-efficient buildings, or during retrofit of existing ones, offset by lower operating costs? The relevance of this issue is supported by the results of a recent analysis carried out by public institutions, according to which "only a few investments" suitable for residential buildings have an "acceptable payback period and thus a positive cost–benefit profile" (Enea, 2014, p. 138). Consistently with the aforementioned framework, this study aims to investigate whether energy efficiency solutions for buildings are profitable under free market conditions, or else they entail the need to be supported by public policies.

2. Literature review

The topic of energy consumption is part of a wider debate involving issues such as energy conservation toward a so-called low carbon economy, reduction of greenhouse gas emissions to counteract climate change and, more generally, sustainable development of urban areas (Feliciano & Prosperi, 2011; Vojnovic, 2014). Within this framework, urban shape and land use planning are considered key factors in determining future energy consumption trend (Torres & Pinho, 2011). Moreover, the energy use of public and private buildings, as well as of other urban facilities, plays a key role within the development of smart city concept (Kylili & Fokaides, 2015). Despite the lack of a shared definition, several studies in this domain have shown a peculiar attention to management systems applied to buildings and facilities, in order to both save energy and improve users' perceived satisfaction (Neirotti, De Marco, Cagliano, Mangano, & Scorrano, 2014). Meanwhile, comparative analyses of case studies have highlighted the relevance of energy saving technologies to enhance awareness of city users about their consumption, achieving remarkable results in terms of reduction of greenhouse gas emissions (Angelidou, 2014).

Since buildings efficiency has emerged as one of the main agenda items, there is a growing interest in its economic implications. An increasing amount of research has addressed the viability of investments aiming to improve the performance of residential and commercial real estate, considering both new buildings as well as the refurbishment of existing ones. From a purely financial point of view, thus not considering externalities and collective benefits, this assessment implies the need to face a trade-off, between short-term investments and monetary savings achievable in the medium to long run (Howarth, 2004).

The study conducted by Verbeeck and Hens (2005) leads to satisfactory results within the climate of Central Europe. For both small terraced houses and rural individual dwellings, monetary savings on energy consumption exceed investment costs, which are to be incurred in order to insulate the building envelope and to improve installations. On the contrary, other research provide conflicting outcomes. A recent study underlines the lack of financial feasibility of investing in green offices (Brotman, 2014). Even if certain energy retrofit interventions appear to be profitable, particularly in the residential sector, sensitivity analysis highlights that Net Present Value (NPV) of an investment may fall below zero, due to minor changes in the input variables (Zalejska-Jonsson, Lind, & Hintze, 2012). Moreover, positive outcomes imply the willingness to accept a moderate return on investment (Copiello, 2015), sometimes only a few tens of basis points higher than threshold represented by the gross yield of government bonds (Sadineni, France, & Boehm, 2011; Zalejska-Jonsson et al., 2012). In turn, this means a low risk premium rate, hence doubts may arise whether or not it is out of the market, with respect to property investment.

As a more general result, given the ability to outline different design alternatives, several retrofit packages may succeed financially, while others do not (as shown in Amstalden, Kost, Nathani, & Imboden, 2007; Kumbaroğlu & Madlener, 2012; Sewalk & Throupe, 2013). Particularly, there are measures far from being viable due to excessive investment costs, compared to poor annual savings. The study performed by Kneifel (2010) exhibits the coexistence of both profitable and unprofitable alternatives, depending on location, building type and analysis period. As a further consequence, refurbishment transactions lacking feasibility entail the need to provide public subsidies, especially in behalf of property owners characterized by high opportunity costs of capital (Winkler, Spalding-fecher, Lwazikazi Tyani, & Matibe, 2002). Moreover, the option to tear down and rebuild older buildings deserves more detailed investigations, since it does not appear to be adequately deepened yet (Sewalk & Throupe, 2013).

A specific research branch concerns the effect of energy-efficient features on property values. This issue has been tackled since the mid-eighties (Laquatra, 1986), but findings were mostly modest (Dinan & Miranowski, 1989; Gilmer, 1989). Nonetheless, several recent studies argue about the occurrence of a price or rent premium as a function of energy performance (Bio Intelligence Service et al., 2013). Most of this research focuses on the United States. With regard to Western European countries, two studies have found a rent premium of 5% analyzing Switzerland (Salvi, Horehájová, & Neeser, 2010), and a price premium whose maximum magnitude is 15% in the Netherlands (Brounen & Kok, 2011). The analysis performed by Morrissey and Horne (2011) has brought out that the price gap hypothesis may highly affect results. Indeed, these authors have obtained a certain amount of positive NPVs under the assumption of an additional price increase. The same NPVs turn out negative considering cash flows relating to energy measures only, particularly for short analysis periods and high labels (see p. 920, tab. 7; p. 921, tab. 8). These findings clash with real estate appraisal fundamentals, which instead state that the income approach "provides an indication of value by converting cash flow to a single current capital value" "through a capitalisation process" (Ivsc, 2013, s. 58, 59). Therefore, only profitable energy measures, namely those exhibiting positive NPVs, should be able to increase real estate value. Nonetheless, this issue is made further complex due to the residual value of energy-efficient installations (Kneifel, 2010), because their useful life may exceed the analysis period.