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Energy savings from housing: Ineffective renovation subsidies vs efficient demolition and reconstruction incentives

Maarten Dubois [a,*], Karen Allacker [b]

[a] KU Leuven, Policy Research Centre for Sustainable Materials, Kasteelpark Arenberg 44, 3001 Leuven, Belgium
[b] KU Leuven, Department of Architecture, Kasteelpark Arenberg 1, 3001 Leuven, Belgium

HIGHLIGHTS

- Renovation subsidies worsen overall energy consumption of housing.
- Renovation induces a lock-in with energy inefficient houses.
- Renovation subsidies should be abolished or structurally reformed.
- Policy should incentivize demolition and reconstruction projects.
- Building on virgin land should be taxed.

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ABSTRACT

Energy savings in the housing sector are key to reduce global greenhouse gas emissions. Policies to incentivize energy savings are however disparate between countries. Taking into account environmental aspects and consumer surplus, the paper uses a stylized economic model to assess the effectiveness and efficiency of three economic instruments: subsidies for renovation, subsidies for demolition and reconstruction projects and subsidies for building new houses on virgin land. The assessment also relates to differentiated value added taxes and other financial incentives such as green loans. In a counter-intuitive way, the model highlights that subsidies for renovations with minor energy gains worsen the overall energy consumption of housing due to the inducement of lock-ins with energy inefficient houses. Structural changes are needed in the use of policy instruments. First, commonly applied support schemes for renovations with minor energy savings should be abolished. Second, scarce public resources should incentivize deep renovation and demolition and reconstruction. Finally, taxes should apply on the use of virgin land to persuade households with a high willingness to pay for a new house, to invest in demolition and reconstruction.

1. Introduction

Energy savings in the housing sector are key to reduce global greenhouse gas emissions. In the Western world, buildings account for 30–40% of final energy consumption (OECD, 2003; Itard, 2008). Residential housing alone, contributes more than 20% of total energy demand (BPIE, 2011; Eurostat, 2013). In addition, reducing the energy consumption of housing is a cost-efficient way to reduce greenhouse gases compared to other potential pathways (European Commission, 2011). The European Commission has therefore laid out ambitious targets for improved energy efficiency of buildings: 27% energy savings by 2020 and a 90% savings by 2050 (European Commission, 2006, 2011). These targets already take into account the recent technological progress and the changes in building practices. Indeed, the energy consumption of new houses has come down by more than 80% compared to houses built before 1960. Moreover, significant progress is expected for new houses in the coming years (Eichhammer et al., 2009; BPIE, 2011).

The European *building stock is old*. More than 40% of the buildings are built before 1960 and about 85% are built before 1990 (Itard, 2007; BPIE, 2011). Therefore, many scholars stress the importance of renovation of existing houses to foster energy savings (Power, 2008; Verbeeck and Cornelis, 2009; Morelli et al., 2014). These scholars typically focus on 'deep renovations' that apply radical changes to old houses and reduce energy consumption to

* Corresponding author.
E-mail address: maarten.dubois@kuleuven.be (M. Dubois).

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the level of new houses. Unfortunately, due to consumer preferences and budget restrictions, most renovations only induce minor energy savings (Eichhammer et al., 2009). Indeed, the first aim of many renovations is to improve comfort rather than energy performance. BPIE (2011) estimates that 85% of all European renovations induces minor energy savings (15%), 10% concerns moderate energy savings (45%) and only 5% concerns a deep renovation with major energy savings (75%). Importantly, once a house has been renovated, it typically takes a couple of decades before a new renovation or reconstruction is considered. A renovation with minor energy savings may therefore create a lock-in that forestalls more structural energy savings (Weiss et al., 2012; Argus 2014). More radical measures to enhance energy savings concern the demolition of old houses and the (re)construction of new houses (Boardman et al., 2005; Argus, 2014). Indeed, the legal requirements for building permits require highly energy efficient houses (directive 2010/31/EU, 2010). However, the current yearly rates of demolition (0.15% of the building stock), construction (1%) and renovation (1.5%) are insufficient to achieve the ambitious policy objectives (Itard, 2008; Eichhammer et al., 2009).

Although typology and size of buildings vary significantly, operational energy consumption in the use phase typically dominates *other environmental aspects* such as energy embodied in materials, water consumption and end-of-life materials management. In a moderate cold climate, operational energy consumption amounts up to 90% of the overall environmental impact of an average house in the current building stock. The energy embodied in construction materials amounts to about 9% and the environmental impact of the end-of-life stage 1%[1]. For a new house with thermal conductivity factor K45, the contribution of operational energy consumption falls to 70% compared to an average house of the current building stock thanks to better insulation and more efficient use of energetic resources. There is also an increase in the environmental impact from energy embodied in materials, but that impact is small compared to the reduction of operational energy consumption. For an advanced energy-saving house with thermal conductivity factor K20, the contribution of operational energy consumption falls further but still amounts to more than 50% of the overall environmental impact (Janssen et al., 2010; Cuellar-Franca and Azapagic, 2012; Debacker et al., 2013). Taking into account the predominance of operational energy consumption in the overall environmental impact of housing, the paper will focus on policies that foster energy savings.

Financial incentives are key drivers of investment in the housing market (OECD, 2011; Vastmans et al., 2014). In order to foster energy savings, a tax on energy consumption would be the most logical policy instrument. However, increasing taxes on energy consumption of households is often considered politically unattractive. In addition, such a tax may be ineffective due to the bounded rationality of households (Weiss et al., 2012; Tuominen et al., 2012). Indeed, Grigolon et al. (2015) find that European households do not fully incorporate the future discounted cost of fuels when purchasing durable goods. Consequently, policy makers are focusing on economic instruments with financial incentives that coincide with the moment of investment. In Europe, a wide variety of economic policy instruments is implemented. For example, in Belgium several economic instruments incentivize renovation: renovation subsidies, tax deductibility of renovation investments, green loans and an advantageous Value Added Tax (VAT) rate of 6% rather than the standard 21%. Although the policies are fragmented due to the involvement of different government levels (federal, regional and municipal), most incentives aim at small or medium scale renovations, e.g. the green loan in Flanders (the northern region of Belgium) is maximum 10.000 €. Incentives for (re)construction also exist, but are typically less generous, certainly when put into perspective to the overall cost of such projects. In addition, the standard VAT rate of 21% applies for (re)construction projects[2].

Considering that the European targets are ambitious and the national policies disparate, a better understanding of economic policy instruments for the housing market is needed. *This paper* uses a stylized model to assess the effectiveness and efficiency of policies that give financial incentives for renovation, demolition and (re)construction. The scope includes environmental and economic aspects. The paper has the following structure: Section 2 drafts the economic model; Section 3 evaluates different policies; Section 4 further explores the significance of the work; the Section 5 presents the policy recommendations and further research.

2. Methods

The assessment uses a stylized economic model for durable goods inspired by Shinkuma (2007)[3]. The first subsection lays out the building blocks of the model. The second subsection derives the comparative statics of market behavior for further analysis.

2.1. Building blocks

The stylized *model* assumes that the life cycle of a house consists of two periods. At the start of the first period, a house is built. At the start of the second period (half way the life cycle of the house), the building can be renovated or demolished with the aim of reconstruction. If reconstruction does not take place, the building will degenerate to a useless state at the end of the second period. The land can be resold as virgin area after demolition of the degraded house. Considering that the estimated life cycle of buildings is between 60 and 90 years (Janssen et al., 2010), one period can be interpreted as a period of approximately 40 years.

In the empirical world, *households* have an infinite amount of choice with respect to housing. However, for the sake of conciseness, in this model households have to make a choice at the beginning of each period between the five options enlisted in Table 1. The option ‘build’ means purchasing virgin land and building a new house. The option ‘reconstruct’ both encompasses demolition and reconstruction projects and radical renovations because they have many elements in common. In reality, ‘demolition and reconstruction projects’ will be more expensive and also induce more energy savings owing to a higher insulation level and air-tightness. Both options can be modeled separately, but radical renovations are currently quite rare, as discussed earlier, and an additional option would increase the mathematical clutter without adding new insights. The option ‘renovation’ represents the typical renovation that contains a mix of comfort improvements, such as embellishment of kitchen and bathroom, and minor energy gains. The option ‘low-grade’ implies buying an older house and living in it without making significant energetic improvements or structural changes. The option ‘rent’ means renting a house rather than buying one.

Note that the model imposes a change of *ownership* every

[1] Proper waste management and recycling techniques can improve the overall environmental impact with 2–3% thanks to environmental gains in ‘waste management’ and ‘energy embodied’ in new materials (Cuellar-Franca and Azapagic 2012, Debacker et al., 2013).

[2] In order to upgrade urban regions, the beneficial VAT rate of 6% also applies to demolition and reconstruction projects in a limited amount of Belgian city centers (KB 20 from 20 July 1970, Belgisch Staatsblad 08/05/2013).

[3] Shinkuma (2007) uses the stylized model to assess the efficiency of economic policy incentives for vehicles.