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Energy Efficiency Information and Valuation Practices in Rental Housing

Andrea Chegut¹ · Piet Eichholtz² · Rogier Holtermans³  · Juan Palacios⁴

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Abstract

The consensus in the academic literature is that energy efficiency is associated with transaction value premiums, but it is not clear to what extent property appraisers take account of this. We decompose external appraisals of rental housing by international valuation firms in England and the Netherlands in two waves, keeping the samples of valued homes constant between these years. We find a notable change in the behavior of external property appraisers. In England, energy performance does not impact assessed values in 2012, while estimation results for 2015 show a significant discount in assessed values for D-, E- and F- relative to C-labeled dwellings. For the Netherlands, we do not observe a significant relationship between energy efficiency and assessed values in 2010, but in 2015 we find that more energy efficiency leads to higher external valuations.

Keywords Affordable housing · Real estate valuation · Energy efficiency · Energy performance certificates

JEL Classification R31 · Q41 · Q5

Introduction

The built environment is instrumental in achieving the climate goals set out in the Paris climate agreement of 2015, which were reiterated recently at the COP23 in Bonn. In the European Union (EU), 25.4% of aggregate energy is consumed in homes, with comparable percentages for other developed economies.¹ As a result, governments encourage energy efficiency measures in the built environment. In the European Union, the Commission has taken a number of initiatives in this direction over the last decades,

¹Data for 2015. Source: http://ec.europa.eu/eurostat/statistics-explained/index.php/Consumption_of_energy.

✉ Piet Eichholtz
p.eichholtz@maastrichtuniversity.nl

all aimed at stimulating energy efficiency in buildings. In addition, member countries have their own measures to decrease the energy demand from buildings, especially so in housing.

Rental housing can play an important role in reducing energy consumption. The rental sector accounts for 30% of the overall EU housing stock. Within the sector, affordable housing has a large market share. Especially in the Netherlands, Austria, Sweden and the United Kingdom, affordable housing represents a major part of the housing stock: 28%, 22%, 20% and 18%, respectively. In many countries it is the dominant form of rental housing (Whitehead and Scanlon 2007). Yet, despite its importance, research on the economic effects of energy efficiency in this segment of the housing market is scant.

For decision-making by rental housing providers, whether affordable or otherwise, an important consideration is how to finance investments in the environmental and energy performance of their assets. If superior energy performance leads to higher rents and/or increased asset valuations – resulting in higher collateral value, the institutions financing rental landlords may incorporate this information in their lending practices, providing the additional financing needed to support these investments.

The early literature on this topic focused on commercial real estate, but there is a growing body of research providing guidance on the relationship between dwellings' energy efficiency and their economic performance, finding consistently higher transaction prices, faster transaction processes, and higher rents for energy efficient dwellings, with the size of the effects depending on the level of energy efficiency (examples include Brounen and Kok 2011; Hyland et al. 2013; Feige et al. 2013; Cerin et al. 2014).² Chegut et al. (2016) show that this is also the case for affordable homes sold in the private housing market.

However, it is not clear whether and how professional property appraisers account for energy efficiency when performing a valuation. Omitting such information in the valuation is potentially a significant impediment to the diffusion of energy efficiency in rental housing. A potential direct outcome may be underinvestment in energy efficiency improvements, if landlords cannot acquire additional financing. For long-term investors the financing mechanism is key in allowing the investment, especially in situations where increased rents or transaction prices are not a viable mechanism for transferring returns on energy efficiency investments. Second-order impacts are significant when financial institutions look to appraisers to identify asset risk. When appraisers can assess decreased risks due to energy efficiency investments, financial institutions can more accurately assess funding availability and costs for borrowers.

Although the academic literature on the topic consistently shows higher market values and rents for energy efficient (rental) dwellings, this literature is rather recent, and it is possible that valuation methods have not yet adjusted to this consensus. The main contribution of this paper is to shed light on this issue, by investigating whether energy efficiency is incorporated in external valuations of affordable dwellings, and whether professional appraisers have adjusted their valuation practices in light of the emerging academic consensus on this topic.

² In studies of commercial real estate, the results point at higher rents and cash flows for environmentally certified buildings, higher and more stable occupancy rates, and higher transaction prices. Examples are Bonde and Song (2013), Chegut et al. (2014), Eichholtz et al. (2010, 2013), Fuerst and McAllister (2011), Holtermans and Kok (2017), and Kok and Jennen (2012).

Studies documenting financial benefits related to the environmental performance of buildings in real estate markets started appearing in 2008 and peaked in 2013 and 2014 (Dalton and Fuerst 2018). For housing, the first convincing paper was Brounen and Kok (2011). By 2015, about 30 peer-reviewed articles provided robust scientific evidence on the positive influence of energy efficiency on the rental and transaction values of commercial and residential real estate in the U.S. and Europe. By 2015 there was a clear consensus in the academic literature on the preferences of agents for sustainable and energy efficient properties, reflected in a higher willingness to pay for these properties.

We analyze the relationship between energy efficiency and the assessed market values of affordable housing by employing the standard hedonic pricing model. We employ a database of dwelling quality characteristics maintained by the dwelling's owners, allowing us to control extensively for building quality, location, and general housing market conditions. The database also contains information on the Energy Performance Certificates (EPCs) awarded to these dwellings. We examine two large samples of external valuations of individual dwellings, owned by one English and one Dutch affordable housing provider.

In England, we gather repeated property valuations for a sample of dwellings between 2012 and 2015. For the Netherlands, we collect valuation data on dwellings owned by a large affordable housing owner, covering over 57,000 dwellings in two valuation waves: 2010 and 2015. So for both countries, we analyze two valuation waves spanning the period in which most of the existing evidence on this issue has been published. For both valuation waves, we first estimate the impact of energy labels on housing valuations in general, by comparing the assessed values of labeled dwellings (at different label quality levels) with those of non-labeled ones. We then study the labeled sample separately. This approach allows us to compare valuations of highly energy efficient homes (labeled A-B) with homes that are less energy efficient (labeled D-G).

We then explore differences in valuations for a constant set of dwellings that were not renovated between 2012 (2010 for the Netherlands) and 2015, and that had the same energy label in both years. This provides a clean identification of the changing impact of a given energy label for a given dwelling on external valuations, without the potentially distorting effect of housing renovations.

Our key finding is that external valuations did not take energy efficiency into account at the beginning of the decade, but that energy efficiency was reflected in external valuations by 2015. That holds for England as well as for the Netherlands. For England, energy performance does not play a role in assessed values for 2012, while the estimation results for 2015 show a significant discount in assessed values of 0.4 to 1.7% for D-, E- and F-labeled dwellings relative to C-labeled dwellings.

Similarly, in the Netherlands, the assessments of value do not show significant differences across energy labels in 2010. However, by 2015, dwellings with the best energy labels – A and B – had higher assessed values than their otherwise comparable peers. For A-labeled dwellings, the valuation premium relative to dwellings without an EPC is 7.1%, which decreases stepwise to 5.4 and 3.1% for B- and C-labeled buildings, respectively. Dwellings labeled D to G are not valued significantly differently than those that have no label at all. An analysis of labeled dwellings corroborates these findings.

These findings point to a change in appraisers' consideration of energy efficiency characteristics of rental dwellings. Interestingly, the timing of this change in assessor practices has coincided with the mounting evidence in the academic literature that energy efficiency is value-relevant.

The remainder of this paper is organized as follows. We first provide an overview of related studies measuring the impact of energy efficiency on residential transaction prices and rents. We then discuss the data employed for the analysis. The subsequent sections present the research method and empirical results. The paper ends with a section summarizing our main findings, as well as interpreting them, especially regarding the likelihood that the academic findings on this matter were indeed influential in the change in valuation practices we observe. That section ends with a discussion of possible policy implications.

Energy Efficiency and Housing Values

There is now a global literature regarding the effect of energy efficiency on transaction values in housing markets. These studies generally find that dwellings certified as being energy efficient have higher transaction prices and/or rents. There is significant variation across studies regarding the setting of the housing market, the type of environmental certification, the environmental performance measures linked to the certification, and the magnitude of the associated premium. However, there is no literature at all about the question whether energy efficiency also influences valuations, and therein lies the contribution of our work.

Early studies of transaction price effects rely on relatively small samples of housing transactions, and are therefore somewhat less convincing than more recent work in this area.³ The first study to employ a large sample of transaction prices and systematically investigate the value consequences of energy efficiency in housing is Brounen and Kok (2011). The authors document that A-labeled homes sell at a 10.2% premium relative to otherwise similar D-labeled homes. The premiums for homes with B and C labels are 5.5% and 2.1%, respectively. Dwellings with a label below D sell at a discount.

Hyland et al. (2013) perform a similar study using Irish housing transactions, but also include housing rents in the analysis. The authors study the effect of Ireland's Building Energy Rating (BER) on house prices and rents. The transaction price results are comparable to those found by Brounen and Kok (2011), both in direction and in magnitude. In addition, they find that A- and B-labeled dwellings are rented at a premium relative to C-labeled dwellings, while E, F and G labels are associated with rental discounts. Also for Ireland, Stanley et al. (2016) measure the impact of the Energy Performance Indicator (EPI) and energy labels on the list price of homes in Dublin. The authors document that a 10% improvement in a home's EPI increases the list price by 0.87%. Their results regarding the BER are similar to Hyland et al. (2013).

³ Laquatra (1986), Gilmer (1989), Dinan and Miranowski (1989).

Feige et al. (2013) study the effect of a broad range of sustainability characteristics on the rent levels of Swiss dwellings. The authors document that environmental performance and rents are positively related, but this holds for attributes improving water efficiency, health and comfort levels, and the safety and security of a building, but not for energy efficiency, which the authors explain by the Swiss practice of incorporating energy costs in the rent.

Cerin et al. (2014) investigate the value effects of energy efficiency in Swedish homes, based on a sample of housing transactions. The findings suggest that only the most energy efficient homes command a (small) premium. A decrease in energy consumption of 1% yields a price increase of 0.03%. Högborg (2013) focuses specifically on homes sold in Sweden's capital city Stockholm. Aside from investigating the impact of a home's energy performance, the author measures the impact of recommendations regarding cost-effective energy efficiency measures on residential transaction prices. Similar to Cerin et al. (2014) energy efficiency is associated with higher transaction prices. Moreover, the author documents that the necessity for more complex measures to improve the energy efficiency of a home is associated with a larger discount.

Fuerst et al. (2015) explore the impact of EPCs using a large sample of repeated sales in England. The results show that A/B- and C-labeled dwellings command a premium of 5% and 1.8% respectively, relative to otherwise similar homes with a D label. These premiums mainly pertain to flats, and especially, terraced houses. Detached and semi-detached homes do not show significant price differentials.

Cajias et al. (2016) collect a large dataset on asking rents for dwellings in Germany from a leading online real estate portal. In line with previous studies, the authors document significant differences in asking rents and time on the market between labeled and non-labeled dwellings.

In contrast to studies documenting that energy efficiency is associated with higher transaction prices and rents, Fregonara et al. (2017) find that EPC labels do not significantly impact list or transaction prices in Turin, Italy. However, it must be noted that the lack of significance may be related to the very small pool of transactions, as the authors employ only 879 housing transactions.

For our study, a notable paper is Chegut et al. (2016). The authors study the transaction prices of Dutch affordable homes sold to the public, and find that energy efficiency is capitalized in these homes, with premiums ranging from 2% to 8%, depending on the certification level.

To provide an overview of this body of knowledge, Appendix Table 6 summarizes the recent findings in the literature analyzing the relationship between the environmental and energy performance and house values, starting with Brounen and Kok (2011).⁴ Notably, the samples of these studies mostly start well before 2010, so market prices had already begun incorporating environmental performance by then. In other words, there was already market evidence of an energy efficiency and sustainability premium before the start of our sample period: 2010 for the Netherlands and 2012 for England.

⁴ This topic has also received attention outside of Europe, and it has been studied for Japan (Yoshida and Sugiura 2015), Singapore (Deng et al. 2012), and China (Zheng et al. 2012; Hu et al., 2014; and Zhang et al. 2017). For the United States, the main studies are Dastrup et al., (2012), Kahn and Kok (2013), and Bond and Devine (2016). The results of these studies point in the same direction as those for European countries: energy efficient homes sell for more, have higher rents, and tend to be more liquid.

To conclude, the academic literature regarding the value effects of sustainability certification shows a clear consensus, and it points towards a premium for environmentally certified dwellings. However, this is rather recent, starting with Brounen and Kok (2011), and despite the fact that it has reached this consensus, it is not yet clear whether and how these results are reflected in the appraisals of (rental) housing. This paper aims to shed light on that issue.

Methodology

To investigate how energy efficiency relates to the assessed (market) value of rental housing we employ the standard hedonic real estate valuation framework proposed by Rosen (1974).⁵ We estimate a semi-log equation, in which we relate the natural log of the assessed value per square meter to a dwelling's energy efficiency, building characteristics, and location:

$$\ln V_i = \alpha + \delta L_i + \beta X_i + \varepsilon_i \quad (1)$$

In Eq. (1), the dependent variable is the natural logarithm of the assessed (market) value V per square meter of home i . The variable of interest in the model is L , which is an indicator variable with a value of one if building i has an energy label and zero otherwise. Therefore, δ is the average marginal value increment (in percent) attributed to a labeled dwelling relative to non-labeled dwellings. In subsequent specifications of the model, L is replaced by G , denoting the quality of the energy label (ranging from A to G, where A depicts the highest energy efficiency and G the lowest). In addition, in the English sample we include the Standard Assessment Procedure (SAP) rating as an additional measure of energy performance (see "Energy Performance Certificates" section for a detailed explanation). X_i is a vector of building characteristics (size in square meters, number of rooms, period of construction, and dwelling type), and location (the four-digit postcode area in the Netherlands and three-digit postcode area in England) of home i . α and β are estimated coefficients for the intercept and the control variables, respectively, and ε_i is an error term.^{6,7} In addition, the Dutch portfolio includes the year in which the last renovation took place in the dwelling. We estimate and compare two purely cross-sectional regressions in 2010 (2012 for England) and 2015, hence Eq. (1) does not contain a time dummy.

The analyses are based on three different methods of assessed value, but all are based on discounted cash flow. In particular, in the Netherlands the measure is an accounting for taxation measure; in England, we employ two different measures in the analysis (existing use value and market based valuation). The

⁵ Given that we observe two valuations per dwelling, one might suggest that a "repeated valuations" framework, in which building-fixed effects are introduced, would be more robust. However, the fact that the EPC label does not change between valuation rounds prevents us from estimating such a model. Our variable of interest (indicating the energy efficiency of a home) would be absorbed in the building-fixed effect. Therefore, we separately estimate the impact of energy efficiency for the two valuation rounds.

⁶ Similar location-fixed effects have been employed by Kok and Jennen (2012) and Chegut et al. (2016).

⁷ The categories "period of construction" and "dwelling types" vary between the two samples. For the exact definitions of the categories, see Table 1 (English sample) and Table 2 (Dutch sample).

diversity in the measurement of assessed value in our analysis allows us to explore differences in the relationship between energy efficiency and valuations across different methods.

In our preferred specification, we examine changes in valuation of energy efficiency attributes in a sample of dwellings that remain unchanged between the two valuation waves, one in 2010 (2012 for England) and another in 2015. The dataset for this analysis is restricted to the dwellings that were part of the portfolio in both valuation waves, that did not observe a change in EPC, and that did not have any renovations.⁸ By keeping the set of dwellings constant between the two valuation waves, we are able to isolate the changes in the approach of appraisers towards energy efficiency.⁹

Data and Descriptive Statistics

Energy Performance Certificates

The European Union (EU) first introduced Energy Performance Certificates (EPCs) in the Energy Performance of Buildings Directive (EPBD) in 2002.¹⁰ The recast of 2010 added further requirements regarding the quality and usability of the energy labels. To date, all 28 member states of the EU have implemented EPCs in the real estate sector. However, member states had considerable freedom in the implementation of the EPCs, largely related to obstacles regarding training the profession, which led to a delay in the adoption across most countries.

EPCs are intended to provide transparency regarding the energy consumption of buildings. The certificate depicts an energy rating ranging from A to G, where A represents high energy efficiency and G low energy efficiency.¹¹ In almost all cases the resulting EPC is based on predicted energy consumption as verified by an engineer. By disclosing a full range of energy efficiency levels EPCs differ from other well-known environmental building performance certificates that are employed, such as BREEAM, LEED, or Energy Star, which require a minimum level of energy efficiency to be eligible for certification.

⁸ Given that all renovation projects are executed by the affordable housing institution, this information is available for all dwellings, and can specifically be controlled for. In England, the initial sample includes only dwellings that are not renovated between the valuation waves and whose energy certificate remains constant.

⁹ Our setup avoids omitted variable problems as much as possible. We are not comparing different dwellings with each other, but always look at the same dwelling at two moments in time. Moreover, these dwellings had the same label at both measurement moments, and had not been refurbished between the two moments. It is likely that some of these dwellings had new tenants, and it is in principle possible that these could pay a higher rent, so affecting valuations. However, for the English sample, we analyze whether rents were higher in the second measurement period (Table 2, column 10), and it turns out they were not. In the Netherlands, it is prohibited to increase the rent for an otherwise unchanged affordable dwelling. In other words, new tenants between the first and second measurement period are unlikely to affect our results, reducing omitted variable concerns.

¹⁰ <http://data.europa.eu/eli/dir/2010/31/oj>

¹¹ The A-category has been expanded with the levels A+ through A+++ to reflect further improvements in energy efficiency after the first introduction of the EPC label, even allowing for net-energy-producing dwellings.

In the United Kingdom, EPCs are required as of 2008. Whenever a building in the social or private sector is constructed, sold, or newly rented an EPC should be disclosed.¹² Initially, EPCs were part of the Home Information Packages (HIPs) as stipulated in the Housing Act of 2004.¹³ After the requirement for HIPs was removed in May 2010, the EPC requirement continued to exist. The EPC rating for new dwellings, or for dwellings created by conversion or change of use is based on the Standard Assessment Procedure (SAP), developed by the Building Research Establishment (BRE). Existing dwellings are evaluated based on the Reduced Data SAP, which is a streamlined version of the more elaborate SAP.¹⁴ In addition to EPCs, the United Kingdom employs Display Energy Certificates (DECs) for public buildings, which are based on actual energy consumption over the past three years, as opposed to a prediction of energy consumption on which EPCs are based.¹⁵ Moreover, as of April 2018, all private rental properties require an EPC of E or higher.¹⁶

In the Netherlands, EPCs – based on predicted energy consumption – are issued since 2008 for all private residential buildings that are newly rented or sold, and since 2009 for public buildings and affordable housing. After the introduction of the energy label in 2008, only a small fraction of transacted homes had an energy label – the absence of a label was allowed if both parties in the transaction acknowledged the lack of an EPC through a waiver. As of 2015 it is mandatory to disclose the EPC whenever a dwelling is rented or sold, and failure to comply can result in a penalty, albeit nominal at EUR 405.¹⁷

Data for England

We employ a dataset from an affordable housing provider in England containing detailed information on 12,000 dwellings – apartments and single-family homes – located in North West England. The measurement of energy efficiency of the dwellings in the sample is based on the Reduced Data Standard Assessment Procedure (RdSAP) and EPCs.¹⁸ The dataset includes two waves of external valuations by the same valuation firm, for 2012 and 2015, both based on rents, and using two different valuation approaches: (1) Market Valuation and (2) Existing Use Value for Social Housing (EUV-SH).¹⁹ In addition, the dataset contains the rents of all individual dwellings in the portfolio for 2015.

¹² <https://www.gov.uk/buy-sell-your-home/energy-performance-certificates>

¹³ https://www.legislation.gov.uk/ukpga/2004/34/pdfs/ukpga_20040034_en.pdf

¹⁴ As documented on page 13 of the report “Energy performance certificates for dwellings in the social and private rented sectors.” Retrieved from: <https://webarchive.nationalarchives.gov.uk/20091105205420/http://www.communities.gov.uk/documents/planningandbuilding/pdf/866773.pdf>

¹⁵ <https://www.gov.uk/check-energy-performance-public-building>

¹⁶ <https://www.gov.uk/government/publications/the-private-rented-property-minimum-standard-landlord-guidance-documents>

¹⁷ <https://www.rvo.nl/onderwerpen/duurzaam-ondernemen/gebouwen/wetten-en-regels-gebouwen/bestaandebouw/energielabel-woningen>

¹⁸ Energy labels are based on the SAP index, following UK government guidelines (see <http://projects.bre.co.uk/sap2005/pdf/SAP-Guidance-document.pdf>). In particular, Label G corresponds to an SAP index below 21, label F to SAP index levels of 21 to 38, E to levels 39 to 54, D to levels 55 to 68, C to levels 69 to 80, B to levels 81 to 91, and A to 92 to 100.

¹⁹ The method used for the calculation of the EUV-SH is the discounted cash flow method (Red Book, 2014). The valuations reflect the restrictions of the regulated affordable housing sector (e.g. capped rents), which must remain affordable. Thus, EUV-SH produces opinions of value that are considerably lower than Market Value. To the knowledge of the authors the valuation methodologies included in the analysis did not suffer any major change between the valuation rounds included in the analysis.

Distribution Energy Performance Certificates – English Sample

Panel A. Percentage dwellings labeled

Panel B. Distribution of energy certificates

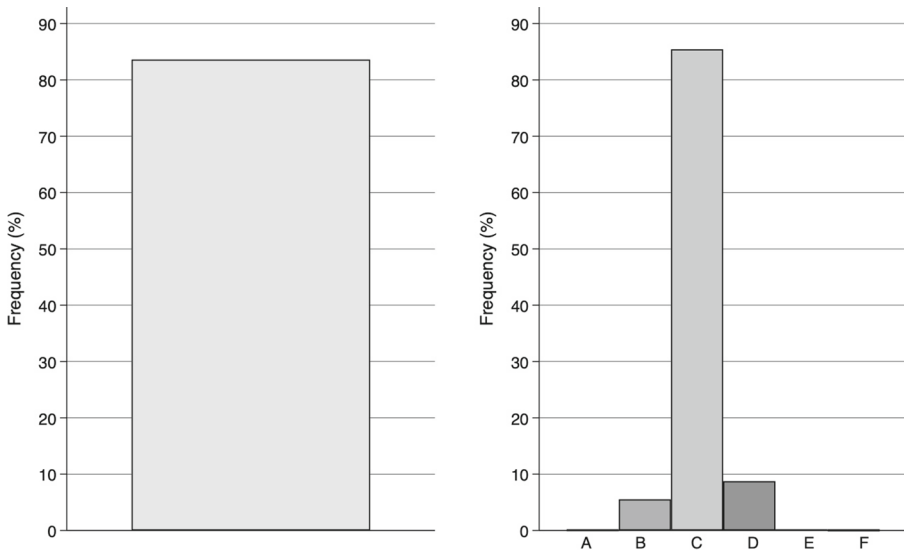


Fig. 1 Distribution Energy Performance Certificates – English Sample. Panel A. Percentage dwellings labeled. Panel B. Distribution of energy certificates. *Notes:* Fig. 1 describes the distribution across label categories in the labeled sub-sample for England for the two valuation rounds (2012 and 2015). The last certification of labeled dwellings occurred before the first valuation round in 2012

Figure 1 provides the distributions of EPCs in housing for the English sample. Label C is most prevalent, with approximately 85% of all dwellings having that energy label, and labels B and D making up the remainder. A-labeled dwellings are virtually not present in the sample. The sample contains fewer dwellings with label A and B, and a higher proportion of labels C and D compared to the building stock at large (e.g. Fuerst et al. 2015).

Table 1 provides the descriptive statistics for the English sample. Simple comparisons indicate that labeled dwellings have slightly higher rents and valuations than their non-labeled counterparts. The dwelling type composition of the labeled sample differs substantially from the non-labeled sample. Especially the proportion of “cottage flats” relative to the other dwelling types is significantly higher in the labeled sample. The samples do not differ notably in terms of average dwelling size, but they do in terms of age: labeled dwellings tend to be older, with more than 57% built before 1970, compared to only 27% for the non-labeled sample.

Data for the Netherlands

The second dataset we employ is from a large affordable housing institution owning approximately 53,000 dwellings in the metropolitan area of Amsterdam, the Netherlands. The dataset contains the exact address of each of the dwellings that has been part of the portfolio of the institution, along with detailed dwelling characteristics and the assessed value attached by external appraisers in two valuation waves in 2010 and 2015.²⁰ The

²⁰ These valuations are conducted by valuers working for three different RICS-certified companies. Each of the principal valuers responsible for the valuation has at least 7 years of experience.

Table 1 Descriptive statistics – english sample

	(1) Total Sample (<i>N</i> = 12,031)	(2) Non-labeled Dwellings (<i>N</i> = 1,971)	(3) Labeled Dwellings (<i>N</i> = 10,060)
Value measures			
EUV-SH value per square meter 2012 (in British pounds)	733.7 (248.9)	639.1 (256)	756.5 (241.7)
EUV-SH value per square meter 2015 (in British pounds)	726.1 (174.3)	670.8 (161.9)	739.3 (174.6)
Market value per square meter 2015 (in British pounds)	1,628 (569.1)	1,469.86 (620.77)	1,666.65 (549.14)
Rent per square meter 2015 (in British pounds)	1.7 (0.4)	1.6 (0.4)	1.7 (0.4)
Building characteristics			
Size (in square meter)	47.5 (9.5)	48.6 (7.6)	47.2 (9.9)
Rooms	2.2 (0.9)	1.9 (1.1)	2.3 (0.9)
Construction period (in percent)			
Pre 1960	38	22	42
1961–70	13	5	15
1971–80	40	54	37
1981–2013	9	20	7
Dwelling type (in percent)			
Flat	35	58	30
House	4	2	5
Maisonette	1	0	1
End terrace	18	11	20
Mid terrace	8	2	9
Multi story	3	3	3
Semi-detached	13	7	15
Terraced	17	17	17

Standard deviations in parentheses. The Standard Assessment Procedure (SAP) is an energy performance rating for buildings. A SAP rating of 100 implies zero net cost of energy use for heating, hot water and lighting (Department of Energy and Climate Change, 2015)

dataset also contains the EPCs for each labeled dwelling in the sample (approximately 34% of the sample).

Figure 2 compares the distribution of energy labels in our sample in the two valuation rounds, with Panel A showing the incidence of energy labels in general, and Panel B providing information on the distribution across certification levels. Panel A shows an increase in the number of labeled dwellings in the sample, from 24% in 2010 to almost 44% in 2015. In addition, there is a significant improvement in

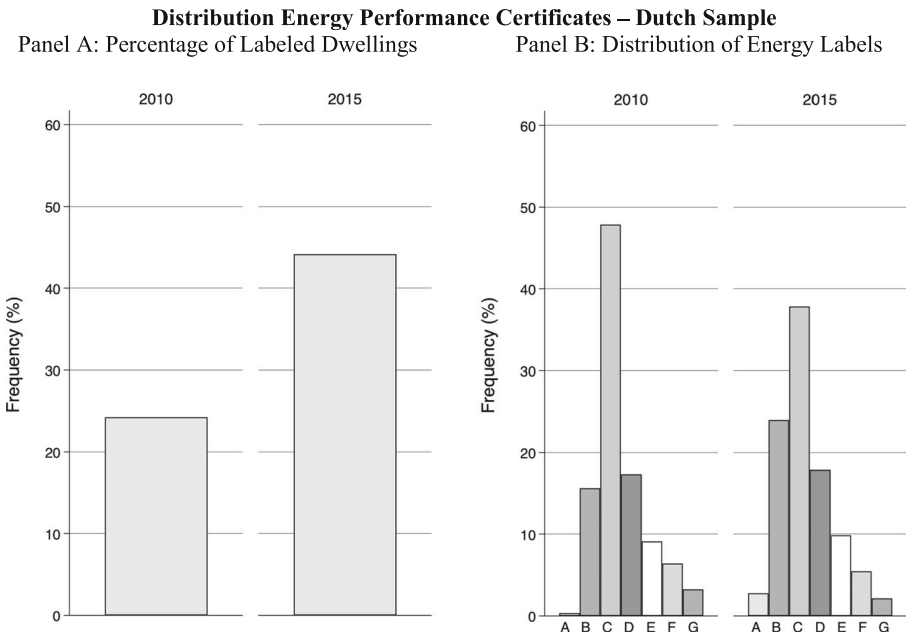


Fig. 2 Distribution Energy Performance Certificates – Dutch Sample. Panel A: Percentage of Labeled Dwellings. Panel B: Distribution of Energy Labels. *Notes:* Panel A displays the proportion of labeled dwellings in the Netherlands in 2010 and 2015. Panel B compares the distribution across label categories in the labeled sub-sample over time

label quality, as displayed in Panel B. The proportion of A- and B-labeled dwellings is substantially higher in 2015 than in 2010. Similarly, the proportion of C-labeled dwellings decreases over time.

Table 2 provides information on the valuation and physical characteristics of the total, labeled and non-labeled samples for the Netherlands. The average value per square meter is slightly lower than the average transaction price reported in Chegut et al. (2016). Simple comparisons show that labeled dwellings were valued about 4% lower than their non-labeled counterparts. Most of the units – both labeled and non-labeled – are in one-level multi-family apartments. The dwellings in the labeled sample tend to be slightly smaller and younger than the non-labeled dwellings. There are no major differences between the two samples regarding renovations: 91% of the dwellings have not been renovated over our sample period.

Estimation Results

England

We first assess the value of energy labels for the English sample, employing two valuations per dwelling in different years, 2012 and 2015. This allows us to explore changes in the approach of the average professional appraiser towards energy efficiency attributes of dwellings. Table 3 displays the results. Columns (1) and (4) show

Table 2 Descriptive statistics – dutch sample

	(1) Total sample (<i>N</i> = 57,736)	(2) Non-labeled dwellings (<i>N</i> = 38,301)	(3) Labeled dwellings (<i>N</i> = 19,435)
Appraised value 2010 (Euro per square meter)	1,594 (411.28)	1,631 (422.43)	1,507 (369.95)
Appraised value 2015 (Euro per square meter)	1,569 (497.79)	1,576 (496.64)	1,562 (498.72)7
Dwelling type (in percent)			
Multifamily	64	62	66
Townhouse corner	9	11	8
Townhouse between	27	27	26
Period of construction (in percent)			
Pre 1930	13	15	9
1930–1944	4	5	3
1945–1960	19	23	13
1961–1970	13	14	12
1971–1980	10	9	11
1981–1990	24	17	33
1991–2000	13	9	18
After 2000	6	9	1
Building characteristics			
Size (in square meter)	76.80 (21.72)	76.71 (22.09)	76.93 (21.18)
Number of rooms	3.37	3.39	3.34
Renovation			
Year last renovation	2008 (8.27)	2009 (9.40)	2008 (5.66)

Standard deviation in parentheses

systematic differences in assessed value between the labeled and non-labeled samples, after controlling extensively for building characteristics, energy components, and the location of the dwellings.²¹ For all analyses, the results for EUV-SH are shown for two separate years, 2012 and 2015. Dwellings that are not labeled at the time of valuation are used as reference group. The results presented in columns (1) and (4) indicate the absence of differences in assessed value between labeled and non-labeled dwellings in EUV-SH for any of the valuation years. Thus, labeled and non-labeled dwellings (83.62% and 16.38% of the sample, respectively) obtained comparable valuations.

Columns (2) and (5) of Table 3 focus on the labeled sub-sample to explore the existence of potential changes in assessed value due to differences in energy efficiency. The energy efficiency of dwellings is measured by the natural logarithm of the Standard

²¹ For all specifications in England we include 3-digit postcode-fixed effects.

Table 3 Assessed Value and Energy Efficiency – English Sample (dependent variable: natural log of EUV-SH and market value per square meter)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	EUV Value 2012	EUV Value 2012	EUV Value 2012	EUV Value 2012	EUV Value 2015	EUV Value 2015	Market Value 2015	Rents 2015
EPC label (1 = yes)	-0.001 [0.005]			-0.001 [0.005]				
Log (SAP Score)		-0.048 [0.097]			-0.048 [0.097]			
EPC category (1 = yes) ^a								
Label A-B			-0.005 [0.019]			-0.001 [0.005]	-0.018 [0.028]	0.028 [0.015]
Label D-E-F			-0.003 [0.010]			-0.004** [0.001]	-0.018** [0.007]	-0.012 [0.009]
Log dwelling size (in square meter)	-1.006*** [0.047]	-1.012*** [0.050]	-1.012*** [0.051]	-1.006*** [0.047]	-1.012*** [0.050]	-1.006*** [0.006]	-1.067*** [0.046]	-0.968*** [0.043]
Number of rooms	0.126*** [0.013]	0.129*** [0.014]	0.129*** [0.014]	0.126*** [0.013]	0.129*** [0.014]	0.111*** [0.005]	0.170*** [0.021]	0.109*** [0.008]
Dwelling type ^b								
Terraced	0.441*** [0.020]	0.415*** [0.031]	0.421*** [0.027]	0.441*** [0.020]	0.415*** [0.031]	0.160*** [0.017]	0.689*** [0.023]	0.323*** [0.031]
Flat	-0.284*** [0.045]	-0.270*** [0.056]	-0.272*** [0.053]	-0.284*** [0.045]	-0.270*** [0.056]	-0.019*** [0.005]	-0.126** [0.035]	-0.041 [0.029]
House	-0.343*** [0.034]	-0.328*** [0.042]	-0.331*** [0.039]	-0.343*** [0.034]	-0.328*** [0.042]	-0.067*** [0.004]	-0.421*** [0.026]	-0.249*** [0.024]
End Terrace	0.004 [0.006]	0.003 [0.006]	0.004 [0.007]	0.004 [0.006]	0.003 [0.006]	-0.003 [0.003]	-0.008 [0.013]	-0.000 [0.002]
Construction Period ^c								
1961–1970	-0.007 [0.008]	-0.011 [0.007]	-0.012 [0.007]	-0.007 [0.008]	-0.011 [0.007]	-0.006 [0.004]	-0.029 [0.021]	-0.002 [0.011]

Table 3 (continued)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	EUV Value 2012	EUV Value 2012	EUV Value 2012	EUV Value 2012	EUV Value 2015	EUV Value 2015	Market Value 2015	Remis 2015
1971–1980	-0.010*** [0.003]	-0.008 [0.004]	-0.010** [0.003]	-0.010*** [0.003]	-0.008 [0.004]	-0.011*** [0.002]	-0.048*** [0.012]	-0.016*** [0.003]
1981–2013	0.008 [0.022]	-0.008 [0.021]	-0.010 [0.022]	0.008 [0.022]	-0.008 [0.021]	0.002 [0.004]	-0.005 [0.009]	-0.031 [0.024]
Observations	7568	6185	6185	7568	6185	6185	6185	6185
Postcode-fixed effects	yes	yes	yes	yes	yes	yes	yes	yes
Adj R-squared	0.98	0.98	0.98	0.98	0.98	0.99	0.94	0.96

Notes: Robust standard errors clustered at the postcode level in brackets. Significance at the 0.10, 0.05, and 0.01 level is indicated by *, **, and *** respectively. All specifications include location-fixed effects at the postcode level. Coefficients associated with location fixed effects are available upon request. ^a Default for EPC label is “Label C.” ^b Default for dwelling type is “Semi-detached” dwellings. ^c Default for construction period is “Before 1960”

Assessment Procedure (SAP) energy performance index, which assigns a higher index to dwellings with higher energy performance. The results suggest that there are no significant differences in dwellings' assessed values related to energy performance, as reflected by the non-significant coefficient associated with the SAP index parameter.

Columns (3), (6) and (7) in Table 3 display the estimation results in the labeled sample, using C-labeled dwellings as reference category. The estimation results pertaining to EUV-SH indicate changes in the valuation approach towards energy efficiency over time. While there are no significant differences between C-labeled dwellings and any other label categories in 2012 (Column (3) in Table 3), the results indicate the existence of a brown discount in EUV-SH valuations in 2015. In particular, dwellings with label D, E or F were valued 0.4% lower than otherwise comparable C-labeled dwellings. Similarly, dwellings with poor energy performance (e.g. label D, E or F) obtained 1.8% lower assessed market values in 2015 than otherwise comparable dwellings with a C label (Column (7) in Table 3).

For the English sample we have rent information, allowing us to investigate the relationship between energy performance and housing rents in 2015 (Column (8) in Table 3). The results do not point to a significant relationship between energy efficiency and the rent level. Therefore, the reported value effects do not seem to be caused by higher rental cash flows, but by a different assessment of other value components (e.g. discount rate or terminal values).

The Netherlands

We first investigate the differences in assessed value related to energy efficiency for all dwellings. After measuring the relative valuation of energy labels for all dwellings in the dataset, we separately investigate the impact of label quality. We then explore differences in external appraisers' approach towards energy efficiency. We restrict the sample to dwellings appearing in both valuation rounds (2010 and 2015), whose energy label does not change, and who experience no renovation in that 5-year period. By holding the sample of dwellings constant and ensuring that these dwellings have not changed over time, this specification provides a clean identification of the impact of energy efficiency in external appraisals.

Table 4 displays the results of our analysis using the specification presented in Eq. (1). Interestingly, the location-fixed effects alone explain 67% of the variance in the assessed value of dwellings in the sample. Including building quality characteristics and energy labels, that increases to 79%.

Columns (1) and (3) in Table 4 explore systematic differences in assessed value between labeled and non-labeled dwellings. The results indicate no significant differences in assessed value between labeled and non-labeled dwellings for 2010 and 2015, suggesting the absence of a selection effect of high (or low) value dwellings into the labeled sample in any of the valuation rounds.

Subsequently, Columns (2) and (4) in Table 4 analyze assessed values of the dwellings in the sample, and include an indicator variable for each EPC category. Dwellings without an energy label are the reference group. We provide estimation results for two valuation waves, 2010 and 2015. The results show significant differences in the valuation of energy efficiency between the 2010 and 2015 valuation rounds. Column (2) shows that assessed values for any of the energy label categories did not significantly differ from

Table 4 Assessed Value and Energy Performance Certificates – Dutch Total Sample (dependent variable: natural log of assessed value per square meter)

	(1) Full sample 2010	(2) Full sample 2010	(3) Full sample 2015	(4) Full sample 2015
EPC label (1 = yes)	-0.004 [0.012]		0.020 [0.016]	
EPC category (1 = yes)				
Label A		0.004 [0.018]		0.071*** [0.017]
Label B		0.013 [0.013]		0.053** [0.021]
Label C		0.010 [0.009]		0.031** [0.015]
Label D		-0.029 [0.024]		0.000 [0.017]
Label E		-0.017 [0.018]		0.014 [0.027]
Label F		-0.006 [0.029]		-0.013 [0.024]
Label G		-0.019 [0.020]		-0.017 [0.023]
Years since last renovation ^a				
Less than 5 years	0.104*** [0.029]	0.103*** [0.028]	0.100*** [0.025]	0.076*** [0.023]
5–10 years	0.025 [0.021]	0.025 [0.021]	0.229** [0.093]	0.211** [0.091]
Log dwelling size (in square meter)	-0.442*** [0.028]	-0.441*** [0.028]	-0.359*** [0.038]	-0.360*** [0.037]
Number of rooms	0.019*** [0.006]	0.019*** [0.006]	0.008 [0.005]	0.008 [0.005]
Dwelling type ^b				
Townhouse corner	0.073*** [0.014]	0.071*** [0.014]	0.084*** [0.018]	0.083*** [0.017]
Townhouse between	0.059*** [0.013]	0.058*** [0.013]	0.070*** [0.017]	0.068*** [0.016]
Construction Period ^c				
1930–1944	0.012 [0.018]	0.011 [0.017]	0.002 [0.027]	-0.001 [0.027]
1945–1960	-0.073** [0.029]	-0.075** [0.029]	-0.125*** [0.037]	-0.129*** [0.036]
1961–1970	-0.082*** [0.023]	-0.082*** [0.024]	-0.124*** [0.039]	-0.129*** [0.039]
1971–1980	-0.017 [0.026]	-0.019 [0.027]	0.005 [0.038]	-0.002 [0.040]

Table 4 (continued)

	(1)	(2)	(3)	(4)
	Full sample 2010	Full sample 2010	Full sample 2015	Full sample 2015
1981–1990	0.044** [0.018]	0.039* [0.020]	0.021 [0.026]	0.008 [0.027]
1991–2000	0.110*** [0.025]	0.102*** [0.027]	0.133*** [0.033]	0.111*** [0.035]
After 2000	0.121*** [0.044]	0.119*** [0.045]	0.241*** [0.056]	0.230*** [0.056]
Postcode-fixed effects	yes	yes	yes	yes
Observations	39,932	39,932	40,973	40,973
Adj. R-squared	0.78	0.78	0.78	0.79

Robust standard errors clustered at the postcode-year level in brackets. All specifications include location-fixed effects at the postcode level. Significance at the 0.10, 0.05, and 0.01 level is indicated by *, **, and *** respectively. ^a Default for last renovation is “More than 10 years or never renovated.” ^b Default for dwelling type is “multifamily.” ^c Default for construction year is “Pre 1930”

non-labeled dwelling values in 2010. In contrast, Column (4) of Table 4 displays significant differences in valuations between highly energy efficient dwellings and non-labeled dwellings. In 2015, dwellings labeled A, B or C were valued significantly higher than otherwise comparable dwellings. The results indicate that an A-labeled affordable dwelling was valued 7.1% higher compared to an otherwise similar non-labeled affordable dwelling in 2015. For an average dwelling in the sample, this implies a valuation premium of approximately EUR 8,100 relative to a non-labeled dwelling. Assessed valuation premiums for homes with an EPC label of B and C amount to 5.4 and 3.1%, respectively. These percentages are in line with the premiums associated with high energy efficiency documented in the literature.

Regarding the control variables, we find some interesting differences in valuation outcomes between 2010 and 2015. For example, we observe that the more luxurious dwelling types, such as semi-detached and detached dwellings, are recently valued higher relative to one-level apartments than they were in 2010. In addition, homes built between 1945 and 1970 seem to have become less valuable since 2010, while homes built after 2000 have become more valuable. It is not exactly clear why this is the case, a possible explanation may be a change in relative transaction prices resulting from changed consumer preferences between the two measurement periods.

Table 5 presents the results for the analysis for the labeled Dutch sub-sample. We make the 2010–2015 comparison twice. Columns (1) and (2) summarize the results for the analysis exploring valuation differences for the entire sub-sample of labeled homes for both years: 12,486 dwellings in 2010 and 22,394 dwellings in 2015. For the second comparison, for which results are presented in Columns (3) and (4), we employ the same sub-sample of dwellings in both years. This addresses the concern that the documented impact of energy efficiency on appraised values does not stem from changes in valuation practices, but simply reflects the fact that a set of buildings of different quality is observed.

Table 5 Assessed value and energy performance certificates – Dutch labeled sample (dependent variable: natural log of assessed value per square meter)

	(1) Labeled sample 2010	(2) Labeled sample 2015	(3) Restricted sample 2010	(4) Restricted sample 2015
EPC category (1 = yes) ^a				
Label A	-0.021 [0.031]	0.017 [0.019]	-0.017 [0.035]	0.065*** [0.022]
Label B	-0.004 [0.012]	0.019* [0.010]	-0.000 [0.014]	0.031** [0.014]
Label C				
Label D	-0.026 [0.022]	-0.023** [0.011]	-0.027 [0.022]	-0.037** [0.016]
Label E	-0.025 [0.020]	0.005 [0.019]	-0.031 [0.021]	-0.005 [0.038]
Label F	-0.011 [0.028]	-0.028 [0.028]	-0.020 [0.029]	-0.038 [0.046]
Label G	-0.031 [0.031]	-0.056 [0.041]	-0.042 [0.031]	-0.070 [0.051]
Last renovation (1 = yes) ^b				
Less than 5 years	0.079 [0.048]	0.104*** [0.019]		
5–10 years	-0.018 [0.038]	0.159*** [0.053]	-0.047 [0.041]	0.226*** [0.078]
Building characteristics ^c	yes	yes	yes	yes
Postcode-fixed effects	yes	yes	yes	yes
Observations	12,486	22,394	12,289	12,289
Adj. R-squared	0.83	0.88	0.84	0.90

Robust standard errors clustered at the postcode-year level in brackets. All specifications include location-fixed effects at the postcode level. Significance at the 0.10, 0.05, and 0.01 level is indicated by *, **, and *** respectively

^a Reference category for EPC label is “Label C”

^b Default for last renovation is “More than 10 years or never renovated”

^c Building quality variables include: the natural logarithm of size of the dwelling in square meters, year of construction, number of rooms, and dwelling type

We study assessed values for the different EPC label categories relative to C-labeled dwellings. Columns (1) and (2) show slight differences in valuation practices with respect to energy efficiency. Relative to a C label, we find no significant value differentials for any EPC label category in 2010. In 2015, B-labeled dwellings show a marginally higher value of 1.9% and D-labeled dwellings a significant discount of 2.3%.²² The coefficients for the other label categories show the expected sign, but are not significant.

²² We also analyze the differences in value along the energy performance index. The estimation results indicate no significant differences in value along this index (estimation results are available upon request).

Importantly, the documented results are much stronger when we restrict the analysis to a constant quality sample – dwellings whose EPC label did not change, and which are not renovated between the two valuation rounds. The results in Columns (3) and (4) show that label levels did not play a significant role in assessed values in 2010. By 2015, that had changed considerably. Compared to dwellings with a C label, we observe significant value premiums for dwellings with label A and B, and a discount for D-labeled dwellings. The estimation results show that A-labeled dwellings are valued 6.5% higher than otherwise comparable dwellings with a C label. The B label is associated with a lower premium of 3.1%. D-labeled dwellings have a 3.7 valuation discount with respect to C-labeled dwellings.²³ The observed discounts are even higher for F- and G-labeled homes, but these are not statistically significant. This may be explained by a lack of statistical power, given the small amount of dwellings with these labels. Interestingly, we find stronger effects for the Netherlands than for England, and this may be caused by the fact that Dutch affordable housing institutions are allowed to – and often do – sell individual dwellings at market prices when they become vacant. In England, some public sector tenants have a right to buy their dwelling, but at a steep discount. So Dutch social housing institutions can more directly profit from higher transaction values, which could have an upward effect on valuations.

Conclusions, Interpretation and Policy Implications

This paper explores the degree to which valuation practices with respect to energy efficiency have changed from 2010 to 2015. Since 2011, when the first large-scale empirical study relating transaction prices to energy performance was published (Brounen and Kok 2011), an academic consensus has emerged on this issue: more energy efficient dwellings sell and rent for more. The question is whether real estate valuation practices have adjusted to this consensus.

We document that valuation practices have changed over time, and have recently started to specifically value the energy efficiency of homes. We study external valuations of English and Dutch affordable rental housing in two waves: 2012 and 2015 for England and 2010 and 2015 for the Netherlands, and document significant changes in the way energy efficiency is valued. In the first wave (2010/2012) energy performance does not seem to have played a significant role in rental housing appraisals. However, by 2015 that had changed. We find that the presence and the level of the energy label plays an important role in the valuation of rental housing in 2015, with the different label levels having value increments comparable to those found in the academic literature.

²³ We also perform an analysis on the differences in value along the energy performance index. In line with the results for the total sample, there are no significant changes in assessed valuations in 2010 linked to changes in the value of the energy performance index. However, the results indicate a marginal impact of the energy performance index on the 2015 valuation (estimation results are available upon request).

As academics, it is appealing to assume that academic research has practical implications, and we are tempted to attribute the apparent change in the rental housing valuation practices to the emerging academic consensus regarding the effects of energy efficiency on market values, especially since some of us are among the academics whose research has contributed to this consensus. However, this change could well be due to other factors.

First, it is possible that external appraisers are merely responding to the market evidence they observe in their daily valuation practice. The academic literature on this issue is based on the prices of housing transactions, and valuers tend to be well aware of these, possibly using them as references in their valuations. But this would be a likely explanation only if that market evidence would have become available between 2010/2012 – when we did not find any evidence for a valuation premium for energy efficiency – and 2015 – when we did. Appendix Table 6 shows that a lot of the papers that are published on this issue are based on transactions data from well before 2010. In other words, the market evidence that could have induced appraisers to change their ways was already available before our first observed wave of valuations, so if appraisers would have responded to it, we would already have observed energy efficiency premiums in our first observed valuation waves.²⁴

The second alternative explanation is that external appraisers are merely responding to higher rents. They employ discounted cash flow models in their valuations, so a higher rental cash flow would lead to a higher valuation no matter whether the cash flow increase would be due to an energy efficiency effect or some other cause of which the appraiser may or may not be aware. So the question is whether rents were indeed higher for more energy efficient rental homes. For the English sample we do not find evidence for an energy efficiency rental premium, as we report in Column (8) in Table 3. We do not have rental data for the Dutch sample, but under Dutch law, increasing rent when a dwelling is not improved is prohibited – and this is the case in our sample between 2010 and 2015. There is only one exception to this rule: when a new tenant comes in. That happens in about 6% of rental dwellings annually. So by 2015, the rent may have been increased in at most 26.6% ($1-0.94^5$) of the dwellings in our sample. Even if cash flows for the changed rents would fully incorporate an energy efficiency premium, this would therefore affect only 26.6% of our observations. In other words, a higher cash flow, even if present, is unlikely to be an important determinant of the observed valuation increase across the Dutch sample. So while we cannot fully rule out this alternative explanation for the Dutch sample, the English evidence suggests that appraisers take account of energy efficiency value beyond any rental effects. Since the increased valuation effect is not through cash flows, it has to come from a reduction in the cap rate used by the appraiser.

²⁴ We find this alternative explanation also unconvincing for another reason. When presenting papers reporting green value premiums for practitioner audiences, including appraisers, we often get reactions of the kind: “I doubt the validity of your results since I do not observe these premiums in my daily practice,” even when the data on which the study is based stem from the market in which the respondent is active. This illustrates how hard it is to assess the correct value of many different building quality characteristics – of which energy performance is merely one – solely on the observation of market information without formal statistical analysis, even if that observation is immediate and frequent.

The third possible alternative explanation is that the appraisers respond to changing valuation standards, either induced by government regulation or by valuation industry bodies. Indeed, if valuation standards would have begun incorporating energy efficiency characteristics somewhere between 2010/2012 and 2015, either on the basis of market evidence, academic research, or regulatory pressure, this would surely have made appraisers do the same. However, European and national valuation standards for (rental) housing have not begun incorporating energy efficiency between 2010 and 2015. In Europe, the dominant industry body to set valuation standards is the Royal Institution of Chartered Surveyors (RICS), and it does not yet mention energy efficiency criteria in its Red Book of valuation guidelines.²⁵

Fourth, the findings presented in this paper could be caused by policy changes pertaining to energy efficiency in housing that occurred between the first and second valuation waves. For example, the UK Government made it illegal to have a low EPC in 2012 and announced at the time that this would be enforced with penalties in 2018. This is relevant for our findings, especially for the fact that we find a brown discount rather than a green premium in the English sample. The fact that EPC labeling requirement broadened between 2011 and 2015 – both in the UK and the Netherlands – may have created stronger awareness of these labels among valuers, possibly also leading to increased incorporation in valuations.

Given the discussion of alternative explanations above, we think that it is indeed likely that the emerged academic consensus between 2011 and 2015 has played at least some role in the change in valuation practices we observe in this study. This is important for practical reasons.

A large part of society's energy is consumed at home, and across the globe the (rental) housing sector can play a key role in decreasing household energy consumption. This has environmental as well as welfare implications. For society to apportion less disposable income to household energy expenses in the present and future, and to reduce carbon emission as agreed to in international climate treaties, regulators are pushing building owners to reduce buildings' energy consumption through retrofit investments and stricter energy efficiency in building codes.

In order to finance the investments in energy efficiency, rental landlords need capital. One way to get that is by borrowing, but if their sustainability investments do not translate into higher valuations for their assets, they will not be able to raise the additional capital needed to finance these investments. This paper shows that, even in the absence of valuation standards that take environmental and energy performance into account, the valuation industry seems to be changing its practices in this way, helping these investments get off the ground.

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²⁵ In the United States, the earliest official guideline regarding this issue was published by The Appraisal Foundation in 2015.

Appendix

Table 6 Studies on the value of energy-efficiency in european housing markets

Study	Market	Transaction type	Sample period	Findings	Notes
Brounen and Kok (2011)	Netherlands	Sales	2007–2008	+15% for a G to A label jump. Low label implies less liquidity	Dwellings with high-quality energy label, C and above, trade at premium
Cerin et al. (2014)	Sweden	Sales	2009–2010	+0.03% for –1% in energy consumption	Only the most energy-efficient homes benefit from a slight transaction premium
Högberg (2013)	Stockholm, Sweden	Sales	2009	+0.04% for –1% in energy consumption	Recommendations regarding energy efficiency improvements impact price. Buyers require larger “discount” for more complex efficiency measures.
Hyland et al. (2013)	Ireland	Sales and rents	2008–2012	+16.6% in price, +4.6% in rent for label G to A	The impact of a Building Energy Rating is stronger when selling conditions are more difficult
Feige et al. (2013)	Switzerland	Rents	2009	–2.9% for a +0.1 in the energy-efficiency rating	All sustainability features positively related to rent level of housing except for energy-efficiency
Fuerst et al. (2015)	England	Sales	1995–2012	+5% for a A/B, +1.8% for C label, –0.7%, –0.9% for E, F	Energy premium highest for terraced dwellings and flats
Chegut et al. (2016)	Netherlands	Sales	2008–2013	+2–6% for label A and B	Label effects plus renovation effects up to 26%
Cajigas et al. (2016)	Germany	Asking rents	2013–2015	+0.6–4% for label A to C. Low label implies less liquidity	The energy efficiency premium is not confirmed for the largest metropolitan housing markets
Stanley et al. (2016)	Dublin, Ireland	List prices	2009–2014	10% improvement in Energy Performance Indicator increases list price by 0.87%	Sign and magnitude of findings are in line with Hyland et al. (2013). Controlling for dwelling age avoids biased estimates of the impact of energy efficiency.
Fregonara et al. (2017)	Turin, Italy	Sales	2011–2014	EPC labels do not impact list or transaction price.	EPC labels explain up to 8% of price variation. Relatively small sample of 879 transactions.

This topic has also received attention outside of Europe, and it has been studied for Japan (Yoshida and Sugiura 2015), Singapore (Deng et al. 2012), and China (Zheng et al. 2012; Hu et al. 2014; and Zhang et al. 2017). For the United States, the main studies are Dastrup et al. (2012), Kahn and Kok (2014), and Bond and Devine (2016). The results of these studies point in the same direction as those for European countries: energy efficient homes sell for more, have higher rents, and tend to be more liquid

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Affiliations

Andrea Chegut¹ · Piet Eichholtz² · Rogier Holtermans³ · Juan Palacios⁴

¹ Massachusetts Institute of Technology, 77 Massachusetts Avenue, Cambridge, MA 02139, USA

² Department of Finance, Maastricht University, PO Box 616, 6200 MD Maastricht, The Netherlands

³ University of Guelph, 50 Stone Road East, Guelph, ON N1G 2W1, Canada

⁴ Maastricht University, PO Box 616, 6200 MD Maastricht, The Netherlands