Capitalization of Energy Efficiency in the Housing Market

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- Underinvestment in energy efficiency in housing sector
  - Uncertainty about the financial returns of efficiency investments
  - Information asymmetry between seller and buyer

Research Questions

1. Do consumers pay for energy efficiency in the housing market?

   Brounen and Kok (2011), Hyland et al. (2013), Kahn and Kok (2014)

   Limitation of the available literature:

   - Unobserved house characteristics

2. What is the role of information transparency (EPC) on the capitalization of energy efficiency?

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On the economics of energy labels in the housing market ☆

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ABSTRACT

Energy efficiency in the residential housing market can play an important role in the reduction of global carbon emissions. This paper reports the first evidence on the market adoption and economic implications of energy performance certificates implemented by the European Union. The results show that adoption rates are low and declining over time, coinciding with a negative sentiment regarding the label in the popular media. Labels are clustered among smaller, post-war homes in neighborhoods with more difficult selling conditions. We also document that geographic variation in the adoption rate of energy labels is positively related to the fraction of "green" voters during the 2006 national elections. Within the sample of labeled homes, the energy label creates transparency in the energy efficiency of dwellings. Our analysis shows that consumers capitalize this information into the price of their prospective homes.

Data

- Single-family dwellings transacted with EPC (*N=30,036*)
- House price and other house characteristics (*Source: NVM*)
  - neighborhood, transaction year, construction year, size, lot size, type, quality, number of floors and rooms, parking place and type, location relative to centre, road, park, water and forest.
- Energy performance index (*Source: RVO*)

Energielabel woning

Afgegeven conform de Regeling energieprestatie gebouwen.

Veel besparingsmogelijkheden

Weinig besparingsmogelijkheden

D
(zie toelichting in bijlage)

Uw woning

Labelklasse maakt vergelijking met woning(en) van het volgende type mogelijk.

Rijwoning - Tussen

Gebruiksoppervlak	**Adviesbedrijf**
131,0 m³	Advies BV
Opnamedatum	**Inschrijfnummer**
01-01-2010	
Energielabel geldig tot	**Handtekening**
01-01-2020	
Afmeldnummer	

Energielabel op basis van een ander representatief gebouw of gebouwdeel? -
Adres representatief gebouw of gebouwdeel: -

Straat
Dorpstraat
Nummer/toevoeging
1
Postcode
9999 AA
Woonplaats
Hoofdstad

Standaard energiegebruik voor uw woning

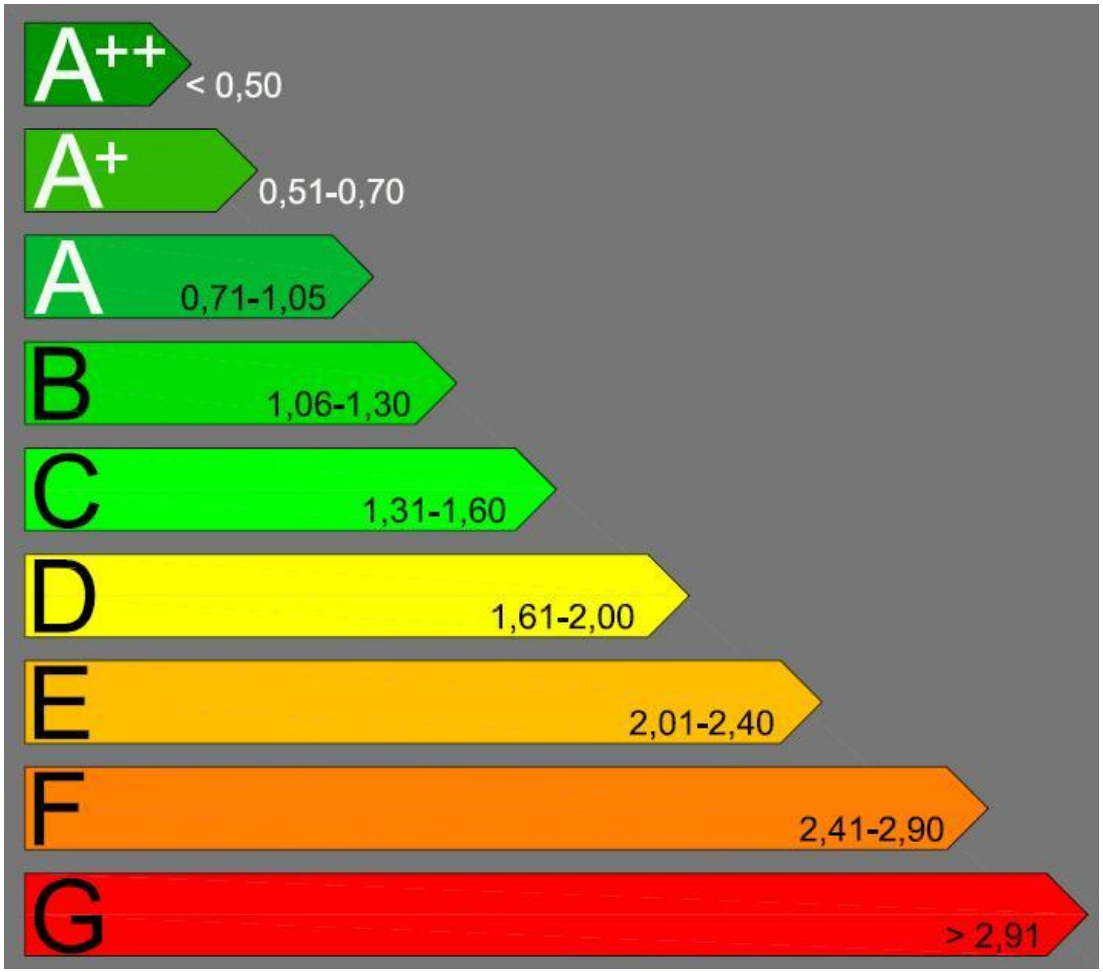
Energiegebruik maakt vergelijking met andere woning(en) mogelijk.

- Het standaard energiegebruik is de hoeveelheid primaire energie die nodig is voor de verwarming van uw woning, de productie van warm water, ventilatie en verlichting.
- De eventuele opbrengst van een zonnepaneel wordt hiervan afgetrokken.
- Het energiegebruik wordt berekend op basis van de bouwkundige eigenschappen en de installaties van uw woning.
- Bij de berekening wordt uitgegaan van het gemiddelde Nederlandse klimaat, een gemiddeld aantal bewoners en gemiddeld bewonersgedrag.
- Het standaard energiegebruik wordt uitgedrukt in de eenheid 'megajoules', dit wordt uitgesplitst naar elektriciteit (kWh), gas (m³) en warmte (GJ).

76705 MJ
(megajoules)

1037 **kWh** (elektriciteit)
1909 **m³** (gas)
0 **GJ** (warmte)

Energy Performance Index



Hedonic Model

$$Log(Price_i) = \beta_0 + \beta_1 Log(E_i) + \beta_j X_i + \alpha_n + t_i + \varepsilon_i \qquad (1)$$

- $Log(Price_i)$: Log of house price
- $Log(E_i)$: Log of energy performance indicator
- X_i: Other home characteristics
- α_n: neighborhood fixed-effects
- t_i: transaction year fixed-effects

OLS Estimations

	(1)	(2)	(3)	(4)
Log(Energy Performance Index)	-0.235***	-0.106***	-0.052***	-0.048***
	[0.009]	[0.004]	[0.005]	[0.005]
Dwelling Characteristics	No	Yes	Yes	Yes
Construction Year	No	No	Yes	Yes
R^2	0.106	0.833	0.841	0.843
Number of observations	30,036	30,036	30,036	30,036

*Construction year is included as a third order polynomial in specification (3). In specification (4), we included as dummy variables.

- 50 percent increase in energy efficiency leads to a 2.5 percent increase in the market value of the home.

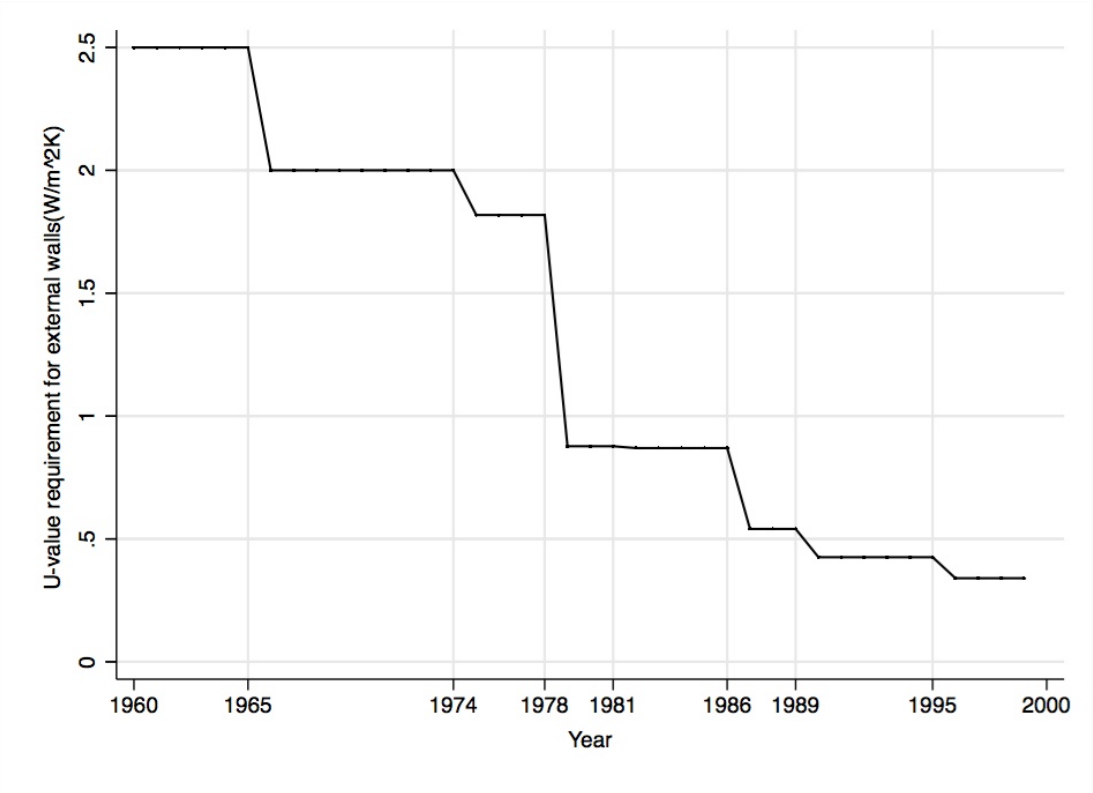
*Rental Market - OLS Estimations

	(1)	(2)	(3)	(4)
Log(Energy Performance Index)	-0.189***	-0.115***	-0.053***	-0.051***
	[0.009]	[0.004]	[0.005]	[0.005]
Dwelling Characteristics	No	Yes	Yes	Yes
Construction Year	No	No	Yes	Yes
R^2	0.049	0.708	0.716	0.734
Number of observations	5,222	5,222	5,222	5,222

*Construction year is included as a third order polynomial in specification (3). In specification (4), we included as dummy variables.

Instrumental Variable Approach: Building Codes

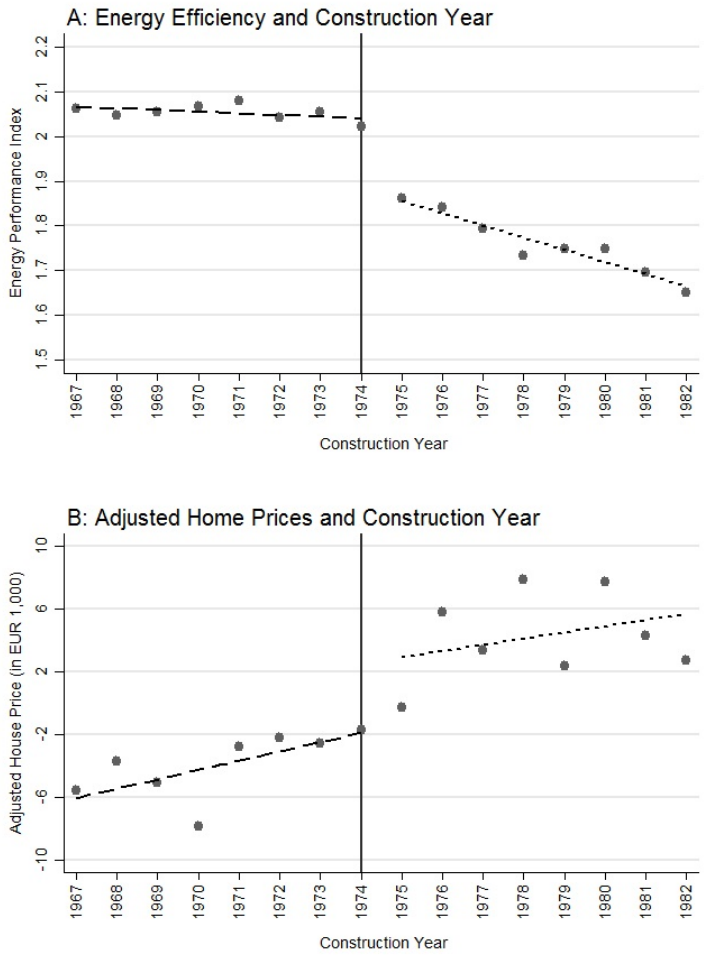
Time Variation in the Stringency of Building Codes



*The U-value is defined as the amount of heat loss through a single square meter of material, for every degree difference in temperature at either side of the material.

Instrumental Variable Approach: 1973-74 Oil Shock

Energy Efficiency and Price of the Dwellings Constructed Before and After 1974



*Panel A presents the average energy performance index based on the year of construction before and after 1974 oil crisis. Panel B presents a figure relating the residuals of an estimation of the hedonic model (excluding EPI and construction year variables) to the year of construction.

Instrumental Variable Estimations

	IV: 1973-74 Oil Shock (Discontinuity)			IV: Building Codes
Construction Period	(1967-1982)	(1959-1990)	(1950-1999)	(Full sample)
Log(Energy Performance Index)	-0.227***	-0.185***	-0.198***	-0.214***
	[0.067]	[0.065]	[0.048]	[0.061]
Dwelling Characteristics	Yes	Yes	Yes	Yes
Construction Year	Yes	Yes	Yes	Yes
R^2	0.846	0.848	0.851	0.835
First Stage				
D^{1974}	-0.080***	-0.071***	-0.060***	
	[0.007]	[0.005]	[0.004]	
U-value				0.071***
				[0.005]
Number of observations	12,513	20,270	25,311	30,036

- 50 percent increase in energy efficiency leads to 11 percent increase in the market value of the home. Its market value increases by around €23,000 for the average dwelling in our sample.

Impact of Information Provision

- Compare the market value of energy efficiency for homes that are transacted with and without EPC (N=103,834).
- Use actual gas consumption (per m^2) as a proxy for energy efficiency
  - Actual gas consumption (2004-2011)
  - Occupant characteristics (2004-2011): Income, number of household members, elderly, female and child
  - Source: CBS

Impact of Information: IV Approach

IV Estimation Results for Non-Certified and Certified Dwellings

	(Non-certified)	(Certified)	(Certified)
Log(Actual Gas Cons. per m^2)	-0.239***	-0.195**	
	[0.040]	[0.079]	
Log(Energy Performance Index)			-0.185***
			[0.070]
Dwelling Characteristics	Yes	Yes	Yes
Construction Year	Yes	Yes	Yes
Household Characteristics	Yes	Yes	Yes
R^2	0.740	0.818	0.844
First Stage Results			
U-value	0.068***	0.065***	0.069***
	[0.004]	[0.008]	[0.006]
Number of observations	103,834	23,187	23,187

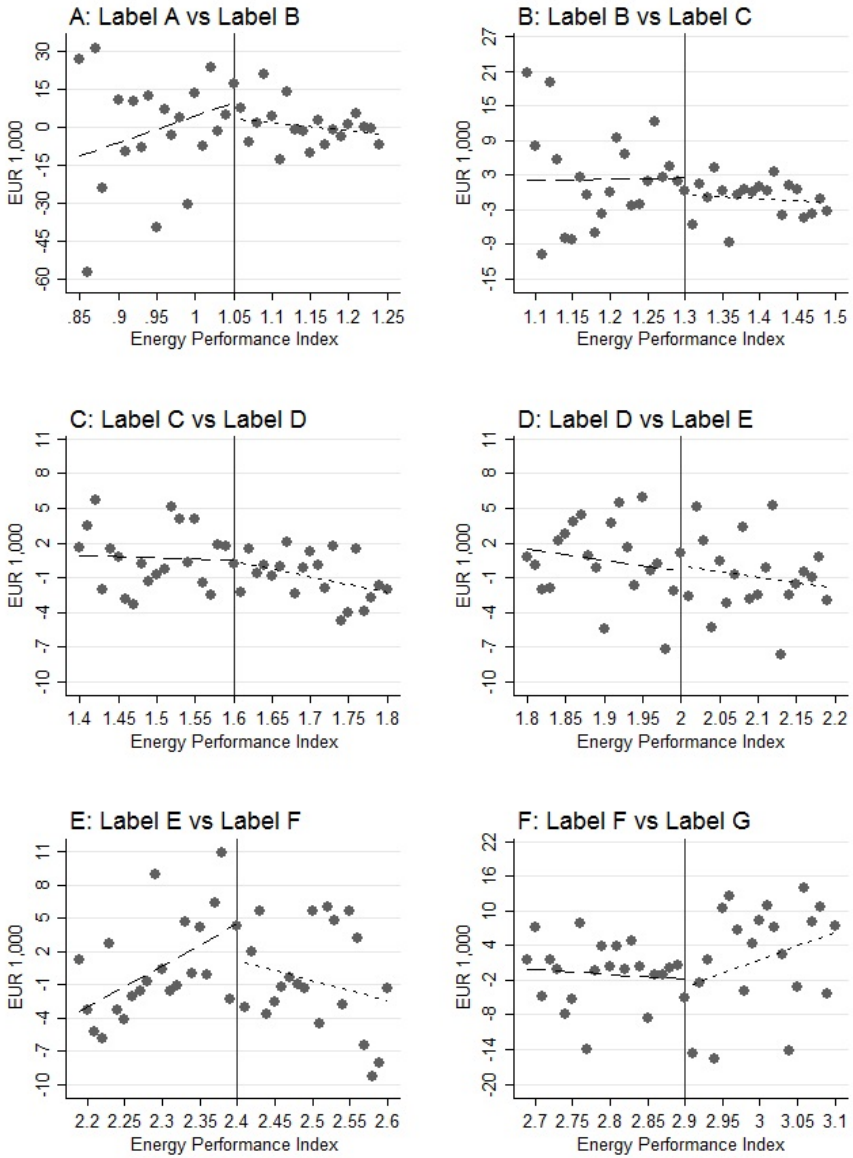
- 50 percent increase in energy efficiency leads to 12 percent increase in the market value of the non-certified homes. The difference between the estimated coefficients for certified and non-certified homes is not statistically significant.

Impact of Information: RD Approach

- Examine whether the energy label itself has an additional impact on the transaction price.
  - Apply a regression discontinuity (RD) approach based on the rule that is used to assign dwellings in energy efficiency classes

Impact of Information: RD Approach

Transaction Price (adjusted) by Label Category and Energy Performance Index



Impact of Information: RD Approach

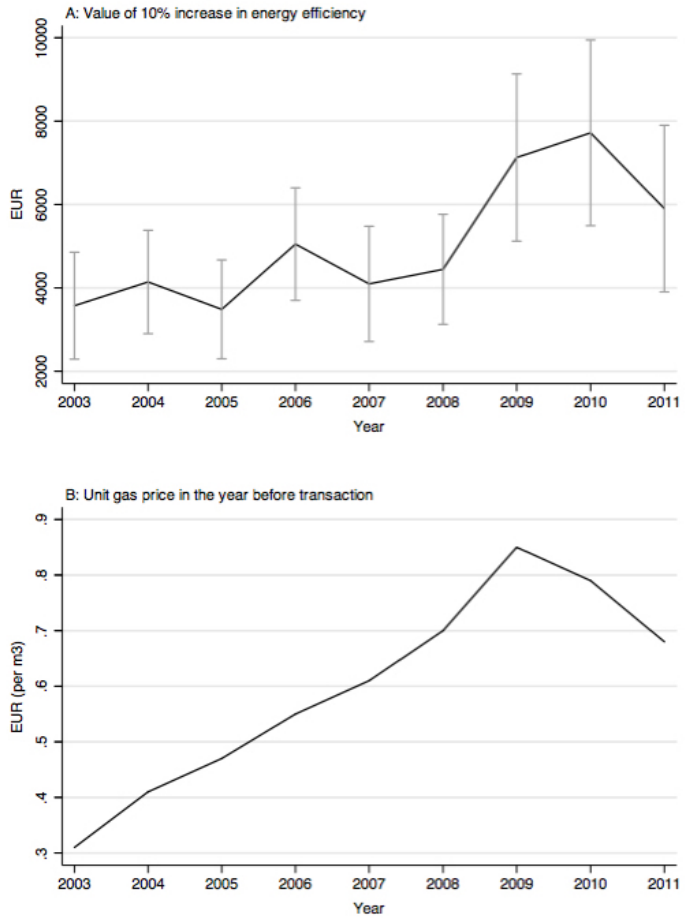
Regression Discontinuity Estimation Results for Label Effect

	(A-B)	(B-C)	(C-D)	(D-E)	(E-F)	(F-G)
$D^{L.label}$=1	-0.013	-0.012	-0.002	-0.000	- 0.007	-0.015
	[0.027]	[0.008]	[0.006]	[0.008]	[0.010]	[0.018]
Log(EPI)	0.171	-0.011	-0.019	-0.052	0.300**	-0.055
	[0.280]	[0.070]	[0.054]	[0.081]	[0.129]	[0.274]
Log(EPI)*$D^{L.label}$	-0.433	-0.060	-0.088	-0.037	-0.494**	0.530
	[0.305]	[0.093]	[0.081]	[0.146]	[0.212]	[0.451]
Dwelling Characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Construction Year	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.881	0.872	0.854	0.852	0.858	0.856
Number of obs.	1,461	6,879	11,009	6,899	4,606	2,146

*In each regression, we focus on a narrow bandwidth ($\pm$0.2 EPI) around the threshold values. $D^{L.label}$ is a dummy variable which is equal to one for homes that were assigned to the label indicating lower energy efficiency level, and zero otherwise. We control for the continuous effect of the EPI on transaction price within each label category, and thus the coefficient of $D^{L.label}$ represents the impact of label itself on the transaction price.

Time Variation in the Value of Energy Efficiency

Value of Energy Efficiency and Gas Prices



Panel A presents the estimated value of a 10 percent increase in energy efficiency in the housing market for each transaction year between 2003 and 2011. Panel B presents the one year lagged residential gas prices ($€/m^3$) for each transaction year.

Policy Implications

- Results can be used to increase public awareness regarding the financial benefits of energy efficiency investments
- Energy performance certification does not lead to a significant change in buyer's valuation of the dwelling.