

Energy performance certification and housing
rents: can certificates help to provide investment
incentives?

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AWEEE

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The paper in a nutshell

- ▶ **What?**

Analyze impact of energy performance certificates (*EPCs*) on rental market.

- ▶ **Why?**

Asymmetric information leads to low insulation in rental property

⇒ Can EPCs provide incentives for investment in insulation?

- ▶ **How?**

Hedonic price regression using data from Region of Brussels.

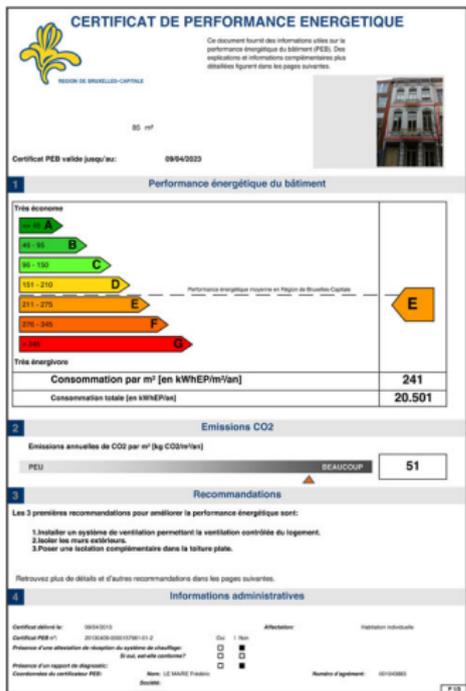
- ▶ **Findings**

- ▶ *Energy efficiency effect*: rent premium from better EPC score = 4.3%;
- ▶ *Information effect*: rent premium from publishing an EPC score = 2.8%.

Low insulation in the rental property market

- ▶ Insulation in rental property is **lower** than in owner-occupied dwellings.
- ▶ Market failure: **Asymmetric information**
 - ▶ Missing market for highly energy efficient dwellings
 - ▶ Missing investment incentives for landlords.
- ▶ Potential solution: **Energy performance certificates (EPCs)**

EPCs in the Region of Brussels



EPCs in the Region of Brussels

- ▶ compulsory in rental ads since November 2011;
 - ▶ EPC score: **A to G**
- ⇒ EPC color code: green, orange, red

Why Brussels?

- ▶ Residential buildings: 37% of total energy consumption; 
- ▶ Rental market: 40% of households are tenants. 

Our research questions

In the Region of Brussels:

1. Does a **better** EPC score provide a **rent premium**?
(*energy efficiency effect*)
2. Does **publishing** EPC scores provide a **rent premium** as opposed to hiding them? (*information effect*)

Contribution

We differ from previous literature by: Literature

- ▶ Using **published EPC scores** as opposed to issued EPCs;
- ▶ Studying the **information effect** of the certificate.

Main dataset (Immoweb)

- ▶ Rental advertisements in Region of Brussels [19 municipalities];
- ▶ Jan 2010 - Sept 2014;
- ▶ Information included in ads:
 - ▶ *Mandatory*: rent, municipality, surface;
 - ▶ *Optional*: nb of rooms, appliances, lift, terrace...
- ▶ EPC scores? After Nov 2011, **8%** of ads publish an EPC score
= **~9800 ads**.

Additional dataset (Brussels Environment Agency)

- ▶ Registry of all EPCs issued in Region of Brussels;
- ▶ Matching with main dataset → **~3700 ads** hide an EPC score.

→ **Sample**: **~13500 ads** with **published/hidden EPC scores**

Estimation strategy

1. How is rent affected by EPC score?
2. How is rent affected by publishing EPC info?
 - ▶ **Hedonic pricing**
 - ▶ **Issue:** Non-random sample selection? ▶



Solution to non-random selection: **Heckman correction**

Step 1: Probability of publishing an EPC score (Probit)

$$Pr(EPC_i = 1) = \xi + \eta ER_i + \mathbf{EPCcolor}_i \mu + \mathbf{X}_i \psi + \mathbf{M}_i \rho + \mathbf{Z}_i \phi + u_i$$

Step 2: Hedonic pricing controlling for selection bias (OLS)

$$\log(\text{real rent/sqm})_i = \alpha + \mathbf{EPCcolor}_i \beta + \mathbf{X}_i \gamma + \mathbf{M}_i \delta + \mathbf{Z}_i \zeta + \theta \hat{\lambda}_i + \epsilon_i$$

- ▶ EPC_i : dummy indicating whether EPC is published or hidden;
- ▶ ER_i : exclusion restriction (share of green party votes); [Details](#)
- ▶ $\mathbf{EPCcolor}_i$: EPC category dummies (green/orange/red);
- ▶ \mathbf{X}_i : dwelling and ad characteristics;
- ▶ \mathbf{M}_i : socio-economic municipality variables;
- ▶ \mathbf{Z}_i : time and municipality dummies.
- ▶ $\hat{\lambda}_i$ (Inverse Mills Ratio) controls for probability of publishing an EPC.

Energy efficiency effect [Heckman step 2 - OLS]

	(1)	(2)	(3)
	Dep. Var.: Log(real rent/sqm)		
Green EPC	0.059*** (0.012)	0.063*** (0.015)	0.043* (0.023)
Orange EPC	0.016* (0.009)	0.016* (0.009)	0.009 (0.021)
Brand new/renovated		0.027*** (0.007)	0.031*** (0.008)
Equipped kitchen		0.009 (0.007)	0.002 (0.007)
Multilingual ad		0.029* (0.016)	0.018 (0.012)
Year of construction			0.001*** (0.000)
Inverse Mills' Ratio	-0.108* (0.060)	-0.055 (0.057)	0.018 (0.032)
Constant	1.972 (1.682)	1.336 (1.642)	0.726 (3.077)
Controls Controls	yes	yes	yes
Municipality dummies	yes	yes	yes
Month-year dummies	yes	yes	yes
Socio-economic variables	yes	yes	yes
R2	0.498	0.501	0.563
Observations	9860	9860	4497

Robust standard errors in parentheses are clustered at the municipality level

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Heckman step 1

Information effect [OLS]

	Dep. Var.: Log(real rent/sqm)
Advertised EPC=0 × Green EPC=1	0.035 (0.022)
Advertised EPC=1 × Green EPC=0	0.028*** (0.008)
Advertised EPC=1 × Green EPC=1	0.070*** (0.017)
Orange EPC	0.014 (0.016)
Brand new/renovated	0.036*** (0.005)
Equipped kitchen	-0.002 (0.006)
Multilingual ad	0.019*** (0.005)
Year of construction	0.001*** (0.000)
Constant	3.564* (1.794)
Controls Controls	yes
Municipality dummies	yes
Month-year dummies	yes
Socio-economic variables	yes
R2	0.559
Observations	6262

Robust standard errors in parentheses are clustered at the municipality level

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The energy efficiency effect in context

A back-of-the-envelope exercise

The **rent premium for "going green"** (4.3%) translates into:

- ▶ **Landlord** perspective:
 - ▶ Average rent of "red" dwelling: EUR 982 per month;
 - ▶ **Monthly rent premium: EUR 42**
- ▶ **Tenant** perspective (assume no behavioral changes): 
 - ▶ Energy consumption is reduced by at least by 46%;
 - ▶ **Monthly reduction in energy bill: EUR 33-72**

Conclusion: Impact of EPC on rental market in Brussels

- ▶ **Energy efficiency effect:**

Publishing a green vs a red EPC has a significant impact on rent.

→ average rent premium to landlords: 4.3%;

→ roughly equivalent to tenants' gain in energy bill.

- ▶ **Information effect:**

Publishing vs hiding an EPC has a significant impact on rent.

→ average rent premium for red dwellings: 2.8%.

- ▶ **No enforcement, no compliance?**

→ only 8% of ads publish an EPC.

- ▶ **No indication for non-random sample selection.**

Policy recommendations

1. **Compliance checks and enforcement** of EPC regulation are necessary to increase EPC uptake and publication in rental ads.
2. **Communicating benefits**
 - ▶ Both landlords and tenants gain from EPC regulation;
 - ▶ Display estimated **monetary gains** on the certificate.

Thank you!

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Netherlands: low insulation in rental properties

Energy measures already implemented in the residential sector

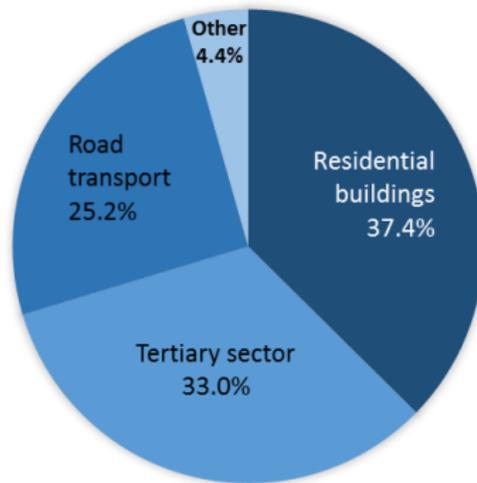
Penetration degree in 2000		Building segment			Insulation degree in 2004
Measure	Total	Privately owned	Social rental	Private rental	Total
Roof insulation	64%	70%	59%	40%	67%
Wall insulation	50%	52%	55%	29%	54%
Floor insulation	35%	39%	30%	21%	38%
Insulated glazing	66%	70%	67%	48%	73%
Boiler (improved yield)	49%	43%	60%	54%	n.a.
Condensing boiler (high yield)	38%	47%	26%	25%	n.a.

Source: KWR, 2000; Milleucentral, 2004.

Source: IEA/OECD 2007. [▶ back](#)

37% of total energy consumption from residential buildings

**Total energy consumption in Brussels Region
(2011)**



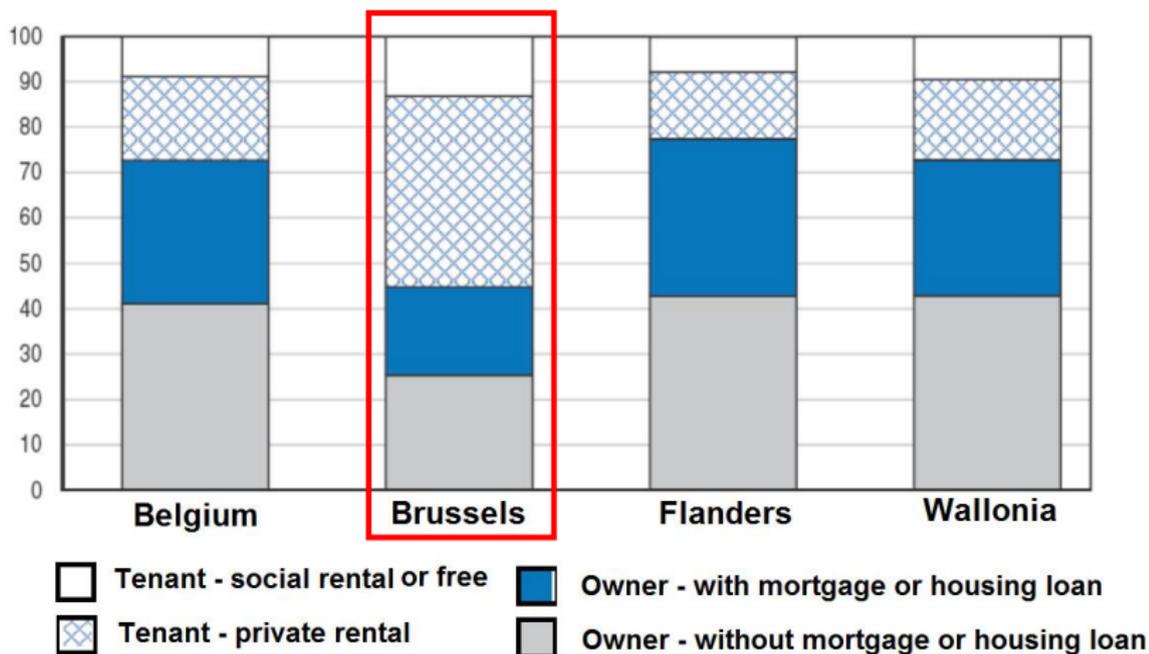
Source: Brussels Environment [Back](#)

Why is Belgium's residential energy demand so high?

1. **Average age of the housing stock:** higher than in neighboring countries because of low demolition rate,
 - ▶ Housing stock built before 1971: 66% in BE, 52% in NL.
[▶ more](#)
(data 2005, from McKinsey 2009 report)

2. **Low uptake of energy efficient housing features**
 - ▶ Homes with double-glazed windows: 36% in BE, 71% in UK
 - ▶ Homes with roof insulation: 58% in BE, 73% in UK.
(data 2001 / 2004, from McKinsey 2009 report)

40% of households are tenants in private rentals



Source: OECD Economic Surveys: Belgium (2015) [Back](#)

Related literature

Previous literature analyzing effect of EPC on real estate prices:

- ▶ EPC for **commercial** buildings
[Eichholtz et al., 2010; Fuerst + McAllister, 2011.]
 - ▶ Green EPC score → price premiums for sales and rentals (smaller).
- ▶ EPC for residential buildings: **sales**
[Brounen + Kok, 2011; Kahn + Kok, 2012; Zheng et al., 2012; Cerin et al., 2014]
 - ▶ Green EPC score → price premiums for sales.
- ▶ EPC for residential buildings: **rentals**
[Hyland et al., 2013]
 - ▶ Better EPC score → price premium for sales and rentals (smaller).
- ▶ **Proxies** for building's energy performance
[Zheng et al., 2012, Cajias + Piazzolo, 2013; Cerin et al., 2014; Kholodilin + Michelsen, 2014.]

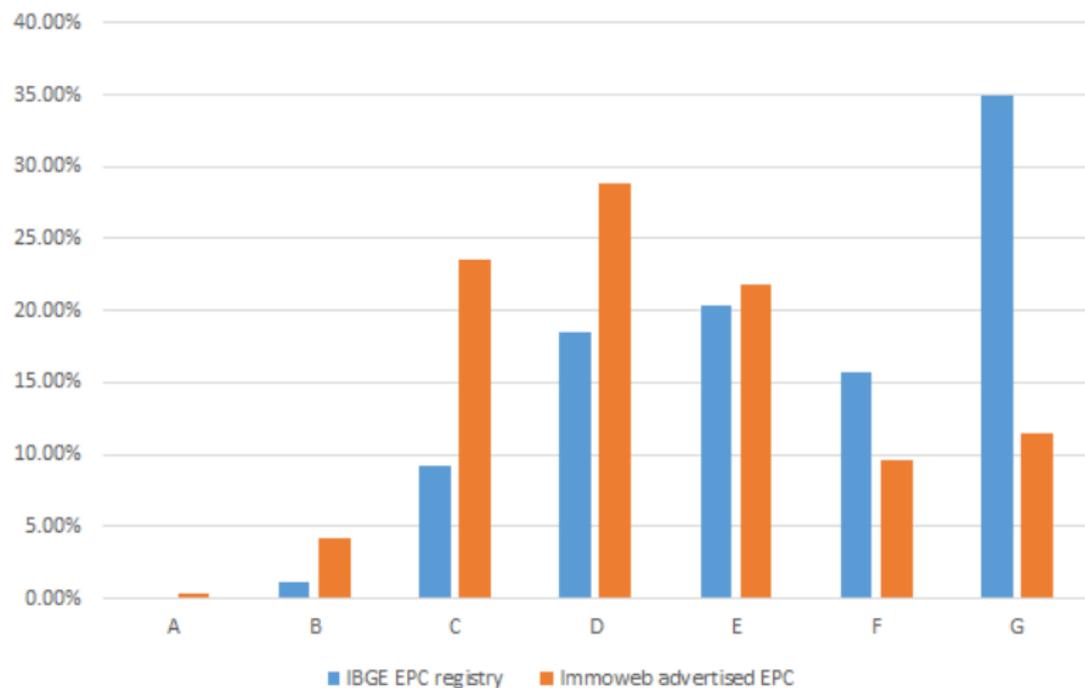
Descriptive Statistics: main variables

	Ads with published EPC N = 9885		Ads with hidden EPC N = 3701	
	Mean	Std.Dev.	Mean	Std.Dev.
<i>Dwellings</i>				
Rent in real terms (2006 €)	1074.14	560.30	855.60	427.87
Rent per sqm, in real terms (2006 €)	10.30	2.56	9.46	2.37
Dwelling surface (sqm)	107.39	53.54	94.38	45.56
Dwelling type: house (proportion)	0.07	0.25	0.05	0.22
<i>EPC categories (proportion)</i>				
Green EPC score (A-C)	0.28	0.45	0.20	0.40
Orange EPC score (D-E)	0.51	0.50	0.52	0.50
Red EPC score (F-G)	0.21	0.41	0.29	0.45

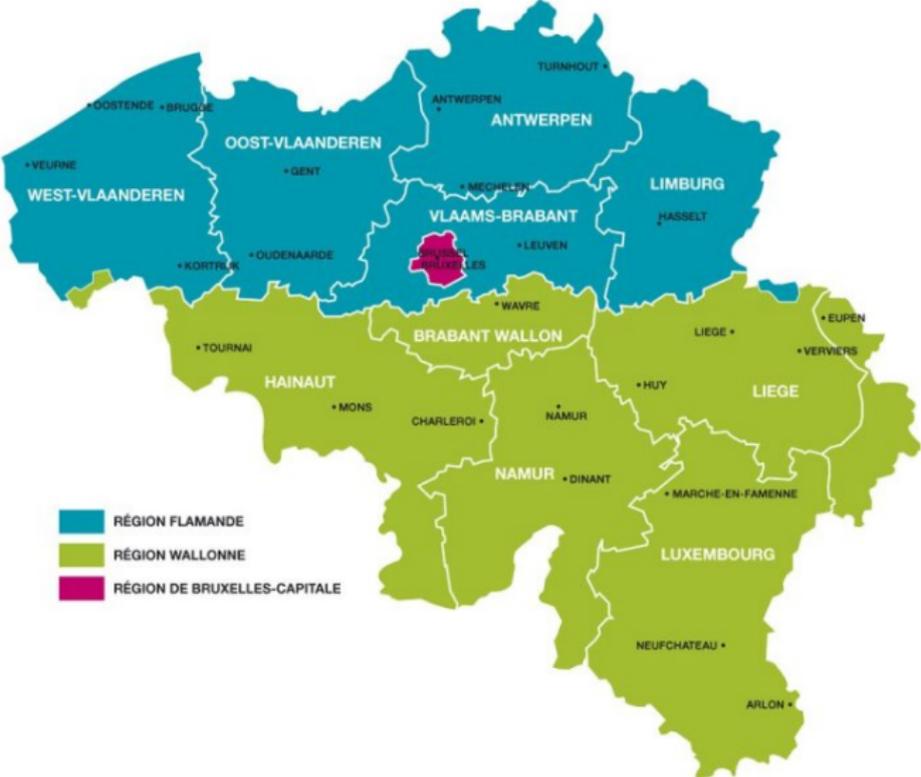
Descriptive Statistics: controls

	Ads with published EPC N = 9885		Ads with hidden EPC N = 3701	
	Mean	Std.Dev.	Mean	Std.Dev.
<i>Dwellings (proportion)</i>				
Access to open space	0.77	0.42	0.74	0.44
Garage/parking	0.19	0.39	0.27	0.44
Lift	0.13	0.34	0.25	0.43
Fully/partly furnished	0.23	0.42	0.11	0.31
Luxury	0.01	0.11	0.01	0.09
Brand new/renovated	0.25	0.43	0.25	0.43
Equipped kitchen	0.18	0.38	0.18	0.38
<i>Contract features (proportion)</i>				
Short-term contract	0.01	0.09	0.00	0.06
Real estate agency	0.06	0.24	0.04	0.20
Multiple language	0.28	0.45	0.52	0.50

Non-random sample selection?



Belgium: three regions



Source: Bruxelles-J

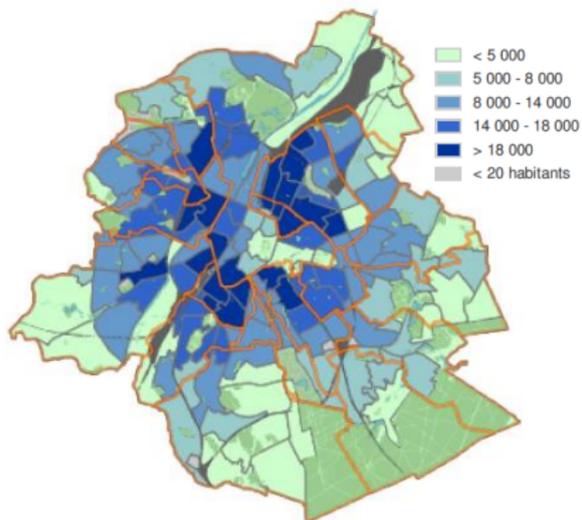
Brussels: geography, built environment, municipalities



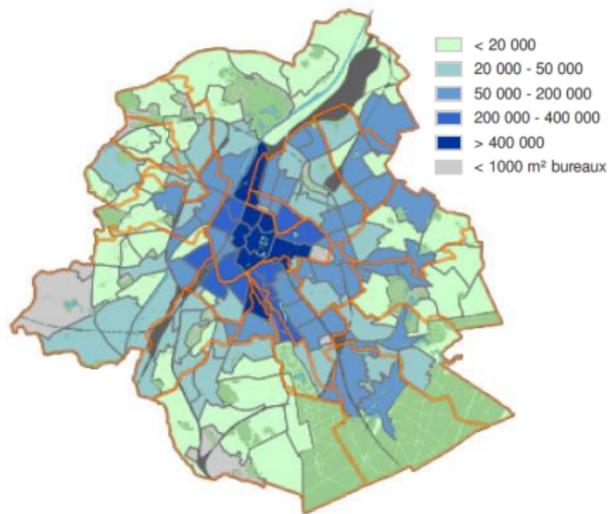
Source: Interface Demography, Vrije Universiteit Brussel

Brussels: city structure

Density [person/km²] (2013)



Density office space [m²/km²] (2014)

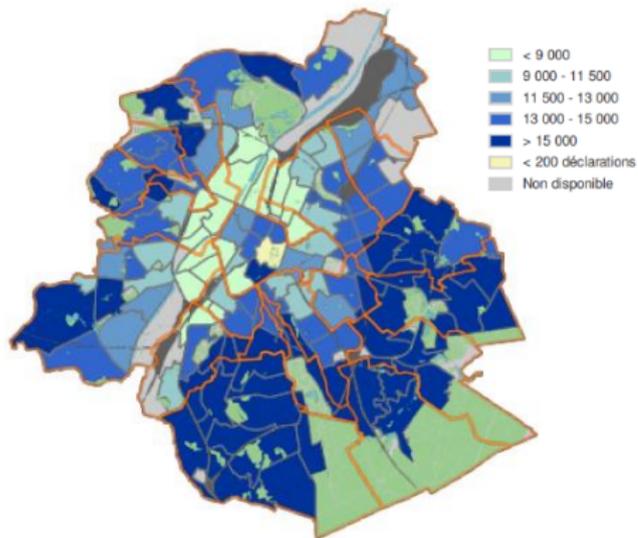


Source: Monitoring des Quartiers, IBSA

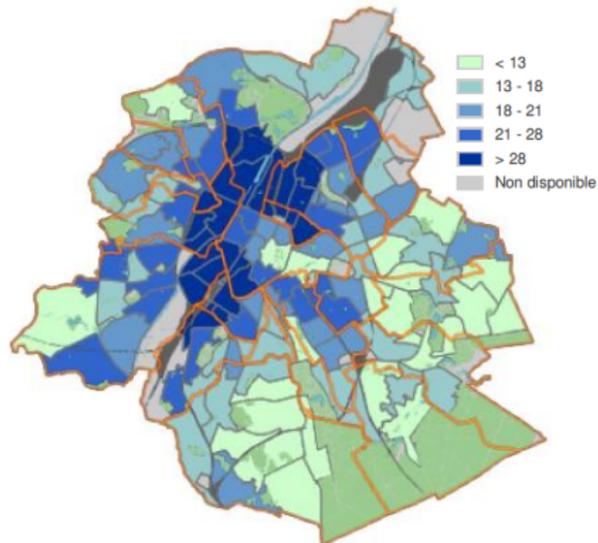
[Back](#)

Brussels: population

Average income [EUR] (2012)



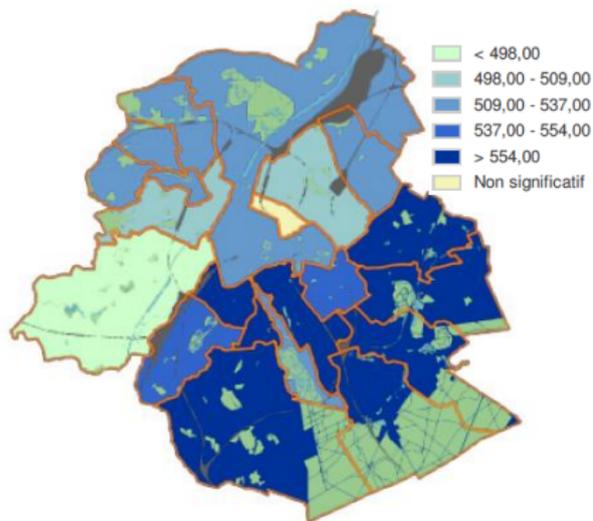
Unemployment rate [%] (2012)



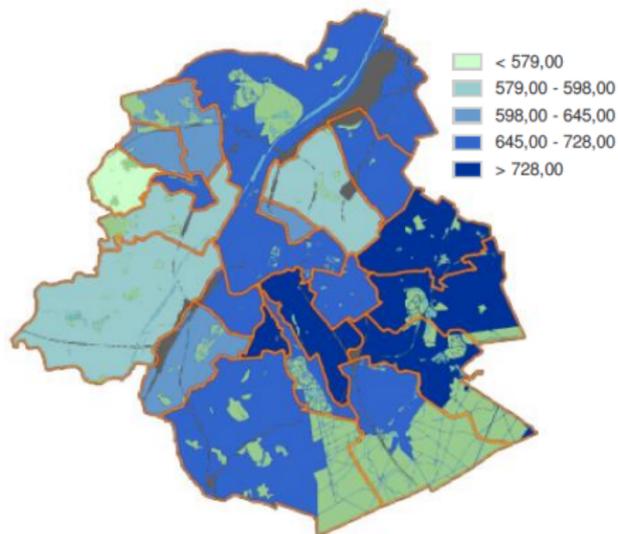
Source: Monitoring des Quartiers, IBSA

Brussels: monthly rents

Average monthly rent (2011) of housing unit
with 1 room [EUR]



with 2 rooms [EUR]



Source: Monitoring des Quartiers, IBSA

Exclusion restriction

What: An exclusion restriction:

- ▶ affects the probability of selecting into the sample (EPC publishing);
- ▶ does **not** directly affect the outcome variable (rent).

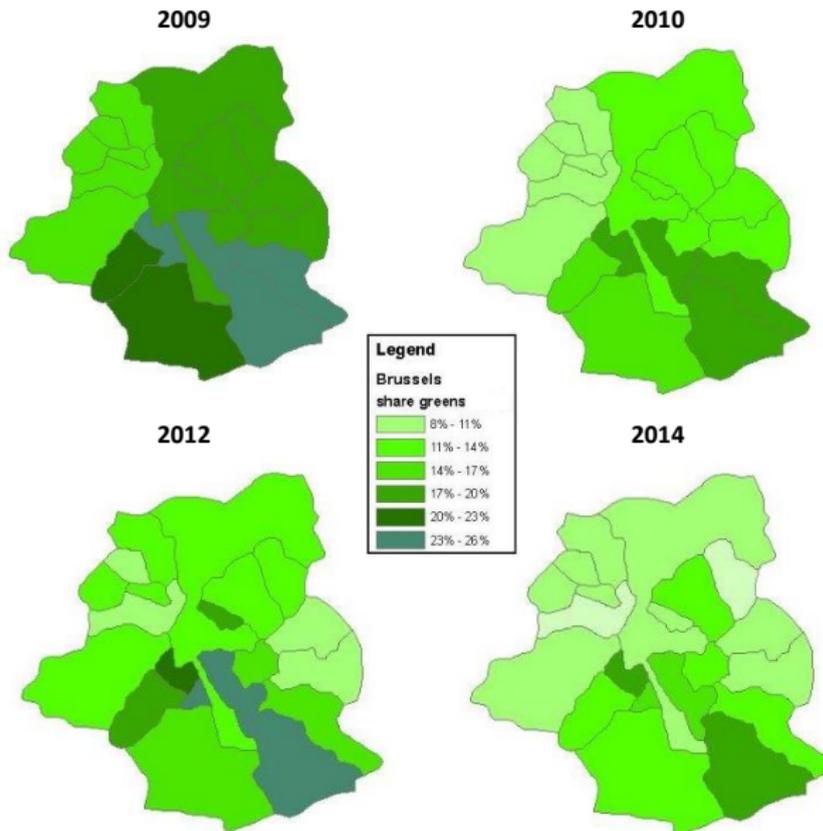
How: We use the **share of votes for green parties**:

- ▶ varies by municipality and over time; [Variation](#)
- ▶ elections: 2009 (regional), 2010 (federal), 2012 (municipal), 2014 (regional).

Why:

- ▶ Awareness of environmental issues,
- ▶ Pressure to advertise (publish) EPCs.

Exclusion restriction: time and geographic variation



Heckman step 2: Controls (energy efficiency effect)

	(1)	(2)	(3)
	Dep.Var.: Log(real rent/sqm)		
Log(surface)	-0.347*** (0.032)	-0.341*** (0.033)	-0.331*** (0.040)
Nb bedrooms	0.057*** (0.008)	0.058*** (0.008)	0.054*** (0.010)
Nb bathrooms	0.004 (0.005)	0.005 (0.006)	0.038*** (0.009)
Dwelling type: house	0.066*** (0.012)	0.064*** (0.012)	0.046** (0.018)
Access to open space	0.037*** (0.006)	0.035*** (0.005)	0.034*** (0.005)
Garage/parking	0.066*** (0.006)	0.064*** (0.008)	0.034*** (0.011)
Lift	-0.008 (0.009)	-0.017** (0.006)	-0.023*** (0.007)
Fully/partly furnished	0.217*** (0.006)	0.229*** (0.006)	0.204*** (0.011)
Short-term contract	0.030 (0.027)	0.037 (0.026)	0.049 (0.046)
Real estate agency	-0.017 (0.010)	-0.014 (0.011)	0.038** (0.015)
Luxury	0.197*** (0.040)	0.193*** (0.038)	0.274*** (0.054)

Robust standard errors in parentheses are clustered at the municipality level
Municipality, month-year dummies and socio-economic variables are included.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

OLS: Controls (information effect)

	Dep. Var.: Log(real rent/sqm)
Log(surface)	-0.365*** (0.029)
Nb bedrooms	0.055*** (0.007)
Nb bathrooms	0.037*** (0.008)
Dwelling type: house	0.075*** (0.020)
Access to open space	0.026*** (0.004)
Garage/parking	0.038*** (0.008)
Lift	-0.033*** (0.006)
Fully/partly furnished	0.198*** (0.007)
Short-term contract	0.056 (0.041)
Real estate agency	0.028** (0.010)
Luxury	0.254*** (0.059)

Robust standard errors in parentheses are clustered at the municipality level
Municipality, month-year dummies and socio-economic variables are included.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Heckman step 1: Main variables

	(1)	(2)	(3)
	Dummy=1 if EPC is advertised		
greenvote	2.479**	2.230**	3.076*
	(1.124)	(1.121)	(1.699)
Green EPC	0.337***	0.383***	0.509***
	(0.068)	(0.073)	(0.070)
Orange EPC	0.106**	0.122***	0.175**
	(0.047)	(0.046)	(0.070)
Brand new/renovated		0.068	-0.023
		(0.051)	(0.096)
Equipped kitchen		-0.032	-0.036
		(0.068)	(0.113)
Multilingual ad		-0.491***	-0.442***
		(0.115)	(0.129)
Year of construction			0.002
			(0.001)
Controls	yes	yes	yes
Municipality dummies	yes	yes	yes
Month-year dummies	yes	yes	yes
Socio-economic variables	yes	yes	yes
Observations	13928	13928	6258

Robust standard errors in parentheses are clustered at the municipality level

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Heckman step 1: Controls

	(1)	(2)	(3)
	Dummy=1 if EPC is advertised		
Log(surface)	0.348*** (0.079)	0.402*** (0.078)	0.638*** (0.059)
Nb bedrooms	-0.032 (0.024)	-0.030 (0.021)	-0.137*** (0.038)
Nb bathrooms	0.213*** (0.050)	0.193*** (0.047)	0.276*** (0.046)
Dwelling type: house	-0.045 (0.064)	-0.045 (0.053)	-0.098 (0.103)
Access to open space	-0.039 (0.038)	0.013 (0.031)	0.114** (0.050)
Garage/parking	-0.118 (0.100)	-0.038 (0.078)	0.068 (0.076)
Lift	-0.256** (0.116)	-0.142 (0.096)	-0.043 (0.096)
Fully/partly furnished	0.348*** (0.085)	0.378*** (0.082)	0.349** (0.143)
Short-term contract	0.379** (0.186)	0.445*** (0.170)	0.074 (0.256)
Real estate agency	0.224 (0.138)	0.207 (0.158)	0.761*** (0.158)
Luxury	-0.188 (0.167)	-0.173 (0.162)	-0.469*** (0.165)

Robust standard errors in parentheses are clustered at the municipality level
Municipality, month-year dummies and socio-economic variables are included.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

[Back](#)

Potential limitations

Non-random sample selection: (EPC publishing \Leftrightarrow rent)

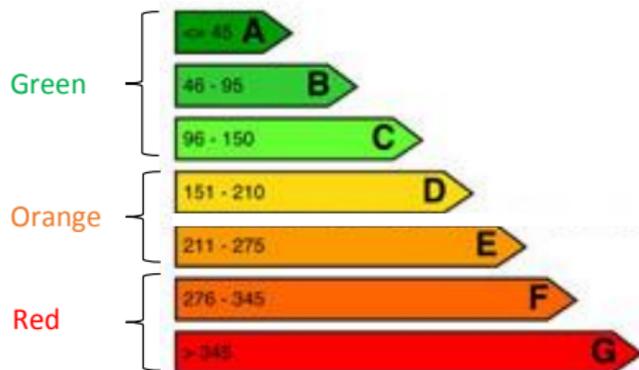
- ▶ We control using Heckman selection model
→ **no indication for non-random selection.**

Endogeneity problem: (EPC category \Leftrightarrow rent)

- ▶ We control for many dwelling characteristics
→ some unobservables might remain.
- ▶ We use published EPCs and (nearly) all information conveyed in ad
→ precisely reproducing information available to tenant.

Reduction in energy bill.

- ▶ "Going green" reduces energy consumption by 46%:
(conservative: min F to max C; assumes no behavioral changes)



- ▶ Monetary gain (i.e. smaller energy bill), depends on
 - ▶ energy source used for heating (e.g. electricity, gas, oil);
 - ▶ electricity/gas supplier and contract choice.