Energy efficiency on the European residential sales market: a meta-analysis

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Sustainable Finance Network : ESG risks in the Pillar 1 prudential framework

Is there a risk differential regarding ESG risks in banks' mortgage portfolios?

- **Physical risks**: acute or chronic climate events can deteriorate buildings. Houses market values plummet hence worsening the borrower's ability to service their loans payments.

- **Transition risks**: Energy inefficient dwellings targeted by environmental regulation become stranded assets on the market.

Property Price differentials relating to energy efficiency can influence the risk profile of a mortgage through LTV and LGD factors

What is the added value of a meta-analysis?

Investigating green premium on the real estate market

- Acknowledge it's existence
- Assess it's magnitude

Profusion of literature on the impact of energy performance on property prices.

Focus of the analysis.

- Real estate market
- More specifically on the sales market

What's at stake ?

Alighani, Reed (2020): "The underlying idea is that by **pooling estimates** across many studies, we get a **more reliable estimate** than by relying on any single study"

Building the Meta-Base

Updating two existing meta-bases, based on *Kahn et al.* (2003) methodology.

- *What is the impact of energy efficiency performance on house prices ?*
- "EPC Green Premium", "Green label housing", "EPC hedonic premium". Google Scholar, Science Direct
- What makes a study relevant ? the presence ***estimates*** and ***standard errors***.

Retrieving the estimate and the standard error

1. The estimate: look for Hedonic models (Rosen 1974)

$$log(p) = \alpha + \beta \mathbf{E} + \delta \mathbf{X} + e \tag{1}$$

   - p, price of the dwelling
   - E, measure of energy efficiency
   - X vector of control variables, Rosen (1974)

2. The standard error: not systematically disclosed !
   - No SE in the study but the t-statistic is given:

$$SE = \frac{\beta}{t} \tag{2}$$

No SE, no t-statistic, also turned out to be relevant for studies not disclosing the t-statistic but the confidence interval (Notaires de France).

The baseline methodology

Fixed effects model

- Assumption: total variability in the individual results are exclusively the outcome of sampling error → absence of true heterogeneity.

Random effects model

- Assumption: total variability in the individual results is the outcome of sampling error and methodological heterogeneity → presence of true heterogeneity. *"the percentage of total variation across studies that is due to heterogeneity rather than chance"* - Higgins *et al.* (2003)

$$W_i^* = \frac{1}{V_{Y_i}^*} = \frac{1}{V_{Y_i} + T^2}$$

- V_{Y_i} is the within study variance.
- T^2 is the between study variance.

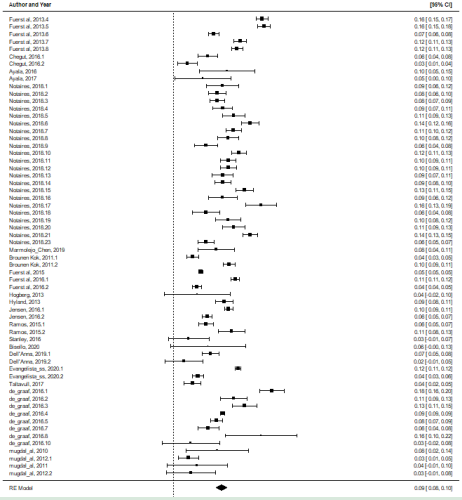
Estimation and results

Overall premium:

$$8.79\%$$

$$[0.0784; 0.0974]$$

High level of heterogeneity, $I^2 = 97.19$ which strongly supports the need for a meta-regression. The goal is to investigate the **drivers of this heterogeneity** in research.


Author and Year
[95% CI]
Fuerst et al., 2013.4
Fuerst et al., 2013.5
Fuerst et al., 2013.6
Fuerst et al., 2013.7
Fuerst et al., 2013.8
Chegut, 2016.1
Chegut, 2016.2
Ayala, 2016
Ayala, 2017
Nolaires, 2016.1
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Nolaires, 2016.21
Nolaires, 2016.23
Marmolejo_Chen, 2019
Brounen Kok, 2011.1
Brounen Kok, 2011.2
Fuerst et al., 2015
Fuerst et al., 2016.1
Fuerst et al., 2016.2
Hogberg, 2013
Hyland, 2013
Jensen, 2016.1
Jensen, 2016.2
Ramos, 2015.1
Ramos, 2015.2
Stanley, 2016
Bisello, 2020
Dell'Anno, 2019.1
Dell'Anno, 2019.2
Evangelista_ss, 2020.1
Evangelista_ss, 2020.2
Tallaveli, 2017
de_graaf, 2016.1
de_graaf, 2016.2
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RE Model
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0.07 [0.06, 0.08]
0.12 [0.11, 0.13]
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0.06 [0.04, 0.08]
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0.04 [0.01, 0.10]
0.03 [0.01, 0.05]
0.09 [0.08, 0.10]

Meta-regression - Hypotheses

1. Primary studies with a higher **"distance to EPC reference"** are expected to report a **higher premium**

$$premium_i = \alpha + \beta_1.distrat_i + \epsilon_i \tag{3}$$

2. There is a significant **negative relationship between the level of grouping and the premium**, i.e: the higher the number of grouped categories, the lower the reported premium for the group.

$$premium_i = \alpha + \beta_1.group_i + \eta_i \tag{4}$$

3. Estimates reported in **scientific papers** might be of **different magnitude** than that of estimates from **non-scientific papers**. i.e: due to different publishing processes.

$$premium_i = \alpha + \beta_1.publi_i + \gamma_i \tag{5}$$

where ϵ, η and γ are the respective error terms in equations (3), (4) and (5).

Meta-regression moderators

The set of moderators is the same as those collected by Cespedes-Lopes (2020)

$$Z = \begin{bmatrix} non-labeled-comparison \\ building \\ neighborhood \\ location \\ market \\ constructiondate \\ published \end{bmatrix}$$

A meta-regression was performed on the set of moderators to determine which were relevant, using the F-test.

Results and robustness

Table: Robust meta-regression

Variables	Estimates	se	pval
Intercept	0.07165	0.01507	0.000596
Distance	0.01231	0.00568	0.053034
Published	-0.02101	0.01005	0.060551
Non labeled	-0.0406	0.01462	0.017999
Neighbourhood controls	-0.01338	0.01162	0.274141
Market controls	0.00215	0.01053	0.842029

Bottom line

As can be expected, robust meta-regression results do affect the conclusions previously drawn.

- Lower significance level: 10%
- Similar magnitude
- New result: *non-labeled* coefficient is now significant at the 5% level. (needs to be further investigated).

Discussing the results

1. **Limited model performance**:
   - Explanatory power of the model is just above 25%
   - High degree of heterogeneity
   - More moderators are needed

2. **Negative relationship between EPC bands group sizes and the level of the premium.** Hypotheses:
   - Mechanical effect: grouping more implies to reduce the distance to the reference band.
   - Heterogeneity between groups with one band diluting the others.

3. Policy implications