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Greenium or manipulation? An analysis of the French housing market

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Greenium or manipulation? An analysis of the French housing market*

joint work with E. Civel & P.R.Aja

- Research questions
  - Is the Energy Certificate Performance (EPC) label useful? Informative? Valuable?
  - Is it possible to disentangle the value of the EPC from other green characteristics?
  - Which is the role of specific classes? Of the assessors/housing markets?

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Greenium or manipulation?
An analysis of the French housing market

- Empirical strategy
  - Regression Discontinuity Design at the class boundaries
    - Caveat: The regression discontinuity design is an appropriate framework to identify treatment effects in quasi-experimental settings, if sorting of the observations can be ruled out.

- Main result in a nutshell
  - EPC (DPE: Diagnostic de Performance Enérgétique) premium of 856 euros in apartments at the crossover from classes where no sorting is detected.
  - Sorting problems can be explained by taking into account market effects, i.e. the interplay between assessors and real estate agencies

ENERGY EFFICIENCY GAP?

- Difference between optimal and actual energy efficiency investments
- **Market and non-market inefficiencies highlighted in the literature**: (Jaffe and Stavins, 1994; Civel, 2019)
  - Energy supply market: does not take into account environmental externalities; average-cost electricity pricing
  - Energy efficiency market: capital market liquidity constraint
  - Economic aspects of energy efficiency adoption: agents' heterogeneous preferences for energy efficiency, rebound effect
  - *Informational and behavioural: Asymmetric and imperfect information, cognitive biases and reliance on heuristics*

Our approach:
Green premium vs label premium

- Green premium: combined premium associated with energy efficiency attributes (better quality isolation, windows, higher performance DPE class, etc)
    - Label premium: premium associated with the DPE label/class only; green attributes that are less easily observable

Literature:

- **Several works on green premiums find that energy efficiency is capitalized in home prices** in France (Civel, 2019), the Netherlands (Brounen and Kok, 2011), Germany (Frondel et al. 2018), Finland (Harjunen and Liski, 2014), Ireland (Stanley et al. 2016)

- Fesselmeyer (2018) finds a green premium in Singapore and **Olaussen et al. (2017) in Norway** but no label premium; similar result in **Aydin et al.** (2020) in the Netherland

The French Case (I)

Residential-tertiary sector is responsible for 46 % of final energy consumption* in 2019 and 23% greenhouse gas emissions in 2018 in France (MTE, 2020a; MTE, 2021a)

Stratégie nationale bas-carbone (SNBC), established in 2015 by the Energy Transition Act:

- **Carbon neutrality by 2050**, reduction of gross emissions by at least factor 6
- Buildings in 2030: **reduction of greenhouse gas emissions by -49%** compared to 2015 levels
- Buildings in 2050: Average annual primary energy consumption according to the norms of “low-consumption building” - **80 kWh per sqm renovated buildings and 50 kWh per sqm new buildings**.
- Plan for the residential sector: approximately **370 000 deep renovations per year** on average in 2022-2030 and **700 000 deep renovations per year** on average in 2030-2050.

The French Case (II)

- **Buildings exceeded the carbon budget** allocated to the sector in SNBC by 8,1% in the period 2015-2018 (HCC, 2021)
- **High energy dependence rate**: 45.4% of primary energy consumption in 2019 (MTE, 2021b)
- Residential sector: Only 1.9 million primary residences (of 29 million) had DPE class A or B in 2019 (annual primary energy consumption of less than 91 kWh per sqm) (CGDD, 2020)
- Target to renovate first buildings with the worst **DPE**

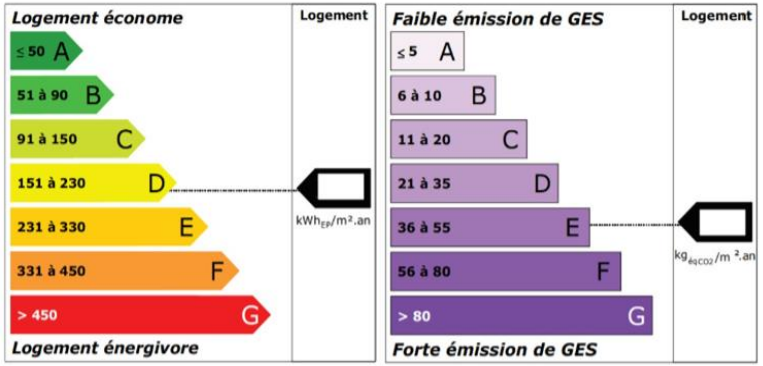
Diagnostic de performance énergétique
DPE

1. Instrument intended to **objective information** about buildings energy and climate performance

2. Aims to **resolve the problem of asymmetry of information** by signaling to the buyers/lessors the energy performance of the dwelling

3. Intended to increase market price of dwellings and **incentivize renovation**

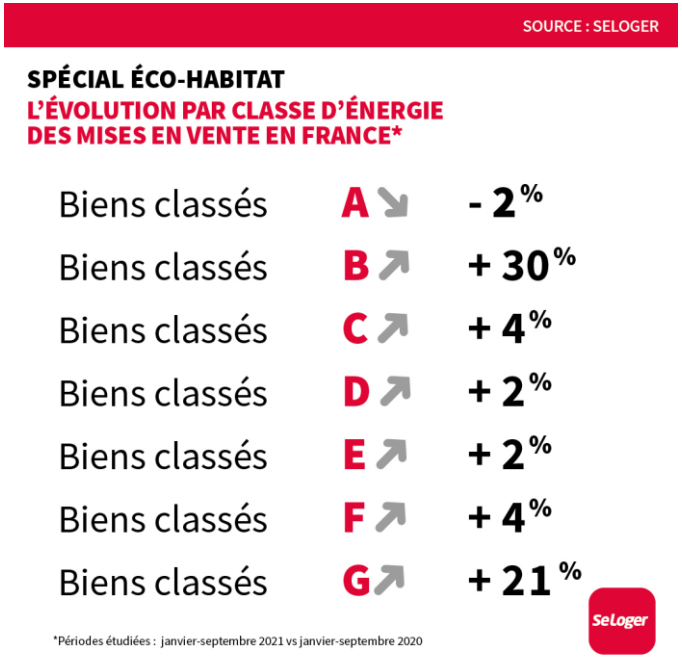
After the Directive 2002/91/EC of the European Parliament



DPE energy performance and greenhouse gas emission intensity labels until 30 June 2021
Source: observatoire-dpe.fr/index.php/impressionDPE

Puzzling (timely!) evidence

Holding A-rated apartments



…to sell them at higher prices?

Un logement bénéficiant d'une classe énergie A coûte, en moyenne, 3 699 € du m². C'est 17 % plus cher qu'en 2020. (Périodes étudiées : janvier-septembre 2021 vs janvier-septembre 2020)

Source: Se Loger, November 29th 2021

Data

1. **Real estate transactions database:** French Ministry for Finance and Public Accounts public data of all real estate transactions made in France between 2014 and 2020

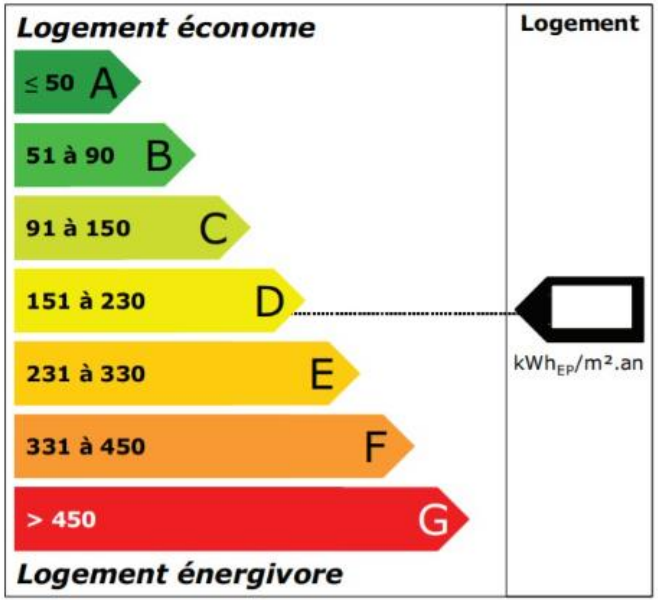
   Key variables:
   - **price of the property,** number of rooms, land area, date of the transaction, postal code, **latitude and longitude**

1. **Energy Performance Certificates database:** ADEME's public data on all the *diagnostics de performance énergétique* registered in France

   Key variables:
   - **primary energy consumption in kWh/sqm/year**, **DPE class**, floor area, number of floors, construction year, postal code, **latitude and longitude**

Analysis

- Matching by geolocalization variables and zip codes: The final database includes **308,898** houses and **601,490** apartments transactions
- **We Study whether and how the DPE energy performance class is valued in housing prices in France**
- Valuation as a sign of public policy effectiveness
- Scope:
  - sales transactions
  - residential sector (houses and apartments)
  - Metropolitan France
  - period: 2014-2020
  - energy performance label



Energy performance label until 30 June 2021

Source: observatoire-dpe.fr/index.php/impressionDPE

Empirical strategy: Regression discontinuity design

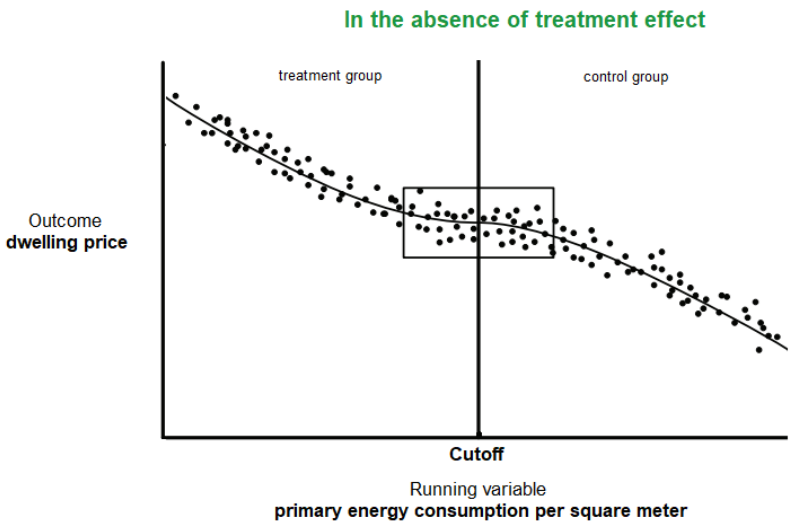
- Separating the effect of a label premium from a general green premium in a framework like hedonic regression would require the presence of data on market prices before and after the introduction of the certificate. However, no data is available on dwellings' sale prices before the DPE was introduced.

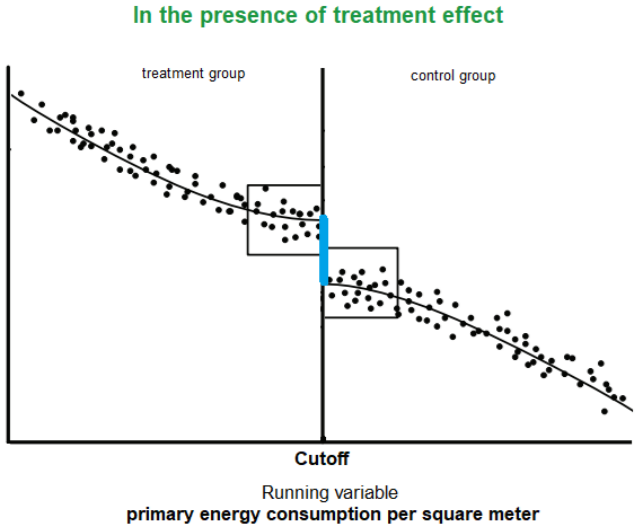
- Due to the discontinuity that the different DPE classes are expected to produce at the cutoffs, the RD design enables to bypass this obstacle and allows us to identify a valid counterfactual for the label effect using only ex post data.

- By studying the difference of dwelling prices at the boundary values of energy consumption between different DPE classes, the effect can be allocated to the DPE and DPE only.

Empirical strategy: Regression discontinuity design

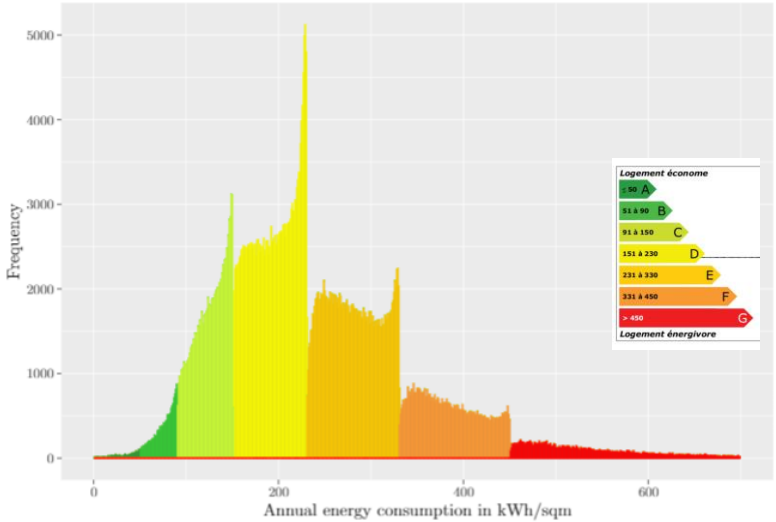
For a valid causal interpretation and estimation, one must be able to determine that the effect from the discontinuity can be allocated to the treatment only.



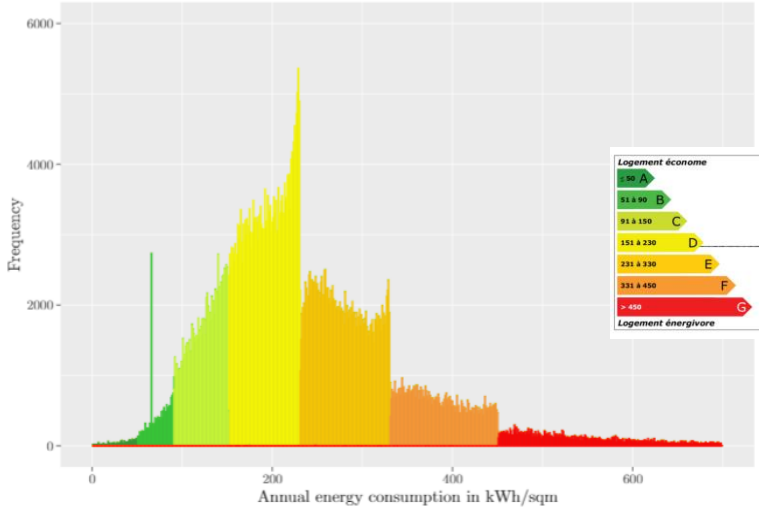


Empirical strategy: Regression discontinuity design

Houses



Apartments



DPE histograms aggregated at 1 kWh/sqm bins
Source: Ademe Energy Performance Certificates database

Empirical strategy: Regression discontinuity design

- We analyze pairs of contiguous DPE classes
- Attributing the class that represents better energy performance, is considered to be the treatment that might have a positive impact on the selling prices of these dwellings.
- We apply the RD approach separately for six treatment and control group pairs at the six cutoffs, representing the bounds of the DPE classes.

Cutoff value	Treatment group	Control group
51	Class A	Class B
91	Class B	Class C
151	Class C	Class D
231	Class D	Class E
331	Class E	Class F
450	Class F	Class G

Cutoff marks as a function of annual primary energy consumption in kWh per square meter

RDD results (I)

HOUSES

- An effect of the DPE on house prices is found between classes C and D, D and E, and, E and F; and possibly between classes B and C.

- The potential label premium is in the range of 1454 to 2549 euros, with cutoff 231 having the lowest and 331 the highest value.

APARTMENTS

- The DPE impact is between 697 to 2086 euros, with, reversely, cutoff 331 having the lowest and 91 the highest premium.

RDD results (II)

- The estimated premiums associated with house sales are higher than those for apartments which suggests that the DPE class premium might be larger for bigger dwellings as houses have on average larger living (and land) area.

- This implies that buyers of bigger dwellings might place a higher value on energy efficiency as they have higher aggregate heating requirements.

RDD results (III)

- No impact at the thresholds between the two most energy efficient classes as well as between the two classes with the worst energy performance.

- With formal tests rejecting sorting at the cutoff 151 in the apartments dataset, the label premium identified between classes could be valid.

- However, given there is no reason to suggest that manipulation only occurs elsewhere and is specifically excluded at this threshold, further tests have been conducted.

Manipulation? (I)

- Do some unobserved characteristics, correlated with energy consumption, introduce a bias?

- We perform corrected density analysis (adjusting the distribution of the sample according to an appropriate parametric distribution and then runs the RD analysis for each adjusted sample) and Donut hole test (removing units right at the cutoff and conducting the standard RD analysis without these observations, Cattaneo et al., 2019).

- The corrected density is rather conclusive (no significative changes in the results) whereas the Donut hole tests is more sensitive at some cutoffs.
  - similar concerns in Collin and Curtis (2018)

Manipulation (II)

- We compute for each department and for each year (from 2014 to 2020) the corrected magnitude of discontinuities, *i.e.* the difference of DPE registered 5kWh below and above each cutoff corrected by the total number of DPE.

- Thanks to an assessor identification number displayed in our dataset on EPC, we can also compute the Herfindahl-Hirschman Index (HHI) for each of these observations. We add other market variables as the average price per square meter, population, and the annual typical heating needs (Dhref).

- Explaining about 20% of corrected magnitude variations, the model gives several interesting insights.
  - The annual heating needs tend to increase the manipulation of DPE by assessors, a consistent result as energy performance will add more value to a house in colder climates.
  - A higher square-meter price will lower the manipulation, a result in phase with an absolute value of energy efficiency given the independence of energy price to the location of a dwelling.
  - A higher HHI (*i.e.* a lower competitive environment for assessors) will increase manipulation: higher concentration in a market tends to lower the quality.

Conclusions

- By arguing that the green priemium is different than a DPE premium, we insisit on the importnace of onfirmational instruments.

- The ongoing reform of the DPE (which includes the civil responsibility of the assessment) goes into the right direction.

- To avoid manipulation, objective measures of energy consumption should be adopted
  - In favor of the continued need for government-imposed certification programs.

Annex

Houses

Table: The effect of DPE on the real estate market in France in 2014-2020. Regression discontinuity analysis under manipulation. Houses

Cutoff	RD Estimate	Standard p-value	Robust p-value	95% Robust C.I.	Bandw. L	Bandw. R	Obs. L	Obs. R
51	**−319.80**	0.8705	**0.8310**	[−5110.72, 4107.20]	**10.1**	**10.1**	367	831
91	**891.98**	0.1724	**0.3102**	[−722.11, 2272.82]	**11.9**	**11.9**	3946	6900
151	**1996.72*** **	0.0001	**0.0001**	[1197.76, 2933.05]	**21.8**	**21.8**	26 706	27 460
231	**1471.48*** **	0.0001	**0.0001**	[770.76, 2161.82]	**28.4**	**28.4**	48 050	25 306
331	**2505.08*** **	0.0001	**0.0001**	[1632.27, 3720.55]	**27.6**	**27.6**	23 092	9597
450	**655.57**	0.3618	**0.6507**	[−1324.33, 2120.10]	**59.0**	**59.0**	13 172	4001
51	**83.87**	0.9645	**0.9479**	[−4176.34, 4464.34]	**12.8**	**8.5**	417	651
91	**1253.60** **	0.0498	**0.1055**	[−260.48, 2733.05]	**9.8**	**17.1**	3418	10 935
151	**2011.18*** **	0.0001	**0.0001**	[1017.68, 2980.48]	**15.6**	**19.0**	20 289	23 575
231	**1453.96*** **	0.0001	**0.0001**	[722.50, 2093.74]	**21.0**	**29.4**	36 997	26 264
331	**2548.92*** **	0.0001	**0.0001**	[1641.88, 3800.40]	**29.9**	**25.7**	24 794	8914
450	**876.63**	0.1631	**0.3094**	[−744.79, 2349.65]	**50.4**	**82.3**	10 978	5138

RD estimate per dwelling sold. Local weighted linear regression. Weights applied using triangular kernel function

*p<0.1; **p<0.05; ***p<0.01

Apartments

Table: The effect of DPE on the real estate market in France in 2014-2020. Regression discontinuity analysis under manipulation. Apartments

Cutoff	RD Estimate	Standard p-value	Robust p-value	95% Robust C.I.	Bandw. L	Bandw. R	Obs. L	Obs. R
51	**1093.26**	0.6432	**0.4125**	[−3040.40, 7409.63]	**6.3**	**6.3**	493	1028
91	**2085.91****	0.0041	**0.0283**	[197.10, 3513.05]	**7.7**	**7.7**	3859	7691
151	**1280.26*****	0.0007	**0.0005**	[624.83, 2261.51]	**10.3**	**10.3**	21 052	25 108
231	**997.46*****	0.0005	**0.0005**	[487.22, 1745.68]	**18.6**	**18.6**	64 728	35 144
331	**696.97****	0.0361	**0.1052**	[−133.90, 1411.70]	**39.1**	**39.1**	60 331	26 461
450	**−113.96**	0.8347	**0.7882**	[−1484.15, 1126.28]	**63.9**	**63.9**	30 820	10 234
51	**861.22**	0.6982	**0.6171**	[−3687.08, 6212.38]	**7.2**	**7.0**	535	1235
91	**1961.48****	0.0072	**0.0211**	[289.97, 3570.77]	**7.1**	**8.7**	3751	8747
151	**855.78****	0.0103	**0.0156**	[173.79, 1660.48]	**10.6**	**18.4**	21 825	46 592
231	**883.80*****	0.0008	**0.0025**	[336.80, 1575.82]	**24.6**	**20.0**	82 459	37 579
331	**700.97***	0.0354	**0.0845**	[−93.52, 1467.22]	**29.6**	**45.9**	45 411	30 539
450	**−22.70**	0.9663	**0.8856**	[−1375.73, 1187.58]	**48.2**	**72.8**	22 387	11 446

RD estimate per dwelling sold. Local weighted linear regression. Weights applied using triangular kernel function

*p<0.1; **p<0.05; ***p<0.01