Success and Failure of a Zero-Interest Green Loan program:
Evidence from France

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Motivation

- Housing sector accounts for $\sim$ 20% of global CO_2 emission
- **Retrofitting housing stock** crucial for mitigation
- Heavy investment: from $\sim$€1,000s for new windows to several €10,000s for complete retrofits
- It often requires **a loan** (40% of French households take a loan for deep retrofit)

$\Rightarrow$ credit facilities as important policy tool, in addition to subsidies

Questions:

Q1: Does access to low-cost credit for home retrofits accelerate retrofit investment?

Q2: What are the possible barriers to implementation of low-cost credit policies?

Motivation

Study the impact of a Zero Interest Green Loan (ZIGL) in France

- Banks get an interest-dependent compensation from the Government in exchange for providing ZIGLs

Why a subsidized loan for home energy retrofits?

1. Classic Pigovian subsidy: internalizing energy-use externalities.
   - The implicit subsidy varies in time
   - Participation should increase with interest rates (demand-driven)
2. Solve information asymmetries excluding risky borrowers from credit markets

This paper

What we do:

- Study introduction of Zero Interest Green Loan (ZIGL) in 2009
- Use household survey from ADEME
- Difference-in-differences of renovation activity of eligible and non-eligible households

Results:

- +3 to 4 p.p. (20-22%) of renovation probability; + €127-175 (3-5%) to renovation spending in 2009-10, no effect in 2011-13
- The effect is strongest for low-income households (+11 p.p. of renovation probability).

Explaining the decline in 2011

- Lack of information about the program.
- Banks' opportunity cost: banks would rather propose their own loan products to finance the same investment.

Related Literature

1. Evaluating energy efficiency subsidies: participation and energy savings
   - Review: Giraudet (2020) and Chlond et al. (2023)
   - France, tax credit program CITE: Nauleau (2014), Mauroux (2014), Risch (2020)

2. Subsidized Loans: effect on participation
   - Student loans (Cadena and Keys, 2012)
   - Housing loans (Martins and Villanueva, 2006; Gruber et al., 2021; Labonne and Welter-Nicol, 2017; Gobillon et al., 2022).

3. Intersection of environmental economics and household finance: the energy efficiency gap (Gerarden et al., 2017).
   - Demand-side choice experiments: debt aversion and financial illiteracy are important barriers to energy efficiency investment (Schleich et al., 2021; Schueftan et al., 2021)
   - Supply-side: high interest rates for home energy retrofits (Giraudet et al., 2021b)

Institutional Setting

The Zero-Interest Green Loan program Policy implemented in France in 2009

- Loans for energy retrofits — e.g. isolation, new heating
- Supplied by banks: banks receive a compensation equal to the government bond rate + fixed spread
- Can be guaranteed, insured, or unsecured: up to banks

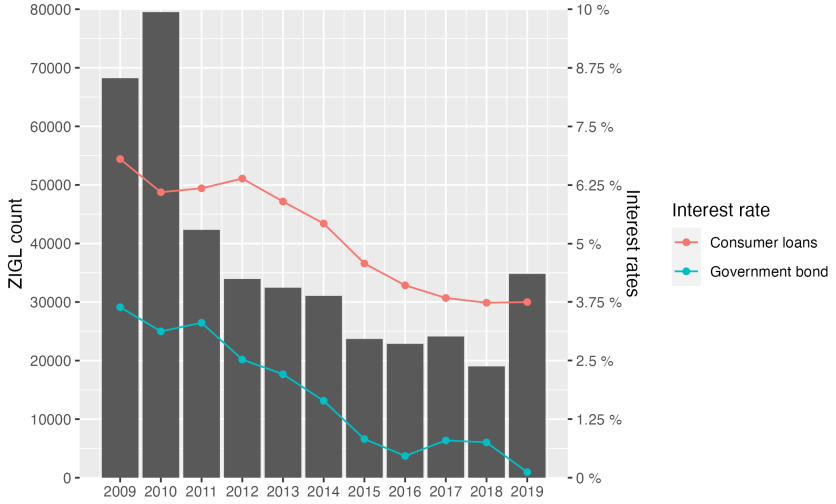
Program conditions in 2009-2013:

- Max amount €30,000. Max duration 15 years
- $>$ 2 renovation actions
- No income restriction
- **Eligibility criterion:** house built before 1990

Co-existing programmes: tax credit, energy economy certificates, energy saving obligations, VAT reductions... In Numbers

Institutional Setting

Evolution of annual ZIGL provision and market interest rates.



Data

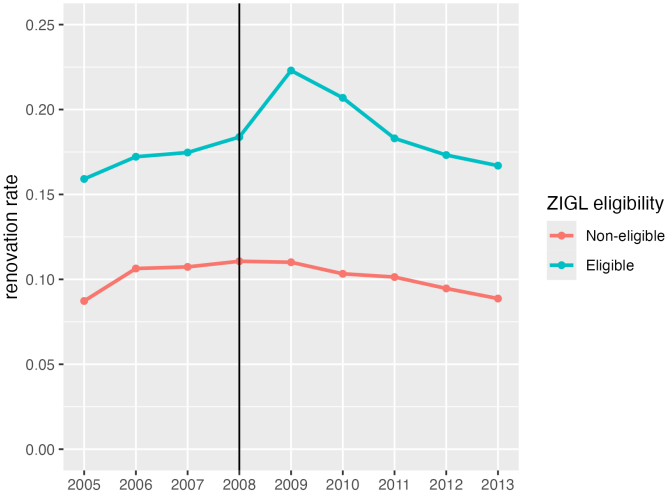
ADEME Panel Survey on energy characteristics of housing, energy consumption and attitudes, **retrofits**, 2000-2013.

- Subsample:
  - Only 2005-2013 — data quality
  - Only homeowners (>95% of ZIGL recipients)
  - Only respondents present for > 1 period — use of HH FE
- Resulting dataset: 9,657 households over 9 periods; 42,418 observations.
- Survey weights from ADEME used in all calculations

Desc. Stats

Descriptive Evidence

Evolution of renovation rates by treatment group, 2005-2013



Empirical Strategy

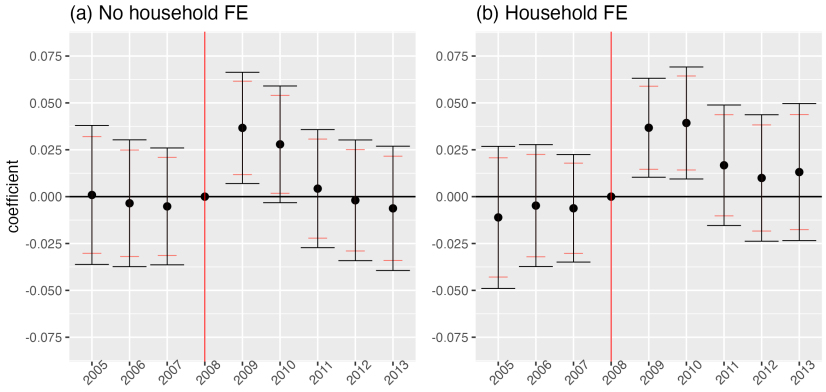
Event-study strategy

$$R_{i,t} = \alpha \text{ Eligible}_{i,t} + \sum_{t \neq 2008} \beta_t \text{ (Eligible}_{i,t} \times \tau_t) + \gamma X'_{i,t} + \tau_t + \mu_i + \epsilon_{i,t}$$

- $R_{i,t}$ — renovation decision (extensive margin) or renovation amount or number of actions (intensive) of HH i in year t
- β_t are differences in differences — effect of ZIGL eligibility
  - effect of access to credit $\leftrightarrow$ intention-to-treat estimates
- $X'_{i,t}$
  - At HH level: renovated in the past, age, occupation, income, surface area, type of heating system.
  - At aggregated level: municipality size (population) and region indicator.
- Survey weights used; standard errors clustered at HH level.

Results

Extensive margin, retrofit probability



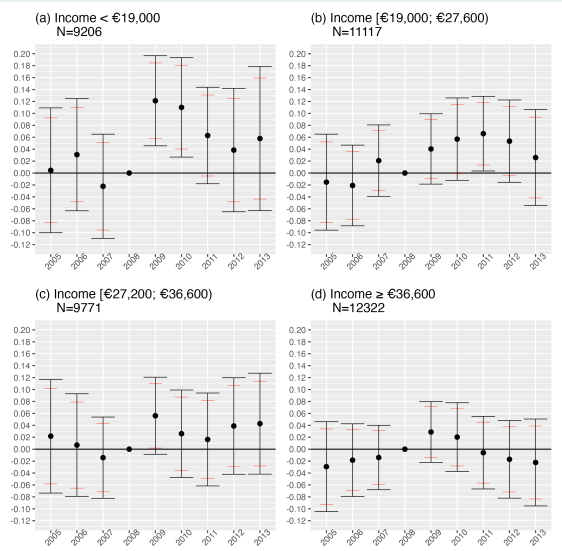
2009: +3.7 p.p. to retrofit probability with FE, +3.7 p.p. without
2010: +3.9 p.p. to retrofit probability with FE, +2.8 p.p. without
2011-2013: No effect

▸ Extended period

Results

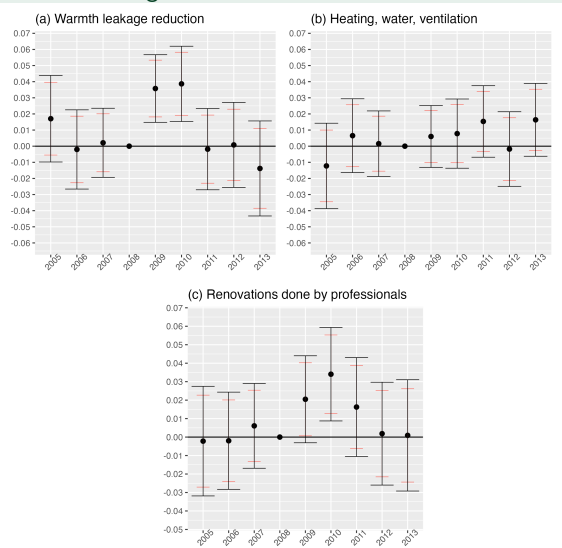
Heterogeneous effects: by income

▸ Triple Diff ▸ Exclude old houses



Results

Heterogeneous effects: by type of renovating action

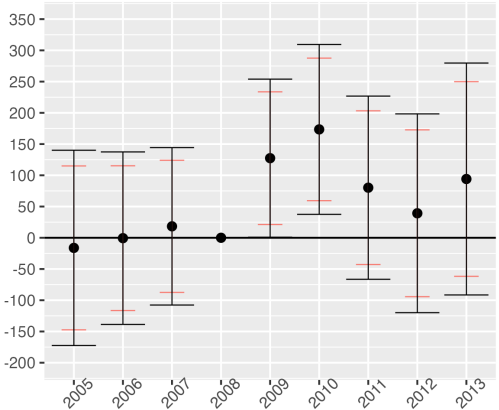


▸ DIY income

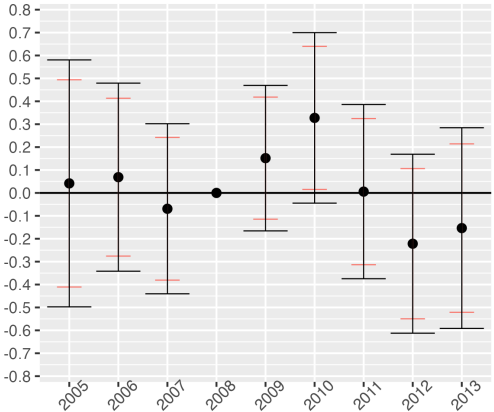
Results

Intensive margin: renovation amount and number of renovation actions

(a) Renovation amount, OLS
N = 40756



(b) Number of renovation actions, Poisson
N = 17799

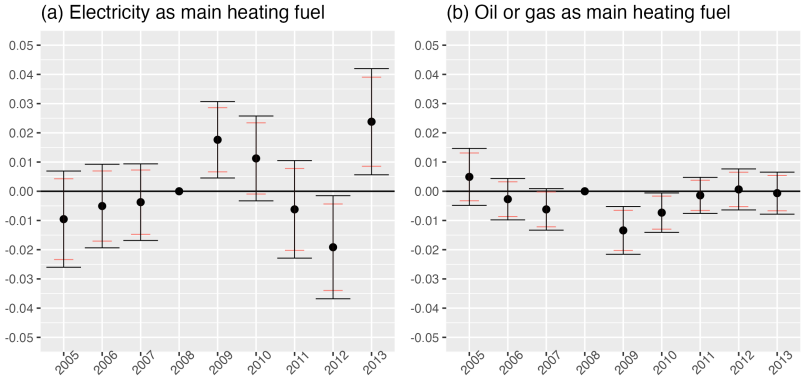


2009 +10[illegible] 2.3% [illegible]

Do households actually reduced their energy consumption?

- Ideally, we would like to look at energy consumption data
  - While energy spending is in the survey, the quality of the data is poor...
    - Electricity consumption
- Instead, we can look at energy source switching

- The ZIGL program may have induced the switch from relatively inefficient oil and gas heating systems to relatively more efficient electric systems.



Leverage: the extra euro amount of private investment induced by one euro of public spending on ZIGLs

$$\text{Leverage}_t = \frac{\%\text{ extensive margin effect}_t + \%\text{ intensive margin effect}_t}{\%\text{ rate of public cost}_t}$$

Year	Extensive margin effect	Intensive margin effect	Public cost	Leverage
2009	20.0%***	3.3%**	17.1%	1.4
2010	21.4%***	4.5%**	14.9%	1.7
2011	9.1%	2.1%	16.0%	0.7
2012	5.4%	1.0%	14.3%	0.5
2013	7.1%	2.4%	12.3%	0.8

▸ Diagram

Public cost:

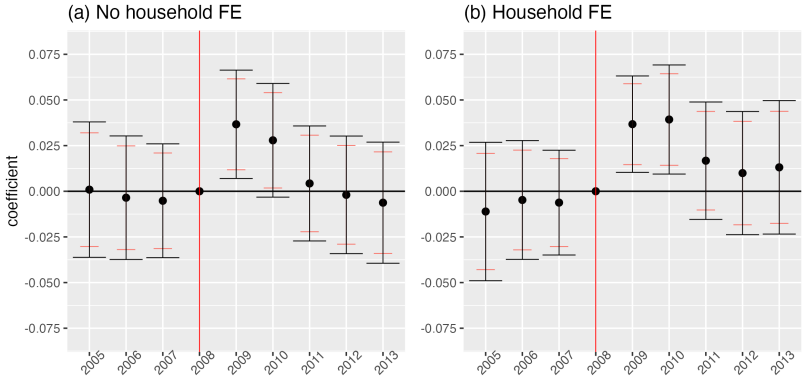
amount the bank receives on each loan as percentage of the underlying investment

Robustness tests

1. Placebo definitions of eligibility (pre-1982, pre-1975, pre-1949 houses) ▸ Placebo results
   - Effect mainly driven by Pre-1949 houses
2. Restrictive definition of treatment:
   - Excluding pre-1949 houses ▸ No pre-1949 houses results
   - T (houses built 1975-1990) C (after 1990) ▸ Restricted T
3. Event Study with Propensity score weighting ▸ PS weighting results
   - Stronger effect with HH FE
4. Attrition test ▸ Attrition

Discussion

Why the short lived effect?



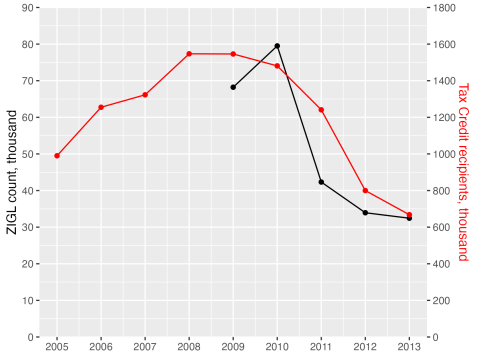
Why did the ZIGL program lost its effectiveness in 2011?

- Demand-side motives
- Supply-side motives?

Discussion

Post-2010 ZIGL failure: **demand-side** motives

1. Strategic participation? No Go
   - No anticipation since parallel pre-trends
2. Debt aversion and financial distress? No changes in 2011 Go
3. Policy interference? Overlap with tax credit forbidden in 2011 Yes



4. Asymmetric information Yes

Table 1: Knowledge of ZIGL

Sample	All		Renovators		Renovators with loan	
	Know ZIGL	N	Know ZIGL	N	Know ZIGL	N
2009	57%	5,596	67%	1,117	76%	187
2010	56%	5,139	67%	944	78%	129
2011	44%	4,646	54%	792	64%	122
2012	42%	4,708	50%	739	67%	111
2013	43%	4,295	65%	637	76%	83

Discussion

Post-2010 ZIGL failure: **supply-side** motives

Banks face an opportunity cost of ZIGL provision

- Difference between consumption loan interest and government bond >2p.p. (compensation covers 1.35p.p.)
- Do banks with better outside options provide less ZIGL?
- Use bank branch *Banque de France* loan data to test the hypothesis

We measure:

$$\text{Opportunity cost}_{b,a,t} = \frac{\sum_i \left(\text{Interest rate}_{i,b,a,t} \cdot \text{Loan amount}_{i,b,a,t}\right)}{\sum_i \text{Loan amount}_{i,b,a,t}}$$

Then, we regress, in a Poisson model:

$$\ln\left(\mathbb{E}[\#\text{ZIGL}_{b,a,t}]\right) = \beta \cdot \text{Opportunity cost}_{b,a,t} + X_{a,t} + \varphi_b + \gamma_a + \tau_t$$

Discussion

Post-2010 ZIGL failure: **supply-side** motives

Effect of banks' opportunity cost on ZIGL origination – Bank × catchment area.

Dependent Variable:	Nb of ZIGL		
Model:	(1)	(2)	(3)
Variables			
Opportunity cost	-0.2177***	-0.0463*	-0.0458*
	(0.0461)	(0.0251)	(0.0268)
Controls	Yes	Yes	Yes
Fixed-effects			
Time	Yes	Yes	
Bank		Yes	
Catchment Area		Yes	Yes
Bank × time			Yes
Fit statistics			
Observations	14,726	14,726	14,726
Squared Correlation	0.244	0.74	0.79
Pseudo R^2	0.206	0.475	0.496

Conclusion

Success 2009-2010

We find a short-lived but significant effect of the zero-interest green loan eligibility on retrofitting activity of homeowners in France:

- $+ \sim 3$ p.p. to probability of retrofit in first years
- Highest effect ($+ \sim 11$ p.p.) for low-income households
- $+ \sim €175$ to retrofit amount
- Energy consumption might have decreased for low-income hhds

Failure 2011-now

- Banks seem reluctant to sell ZIGLs
- Consumers less and less informed: no effort from banks; short info campaign from state
- Administrative complexity

Thank you

Institutional Setting

ZIGL Program – in numbers

	2009	2010	2011	2012	2013
Descriptive statistics					
N loans	68,225	79,508	42,324	33,936	32,448
N lenders	99	104	101	102	99
N municipalities	15,823	17,497	12,633	11,238	11,330
Average amount, euros	16,318	16,798	17,020	17,119	17,297
Average retrofit, euros	18,518	19,091	19,383	19,556	20,003
Average duration, months	107	109	110	116	122
Effective interest, p.p.	0.43	0.58	0.69	0.35	0.31
Secured, share	0.30	0.32	0.31	0.30	0.31
Amount financed	0.89	0.87	0.87	0.86	0.85

Initial government target — 400,000 loans annually. Back

Appendix

Household Characteristics

Variable	# categories	Most frequent
House year of constr.	6	1949 to 1973
Age of HH head	6	$\geq$ 65 years old
Occupation (*PCS*)	7	Non-employed
Income	6	€ 27k to 32k
Dwelling type	2	House
Surface	6	100 to 149 m2
Heating main energy	4	Gas
Heating type	4	Individual non-elec.
Agglomeration	5	population $>$ 100k
Region	22	Ile-de-France

4% of income and 3% of surface data are missing $\rightarrow$ imputation with ordered logit

Appendix

Descriptive statistics

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		2008		2013	
Variable	Category	Mean	Std.Dev.	Mean	Std.Dev.
Renovate	Yes/No	0.17	0.38	0.15	0.36
Eligible	Yes/No	0.81	0.40	0.77	0.42
Construction	Before 1949	0.28	0.45	0.26	0.44
period	1949 to 1974	0.29	0.45	0.29	0.45
	1975 to 1981	0.14	0.34	0.13	0.34
	1982 to 1988	0.10	0.30	0.09	0.29
	After 1988	0.19	0.40	0.23	0.42
Appartment	Yes/No	0.25	0.43	0.26	0.44
Income	$<$ 19k €	0.22	0.42	0.20	0.40
	19k to 22.8k €	0.13	0.34	0.13	0.34
	22.8k to 27.6k €	0.15	0.36	0.12	0.33
	27.2k to 36.6k €	0.20	0.40	0.23	0.42
	36.6k to 45.6k €	0.15	0.36	0.13	0.33
	$>$ 45.6k €	0.14	0.34	0.18	0.38

Appendix

Balancing test

		Eligible (T)		Non-Eligible (C)				
Variable	Category	Mean	SD	Mean	SD	Diff	T-stat	p-value
Multi-family unit	Yes/No	0.27	0.44	0.19	0.39	0.07	4.99	0***
Agglomeration	Paris Area	0.14	0.35	0.08	0.28	0.06	5.15	0***
	Pop. $>$ 100k	0.27	0.45	0.21	0.41	0.07	4.36	0***
	Pop. 20k to 100k	0.13	0.34	0.10	0.30	0.04	3.08	0.002***
	Pop. $<$ 2k	0.17	0.38	0.22	0.41	-0.04	-3.23	0.001***
	Rural	0.28	0.45	0.39	0.49	-0.12	-7.54	0***
Age	$<$ 25 y.o.	0.01	0.08	0.00	0.04	0.00	1.61	0.107
	25 to 34 y.o.	0.07	0.26	0.17	0.37	-0.10	-9.77	0***
	35 to 44 y.o.	0.13	0.34	0.34	0.48	-0.21	-16.88	0***
	45 to 54 y.o.	0.18	0.39	0.22	0.41	-0.03	-2.28	0.022**
	55 to 64 y.o.	0.21	0.41	0.13	0.34	0.08	6.16	0***
	$>$ 65 y.o.	0.39	0.49	0.14	0.35	0.25	15.80	0***
Occupation	Agriculture	0.02	0.13	0.03	0.16	-0.01	-1.84	0.065*
	Blue-col. worker	0.12	0.33	0.26	0.44	-0.14	-11.79	0***
	Indep./Mngmnt	0.11	0.31	0.15	0.36	-0.05	-4.21	0***
	Intermediary	0.13	0.33	0.20	0.40	-0.08	-6.55	0***
	Non-employed	0.52	0.50	0.22	0.42	0.30	17.79	0***
	Trade/Entrepr.	0.04	0.19	0.04	0.19	-0.00	-0.16	0.869
	White-col. worker	0.07	0.26	0.09	0.29	-0.02	-2.13	0.034**
Income	$<$ 19k €	0.25	0.43	0.12	0.32	0.13	9.35	0***
	19k to 22.8k €	0.14	0.35	0.10	0.31	0.04	3.01	0.003***
	22.8k to 27.6k €	0.14	0.35	0.16	0.37	-0.02	-1.61	0.106
	27.2k to 36.6k €	0.19	0.40	0.23	0.42	-0.04	-2.97	0.003***
	36.6k to 45.6k €	0.14	0.35	0.20	0.40	-0.06	-5.18	0***
	$>$ 45.6k €	0.13	0.34	0.17	0.38	-0.04	-3.71	0***
Surface area	$<$ 50 sq.m.	0.04	0.19	0.03	0.17	0.01	0.97	0.332
	50 to 74 sq.m.	0.15	0.36	0.08	0.28	0.07	5.75	0***
	100 to 149 sq.m.	0.37	0.48	0.49	0.50	-0.12	-7.33	0***
	$>$ 150 sq.m.	0.18	0.38	0.17	0.38	0.01	0.70	0.484
Main heating fuel	Electricity	0.26	0.44	0.51	0.50	-0.26	-16.56	0***
	Fuel Oil	0.23	0.42	0.10	0.30	0.13	9.63	0***

Eligible and non-eligible groups very different.

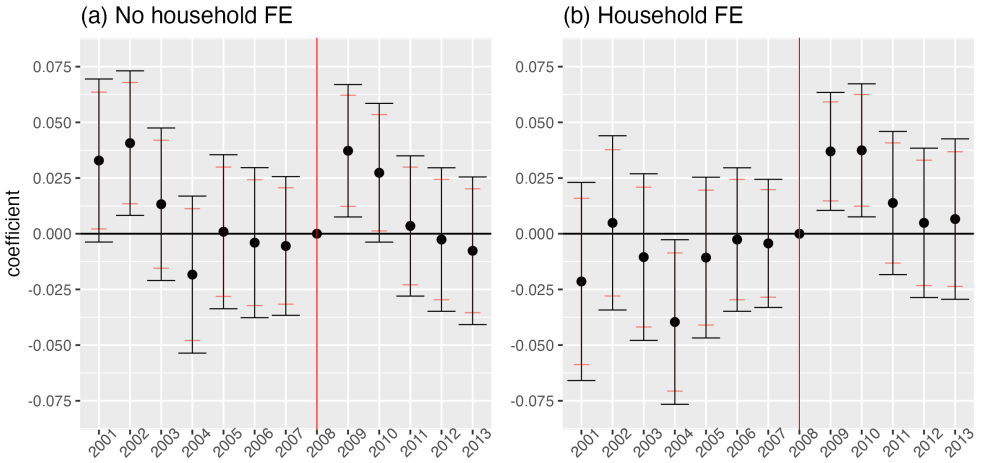
Solutions:

1. Regressions with controls
2. Propensity score weighting

◂ back

Appendix

Effects of eligibility on renovation decision, extended



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Appendix

Heterogeneity of extensive margin effect: Triple Difference and exclude old houses

Dependent Variable:	Renovation this year			
	All houses		No pre-1945 houses	
Model:	(1)	(2)	(3)	(4)
Variables				
Eligible	0.1083***	0.0095	0.0924***	0.0378
	(0.0142)	(0.0240)	(0.0149)	(0.0258)
Eligible × Post	0.0191	0.0435*	0.0255	0.0368
	(0.0226)	(0.0238)	(0.0242)	(0.0255)
Eligible × Post × Income < 19k	0.0704**	0.0616*	0.0750**	0.0773**
	(0.0330)	(0.0348)	(0.0355)	(0.0381)
Eligible × Post × Income [27.2k, 36.6k)	0.0042	-0.0184	-0.0117	-0.0181
	(0.0318)	(0.0316)	(0.0341)	(0.0346)
Eligible × Post × Income ≥ 36.6k	0.0114	0.0063	0.0127	0.0222
	(0.0294)	(0.0317)	(0.0316)	(0.0339)
Controls	Yes	Yes	Yes	Yes
Fixed-effects				
Year	Yes	Yes	Yes	Yes
Household		Yes		Yes
Fit statistics				
Observations	28,767	28,767	21,374	21,374
R^2	0.04440	0.50804	0.04187	0.50074
Within R^2	0.04249	0.13159	0.03986	0.11830

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Heterogeneous effects by income of professional renovations

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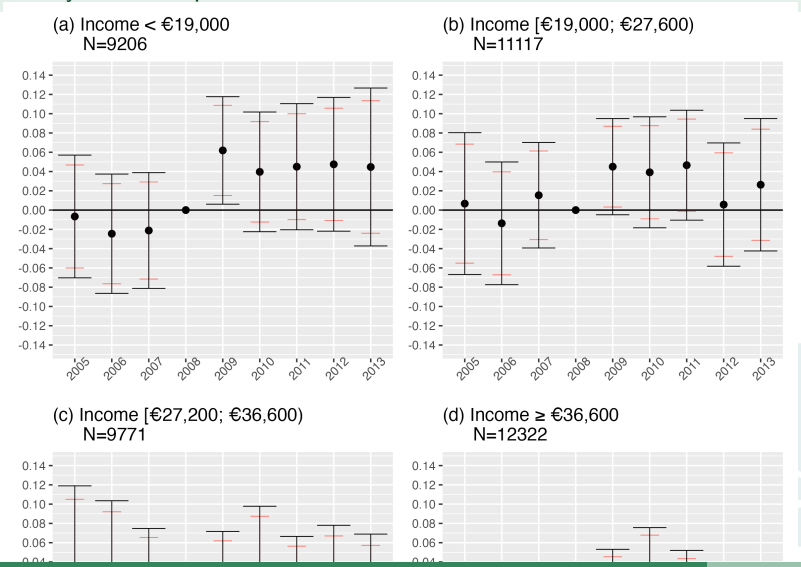
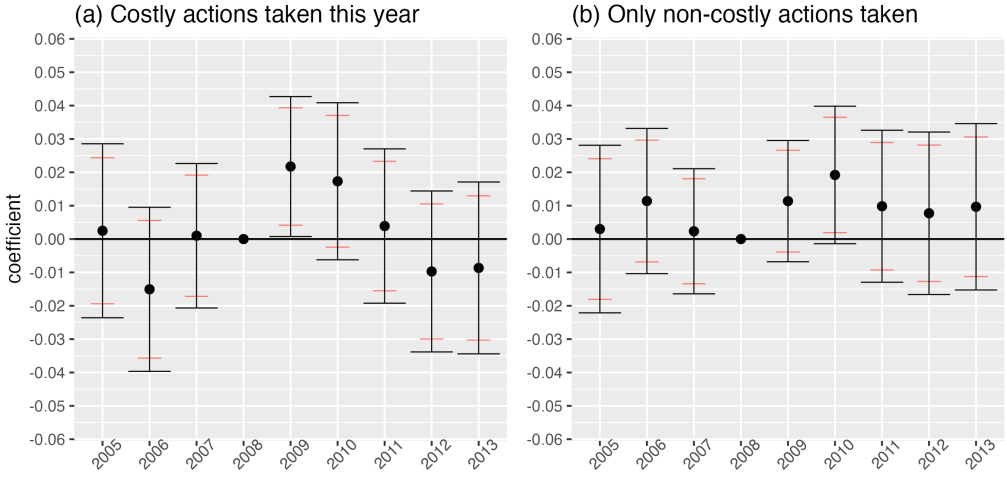


Appendix

Intensive margin: costly actions



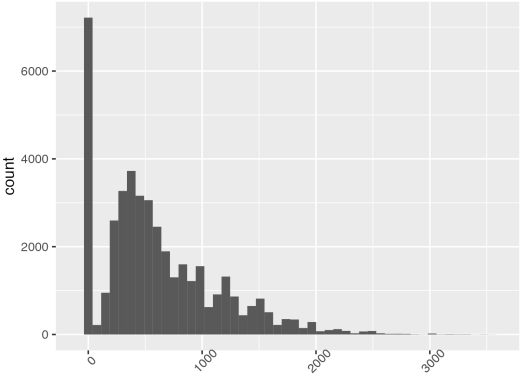
Appendix

Energy consumption data

1. Survey question: yearly spending (€) on a given energy source
2. Convert € to kWh with Pegase&Enerdata energy price data

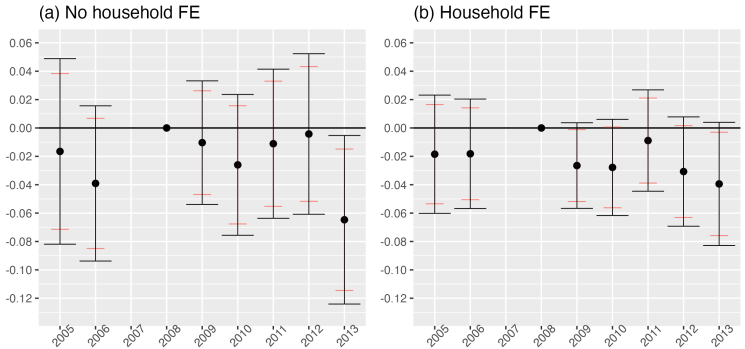
Issues:

- Data quality: many obs with 0 spending
- Worst quality in 2007 (especially



Appendix

Impact on self-reported electricity consumption



No significant effect. Why?

- Low statistical power: Half the sample
- Only 31% of households use electricity for heating

Results

Income heterogeneity on electricity consumption

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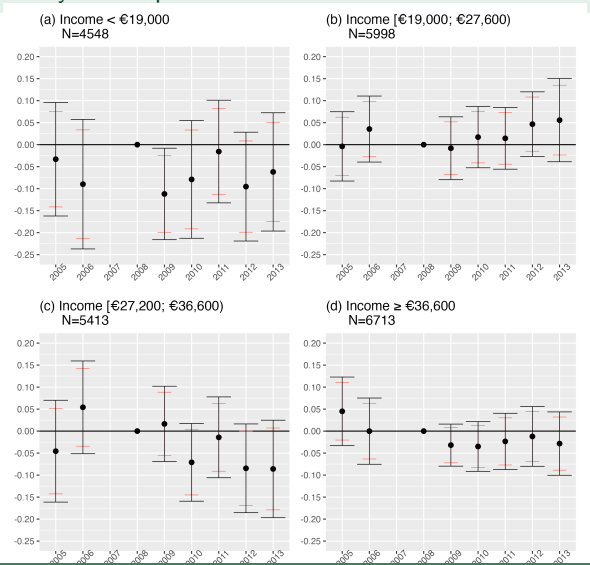

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Leverage Diagram

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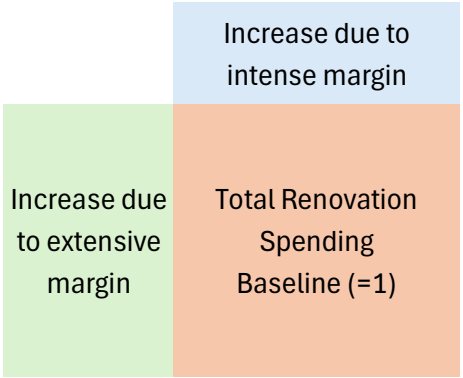

$$\frac{\text{additional spending €}}{\text{baseline spending 2008 €}} = \frac{125€}{3800€} = 3.3\%$$

$$\frac{\text{increase in proba to renovate (pp)}}{\text{baseline proba to renovate}} = \frac{3pp}{15} = 20\%$$

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Placebo eligibility

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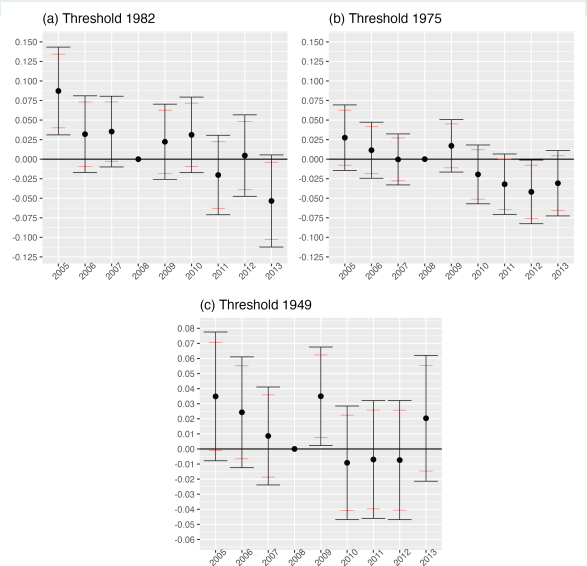
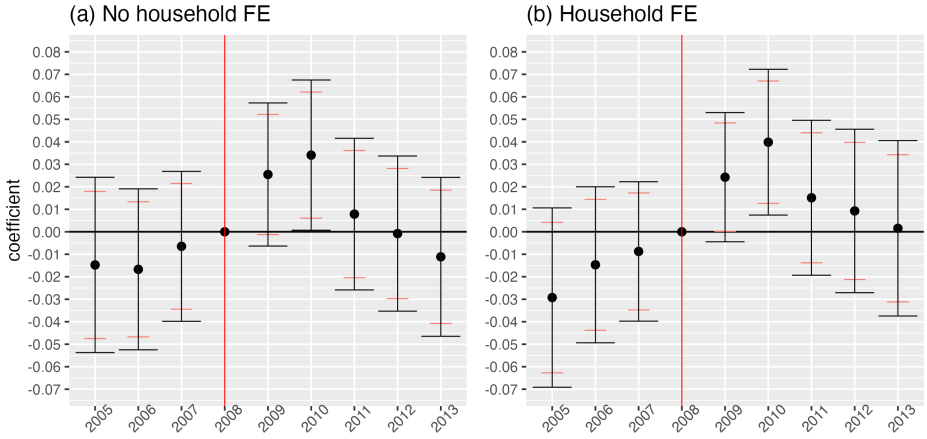


Appendix

Subsample without pre-1949 houses



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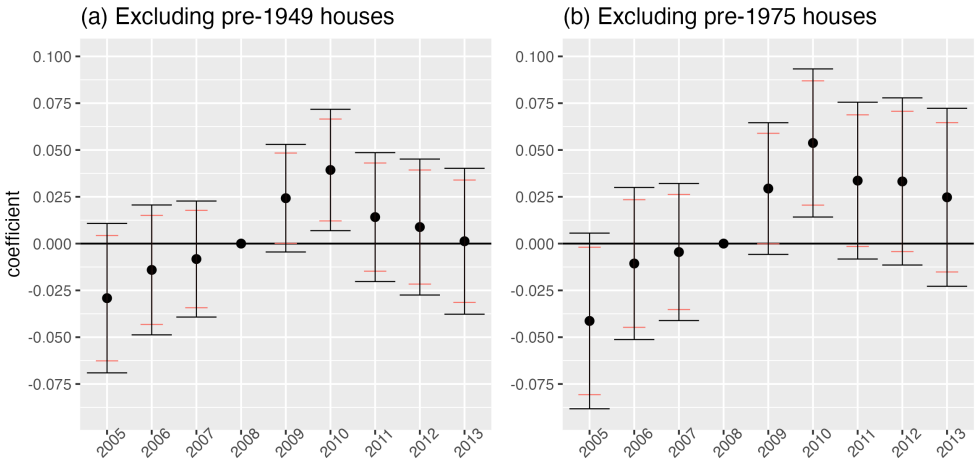
Appendix

Effects of eligibility on renovation decision, excluding oldest houses



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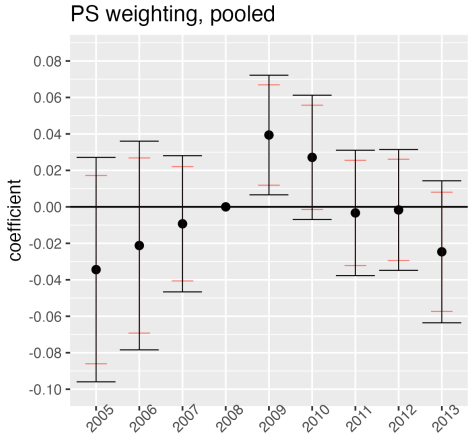
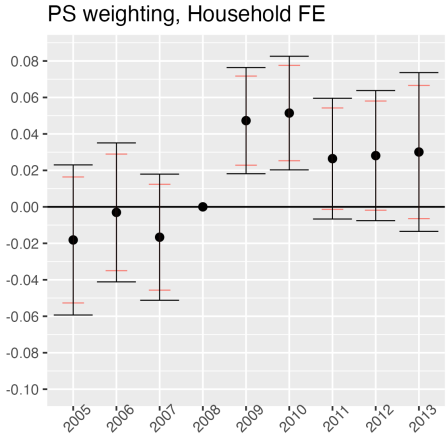
Appendix

Probability to renovate – Event Study with PS weighting





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Attrition Test

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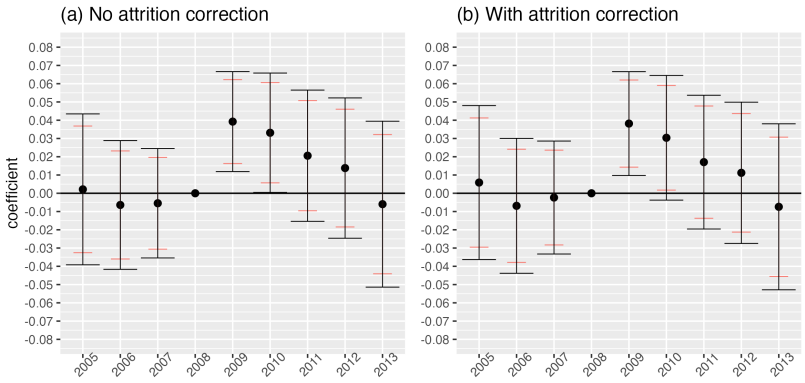
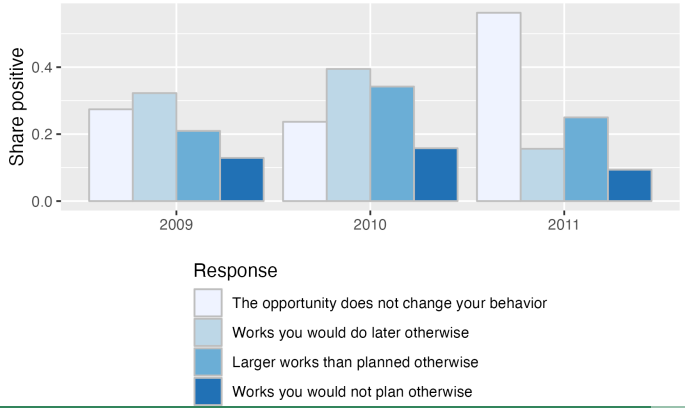
- Following Wooldrige (2010), we focus on 2008 cohort and identify *Xs* that explain probability to remain in sample to build a propensity score
- We weight regressions by this PS



Survey questions to ZIGL users on their motivations

- Acceleration of already planned renovations? Yes (second lightest blue)
- Newly created demand for renovations? Yes (darkest blue)



Appendix

Debt aversion and financial distress

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Survey questions on reasons why not to take a ZIGL and financial distress

- No remarkable change in trend in 2011