How do lenders price energy-efficiency loans? Evidence from consumer credit in France

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Home Energy Retrofits, e.g., France

- Major potential for energy savings
  - Building sector: 40% final energy use, 25% CO_2 emissions
  - Low stock turnover (1%/yr) → energy retrofit is crucial
  - French target: 500,000 annual home retrofits

- Financing issue
  - Average investment cost: 9,978€ [5,500€-25,500€]
  - 20-40% of retrofits involve credit (75% in automobile)
  - Resulting annual borrowing needs: 1-2 billion euros

For retrofits to deliver,
it is important that credit markets function well

What's the Efficient Price of Energy Retrofit Loans?

$$IR_{energy\ efficiency} < IR_{conventional}$$

Unless energy efficiency fails to deliver due to **information asymmetries** (Fowlie et al., 2015; Giraudet et al., 2018)

$$IR_{retrofit} = IR_{automobile}$$

Unless project used as a **screening device** of unobservable borrowers' characteristics.

Assuming retrofit borrower are more likely to be homeowners, hence wealthier, the effect is ambiguous:

$IR_{retrofit} > IR_{automobile}$ ⇒ *Higher WTP prevails (assuming away collateral)*

$IR_{retrofit} < IR_{automobile}$ ⇒ *Lower risk prevails*

Empirical Tests of Efficient Pricing

- Kaza et al. (Cityscape, 2014)
  - Residential mortgages in the US
  - ENERGY STAR buildings associated with lower default and prepayment rates

- An and Pivo (Real Estate Econ., 2018)
  - Commercial mortgages in the US
  - Same finding + better loan terms when buildings certified at loan origination

- **Together suggest efficient pricing, BUT…**
  - Selection issue: no control for borrower characteristics
  - One source of variation only: green versus non-green
  - Plus: focus on new constructions, relatively less important for CO_2

Our Approach

- We test for efficient pricing using **two** sources of variation in **unsecured** consumer credit
- We use a novel dataset of **posted** interest rates that is immune from **sorting bias**

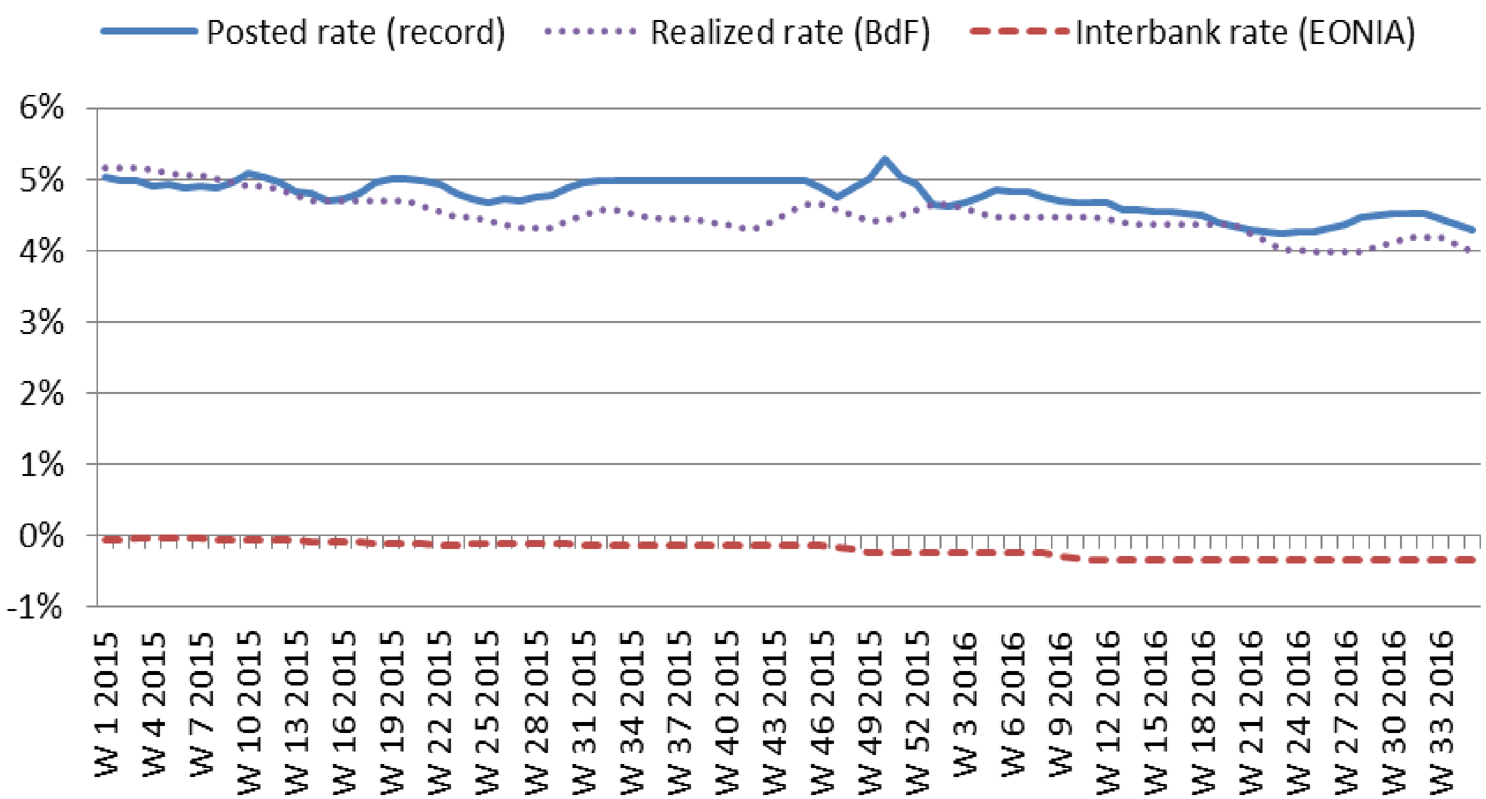
➢ *We find evidence of* ***inefficient*** *pricing*
  - *Worse terms for retrofits than for autos*
  - *Even worse terms for green than conventional retrofits*
  - *Results are robust but vary over the sample period*

A Panel of Scraped Data on Unsecured Credit

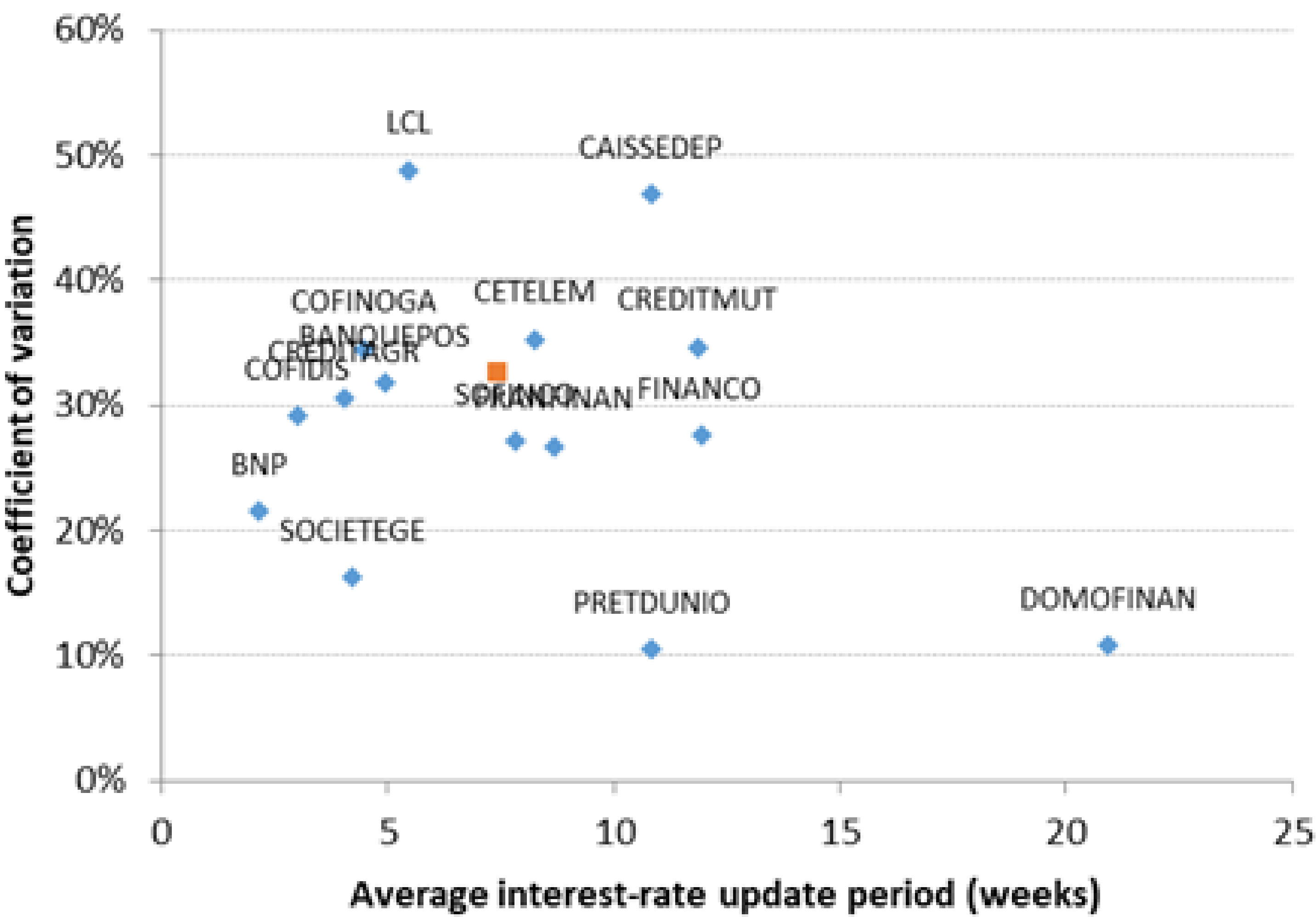
interest rate
=
*f(amount, maturity, **category**)*

- **240,962 simulations** (a.k.a. observations)
  - 15 credit institutions surveyed, covering near totality of the market
  - Data retrieved every week, for 2015-2016 (93 weeks)
  - For each week-institution-category tuple, 11*8 = 88 simulations
- Crucially: **no credit score** or other borrower characteristics queried

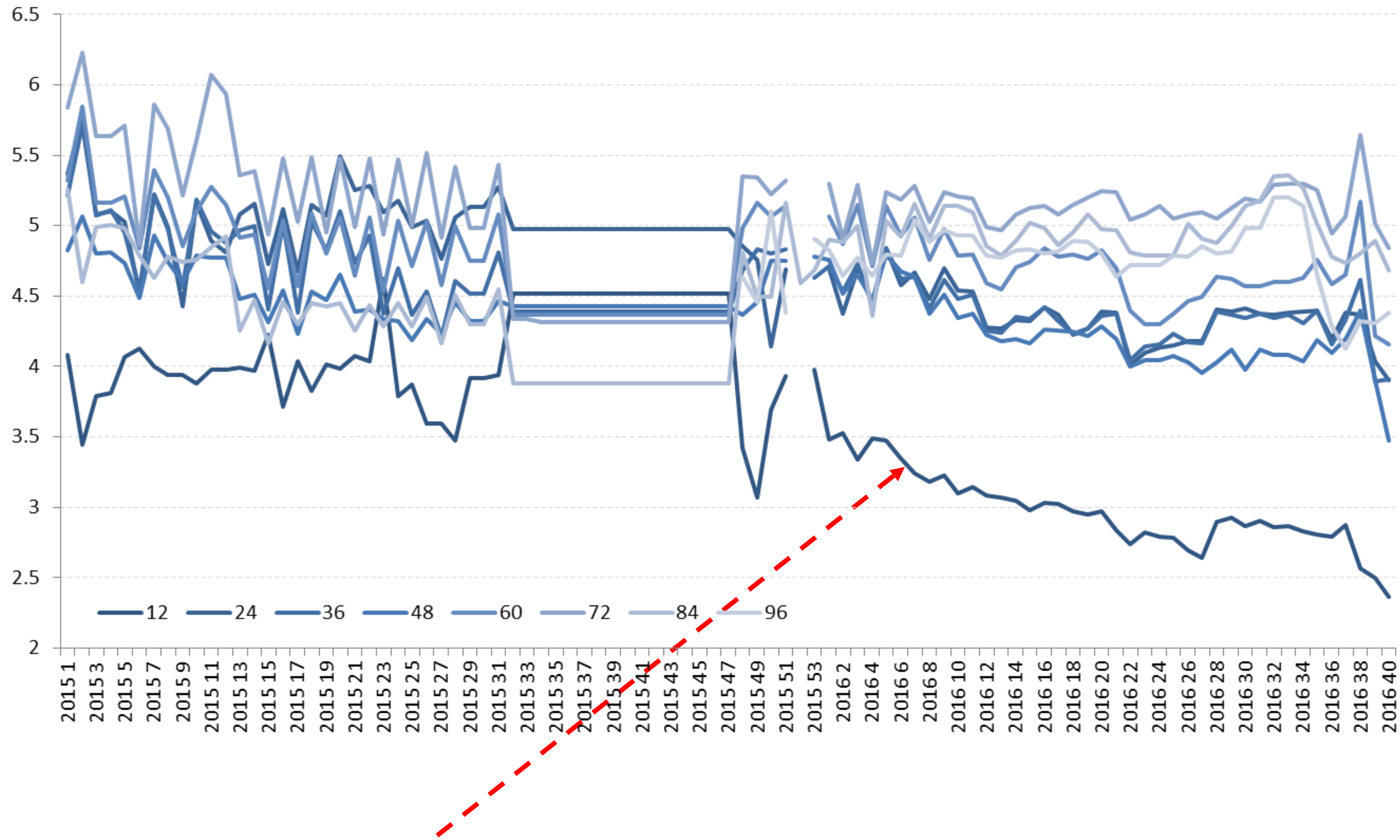
External Validity: Posted vs. Realized Rates



Price Dispersion in Time and Space



Time Series, by Maturity



12-month loans substantially cheaper from early 2016 on

Effect coincides with an increase in deposits of 154 billion euro between 2015 and 2016 (ACPR annual report, 2016). Role of Quantitative Easing?

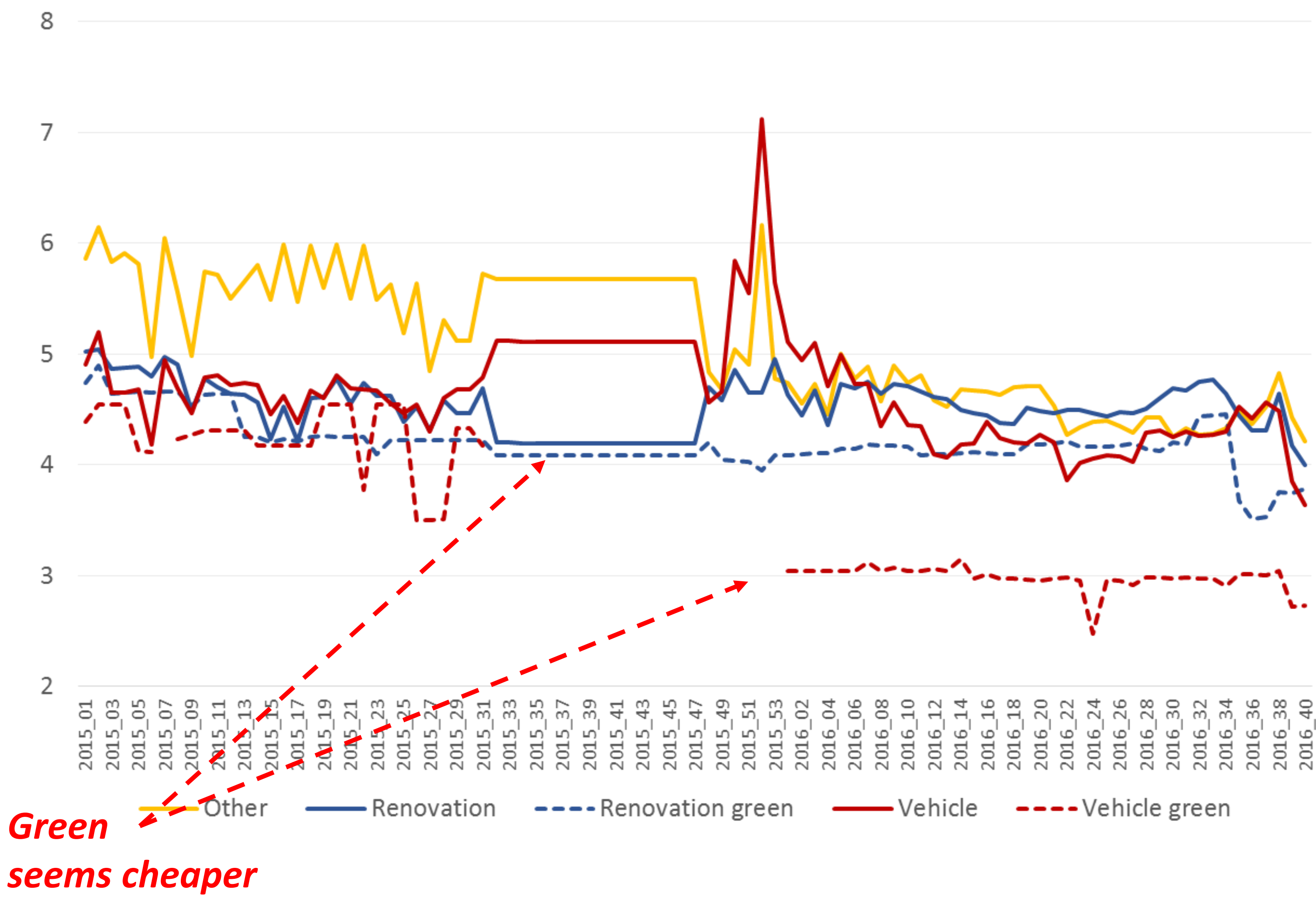
Categorization of Loan Purposes

Collected entries (90)	Categorization 1	Categorization 2	Categorization 3
Car, motorcycle	**Conventional**	**Vehicle**	**Vehicle**
Used car, used vehicle, used boat, used camping car, used trailer, used motorcycle	**Conventional**	**Vehicle**	**Vehicle**
Brand new vehicle, Brand new car, Brand new or less than 2-year-old car, brand new or less than 2-year-old camping car, brand new or less than 2-year-old trailer, brand new or less than 2-year-old motorcycle	**Conventional**	**Vehicle**	**Vehicle**
Brand new efficient car	**Green**	**Vehicle**	**Vehicle_efficient**
Other works, decoration, construction, veranda, indoor/outdoor design	**Conventional**	**Renovation**	**Renovation**
Boiler, wood boiler, electrical heating, water heating, windows, insulation, heat pumps, heating, home improvement	**Green**	**Renovation**	**Renovation_efficient**
Other project, consumption, relocation, wedding, birth, DIY supplies, holidays, event, leisure	**Conventional**	**Other**	**Other**
Health, Family problems	**Conventional**	**Other**	**Other**
Need for money, Need for cash, budget	**Conventional**	**Other**	**Other**
Student loan	**Conventional**	**Other**	**Other**
Electronic device, appliances, Hi-fi, furniture, computer accessories	**Conventional**	**Other**	**Other**

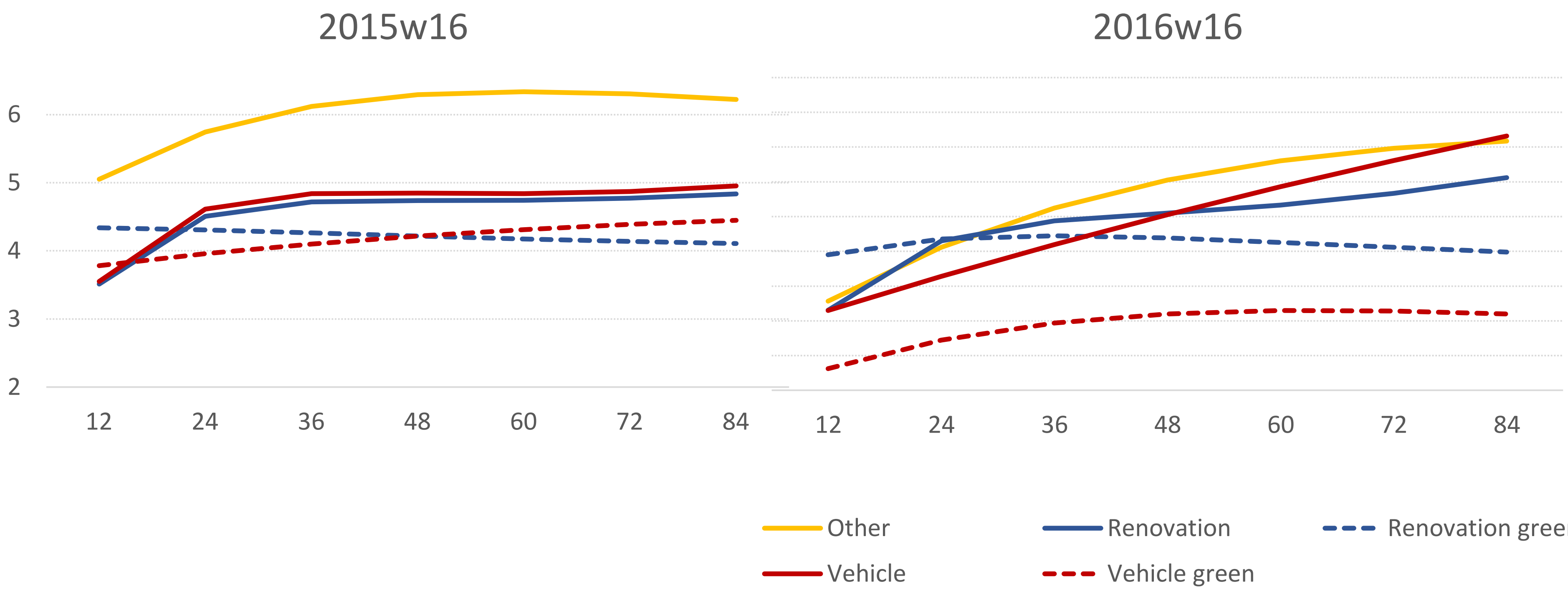
Out of 15 credit institutions…

- 11 distinguish between renovation and vehicle
- 4 distinguish between green and conventional renovation
- 1 distinguishes between green and conventional autos

Time Series, by Purpose



Yield Curves (rate vs. maturity)



Simplest Econometric Model

l: lender
c: category
y: yield
t: time

$$s_{lyct} = \beta_0 + \beta_1 L_y + \beta_2 P_c + \underbrace{\gamma_l + \gamma_l \cdot \mu_t}_{\text{FE capturing conjuncture and variation by institution (Khwaja \& Mian, 2008)}} + \varepsilon_{lyct}$$

Interest rate minus gvt bond of same maturity

Loan characteristics

Project dummy

FE capturing conjuncture and variation by institution (Khwaja & Mian, 2008)

Efficient pricing hypotheses

- H1: ${\beta_2}^{green} \leq {\beta_2}^{conventional}$
- H2: ${\beta_2}^{retrofit} = {\beta_2}^{automobile}$

Estimation Results

Dependent variable	Model 1	Model 2	Model 3
spread	Two categories	Three categories	Five categories
_cons	4.455***	4.576***	4.574***
	(46.23)	(47.50)	(47.51)
duration	0.0384***	0.0382***	0.0382***
	(93.15)	(92.87)	(92.76)
duration2	-0.000261***	-0.000259***	-0.000258***
	(-64.06)	(-63.34)	(-63.11)
amount	-0.0249***	-0.0249***	-0.0249***
	(-74.05)	(-74.24)	(-74.16)
cst_GREEN	-0.00731		
	(-0.96)		
Retrofit		-0.122***	-0.136***
		(-16.65)	(-17.88)
Vehicle		-0.172***	-0.162***
		(-26.43)	(-24.78)
Retrofit green			-0.0842***
			(-8.68)
Vehicle green			-0.588***
			(-22.89)
Institution dummy	YES	YES	YES
Institution dummy x Time dummy	YES	YES	YES
N	240962	240962	240962
R-sq	0.386	0.388	0.389
R-sq adj	0.384	0.386	0.386

t-statistics in parentheses

* p<0.05, ** p<0.01, *** p<0.001

(Small) green premium

Screening?

Green discoun

Estimation on Year Subsamples

Dependent variable	Two categories		Three categories		Five categories	
spread	2015	2016	2015	2016	2015	2016
_cons	5.035***	5.799***	5.448***	5.851***	5.448***	5.843***
	(54.67)	(25.06)	(59.67)	(25.29)	(59.72)	(25.29)
duration	0.0253***	0.0492***	0.0246***	0.0496***	0.0247***	0.0493***
	(31.67)	(101.21)	(31.21)	(102.00)	(31.44)	(101.57)
duration2	-0.000247***	-0.000330***	-0.000236***	-0.000334***	-0.000238***	-0.000331***
	(-28.79)	(-70.20)	(-27.89)	(-71.04)	(-28.11)	(-70.42)
amount	-0.0307***	-0.0240***	-0.0299***	-0.0240***	-0.0299***	-0.0239***
	(-33.67)	(-66.31)	(-33.27)	(-66.41)	(-33.29)	(-66.29)
cst_GREEN	0.0681***	-0.0467***				
	(5.47)	(-4.96)				
Retrofit			-0.593***	0.0147	-0.616***	0.0146
			(-42.81)	(1.72)	(-43.89)	(1.63)
Vehicle			-0.505***	-0.105***	-0.501***	-0.0885***
			(-39.13)	(-14.07)	(-38.69)	(-11.78)
Retrofit green					-0.481***	0.000613
					(-26.89)	(0.05)
Vehicle green					-0.426***	-0.866***
					(-11.63)	(-25.11)
Institution dummy	YES	YES	YES	YES	YES	YES
Institution dummy x Time du	YES	YES	YES	YES	YES	YES
N	69695	171267	69695	171267	69695	171267
R-sq	0.448	0.380	0.464	0.381	0.464	0.383
R-sq adj	0.444	0.378	0.460	0.379	0.460	0.381

t-statistics in parentheses
* p<0.05, ** p<0.01, *** p<0.001

twist

Robustness: Control Variables

*Instead of using lender*time dummies, we control for*

- *macro factors*
- *financial factors*

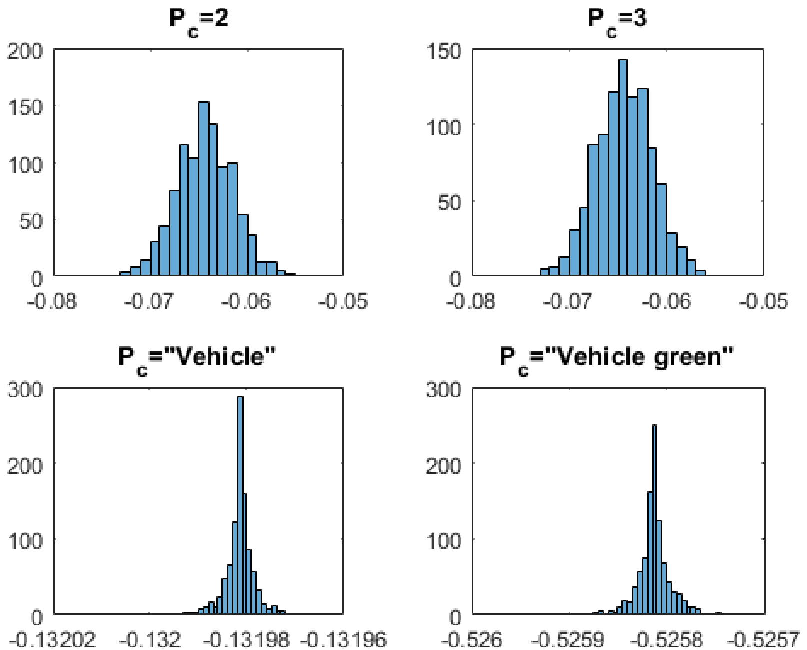
Dependent variable	Model				
Spread APY	(1)	(2)	(3)	(4)	(5)
intercept	4.449***	3.757***	4.305***	4.029***	1.612***
	(28.34)	(24.33)	(29.63)	(28.67)	(7.83)
Loan characteristics					
duration	0.100***	0.0985***	0.102***	0.102***	0.103***
	(68.68)	(69.00)	(81.34)	(86.67)	(87.01)
duration^2	-0.002***	-0.002***	-0.002***	-0.002***	-0.002***
	(-50.16)	(-51.36)	(-63.24)	(-67.60)	(-67.97)
duration^3	0.000***	0.000***	0.000***	0.000***	0.000***
	(39.03)	(41.88)	(54.35)	(58.18)	(58.57)
amount	-0.020***	-0.020***	-0.025***	-0.025***	-0.025***
	(-50.70)	(-52.52)	(-74.11)	(-77.62)	(-77.26)
Macroeconomic factors					
ir_1y	-0.343***	-0.155***	-0.219***	-0.266***	-0.380***
	(-14.53)	(-6.68)	(-10.48)	(-13.47)	(-16.63)
hicp	-0.234***	-0.241***	-0.201***	-0.203***	-0.229***
	(-43.02)	(-45.29)	(-42.51)	(-45.91)	(-45.09)
u	-0.082***	-0.002	-0.069***	-0.030*	-0.027*
	(-5.79)	(-0.17)	(-5.43)	(-2.52)	(-2.25)
Financial factors					
CAC40_spread	0.022	0.096***	0.103***	0.092***	0.079***
	(1.78)	(8.05)	(9.64)	(9.17)	(7.75)
ciss_stress	-2.918***	-3.069***	-1.599***	-1.314***	-1.075***
	(-12.80)	(-13.75)	(-8.11)	(-7.11)	(-5.75)
yc_slope	-0.388***	-0.413***	-0.407***	-0.417***	-0.406***
	(-21.74)	(-23.61)	(-26.38)	(-28.78)	(-28.03)
Indicator variables					
loan type		X	X	X	X
lender			X	X	X
loan type*lender				X	X
loan type*fuel price (S95)					X
time dummy					
N	240962	240962	240962	240962	240962
R-sq	0.083	0.121	0.321	0.404	0.405
R-sq adj.	0.083	0.121	0.321	0.404	0.405

t-statistics in parentheses
p<0.1, **p<0.01, ***p<0.001

Previously obtained results continue to hold

Robustness: Placebo tests on Renovation

After 1000 tests



H0: $\beta_1^{Renovation1} = \beta_1^{Renovation2}$

H1: $\beta_1^{Renovation1} \neq \beta_1^{Renovation2}$

F(1,239939)	0.16
Prob>F	0.6901
H0 not rejected	

H0: $\beta_1^{Renovation} = \beta_1^{Renovation_{g}reen}$

H1: $\beta_1^{Renovation} \neq \beta_1^{Renovation_{g}reen}$

F(1,239939)	17.74
Prob>F	0.0000
H0 rejected	

H0: $\beta_1^{Renovation} =$ -0,06 & $\beta_1^{Renovation_{g}reen} =$ -0,06

H1: $\beta_1^{Renovation} \neq -0,06 \& \beta_1^{Renovation_{g}reen} \neq -0,06$

F(1,239939)	9.03
Prob>F	0.0001
H0 rejected	

CONCLUSION: Efficient loan pricing? Not quite.

$$IR_{energy\ efficiency} < IR_{conventional}\ ???$$

- **Yes** for automobiles (1 bank)
- **No** for retrofits (4 banks)

$$IR_{retrofit} = IR_{automobile}???$$

- **No.** Automobile overall cheaper, though not initially (11 banks)

$\Rightarrow$ Interacting the two effects:
Energy-retrofit loans subject to ***double energy-efficiency gap****???*

Further research

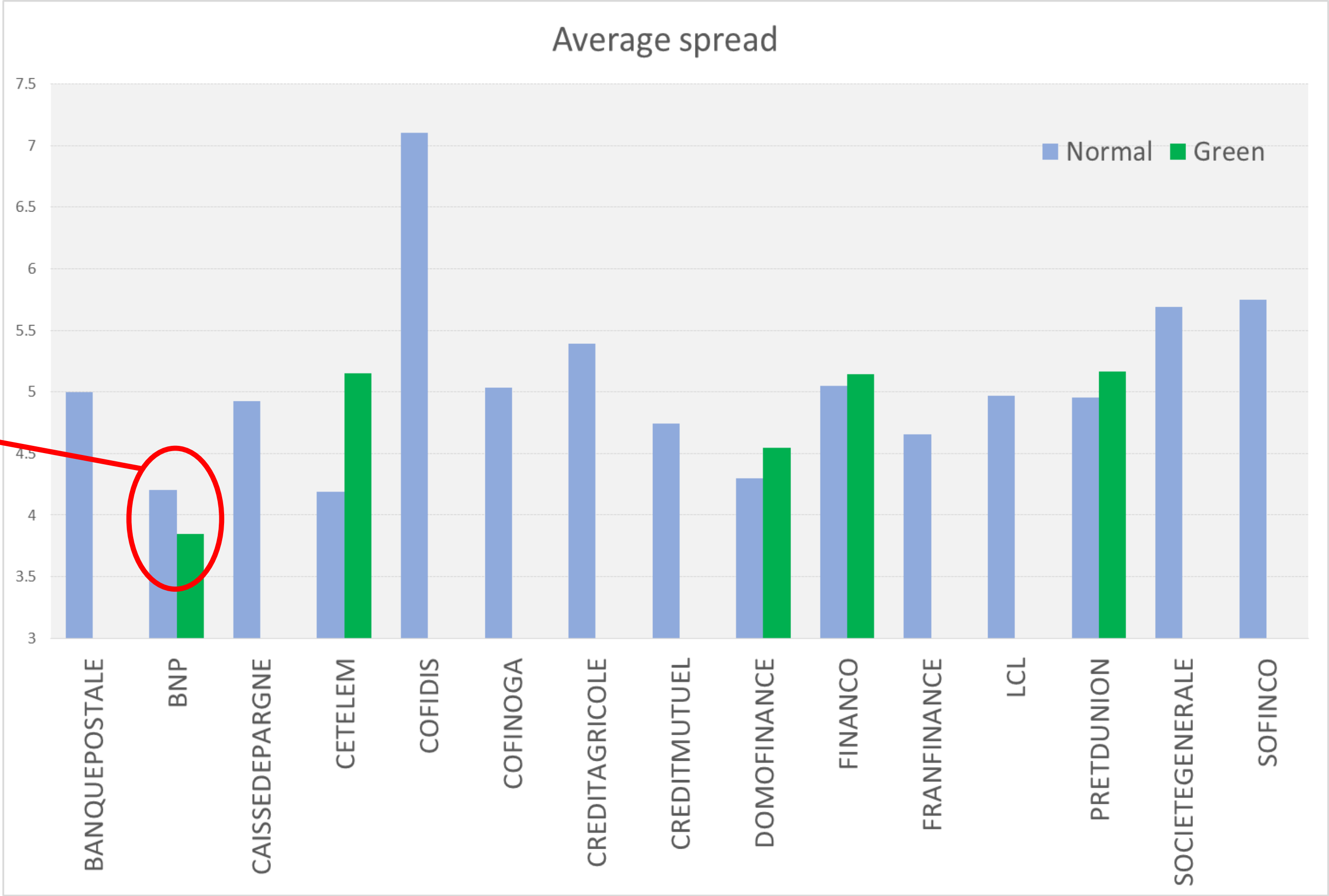
- Extensions
  - 12-month puzzle needs further investigation
  - Control for lending institutions’ characteristics
  - A theory of project-based discrimination in loan pricing
- Policy implications
  - Public cost of zero-interest loans inflated?
  - Linked credit: e.g., Domofinance (Iossa and Palumbo, 2004)

APPENDIX

Type of institution	**Institution**	Group
Public bank	**La Banque postale**	La Banque postale
Private banks	**BNP Paribas**	BNP Paribas
	LCL	Groupe Crédit agricole
	Société générale	Société générale
Cooperative banks	**Crédit agricole**	Groupe Crédit agricole
	Caisse d'épargne	Groupe BPCE
	Crédit mutuel	Groupe Crédit mutuel
Credit finance establishments	**Cofinoga**	BNP Paribas
	Cofidis	Groupe Crédit mutuel
	Prêt d'union	Groupe Crédit mutuel
	Domofinance	BNP Paribas
	Franfinance	Société générale
	Financo	Groupe Crédit mutuel
	Cetelem	BNP Paribas
	Sofinco	Groupe Crédit agricole

Cross-section, by Bank*Purpose

Green only cheaper for autos



Tests

Dependent variable spread	Model 1	Model 2	Model 3
	Two categories	Three categories	Five categories
H1: Green premium	**H1 rejected**		**H1 not rejected**
H1°: b_green= b_conv	H1° not rejected	n/a	H1° rejected
	t=-0.13		F=317.47
H2: Loan type as screening device		**H2 not rejected**	**H2 not rejected**
H2°: b_renov=b_auto		H2° rejected	H2° rejected
		F=192.71	F=511.58

F correspond to the F-statistics of the Wald test for the corresponding null

Role of Energy Prices

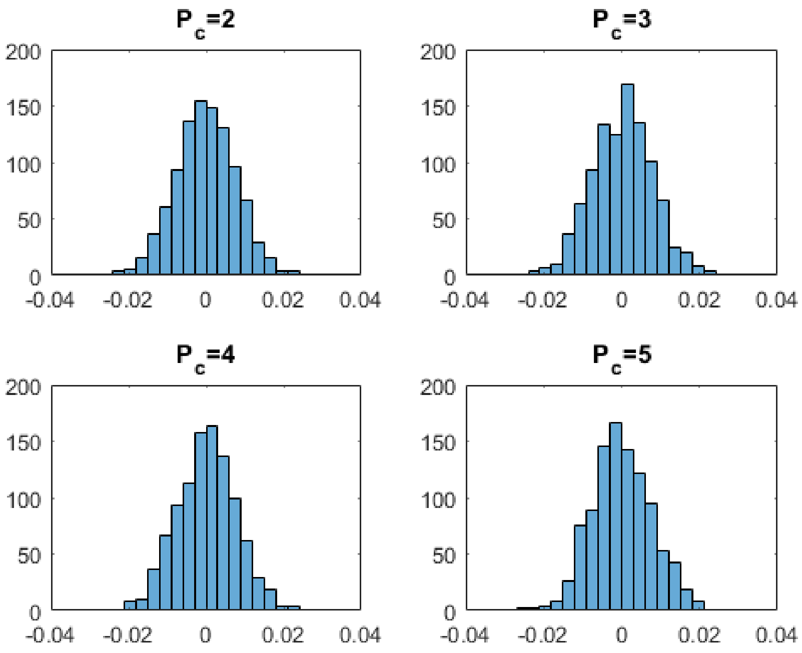
Dependent variable	Energy price (EP)		
spread	S95	Electricity	Crude oil futures
Other*EP	0.615***	-1.622***	-0,000327
Renovation*EP	-0.560***	1.324***	0,000134
Renovation_green*EP	-0.357***	0.401***	-0,000412
Vehicle*EP	-0.383***	-0.226**	0.000615**
Vehicle_green*EP	1.643***	-3.245***	0,000271
Institution dummies	X	X	X
Institution dummies*time dummies	X	X	X
N	240803	240803	240803
R-sq	0,32	0,32	0,32
R-sq adj	0,32	0,32	0,32

* p<0.05, ** p<0.01, *** p<0.001

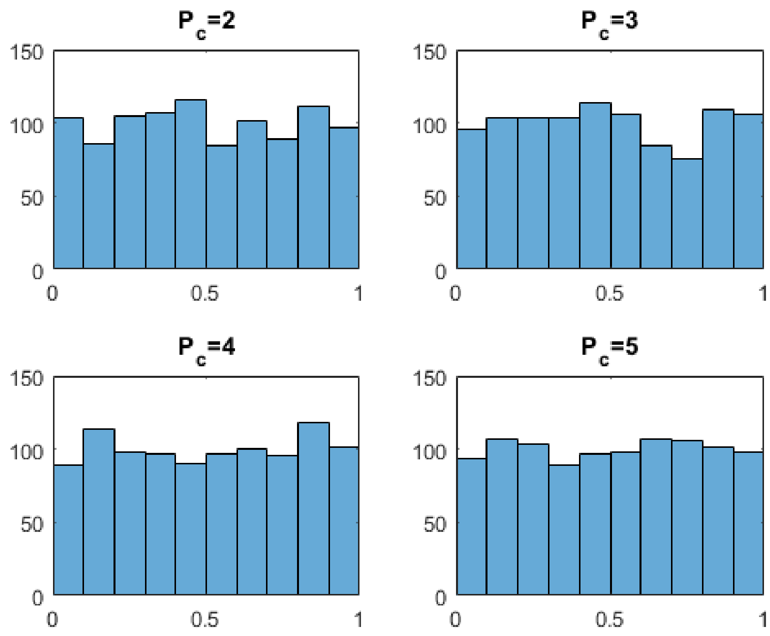
Price discrimination?

Robustness: Placebo tests on All Categories

After 1000 tests



Distribution of estimated dummy coefficients



Distribution of p-values of the estimated dummy coefficients