Picking Up the PACE:
Loans for Residential Climate-Proofing

Aymeric Bellon   Cameron LaPoint   Francesco Mazzola   Guosong Xu

UNC-Chapel Hill   Yale SOM   ESCP Europe   Erasmus RSM

Emory University

Goizueta Business School

November 15th, 2024

How to accelerate green transition of housing?

- Greater investments are necessary for climate change **mitigation** ⟿ IEA Report
  - ▸ Homes accounted for 16% of global energy-related emissions in 2022 (IEA, 2023)
  - ▸ Total global investment in mitigation alone is currently $28.7 bil./year for RE ⟿ CPI report
  - ▸ Yet, $827.1 bil./year needed to reach net zero emissions by 2050 (CPI, 2023)

- Greater investments also necessary for climate change **adaptation** (World Bank 2016)
  - ▸ 1 in every 10 homes in the US was impacted by natural hazards in 2021 (CoreLogic 2022)
  - ▸ Insurance markets unraveling in areas exposed to many climate risks (e.g. Florida)
  - ▸ Cities' losses from natural disasters could cost an estimated $314 billion annually by 2030

- **In practice, green home improvements (HIs) can help on both margins** ⟶
  impact-resistant windows offer better insulation <u>and</u> storm protection ⟿ DP ratings

REAL EFFECTS OF UNRAVELING HOME INSURANCE MARKETS

Homeowners Policies Surging in Florida
Average homeowners insurance rates in Florida have tripled this decade

■ Florida premiums ■ US premiums

2023
■ $6.0K
■ $1.7K

$6K
5
4
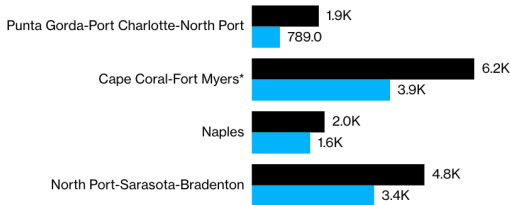3
2
1

2018 2019 2020 2021 2022 2023
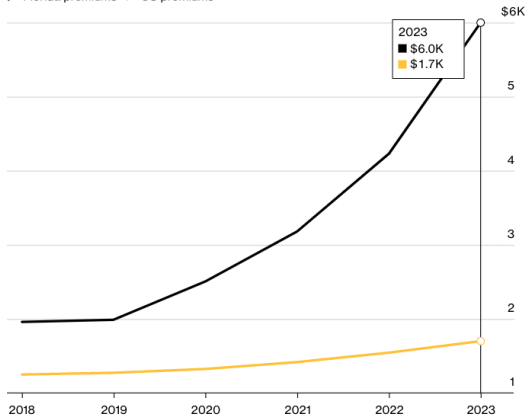
Source: Insurance Information Institute

Surge in Existing Homes for Sale
Southwest Florida is seeing a spike in active listings of single-family homes

■ December 2023 listings ■ December 2022 listings

Punta Gorda-Port Charlotte-North Port — 1.9K / 789.0

Cape Coral-Fort Myers* — 6.2K / 3.9K

Naples — 2.0K / 1.6K

North Port-Sarasota-Bradenton — 4.8K / 3.4K

Source: Realtor Association of Sarasota and Manatee; Royal Palm Coast Realtor Association; Naples Area Board of Realtors; Realtors of Punta Gorda-Port Charlotte-North Port-DeSoto Inc.
Note: Cape Coral-Fort Myers data are for Jan. 2023-Jan. 2024

Source: *Bloomberg*, "In Southwest Florida, High Home Insurance Rates Are Driving Away Would-Be Buyers," February 14, 2024.

⊕ Storm projections   ⊳ Map   ⊳ Result

How to accelerate green transition of housing?

- Greater investments are necessary for climate change **mitigation**

- Greater investments are necessary for climate change **adaptation**

We study a new class of loans designed to help close these investment gaps

- **Residential Property Assessed Clean Energy (PACE) loans**
- Key innovation: borrowers pay off debt through local property tax bill
- Solves lack of private credit provision for NPV > 0 projects due to transaction costs + inability to force borrowers to commit to green HIs ⟫ Market failures

Increase in risk: Lax screening and potential predatory lending practices. Breaches the priority of traditional mortgages (**super seniority**).

Efficiency: Allows financially constrained households to invest in (**green**) projects that increase their home equity value.

- Ultimately an empirical question which force dominates!

SUMMARY OF OUR EMPIRICAL FINDINGS

❶ Households that appear **ex ante financially constrained** more likely to use PACE loans

- ▶ PACE HHs have lower income and wealth, and reside in properties which are smaller, older, and have lower assessed values than HELOC HHs

❷ Florida PACE loans finance projects that **significantly increase the home's value**

- ▶ PACE properties with climate-proof HIs experience a 20% appreciation in sales price
- ▶ Smaller pricing ATTs in full sample or pre-COVID period, driven by window/door installs

❸ **PACE loans significantly increase property tax delinquency rates**

- ▶ Ever-delinquent rate 1 p.p. ↑ (20% ↑) within a year of origination, relative to comparable HELOC borrowers ⟶ effect grows over repayment term despite fixed payment amount

❹ **We find no evidence of crowdout in traditional mortgage lending**

- ▶ Exploit staggered adoption of PACE across counties: 1-2 p.p. ↑ approval rate for both first lien home purchase and refinance loans

PACE EXPANDS NET FISCAL POSITION OF LOCAL GOVT.

- Simple back-of-envelope calculation combining our DiD estimates (ATT effects)

$$\Delta R_{t,t+1} = \underbrace{\tau_{t+1}}_{\text{effective tax rate}} \times (\ \underbrace{\Delta P_{t,t+1}}_{\text{capitalization effect}} \ - \ \underbrace{\Delta D_{t,t+1} \cdot P_t}_{\text{revenue lost from delinquency}}\ )$$

- Even after netting out delinquencies, **revenues grow by \$300 to \$600 per PACE loan-year** in counties participating in program

- Lower-bound estimate of the increase in revenue from PACE adoption because...

  - Assumes 100% of the delinquency costs are borne by local govt.

    - Municipal bond investors bear some of incidence when coupons backed by PACE payments

  - Ignores spillover effects on local employment (e.g. through contractors) or investment spending (e.g. through peer effects) $\longrightarrow$ follow up paper on California PACE

CONTRIBUTIONS & RELATED LITERATURE

❶ Effects of climate adaptation on property/mortgage markets

Eichholtz et al. (2010); Goodman & Zhu (2016); Issler et al. (2020); Jaffee et al. (2019); Keys & Mulder (2020,24); Rose & Wei (2019,20); Baldauf et al. (2020); Giglio et al. (2021); Ouazad & Kahn (2022); Sastry et al. (2024); Millar & White (2024); Gillingham & Watten (2024); Collier & Ellis (2024)

→ First cost-benefit analysis of PACE using comprehensive microdata

❷ Green investment gap

Fowlie et al. (2015,18); Levinson (2016); Houde & Aldy (2017); Gerarden et al. (2017); Hahn & Metcalfe (2021); Berkouwer & Dean (2022); Myers et al. (2022); Clara et al. (2022); Lu & Spaenjers (2023)

→ Highlight the role of households' financial constraints in developed countries

❸ Green financial contracts

Zerbib (2019); Tang & Zhang (2020); Flammer (2021); Baker et al. (2022); Kim et al. (2022); Lanteri & Rampini (2023) → We study a new type of local govt.-backed lending product

❹ Corporate environmental liens

Bellon (2021); Akey & Appel (2021); Ohlrogge (2022); Chen (2022)

→ We study environmental liens linked to households

Institutional Background on PACE Programs
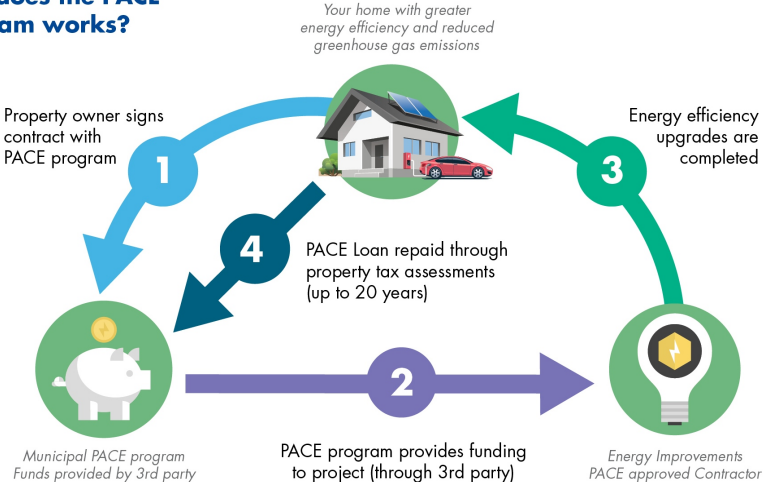
Legal background on PACE contracts

> **Property Assessed Clean Energy (PACE) Program**
>
> Loans for <u>qualified</u> energy efficient and climate-proofing home improvement projects where borrowers pay back debt through annual local <u>property tax bill</u>.

- Qualified uses are fairly expansive: solar panels, HVAC upgrade, **(re)roofing, impact-resistant windows/doors,** generator, water conservation, etc. ⟿ DP vs. U-Factor

- Local govt. as the loan servicer means that lien on the property is *super senior* to all other forms of debt $\implies$ dominates mortgage lender or bankruptcy claims (LaPoint 2023)

- In practice, a public-private partnership: local govt. issues bonds backed by tax payments and outsources underwriting to private lenders ("administrators")

  - ▶ Municipal backing keeps fixed interest rate low relative to other consumer debt ⟿ Rates

HOW PACE WORKS IN PRACTICE

How does the PACE program works?

Your home with greater energy efficiency and reduced greenhouse gas emissions

Property owner signs contract with PACE program

1

Energy efficiency upgrades are completed

3

4

PACE Loan repaid through property tax assessments (up to 20 years)

Municipal PACE program Funds provided by 3rd party

2

PACE program provides funding to project (through 3rd party)

Energy Improvements PACE approved Contractor

Source: City of Miami Beach.

How do borrowers obtain PACE financing?

- **Two application methods:**
  1. Apply directly through district or lender's website
  2. Work with registered contractor on home improvement project, and contractor forwards your application to district operating in that area

- **Screening process:**
  - Lender may perform a hard credit inquiry but cannot use FICO score in approval decision
  - Credit inquiry used to uncover DTI, payment delinquency, and bankruptcy history
  - PACE loan can't exceed 10% of income or 20% LTV, and property CLTV $\leq$ 100%

- **At origination:**
  - Notice of assessment lists the loan terms $\longrightarrow$ filed with town clerk (borrower CC'ed)
  - Notice of commencement attached to loan details the home improvement project
    $\implies$ difficult to commit fraud using loan proceeds towards unqualified use

NOTICE OF ASSESSMENT

GADSDEN

THIS NOTICE OF ASSESSMENT ("Notice") provides a summary memorandum of a Financing Agreement entered into by and between the FLORIDA PACE FUNDING AGENCY (the "Agency") and the record owner(s) of the Assessed Property (the "Property Owner"), both as described hereinafter. This Notice is executed pursuant to such Financing Agreement in substantially the form appended to Agency Resolution #2016-0809-3, a certified copy of which is recorded in the Official Records at 160008599; a Final Judgment, a certified copy of which is recorded at 140007031; a Final judgment, a certified copy of which is recorded at 220010257; all in the Public Records of GADSDEN, Florida, and all of the terms and provisions thereof are incorporated herein by reference. Agency has levied and imposed a non-ad valorem assessment as a lien of equal dignity to taxes and assessments, and as more particularly described herein and in such Financing Agreement, on the Assessed Property in conformance with Section 163.08, Florida Statutes (the "Supplemental Act").

1. Property Owner: ▨▨▨▨▨▨▨
2. Assessed Property: See Legal Description in Attachment I. OR 873 P 138 OR 579 P 1338 OR
3. Street Address of Assessed Property: 388 Charlie Harris Loop, Quincy FL 32352
4. Property Appraiser Parcel Identification Number: 2-17-3N-3W-0000-00244-0100
5. Qualifying Improvements:
   Energy Efficiency Improvement:

   Roof - Asphalt Shingle

6. Financed Amount (pursuant to the Financing Agreement; this amount may be reduced WITH SUCH REDUCED AMOUNT REFLECTED IN A SUPPLEMENTAL NOTICE OF ASSESSMENT): $22,777.37
7. Interest Rate (to be applied to the principal amount of the Financed Amount): 9.99%
8. Assessment Installment (pursuant to the Financing Agreement; this amount may be reduced WITH SUCH REDUCED AMOUNT REFLECTED IN A SUPPLEMENTAL NOTICE OF ASSESSMENT): $2,992.92
9. Period of years (number of Annual Payments): 15 years
10. The Annual Payment of the Assessment will appear on the same bill as for property taxes, and will include the Assessment Installment, plus any annual costs of administration and charges associated with the Assessment, annual collection costs, and annual charges required by the local property appraiser and tax collector.
11. The Assessment is NOT due on sale or transfer of the Assessed Property. Payoff and release

NOTICE OF COMMENCEMENT

The undersigned hereby gives notice that improvements will be made to certain real property, and in accordance with Chapter 713. Florida Statutes, the following information is provided in this Notice of Commencement.

1. Description of Property
   Legal Description Lot 1 / Block 2-17-3N-3W-0000-00244-0100 / Pin 2-17-3N-3W-0000-00244-0100

   Street Address 388 Charlie Harris loop   City Quincy   FL. Zip 32351

2. General description of improvement RE-Roofing (Remove + Replace shingles)

3. Owner information
   A. Name ▮▮▮▮▮▮▮▮▮▮▮▮
   B. Address 388 Charlie Harris loop City Quincy   St FL Zip 32351
   C. Interest in Property
   D. Name & Address of Fee Simple Title Holder
      (Other than Owner)

4. Contractor Name and Address

   Kevin Krueger   8934 Western Way Jacksonville Fl 32256

5. Surety Name

   Bond amount $ 19,500

Zillow
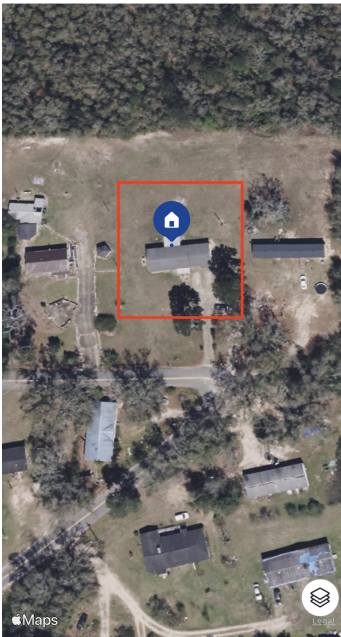
✏ Edit ♡ Save ↗ Share ••• More

3 bd | 1 ba | 984 sqft

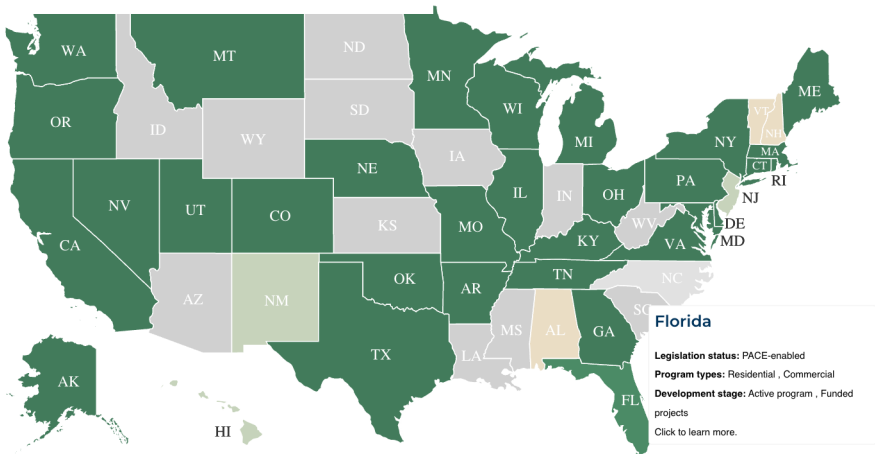388 Charlie Harris Loop, Quincy, FL 32352

● **Off market**

Zestimate®: **$135,700** | Rent Zestimate®: **$1,126**

Est. refi payment: $807/mo $ **Refinance your loan**

Home value | Owner tools | Home details | Neighborhood details

This home **$132.3K**
Jul 2023

$140K
$120K
$100K
$80K
$60K

Jan 2021   Jan 2022   Jan 2023   Jan 2024

PACE loans offered in 30 states + D.C. and growing

Florida

Legislation status: PACE-enabled
Program types: Residential , Commercial
Development stage: Active program , Funded projects
Click to learn more.

- 8 additional states have proposed C-PACE legislation (pacenation.org) [R-PACE]
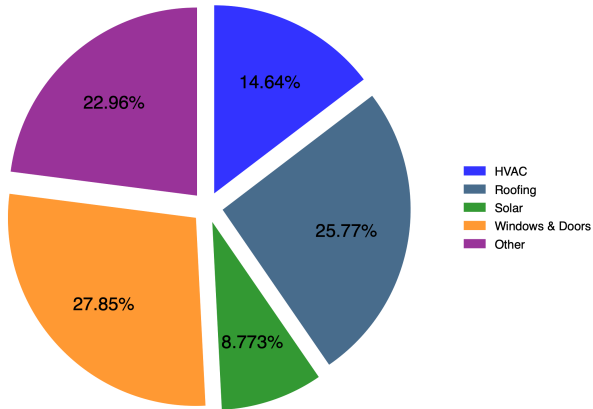- R-PACE currently only available in California + Florida ⟶ but $9.1 bil. market

PACE LOANS MAINLY USED FOR HURRICANE PROOFING

All Non-PACE FL Residential Permits
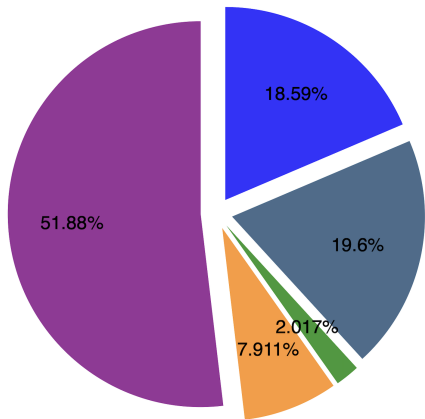
Permits Tied to FL R-PACE Properties

Legend:
- HVAC
- Roofing
- Solar
- Windows & Doors
- Other

- First stage: "other" non-PACE projects far less common among PACE borrowers

Data & Empirical Strategies

DATASETS: PACE LOANS LINKED TO PERMITS AND PROPERTIES

- **Individual PACE loan data**
  - ▸ 55,519 property-level loans matched using the assessor's parcel number (APN)

- **CoreLogic Owner Transfers, Mortgage, and Tax data**
  - ▸ House prices, buyers and sellers, information about the use (e.g. single vs. multi-family), tax assessment, combined loan-to-value (CLTV) ratios, and location of the property

- **CoreLogic Involuntary Liens data**
  - ▸ Isolate liens placed on property due to local tax delinquency (i.e. PACE default)

- **CoreLogic Building Permits**
  - ▸ Tracks building permit applications tied to APNs in other CoreLogic datasets
  - ▸ New approach to classify green home investments using keyword parsing ⟫ Method
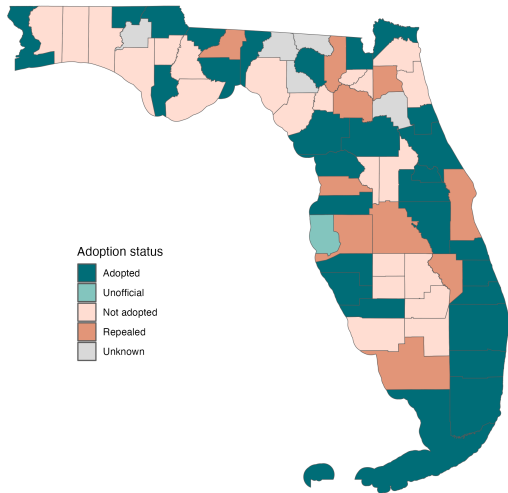
- **HMDA mortgage lending data**
  - ▸ Applicants' demographic information, approval/rejection, pricing, and securitization decisions

ENTRY OF R-PACE LENDING IN FLORIDA: 2011 – 2023

PACE adoption and lender activity 2023

Adoption status
- Adopted
- Unofficial
- Not adopted
- Repealed
- Unknown

- County-level staggered DiD design for mortgage/insurance market outcomes
  - ▶ Adoption dates from news sources, LexisNexis, and **FOIA'ed** loan records
  - ▶ Focus on pre-2020 period before legal challenges ⟶ **absorbing treatment**

- Local govt. PACE adoption in a year is uncorrelated with...
  - ▶ Population size, racial demographics, income, education, unemployment, Democratic vote share

- Only thing that predicts PACE adoption is **turnover in the tax assessor** (retirements/predetermined elections)

What predicts counties' PACE adoption decisions?

Dep. variable: PACE Adopted	(1)	(2)	(3)	(4)
Population	0.018	0.046	-0.443	-0.046
	(0.067)	(0.070)	(1.027)	(0.997)
Household median income	0.763**	0.471	-0.167	-0.161
	(0.337)	(0.382)	(0.337)	(0.327)
% Bachelor's degree or higher	-1.626**	-1.439*	1.648	1.289
	(0.769)	(0.777)	(1.310)	(1.217)
% Black	1.709	3.011	0.579	0.386
	(2.586)	(2.548)	(2.682)	(2.590)
% Latino	1.627	2.513	-2.040	-1.224
	(2.228)	(2.166)	(7.296)	(6.880)
% White	1.248	2.646	-5.417	-2.031
	(2.244)	(2.169)	(4.828)	(5.062)
Unemployment rate	-3.977***	-3.614***	-0.514	-0.846
	(1.397)	(1.169)	(1.228)	(1.222)
Municipal debt/Revenue	0.028	0.005	-0.013	-0.019
	(0.034)	(0.034)	(0.028)	(0.027)
Democratic leaning	1.004*	0.032	-0.771	-1.093
	(0.594)	(0.610)	(1.126)	(1.023)
Neighbor PACE	0.053	-0.058	0.044	0.024
	(0.100)	(0.096)	(0.085)	(0.087)
#Declared natural disasters	0.125***	0.085***	-0.020	-0.026
	(0.025)	(0.029)	(0.028)	(0.029)
Abnormal property damage	0.000	0.000	-0.000	-0.000
	(0.001)	(0.001)	(0.001)	(0.001)
Abnormal injuries	-0.005	-0.007*	-0.003	-0.002
	(0.004)	(0.004)	(0.002)	(0.002)
Climate concerns		0.039***		0.021
		(0.012)		(0.019)
Assessor turnover		-0.124		-1.230**
		(0.677)		(0.525)
Assessor turnover × Climate concerns		0.002		0.023**
		(0.012)		(0.010)
Observations	466	466	466	466
R-squared	0.350	0.400	0.709	0.724
County FE	No	No	Yes	Yes
Year FE	No	No	Yes	Yes

- Run linear probability models with dummy for county adoption of PACE in a given year as the outcome

- Labor market conditions not predictive within county and within year

- On average, counties with new assessors are far less likely to adopt PACE

- But, counties more **concerned about climate change** with a new assessor are more likely to adopt PACE
  - FL tax assessor's are elected officials
  - Data source: Yale Climate Change Surveys

Balance test: PACE vs. HELOC, No FEs
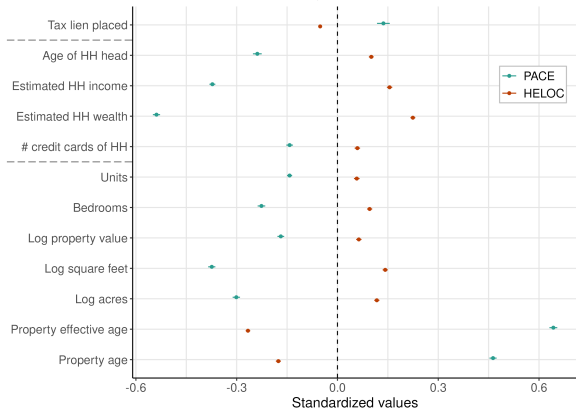
Note: Household income, age, wealth, and credit access variables merged in from Data Axle via unique property location identifiers.

- HELOCs widely available and main source of financing for HI projects in U.S. (Hurst & Stafford 2004)

- PACE properties are smaller, older, trade at lower values, and more likely to be tax-delinquent *ex ante*

  - ▶ PACE HHs also have lower income, wealth, and credit access

  - ▶ Points to binding *ex ante* **liquidity constraints** among PACE borrowers

- Gaps remain even if condtioning on Census tract FEs, or matching borrowers on HI project type and LTV (▸ With FEs)

How are PACE loans priced? ▸ Back

$$r_{i,c,t} = \alpha + \beta_1 \cdot PACE_{i,c,t} + \beta_2 \cdot PrimaryMtg_{i,c,t}$$

$$+ \beta_3 \cdot \left(PACE_{i,c,t} \times PrimaryMtg_{i,c,t} \right) + \sum_{m=1}^{M} LTVbin_{i,c,t} + \gamma_c + \delta_t + \varepsilon_{i,c,t}$$

- $PrimaryMtg_{i,c,t} = 1$ for PACE if mortgage term $>$ (year of PACE origination $-$ year of mortgage origination) $\longrightarrow$ 63% of cases

  - For 54% of HELOCs, $PrimaryMtg = 1$ b/c second lien flag turned on in HMDA

- $\beta_2 > 0$ and $\beta_3 < 0 \implies$ conditional on LTV, mortgage lender's claim has less of an effect on PACE rates ▸ LTV distributions

- $H_0 : \beta_2 + \beta_3 = 0$ tests role of PACE **super seniority** in not pricing in primary mortgage claim $\longrightarrow$ govt. can always get their money back if HH defaults

  - Govt. can directly sell tax liens to recoup any losses, or move to foreclose

  - No record from auctions of any PACE property going through tax foreclosure

Dep. variable: % interest rate ($r_{i,c,t}$)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$PACE$	2.096***	0.746***	0.791***	0.584***	1.533***	1.268***	0.587***	1.052***	0.824***	1.834***
	(0.093)	(0.100)	(0.102)	(0.103)	(0.131)	(0.140)	(0.095)	(0.127)	(0.193)	(0.212)
$PrimaryMtg$			0.304***	0.307***	1.044***	0.992***	0.297***	0.706***	0.233***	2.029***
			(0.070)	(0.068)	(0.107)	(0.123)	(0.064)	(0.089)	(0.079)	(0.277)
$PACE \times PrimaryMtg$					−0.946***	−0.863***		−0.576***		−1.932***
					(0.136)	(0.145)		(0.118)		(0.288)
Sample	Closed	Closed	Closed	Closed	Closed	Closed	Both	Both	30-year	30-year
Origination year FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
$LTVbins$	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Census tract FEs	No	No	No	Yes	No	Yes	Yes	Yes	Yes	Yes
p-value on seniority	–	–	–	–	0.244	0.104	–	0.233	–	0.103
N	6,290	6,271	6,222	6,185	6,222	6,185	7,342	7,342	4,736	4,736
Adj. R^2	0.170	0.310	0.314	0.379	0.318	0.381	0.354	0.356	0.516	0.520

- Spread attenuates, but remains, conditional on (C)LTV and location $\implies$ unobserved differences in expected default risk drive the spread

Dep. variable: % interest rate ($r_{i,c,t}$)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$PACE$	2.096***	0.746***	0.791***	0.584***	1.533***	1.268***	0.587***	1.052***	0.824***	1.834***
	(0.093)	(0.100)	(0.102)	(0.103)	(0.131)	(0.140)	(0.095)	(0.127)	(0.193)	(0.212)
$PrimaryMtg$			0.304***	0.307***	1.044***	0.992***	0.297***	0.706***	0.233***	2.029***
			(0.070)	(0.068)	(0.107)	(0.123)	(0.064)	(0.089)	(0.079)	(0.277)
$PACE \times PrimaryMtg$					−0.946***	−0.863***		−0.576***		−1.932***
					(0.136)	(0.145)		(0.118)		(0.288)
Sample	Closed	Closed	Closed	Closed	Closed	Closed	Both	Both	30-year	30-year
Origination year FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
$LTV bins$	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Census tract FEs	No	No	No	Yes	No	Yes	Yes	Yes	Yes	Yes
p-value on seniority	–	–	–	–	0.244	0.104	–	0.233	–	0.103
N	6,290	6,271	6,222	6,185	6,222	6,185	7,342	7,342	4,736	4,736
Adj. R^2	0.170	0.310	0.314	0.379	0.318	0.381	0.354	0.356	0.516	0.520

Notes: "Both" refers to a sample pooling both closed and open-end home improvement HELOCs without an interest only payment option.

- ⟹ Fail to reject null of super seniority

Battery of staggered DiD designs to overcome selection

1. In matched loan-property sample, **compare early to late PACE borrowers** using Callaway & Sant'Anna (2021) estimator

   - Holds fixed the subprimeness of PACE borrowers relative to alternate loan products
   - Estimate in long differences to render pre-period coefficients interpretable (Roth 2024)

2. **Compare delinquency rates of PACE to HELOC borrowers**, controlling for observables showing negative selection of PACE

   - Use stacked DiD (Cengiz et al. 2019; Baker et al. 2022) given that there is no untreated group in this setting
   - Idea: HELOCs are similar loans to PACE except not paid through tax system

3. **DiD using staggered enrollment into the program by counties**

   - Exploits fact that timing of adoption appears quasi-random w.r.t. observables
   - Apply to HMDA data on loan approvals (supply) and applications (demand)

Evaluating the Capitalization Effects of PACE

- Important to assess returns to borrowers and **change in recovery value** for lenders

- **Identification:** focus on PACE homes that sell after loan origination
  - ▸ Repeat transactions: could be negative or positive selection

- PACE borrower cohorts more balanced on *ex ante* characteristics than HELOC vs. PACE ➤ No FEs
  - ▸ Prior delinquency rates constant across cohorts

Balance test: Early vs. Late PACE cohorts, Tract FEs
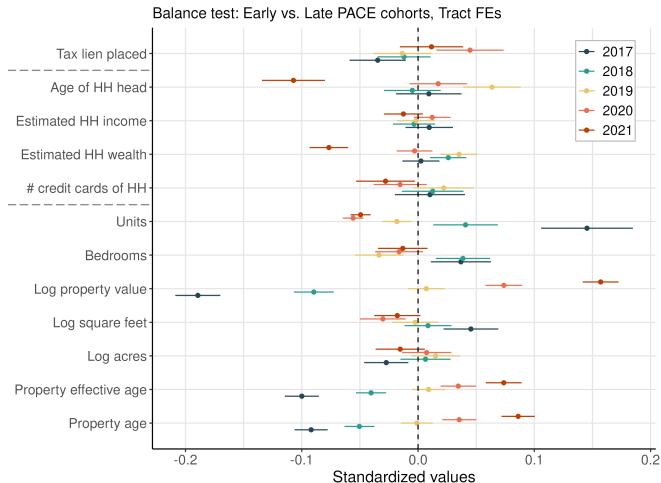
PACE projects strongly capitalized into home values

$$\log(Price_{i,t}) = \beta \cdot PACE_{i,t} + \gamma' \cdot \mathbf{X}_{i,t-1} + \theta_{g,t} + \delta_m + \varepsilon_{i,t}$$

Dep. variable: log(Price)	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$PACE_{i,t}$	0.031***	0.040***	0.016***	0.095***	0.091***	0.180***	0.184***
	(0.008)	(0.006)	(0.004)	(0.013)	(0.034)	(0.050)	(0.061)
Pre-/Post-COVID	Post	Pre	Pre	Pre	Pre	Pre	Pre
Loan sample	All	All	All	All	All	Permitted	LoanAmt
Estimator	OLS	OLS	OLS	CSDID	CSDID	CSDID	CSDID
Observations	7,835	10,767	10,767	16,436	16,436	7,387	4,707
Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Property Controls	No	No	Yes	No	Yes	Yes	Yes
Census Tract × Year FE	Yes	Yes	Yes	No	No	No	No
Zip code × Year FE	No	No	Yes	Yes	Yes	Yes	Yes
Mean Dep. Var.	12.740	12.287	12.287	12.287	12.287	12.312	12.066

- Permit dummies account for type of permit at origination ($t = 0$) and autocorrelation in permitting decisions ⟿ Summary stats ⟿ Robustness

- δ_m soaks up any intra-year seasonality in property markets

$$\log(Price_{i,t}) = \sum_{t=-4}^{+3} \beta_t \cdot PACE_{i,t} + \gamma' \cdot \mathbf{X}_{i,t-1} + \theta_{z,t} + \varepsilon_{i,t} \quad \text{[via CSDID]}$$
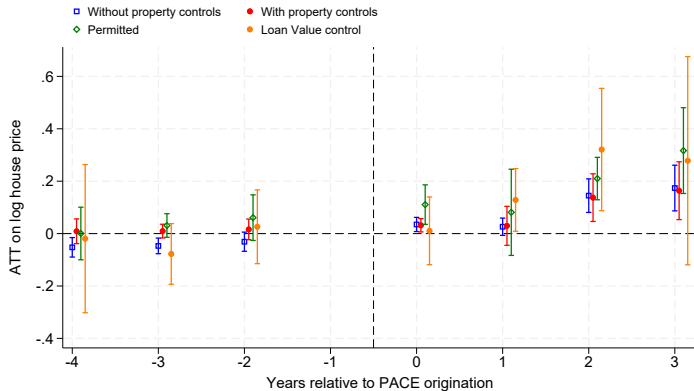
- Slight pre-trend w/o property controls $\implies$ positive selection dominates repeat sales

ESTIMATES TRANSLATE TO LARGE INDIVIDUAL RETURNS

1. Cash-on-cash return (ROI) $= (\Delta P/\text{Loan Amount}) \times (\text{Loan Amount}/\text{Project Cost})$
2. Annualized net capital gain $= \text{ROI}^{(1/T)}$ where T is tenure between home sale

	Urban + COVID	All pre-COVID	Proofing + pre-COVID
ROI	$\$60k/\$27k = 2.1x$	$\$31k/\$23k = 1.4x$	$\$62k/\$27k = 2.3x$
Net cap gain	$2.1^{(1/2.3)} = 39\%$	$1.4^{(1/3.8)} = 8\%$	$2.3^{(1/3.8)} = 24\%$

- Adding in permit + admin fees + discounted change in tax bill has little effect on ROI
  - Permit fees typically very small, vary by town ($100 – $200)
  - Admin fees for FL PACE capped at 4% of loan amount over full loan term, or $\approx \$1,200$
  - Tax assessed value increments capped in Florida at $\min\{\%\Delta CPI, 3\%\}$
  - Origination fees typically included in loan amount (avg. $\approx 5\%$ based on CFPB report)

Property Tax Delinquency Rates for PACE Borrowers

DELINQUENCY ↑ BY 1 P.P. (12%) WITHIN YEAR OF ORIGINATION
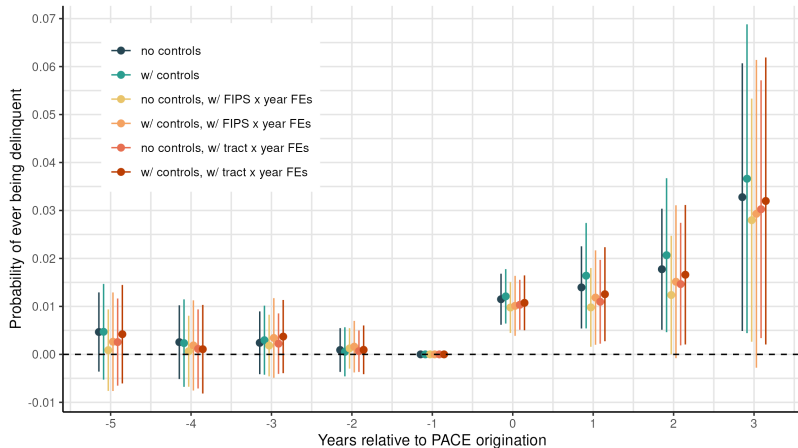
- Effect grows over time due to ever-delinquency flag (2.5 p.p., or 30% ↑ within 3 years)
  - ▶ Similar trajectory if use property or property × owner combo as the panel unit

Delinquency ↑ if compare PACE to HELOC borrowers
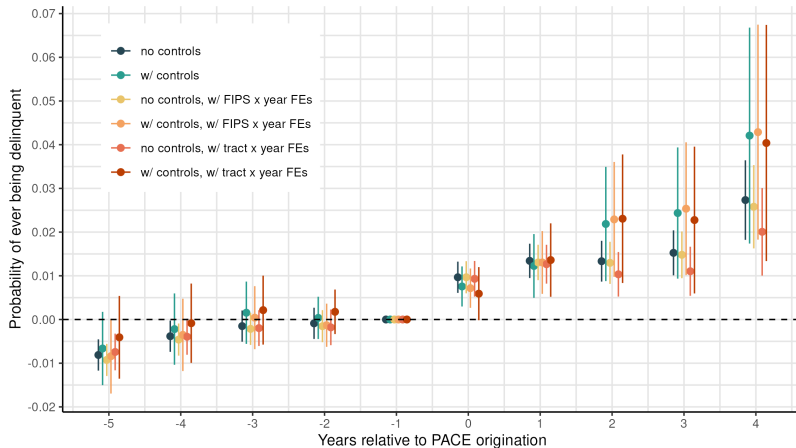
- Spike of similar magnitude to within-PACE loan early vs. late comparison
- Some pre-trend indicates negative selection of PACE borrowers

WHY IS THERE AN UPTICK IN TAX DELINQUENCY?
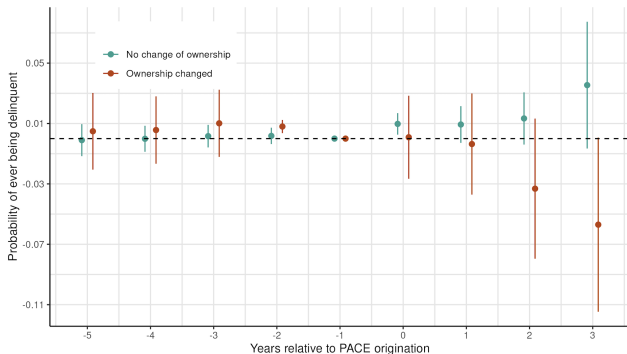
- **Non-salience** of the property tax payment (Cabral & Hoxby 2012)
  - ▶ Proxy for age/lack of escrow account
  - ▶ Entire delinquency effect driven by borrowers with long tenure in the house

- Lack of understanding of the loan contract and/or **financial burden**
  - ▶ For standard loan contract of 20-year term, $30k, and 7% interest rate, annual payment is $2,831.79 ⟨▶ Sample bill⟩
  - ▶ ⟹ **79% ↑ in average annual property tax bill for PACE borrowers**
  - ▶ Payment effectively deferred by > 12 months in some cases

Does PACE Loan Adoption Crowdout Other Forms of Mortgage Credit?

How might mortgage lenders respond to PACE?

- Simple conceptual framework where lenders make underwriting decisions with vs. w/o PACE availability to mortgage borrowers ⟶ Full model

  ▸ Two-period model: HH makes downpayment and buys house in $t = 1$ and then decides on PACE in $t = 2$

- Crowdout: reduce mortgage supply due to loss given default ↑ and default probability ↑

  ▸ PACE super seniority makes other loans less liquid on secondary market

  ▸ CDTI higher w/PACE, leading to strategic defaults on mortgage (Ganong & Noel 2023)

- **Crowdin:** collateral recovery value grows if PACE loans are used to finance projects which result in $\Delta P >> 0$

  ▸ Default prob. might decline if projects generate new cash flows (e.g. energy savings or lower HO insurance premia) put towards making mortgage payment

- Ultimately an empirical question which force dominates!

Summary of our findings – mortgage crowd<u>in</u> after PACE

$$Lending_{i,c,t} = \beta \cdot PACE\ adoption_{c,t} + \gamma' \cdot \mathbf{X}_{i,c,t} + \alpha_c + \delta_t + \varepsilon_{i,c,t}$$

- Using DiD estimators with county-level staggered adoption (Cengiz et al. 2019; Sun & Abraham 2021; Baker et al. 2022), we find…

  ❶ Loan approvals ↑ for both purchase and refinance mortgages ⏩ Robustness ⏩ Rates

    ★ 1.3 p.p. ↑ in approval rate, or 2% increase relative to $t = -1$

  ❷ Credit supply response concentrated among higher risk (i.e. high LTI) borrowers

  ❸ Driven by loans which are subsequently private-label securitized

  ❹ 8% ↓ in home improvement loan demand (applications) ⏩ HI loans

    ★ Two opposing effects: PACE is substitutable for HELOC for qualified borrowers, but HELOC allows for "top-up" funding to do multiple HI projects

CREDIT SUPPLY EXPANDS DUE TO IMPROVED COLLATERAL VALUES
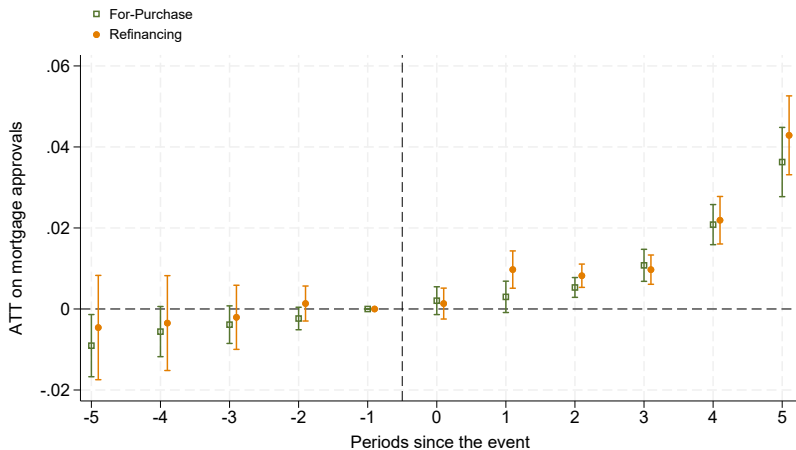
- **Effect grows over time** with PACE takeup $\implies$ not an anticipatory effect ⤷ Stacked DiD
- Placebo: no effect on approvals if randomly assign adoption dates ⤷ Dates ⤷ Conventional

CREDIT SUPPLY ↑ DRIVEN BY HIGH-RISK BORROWER APPROVALS
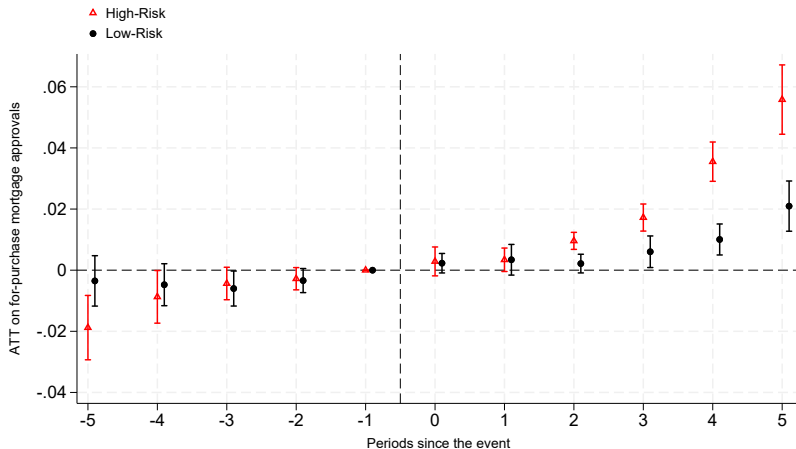
- High/low risk proxied by above/below median loan-to-income (LTI) ratio
- $\implies$ democratization of access to credit in primary mortgage market

New mortgage loans are private-label securitized
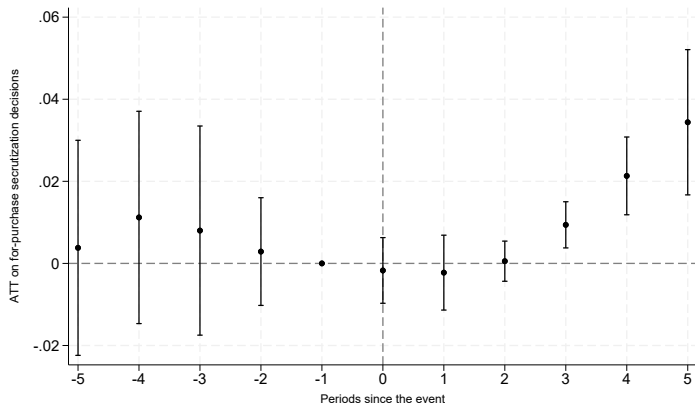
- In response to PACE passage in California, GSEs announced in July 2010 that they would <u>not</u> purchase mortgages with a PACE lien attached due to super seniority

Local Cost-Benefit Implications of PACE

COMBINING OUR ESTIMATES $\implies$ PACE EXPANDS TAX BASE

- Simple back-of-envelope calculation combining our DiD estimates

$$\Delta R_{t,t+1} = \underbrace{\tau_{t+1}}_{\text{effective tax rate}} \times (\ \underbrace{\Delta P_{t,t+1}}_{\text{capitalization effect}} - \underbrace{\Delta D_{t,t+1} \cdot P_t}_{\text{revenue lost from delinquency}}\ )$$

- Even after netting out delinquencies, **revenues grow by \$300 to \$600 per PACE loan-year** in Florida counties participating in program
  - ▸ Lower ΔP if instead use market assessed values (tax base revalued each year in FL)
    - ★ But statutory tax rates higher than effective rates in FL (1.6% vs. 1.2%) ⟿ Details
  - ▸ ATT effects: evidence from HMDA consistent with positive pecuniary externalities

- **Lower-bound** estimate of the increase in revenue because...
  - ▸ This is without accounting for spillovers to local employment or non-PACE investments
  - ▸ Some delinquency costs are partially borne by municipal bond investors
  - ▸ Measure ΔD using an "ever-delinquent" flag, but some loans are performing

WHAT IS THE BREAK-EVEN $\%\Delta P$ FOR REVENUE?

- Simple back-of-envelope calculation combining our DiD estimates

$$\Delta R_{t,t+1} = \underbrace{\tau_{t+1}}_{\text{effective tax rate}} \times (\underbrace{\Delta P_{t,t+1}}_{\text{capitalization effect}} - \underbrace{\Delta D_{t,t+1} \cdot P_t}_{\text{revenue lost from delinquency}})$$

  - ▶ Lower bound $\%\Delta P \approx 10\%$ excluding COVID period and including all areas
  - ▶ Upper bound $\%\Delta P \approx 20\%$ including COVID period and focusing on urban areas
  - ▶ $\implies$ range of revenue gains per loan-year of \$300 to \$600

- Break-even capitalization effect to cancel out delinquencies of $\%\Delta P = 1\%$

- Florida has an assessment growth cap of $\%\Delta \overline{V} = \min\{\%\Delta CPI, 3\%\}$
  - ▶ Even if cap were binding for all households at inflation rate, still at break even
  - ▶ We find average $\%\Delta V \approx 2\%$ after a PACE loan with an eligible project

PACE REMAINS CONTROVERSIAL, BUT EQUITY-EFFICIENCY TRADEOFFS IN PROGRAM DESIGN

Ray and Kelly Coulter display the paperwork from when they financed a new roof and impact windows on their West Palm Beach home through Green Solutions and Ygrene Energy Florida.
MATIAS J. OCNER *mocner@miamiherald.com*

As more complaints surfaced, other counties soon followed Pasco's lead by introducing stronger consumer protections and disclosure forms for new PACE customers.

- <u>No evidence</u> of crowdout of traditional mortgage credit

- CFPB complaints against PACE districts allege contractors mislead borrowers
  - ▶ PACE lien can make it difficult for consumers to refinance
  - ▶ We find refi approvals ↑

- Delinquency leads to mild revenue losses relative to expansion of tax base

- **Optimal screening**, LTV caps, income requirements?

- Pairing PACE with **HO insurance contracts** to prevent unraveling ▸ Result

Conclusion: lack of strategic default helps green lending

- **We show that local government-backed loans can help close the investment gap in green residential projects while growing the tax base**

- **Mechanism:** lowering screening standards without subsidizing credit helps relax households' **financing constraints** to do NPV > 0 home improvements
  - ▶ PACE borrowers are negatively selected compared to HELOC borrowers for home improvement projects, but LTV is capped
  - ▶ Uptick in delinquency rates quantitatively small relative to capitalization into home values

- Super seniority of the tax lien does <u>not</u> lead to crowdout of traditional mortgage credit, since recovery value of collateral $\uparrow$
  - ▶ Unlike traditional lending, tax lien creates virtually non-existent strategic default motives
  - ▶ **Incentive compatibility** is a major strength relative to other green lending programs

THANK YOU!

Appendix
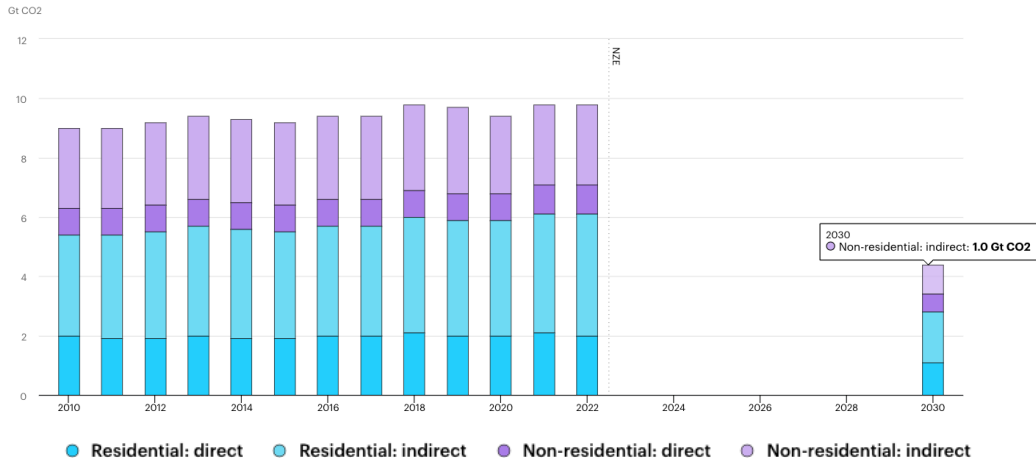
**Source:** International Energy Agency (IEA): https://www.iea.org/energy-system/buildings (June 15, 2023)

Figure 9: Climate finance flows in key mitigation sectors, finance needs and mitigation potential
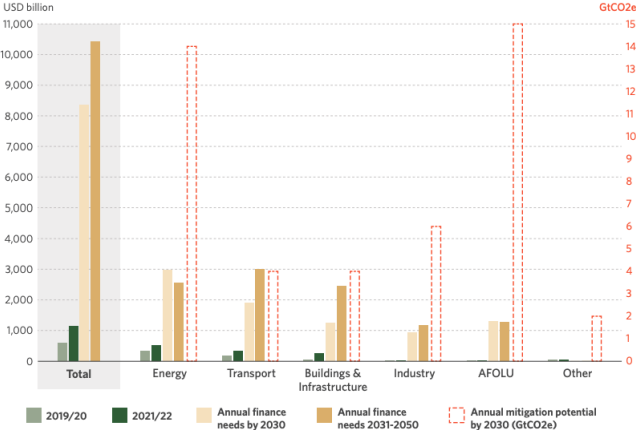
Note: Historical finance flows (2019-2022) are expressed in nominal USD. Climate finance needs for 2023-2050 are expressed in 2022 USD. Average mitigation potential is sourced from the IPCC AR6 (2022a). This applies to similar analyses hereafter.

Percentage of housing properties identified as at risk for "insurance correction" due to wind risk

0%   50%   100%
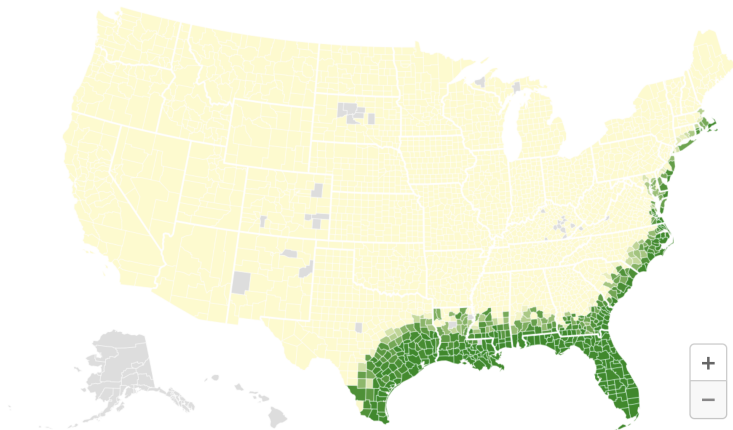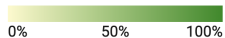
Map: Lance Lambert • Source: First Street Foundation • Created with Datawrapper

ResiClub

Mean Absolute Latitude from 10 CMIP 6 Models
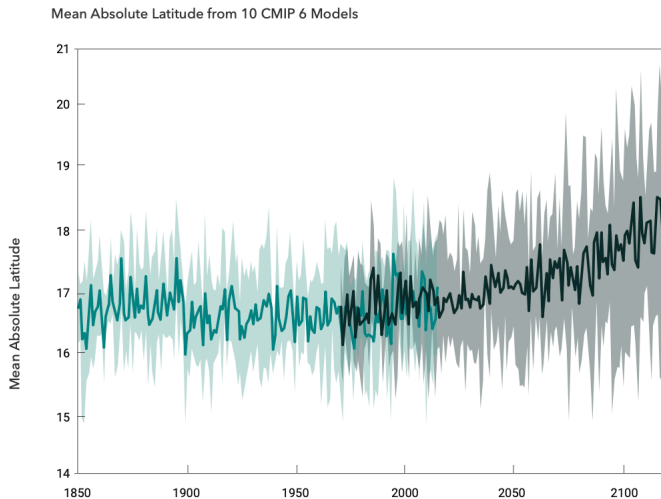
Figure 3. Mean absolute storm latitude from global modeled storms under historical conditions (green line) and future conditions (black line) from Dr. K. Emanuel (pers. comm, 2023)
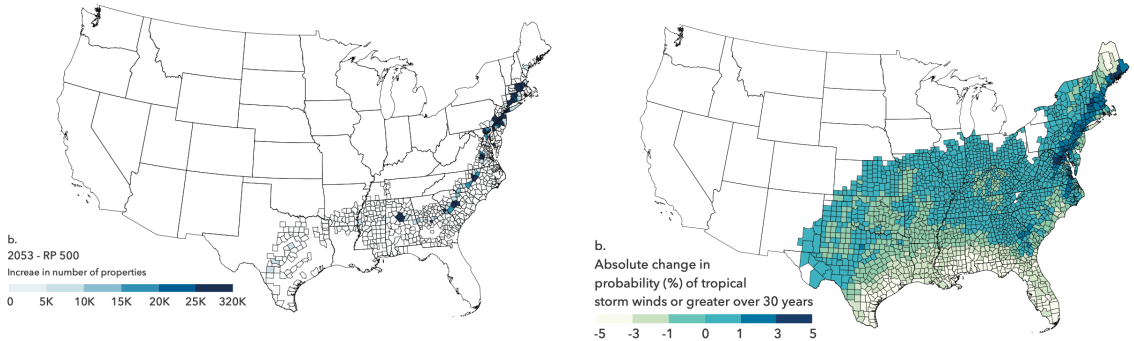
FL's storm risk expected to decline over next 30 years

b.
2053 - RP 500
Increase in number of properties

0   5K   10K   15K   20K   25K   320K

b.
Absolute change in
probability (%) of tropical
storm winds or greater over 30 years

-5   -3   -1   0   1   3   5

*Figure 19. Number of properties with damages for RP 500 in 2023 (a) and the increase in the
number of properties with damages for RP500 in 2053 (b)*

**Source:** First Street Foundation. "The 7th National Risk Assessment: Worsening Winds."

- Similar to problems in the place-based policy literature $\longrightarrow$ very hard for government to pick "winning" areas to subsidize for climate migration ↩ Back

- Under-investment in climate-resilient retrofitting could be due to...
  - ▶ High discount rates due to (false) perception that risks are at long horizons
  - ▶ Uncertainty about returns or hedonic value of such investments
  - ▶ **Liquidity constraints** preventing NPV > 0 projects

- On top of this, there may be **externalities** associated with PACE projects
  - ▶ Increasing resiliency of structures may put downward pressure on insurance premia
  - ▶ Peer effects: uncertainty about future returns to green home improvements may be resolved by observed success of neighbors

- PACE program could create **new frictions** in the form of predatory lending (exempt from Truth in Lending Act) and **crowdout effects on mortgage supply**

- **Evidence:** PACE relaxes borrowing constraints by lowering credit screening standards rather than through direct subsidies

R-PACE program reached $9.1 billion in total originations by end of 2023
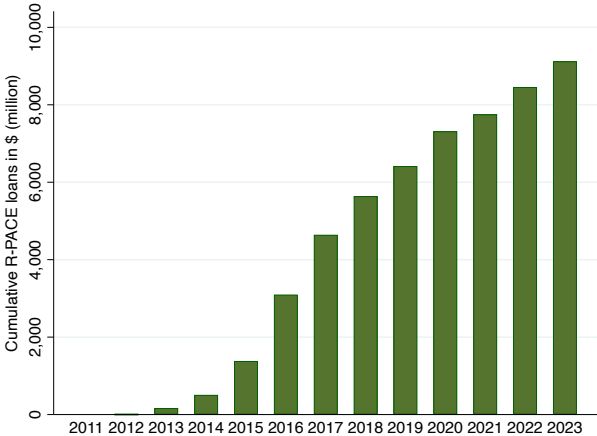
ACCOUNT NUMBER	ESCROW CODE	MILLAGE CODE	PROPERTY ID #
1610844		500K	1610844

MUST PAY BY CASH, CREDIT CARD OR CERTIFIED FUNDS

205 Pirates Dr
Key Largo, FL 33037-2323

NEW OWNER DUP BILL MAILED

00494680000000326139
205 PIRATES Dr

BK 13 LT 14 AND 15 PIRATES COVE PB3-18 KEY
LARGO OR502-826 OR672-82D/C OR1170-621AFF
OR1170-622 OR117

Paid 06/22/2020 $7,106.47

Receipt # 116-19-00001470

AD VALOREM TAXES

TAXING AUTHORITY	TELEPHONE	ASSESSED VALUE	EXEMPTION AMT	TAXABLE VALUE	MILLAGE RATE	TAXES LEVIED
SCHOOL STATE LAW	305-293-1400	401,428	0	401,428	1.5550	624.22
SCHOOL LOCAL BOARD	305-293-1400	401,428	0	401,428	1.7880	717.75
GENERAL FUND	305-292-4473	401,428	0	401,428	0.7697	308.98
F&F LAW ENFORCE JAIL	305-292-7017	401,428	0	401,428	1.7747	712.41
HEALTH CLINIC	305-296-4886	401,428	0	401,428	0.0437	17.54
GENERAL PURPOSE	305-292-4473	401,428	0	401,428	0.1725	69.25
MOSQUITO CONTROL	305-292-7190	401,428	0	401,428	0.4508	180.96
M C LOCAL ROAD PATROL	305-292-7017	401,428	0	401,428	0.3484	139.86
SFWM DIST	800-432-2045	401,428	0	401,428	0.1152	46.24
OKEECHOBEE BASIN	800-432-2045	401,428	0	401,428	0.1246	50.02
EVERGLADES CONST PR.	800-432-2045	401,428	0	401,428	0.0397	15.94
K L FIRE RESC & EMERG	305-743-6586	401,428	0	401,428	1.0000	401.43

		AD VALOREM TAXES:	8.1823	$3,284.60

NON-AD VALOREM ASSESSMENTS

BILL EXPRESS
SCAN TO PAY ONLINE!

LEVYING AUTHORITY	TELEPHONE	UNITS	AMOUNT
MO CO SOLID WASTE	305-295-4323	1.000	402.00
KEY LARGO WASTEWATER #4	305-451-4019	0.000	340.23
GREEN CORRIDOR PACE	866-807-6864	1.000	2,198.84

NON-AD VALOREM ASSESSMENTS:	$2,941.07

TOTAL COMBINED TAXES AND ASSESSMENTS:
$6,225.67

▸ Back

PACE LOANS CARRY HIGHER INTEREST RATES THAN HOME IMPROVEMENT LOANS

PACE mean rate = 7.31
PACE median rate = 6.97
HELOC mean rate = 5.76
HELOC median rate = 5.39

Fraction — Interest rate (%)

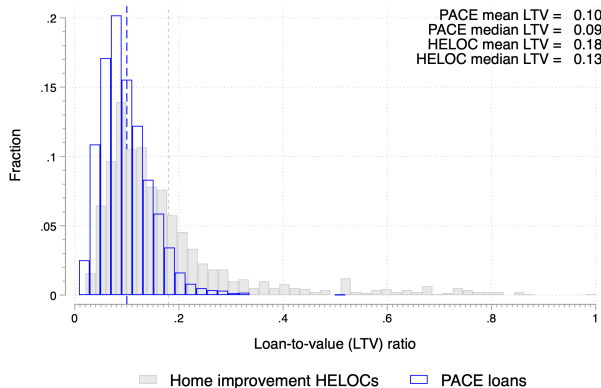Home improvement HELOCs   PACE loans
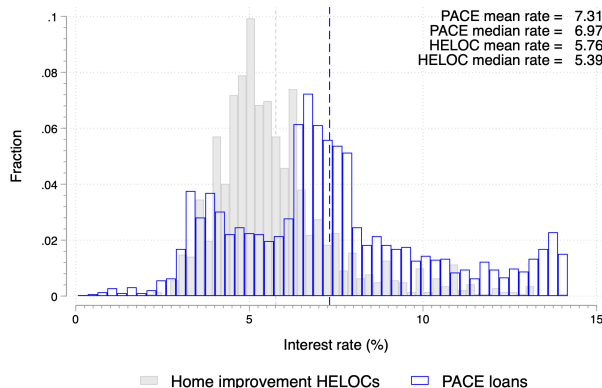
Note: Sample of PACE interest rates for Broward County, FL.

- Over this period, PACE interest rates **155 bps higher**, on average, than comparable HELOCs

- HELOC definition: closed-end (fixed-rate), fully amortizing home improvement equity lines in HMDA

- Note: PACE interest rates are contract-level information $\implies$ not available via FOIA request

- Back out interest rates using scraped PACE tax bill payments and origination amounts

HI EQUITY LOANS HAVE HIGHER LTVs THAN PACE LOANS

PACE mean LTV = 0.10
PACE median LTV = 0.09
HELOC mean LTV = 0.18
HELOC median LTV = 0.13

Home improvement HELOCs   □ PACE loans

Notes: Under CS/HB 7179, PACE LTVs cannot exceed 20% except in cases where the primary mortgage lender agrees to higher LTVs or an energy audit is performed on the property.

- Creditworthy borrowers face drawbacks to PACE
  - ▶ Higher LTV with HELOC can be used towards PACE-eligible and ineligible projects

- Conditional on LTV, w/o financing constraints HELOC strictly preferred
  - ▶ Lower interest rate for HELOC
  - ▶ Deferred payment options > 12 months available

- HELOCs also preferable due to interest tax deduction
  - ▶ Widens unconditional average spread by another 13 basis points

SUMMARY STATS FOR HOUSE PRICE AND LENDING SAMPLES

	N	Mean	Std. Dev.	p5	p95
Panel A: House Price Analysis (CoreLogic-PACE matched repeat sales sample)					
Sale amount$_{i,t}$	20,947	313,435	178,773	103,000	625,000
log(Price)$_{i,t}$	20,947	12.51	0.55	11.54	13.35
log(AssessValue)$_{i,t}$	20,941	11.90	0.66	10.78	12.89
HVAC$_{i,t}$	20,947	0.075	0.26	0	1
Solar$_{i,t}$	20,947	0.040	0.20	0	0
Roof$_{i,t}$	20,947	0.11	0.31	0	1
Windows$_{i,t}$	20,947	0.14	0.35	0	1
Ex-ante Permits$_{i,t}$	20,947	0.45	1.01	0	2
Ex-post Permits$_{i,t}$	20,947	0.10	0.43	0	1
Bedrooms$_{i,t}$	17,912	2.97	0.89	2	4
Bathrooms$_{i,t}$	18,493	2.08	1.55	1	3
log(square footage)$_{i,t}$	20,685	7.37	0.35	6.82	7.98
Age deciles$_{i,t}$	20,682	5.44	2.90	1	10
Panel B: Mortgage Lending Analysis (HMDA sample)					
Approval$_{i,l,c,t}$	2,137,224	0.842	0.364	0	1
PACE$_{i,c,t}$	2,582,095	0.427	0.495	0	1
Private securitization$_{i,c,t}$	1,818,279	0.328	0.469	0	1
Rate spread$_{i,c,t}$	625,475	0.945	1.712	-0.19	2.25

	Counties with PACE programs	Counties without PACE programs	Difference
Fraction w/high school diploma or less (2017-2021)	11.28	17.13	5.86***
Fraction w/bachelor's degree or higher (2017-2021)	27.22	18.74	-8.48***
Population (Census 2020)	446,460	136,288	-310,172***
Declared natural disasters (since 2015)	14.25	13.86	-0.40
Unemployment rate (2021)	4.45	4.52	0.08
Median household income (2021)	60,102	53,927	-61,745**
White fraction of population (2020)	0.64	0.68	0.04
Black fraction of population (2020)	0.13	0.13	-0.00
Latino fraction of population (2020)	0.16	0.13	-0.03

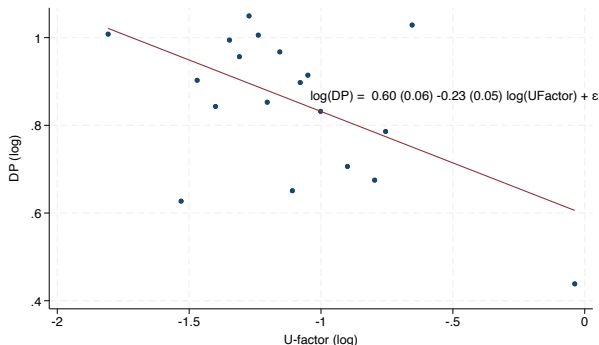**Sources:** FEMA, the decennial Census, and the American Community Survey (ACS).
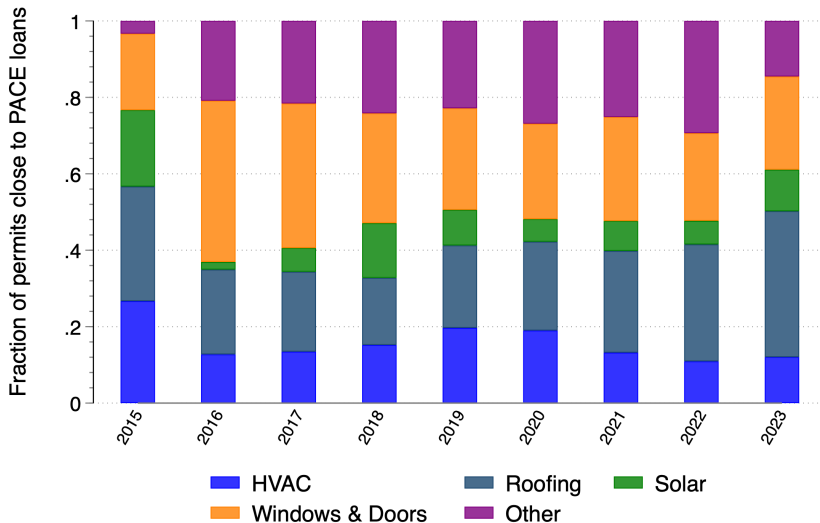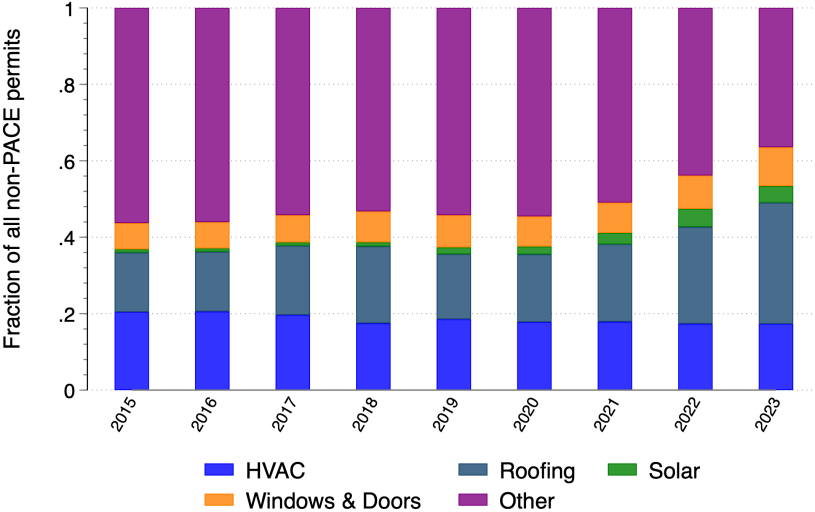
Keyword classification for home improvement permits

- Use CoreLogic Building Permits to identify types of projects
  - Focus on permit applications, but dates, but subset to completed permits
  - Each permit can have multiple projects listed (up to 3)
  - Focus on SFHs, no teardowns, no new construction

- Parse strings from town clerk's memo to sort permits into 5 mutually exclusive types:
  - Windows and doors: windows, doors, impact, etc.
  - Roofing: roof, shingle, asphalt, etc.
  - HVAC: cool, heat, air conditioning, AC, HVAC, duct, etc.
  - Solar: photovoltaic, cell, solar, generator, etc.
  - Other: any other permits with no explicitly mentioned PACE-qualified project

▸ Back

Scatter plot with regression line. Y-axis: DP (log), ranging from .4 to 1. X-axis: U-factor (log), ranging from -2 to 0. Regression equation shown: log(DP) = 0.60 (0.06) -0.23 (0.05) log(UFactor) + ε

- Scrape information on 500 window products from the National Fenestration Rating Council

- **Design pressure (DP)** rating ranks products on 0 to 100 on how well they can withstand storms

- **U-Factor** on scale from 0.2 to 1.2, with lower values indicating better insulation

- 1% U-Factor ↑ associated with a 0.23% ↓ in window's DP rating

- $\implies$ can be energy efficiency gains even if motivation is hurricane-proofing

Permit probability spikes around PACE origination

$$\text{Permit}_{i,t} = \sum_{t=-3, t\neq-1}^{+3} \beta_t \cdot PACE_{i,t} + \eta_i + \theta_{z,t} + \varepsilon_{i,t}$$

	Windows/Doors	Roofing	HVAC	Solar
$t=-3$	-0.08^{***}	-0.06^{***}	-0.03^{***}	-0.01^{***}
$t=-2$	-0.08^{***}	-0.05^{***}	-0.03^{***}	-0.02^{***}
$t=0$	0.03^{***}	0.04^{***}	0.03^{***}	0.02^{***}
$t=1$	-0.09^{***}	-0.06^{***}	-0.03^{***}	-0.01^{***}
$t=2$	-0.10^{***}	-0.07^{***}	-0.03^{***}	-0.01^{***}
$t=3$	-0.09^{***}	-0.06^{***}	-0.03^{***}	-0.01^{***}
Estimator	CSDID	CSDID	CSDID	CSDID
Property FEs	✓	✓	✓	✓
Year FEs	✓	✓	✓	✓
5-digit zip code × year FEs	✓	✓	✓	✓
# clusters	895	895	895	895
N	2,326,879	2,326,879	2,326,879	2,326,879

**Note:** Standard errors clustered at 5-digit zip code level.

- Compare permits for PACE properties to "never treated" using Callaway & Sant'Anna (2021)

- Timing: we define $t=0$ to be within one year of origination ↦ Graph
  - Retroactive permitting possible without penalty in most FL towns
  - Notice of commencement has a one-year expiration date

- Permitting for non-PACE projects also spikes $\implies$ **complementarity**
  - Some of the permits in "other" category may be small green projects below permit exemption thresholds

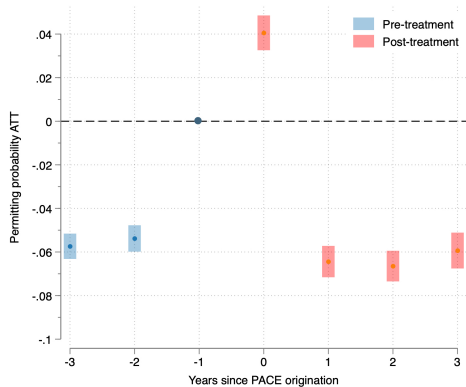# PERMITTING SPIKES AROUND PACE ORIGINATION

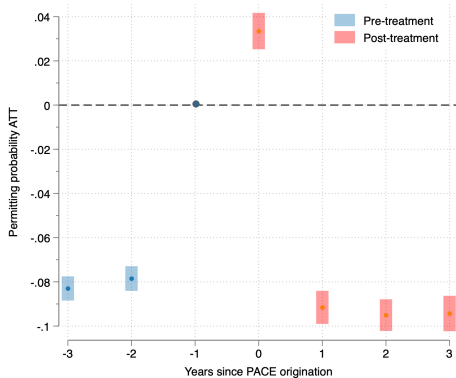## HVAC Permits
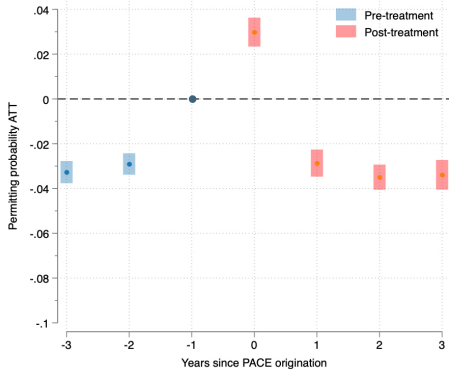
Solar Panel Permits
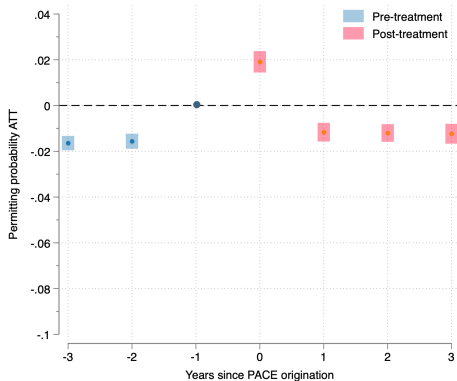
- Clear jump in permitting probability of 2 p.p. for **energy efficiency** projects ▸▸ Back

Permitting spikes around PACE origination
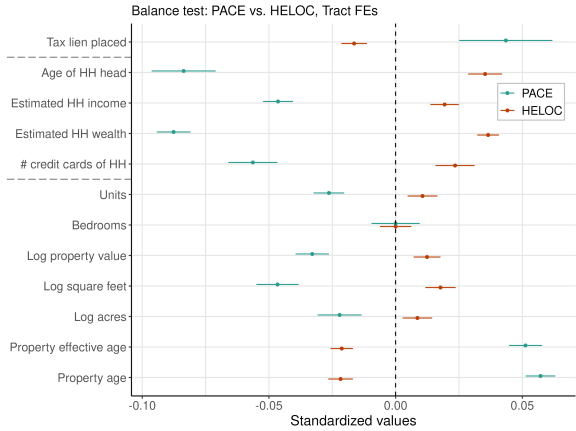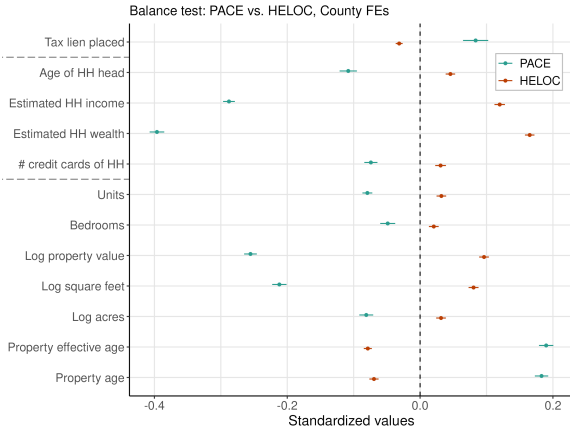
Roofing Permits

Window & Door Permits

- Clear jump in permitting probability of 2 p.p. for **disaster-proofing** projects ⇥ Back
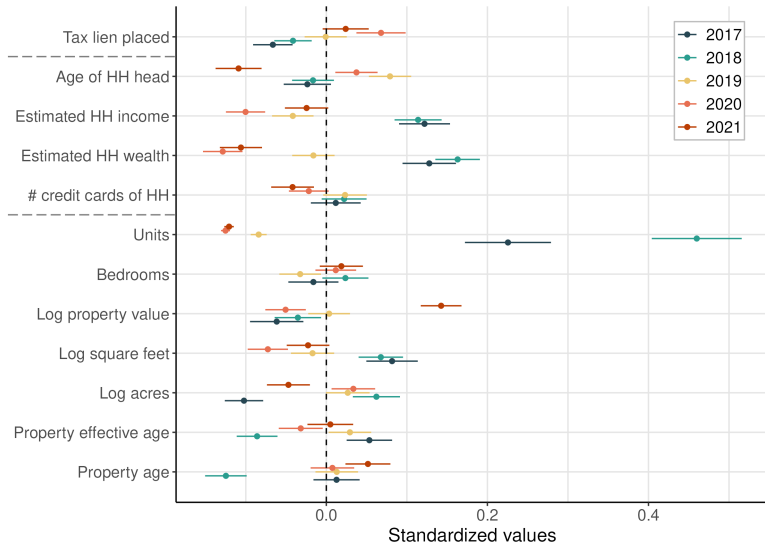
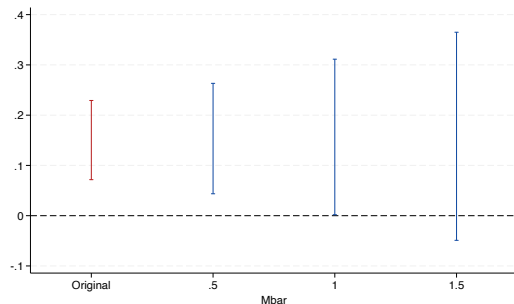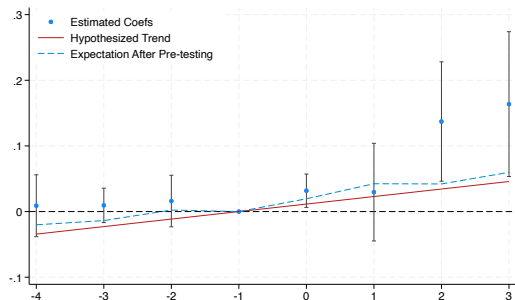# Negative selection of PACE relative to HELOC holds conditional on geography ⟿ Back

| Dep. variable: log(Price)	(1)	(2)	(3)	(4)	(5)	(6)
$PACE_{i,t}$	0.047***	0.040***	0.041***	0.047***	0.039***	0.027***
	(0.008)	(0.006)	(0.004)	(0.004)	(0.003)	(0.006)
$PACE_{i,t} \times Roof_i$						0.0202
						(0.017)
$PACE_{i,t} \times Windows_i$						0.024**
						(0.010)
$PACE_{i,t} \times HVAC_i$						0.024**
						(0.010)
$PACE_{i,t} \times Solar_i$						0.059**
						(0.027)
Observations	20,947	20,947	20,947	20,947	20,947	20,947
Month FE	Yes	Yes	Yes	Yes	Yes	Yes
County $\times$ Year FE	Yes	No	No	No	No	No
Zip code $\times$ Year FE	No	Yes	No	No	No	No
Census Tract $\times$ Year FE	No	No	Yes	Yes	Yes	Yes
Ex-ante Permits	No	No	No	Yes	Yes	Yes
Ex-post Permits	No	No	No	No	Yes	Yes
Mean Dep. Var.	12.422	12.422	12.422	12.422	12.422	12.422

- Problem: there may be property market-specific shocks differentially impacting property values across borrower cohorts

- Rambachan & Roth (2023) sensitivity test shows that these shocks would need to be quite large for us to conclude a null pricing effect

  ▶ Post-origination violation of parallel trends cannot exceed the maximal pre-origination violation (pivotal Mbar = 1)

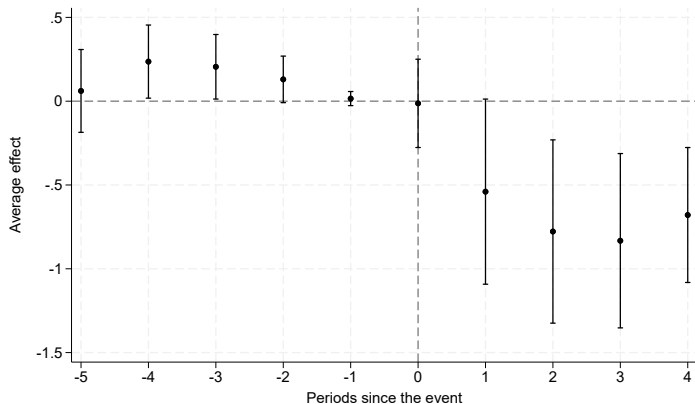# Lenders' supply response for purchase mortgages (stacked DiD estimator)

$$Lending_{i,c,t} = \beta \cdot \textit{PACE adoption}_{c,t} + \gamma' \cdot \mathbf{X}_{i,c,t} + \lambda_{c,y} + \varepsilon_{i,c,t}$$
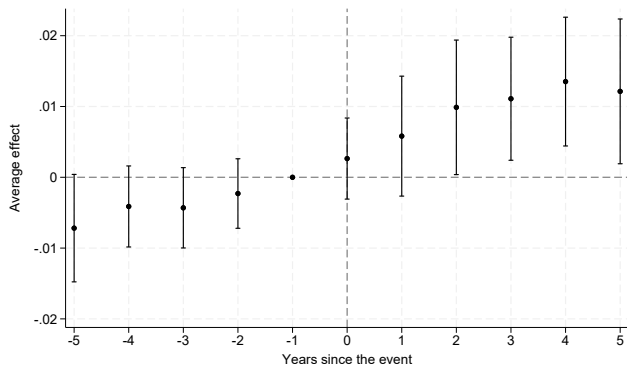
- $\implies$ Still no evidence of crowd-out in response to county PACE adoption [Back]

- Avg. number of HI loan applications in a tract-year $\implies 0.5/6 \approx -8\%$ decline

- PACE **substitutes** for HELOC despite rate spread due to financing constraints

Pooled SA DiD mortgage market results

Dep. variable:	Approval				PriSec	RateSpread
	(1)	(2)	(3)	(4)	(5)	(6)
PACE adoption$_{c,t}$	0.013***	0.016***	0.021***	0.008***	0.010***	0.016*
	(0.002)	(0.002)	(0.002)	(0.002)	(0.004)	(0.009)
Loan type	Purchase	Refinancing	Purchase	Purchase	Purchase	Purchase
Borrower Sample:	All	All	High LTI	Low LTI	All	All
Observations	2,136,429	1,705,797	1,037,778	1,098,026	1,817,657	624,855
R-squared	0.086	0.178	0.090	0.089	0.523	0.153
Census tract FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Lender FE	Yes	Yes	Yes	Yes	Yes	Yes
Borrower Controls	Yes	Yes	Yes	Yes	Yes	Yes
Mean Dep. Var.	0.843	0.843	0.836	0.874	0.328	0.945
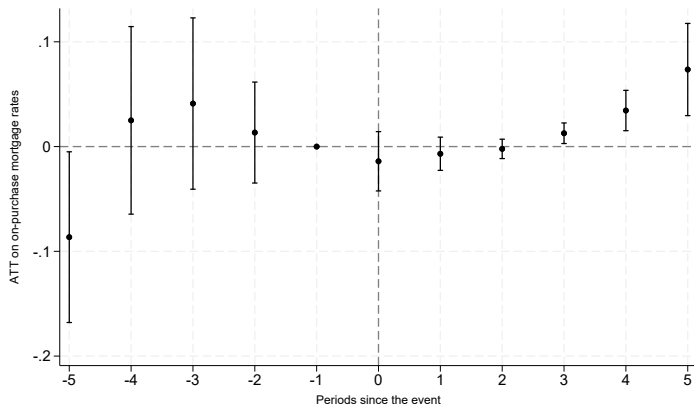
- Rate ↑ even conditional on applicant characteristics

- Consistent with model framework, since expected CLTI will be higher with PACE
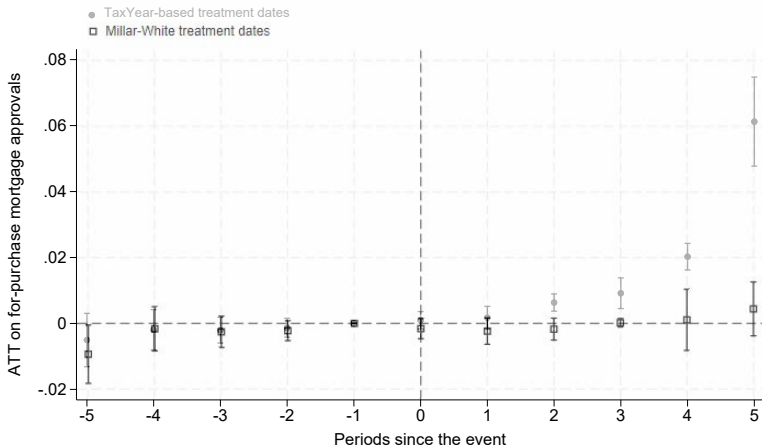
STRONGER RESPONSE OF APPROVALS FOR CONVENTIONAL LOANS
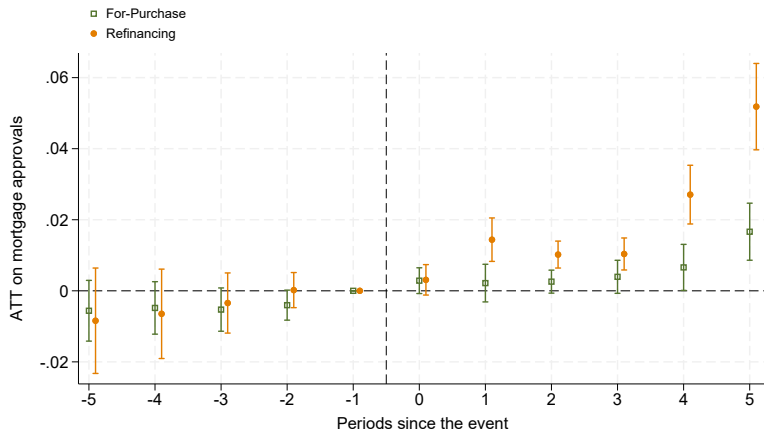
- Unsurprising given that conventional loans are not government-backed, and therefore super seniority of PACE is less of an issue ▸ Back

- Still, no evidence of crowdout even if we use purely news-based PACE adoption dates

Computing county-level tax rates

- We follow Horton et al. (2024), who map effective tax rates (ETRs) and statutory tax rates (STRs) across the U.S.

- Sample restrictions: 2015-19 to avoid COVID period, single-family homes and condos, winsorize sale prices at the 1st and 99th percentiles

- We compute ETRs as the average of the buyer's tax bill in $t+1$ and seller's tax bill in $t-1$ relative to the sale price in t:

$$ETR_{i,t} = \frac{TaxBill_{i,t+1} + TaxBill_{i,t-1}}{2 \cdot SalePrice_{i,t}}$$

- STRs follow the same convention but using winsorized assessed values rather than sale prices as the denominator

PACE adoption prevents HO insurance unraveling
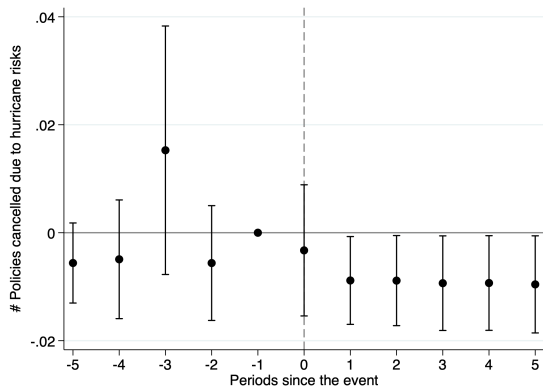
Notes: Data from Quarterly and Supplemental Reporting System (QUASR) collapsed to the county level for private homeowners insurance policies.

- **Persistent ≈ 1 p.p. ↓ in HO insurance policy cancellation rates**

- "Cancellation" is an action taken by the private insurance company

- Magnitude roughly matches the take-up rate of PACE among eligible FL single-family homes

- Effect shows up within one quarter of county PACE adoption

Zillow

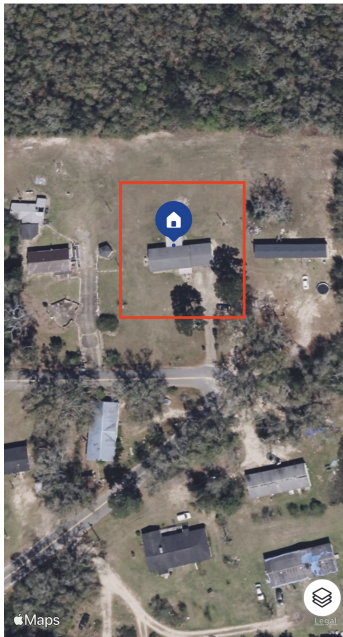3 bd | 1 ba | 984 sqft

388 Charlie Harris Loop, Quincy, FL 32352

● Off market

Zestimate®: **$136,700**   Rent Zestimate®: **$1,090**

Est. refi payment: $770/mo   ⓢ **Refinance your loan**

Home value | Owner tools | **Home details** | Neighborhood details

Public tax history

Year	Property taxes	Tax assessment
2023	$417 +1.9%	$60,071 +3%
2022	$409 -0.5%	$58,322 +3%
2021	$412 +1.4%	$56,624 -0.8%
2020	$406 -3.5%	$57,063 -1.3%
2019	$421	$57,825

- Households' expected utility function with mortgage repayment D, PACE repayment ℓ, and random income $\widetilde{R}_2$:

$$U(A, D) = \underbrace{-A}_{\text{down payment}} + \underbrace{\beta \int_{\underline{R}}^{D+\ell} \widetilde{R}_2 \ dF(\widetilde{R}_2)}_{\text{Expected utility if default}} + \underbrace{\beta \int_{D+\ell}^{\overline{R}} \widetilde{R}_2 - D - \ell \ dF(\widetilde{R}_2)}_{\text{Expected utility if no default}}$$

- HH defaults whenever $\widetilde{R}_2 < D + \ell$, and PACE increases probability of default (CDTI ↑)

- Lender's have profit function with discount factor $\delta > \beta$ (gains from trade):

$$\Pi(A, D) = \underbrace{-(H_0 - A)}_{\text{Loan amount}} + \underbrace{\delta \int_{\underline{R}}^{D+\ell} H + \Delta H - \ell \ dF(\widetilde{R}_2)}_{\text{Expected profit if borrower defaults}} + \underbrace{\delta \int_{D+\ell}^{\overline{R}} D \ dF(\widetilde{R}_2)}_{\text{Expected profit if borrower does not default}}$$

- PACE loans have a theoretically ambiguous effect on lenders' profits! ▸ Back

Mortgage lenders' responses à la Holmstrom/Tirole (2)

- Assume $\widetilde{R}_2$ uniformly distributed and optimal repayment $D^* \in [\underline{R}, \overline{R}]$

- First-order condition for households: `▸ Back`

$$\underbrace{\beta \int_{D+\ell}^{\overline{R}} dF(\widetilde{R}_2) - \beta(D+\ell)f(D+\ell)}_{\text{Marginal NPV cost of more debt repayment}} =$$

$$\underbrace{\delta(H + \Delta U - \ell)f(D+\ell) + \delta \int_{D+\ell}^{\overline{R}} dF(\widetilde{R}_2) - \delta D f(D+\ell)}_{\text{Marginal NPV benefit of lower downpayment}}$$

- **Key observation** $\partial D / \partial \Delta H > 0$: lenders more willing to supply credit when collateral recovery value is greater (i.e. loss given default is lower)

  - Since, ΔH is independent of $\widetilde{R}_2$, can think of this as lenders follow local HPI
  - Empirical results: ΔH from PACE-financed projects is large enough to avoid crowdout