

When Insurers Exit: Climate Losses, Fragile Insurers, and Mortgage Markets

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*Disclaimer: The views expressed do not represent the views of the Federal Reserve System.

Motivation

- | Unprecedented rise in climate-related property damage.
- | Yet economic activity in the riskiest areas continues to grow.
- | Are financial markets providing the right incentives?

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This paper:

- | We identify key frictions in how insurance and mortgage markets interact with each other.
- | We show distortions in:
 - | Who bears risks and how they are priced.
 - | How much credit flows to risky areas.

This Paper

Background: Physical climate losses are distributed through connections in the mortgage market.

Households

Home Equity

Lenders

Mortgage Origination

Insurers

Property Damage

GSEs

Mortgage Purchase

Novel Data: Link county-level property insurance data to mortgages for Florida.

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Key Friction: GSE insurer requirements are **mis-calibrated** GSEs accept risky insurers.

Main Findings

1. Fragile insurers with inflated ratings now dominate insurance markets.
2. GSEs are more exposed to fragile insurers, due in part to strategic securitization by lenders.
3. Fragile insurers amplify mortgage delinquency outcomes large taxpayer externality.
4. GSE policy increases credit supply in risky areas distorts adaptation.

Outline

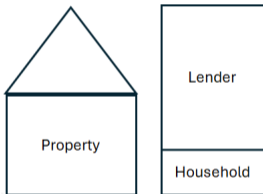
Institutional Background and Data

Empirical results:

- | Part 1: Insurance market trends.
- | Part 2: Mortgage securitization: who is bearing risks?
- | Part 3: Broader implications.

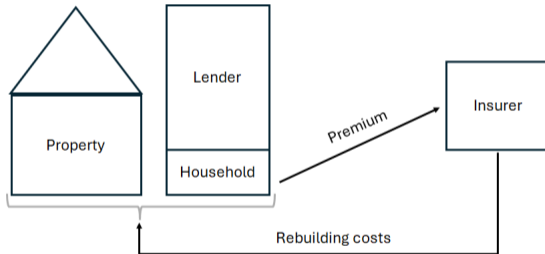
The distribution of physical climate risk

- Climate losses are distributed through connections in the mortgage market.



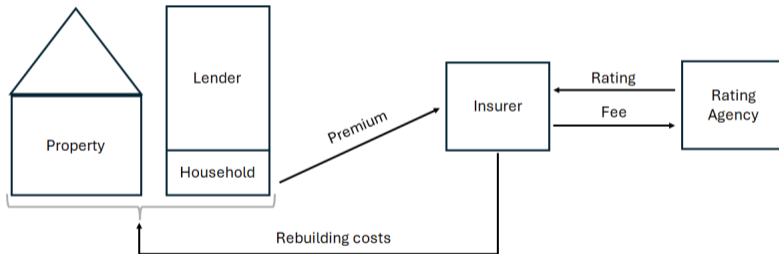
The distribution of physical climate risk

- Insurers protect **collateral** value + prevent **default**; absorbed vast majority of the losses.



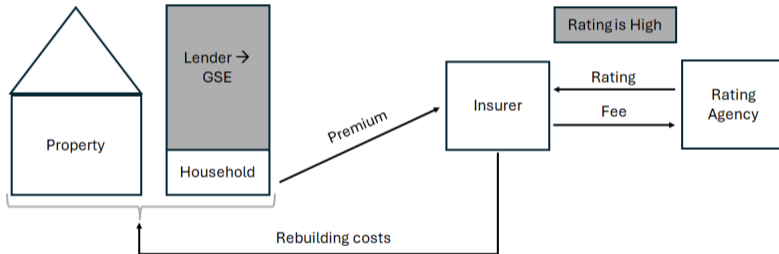
The distribution of physical climate risk

- Banks sell loans to GSEs (e.g., Fannie Mae) GSEs rely on insurer **ratings** to assess eligibility.



The distribution of physical climate risk

- If ratings are **high** enough, loans are eligible to be sold to the GSEs.



GSEs insurance requirements and pricing

- | Homeowners insurance is **mandatory** to obtain a mortgage (all households, not just high risk).

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- GSEs have a **minimum Financial Strength Rating** requirement for insurers.

Rating Agency	Type	Began	Fannie Mae	Freddie Mac
AM Best	Traditional	1899	"B" or better	"B+" or better
S&P Global	Traditional	1971	"BBB" or better	"BBB" or better
Demotech	Emerging	1990s	"A" or better	"A" or better

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- Types of insurers:
 - Traditional insurers:** rated *only* by AM Best/ S&P.
 - Demotech insurers:** rated at *some point* by Demotech.
 - Citizens:** Florida government run insurer-of-last-resort (residual market).

Outline

Empirical results:

- | **Part 1: Insurance market trends.**
- | Part 2: Mortgage securitization: who is bearing risks?
- | Part 3: Broader implications.

Demotech insurers have grown dramatically

(i) Premiums over time

(ii) Premium shares across counties

Demotech insurers have grown dramatically

(i) Premiums over time

(ii) Premium shares across counties

I Dramatic rise of Demotech insurers who dominate a large fraction of counties.

▶ Across US Trend

Insolvency rates and Demotech FSRs

- I Underwrite in riskier areas, less diversified, less capitalized, riskier reinsurance relationships.
- I % of Demotech insurers go insolvent.

riskierareas

diversification

balancesheet

reinsurance

	Demotech	Traditional
No. insurers	80	50
Liquidated	15	0
% liquidated	19%	0.0%

Note: We track liquidations between 2009 and 2022.

- I A^{00} and A^0 (Unsurpassed), A (Exceptional)

Demotech insurers receive in ated ratings

▶ Model

- | 21% would not meet Fannie (blue line); 67% would not meet Freddie (red line).
- | Insolvent insurers would not have been eligible for GSE securitization prior to their insolvency

Outline

Empirical results:

- I Part 1: Insurance market trends.
- I Part 2: Mortgage securitization: who is bearing risks?
- I Part 3: Broader implications.

GSEs bear large exposure to Demotech insurers

	(1)	(2)	(3)	(4)
	GSE Share	GSE Share	GSE Share	GSE Share
Demotech Share	0.291*** (0.0388)	0.224*** (0.0599)	0.0820** (0.0403)	0.0837** (0.0399)
County FE	N	N	Y	Y
Year FE	N	Y	Y	Y
Controls	N	N	N	Y
Sample Period	2009-2018	2009-2018	2009-2018	2009-2016
Number of Observations	670	670	670	536
Adjusted R-squared	0.255	0.283	0.746	0.767

$$\text{GSE Share}_{c,t} = \text{Demotech Share}_{c,t} + \alpha_c + \beta_t + \gamma X_{ct} + \epsilon_{c,t}$$

- | GSE market shares strongly covary with Demotech shares both across and within counties.
- | Magnitudes: Demotech share rose by 20pp (2009-18) GSE share' by 1.6pp (8% of average).

Explaining GSE exposures: insurer quality and borrower selection

- I Two potential explanations for why we observe higher GSE shares:
 1. Causal effect of insurer quality: Lenders avoid exposure to Demotech insurers.
 2. Borrower selection: Lenders reduce exposure to high risk borrowers, and high risk are insured by Demotech insurers.


Strong selection: Demotech insurers serve lower income households

Market shares by no. of policies

- | Use coverage as a proxy for home value.
 - | Lower coverage → Lower valued homes
 - ! Lower income households.
- | Lower (higher) valued homes more likely to have Demotech (Traditional) insurers.
- | Demotech insurers charge lower premiums, controlling for risk. ▶ Pricing
- | Demotech has higher shares in what is likely the conforming market

Identifying causal effect of insurer quality

We address borrower selection using **Citizens depopulation natural experiment.**

- | Citizens provides incentives to private insurers to assume policies.
- | Program was large > 850K policies transferred to private insurers between 2009 and 2018.
- | Demotech insurers dominate the depopulation program (39/40 participating insurers) 
- | Participating insurers have higher insolvency rates and counterfactual AM Best ratings **A-**.
- | Advantage: Shift from a high quality to a low quality insurer for the same borrower.

Are mortgages more likely to be sold to the GSEs following a Depopulation?

Empirical approach

$$\log(\text{GSE})_{c;t} = \alpha + \log(\text{Depopulated})_{c;t} + \beta_c + \gamma_t + X_{ct} + \epsilon_{c;t}$$

$\text{GSE}_{c;t}$: Dollar value of mortgages sold after the origination year to the GSEs in county c , year t .

$\text{Depopulated}_{c;t}$: Policies transferred to Demotech in county c , year t . [Details](#)

Institutional features:

- Not all conforming mortgages are immediately securitized: only 50% sold within 3 months. [Details](#)

Identifying assumptions:

- Declines in borrower quality do not correlate with the Depopulation schedule.
 - Schedule is pre-determined & unlikely to coincide with changes in borrower characteristics.
 - Insurers unlikely to choose worse quality homeowners.
- Nothing else about the Depopulated insurance contract changes (coverage, premiums).

Depopulation experiment shows banks avoid counterparty risk

	(1)	(2)	(3)	(4)
	log(GSE)	log(GSE)	log(GSE)	log(GSE)
log(Depopulated)	0.795	0.929	0.0343	0.0331
	(0.0367)	(0.0346)	(0.0157)	(0.0162)
County FE	N	N	Y	Y
Year FE	N	Y	Y	Y
Controls	N	N	N	Y
Sample Period	2009-2018	2009-2018	2009-2018	2009-2018
Number of Observations	619	619	619	618
Adjusted R-squared	0.580	0.762	0.974	0.974

$$\log(\text{GSE})_{c;t} = \alpha + \beta \log(\text{Depopulated})_{c;t} + \gamma_c + \delta_t + X_{ct} + \epsilon_{c;t}$$

- Magnitudes: Average annual growth rate in takeouts 62% GSE purchases by 1.8% (9% of average). [Details](#)

Outline

Empirical results:

- I Part 1: Insurance market trends.
- I Part 2: Mortgage securitization: who is bearing risks?
- I Part 3: Broader Implications

Broader Implications

1. Effect on household welfare: serious delinquency
2. Taxpayer externality: quantifying GSE exposure (back-of-the-envelope)
3. Distorted adaptation: Too much credit supply

1. Delinquency event study around hurricane Irma

Hurricane Irma: Hit Florida in Sep 2017; \$50bn in damages and significant insurer insolvencies.

Event study (difference-in-differences approach):

$$\text{Serious Delinquency Rate}_{c,t} = \beta_1(\text{Post Irma} \cdot \log \text{Damages}_{c,t}) + \beta_2(\text{Post Irma} \cdot \text{Insolvent Insurer Share}_{c,t}) + \alpha_c + \alpha_t + \epsilon_{c,t}$$

Variable definitions:

- | Serious Delinquency Rate: 90 day+, foreclosure, REO.
- | logDamages: property damages within 3 months after Irma.
- | Insolvent Insurer Share: county's ex-ante exposure to insolvent insurers (premium shares) in the year before the storm.

1. Delinquency trends by exposure to hurricane Irma

- | Serious delinquencies: 90+ DPD, foreclosures, REO.
- | Exposed: Counties receiving Presidential disaster declaration

[▶ Back](#)

1. Delinquency event study around hurricane Irma

		Seriously Delinquent Rate					
		(1)	(2)	(3)	(4)	(5)	(6)
Post Irma=1	Log Damages	0.000919** (0.000345)	0.000653** (0.000289)			0.000635** (0.000294)	0.000450* (0.000267)
Post Irma=1	Insolvent Insurer Shares			0.106*** (0.0291)	0.0760*** (0.0242)	0.0853*** (0.0280)	0.0612** (0.0241)
	County FE	Y	Y	Y	Y	Y	Y
	Year-Month FE	Y	Y	Y	Y	Y	Y
	Number of Observations	1250	3800	1250	3800	1250	3800
	Adjusted R-squared	0.773	0.813	0.780	0.814	0.788	0.815
	Time Period	9/2016- 9/2018	9/2016- 12/2022	9/2016- 9/2018	9/2016- 12/2022	9/2016- 9/2018	9/2016- 12/2022

- Surge in delinquencies after disasters, e.g., by 20 bps in the average loss county.
- Delinquencies further, e.g., by 26 bps, where insurers are more fragile (average county).

2. Estimating GSEs' climate and insurance market exposures

$$\text{Expected Losses} = \underbrace{P_B \{Z\} \text{LGD}_B}_{\text{Baseline}} + \underbrace{P_H (\text{DIR} + \{Z\} \text{INS}) \text{LGD}_H}_{\text{Hurricane}} :$$

- Approach: Extrapolate from the delinquency dynamics during Irma (CAT3/4 hurricane).

	No hurricane	Hurricane
Probability ⁽¹⁾	73%	27%
Default rate ⁽²⁾	1.2%	1.7%
Loss given default ⁽³⁾	40%	40%
Loan size	\$100	
Expected loss	\$ 0.53	
Expected loss (hurricane)	\$ 0.05	
% losses (hurricane)	9.6%	
Contribution of insurance fragility	57%	

- 10% of GSE losses are due to climate, due in large part to local insurance market fragility.

Sources: ⁽¹⁾ CAT 3/4 hurricanes in FL. US National Hurricane Center (2023); ⁽²⁾ Our estimates; ⁽³⁾ An and Cordell (2019).

3. GSE mortgage expansion in "Demotech" counties

- ⌋ Mortgage lenders are more likely to deny jumbo loans in Demotech counties.
- ⌋ Acceptance of Demotech by GSE expansion of credit supply in the conforming segment.

		Mortgage Denied (Y/N)	
		(1)	(2)
jumbo=1		-0.0265*	-0.0279*
		(0.0152)	(0.0144)
Demotech Premium Share		-0.0166	-0.0152
		(0.0164)	(0.0161)
jumbo=1	Demotech Premium Share	0.0526**	0.0521**
		(0.0208)	(0.0201)
County FE		Y	Y
Year FE		Y	Y
Controls		N	Y
Number of Observations		2,275,138	2,250,777
Adjusted R-squared		0.0112	0.0131

Conclusion and next steps

This paper: GSE insurance requirements are mis-calibrated leading to growth of fragile insurers.

- | GSEs bear large unpriced exposure to climate due to insurance risk taxpayer externality.
- | Too much GSE mortgage origination in risky areas is a distorted adaptation.

Next steps:

- | Optimal GSE policy: "pricing" in counterparty risk into g-fees.

Appendix

Homeowners vs. Flood

	Homeowners insurance	Flood insurance
1. Who sells	Private sector	Government
2. Coverage sold per year	> \$15 trillion	\$1 trillion
3. % of losses (natural disasters)	93%	100%
4. Risks covered	All perils except flood	Flood
5. Take up	85%	< 20%
6. Mortgage requirements	Mandatory for all homeowners	Mandatory only in high risk zones
7. GSE requirements	FSR based	N/A

▶ Back

Demotech market share across US states

Counterfactual AM Best ratings of Demotech insurers

Step 1: AM Best rating replication model.

- | Mapping observable insurer characteristics to AM Best FSRs.

$$AMBFSR_{it} = \alpha + \beta X_{it} + \epsilon_i \quad (1)$$

- | Choosing characteristics:

- | Literature: measures of insurers' risk and capitalization from Koijen and Yogo (2015).
- | LASSO regression.
- | AM Best factors from publicly available reports.

- | Model explains 60% of the variation in AM Best FSRs. Predictive model Distribution

Step 2: Predict counterfactual ratings of Demotech insurers

- | For the last year an "A" or higher rating was assigned by Demotech.

$$AMBFSR_{DEM} = \alpha + \beta X_{DEM} \quad (2)$$

- | Construct confidence intervals numerically using bootstrapping Back

Note: 1,000 predicted values simulated for each model. Dots = average, bars = 90% confidence interval.

AM Best rating replication model (panel)

	AM Best rating _{it}		
	(1)	(2)	(3)
% bonds in NAIC 3+	0.838 (1.362)		
% assets in equities	1.185 (0.569)		1.127 (0.561)
No. states selling HO	0.012 (0.005)	0.011 (0.004)	0.012 (0.004)
% of assets in the group	0.012 (0.003)	0.009 (0.002)	0.012 (0.003)
% premium from HO	0.024 (0.003)	0.023 (0.003)	0.024 (0.003)
Leverage ratio	5.474 (1.461)		5.591 (1.447)
Leverage ratio ²	8.838 (1.578)	3.644 (0.572)	8.921 (1.571)
Log(Assets)	1.584 (0.482)	0.520 (0.050)	1.572 (0.481)
Log(Assets) ²	0.042 (0.018)		0.042 (0.018)
Log(RBC ratio)	0.276 (0.100)	0.095 (0.093)	0.286 (0.099)
Loss Ratio (Florida)	0.478 (0.140)	0.388 (0.141)	0.491 (0.138)
% premiums reinsured	1.505 (0.332)	2.177 (0.287)	1.529 (0.330)
Constant	17.550 (3.537)	8.446 (1.289)	17.579 (3.535)
Variable choice	All	Lasso	Selected
Observations	589	589	589
R ²	0.588	0.564	0.588
Adjusted R ²	0.580	0.558	0.580

▶ Back

AM Best FSRs distribution

Ratings shopping (suggestive evidence)

GSE ineligible insurers have minimal market shares

I GSE ineligible insurers have minimal market shares [▶ Back](#)

Insurance regulation

(a) Regulatory supervision over time	2009-2013 (1)	2014-2018 (2)	Difference (1) - (2)
Likelihood of exam in a year (%)	36.2	28.1	8.1
% insurers ever restated	34.4	24.6	9.8
% exams with restatements	37.6	21.3	16.3**
(b) Regulatory supervision across insurers	Demotech (1)	Traditional (2)	Difference (1) - (2)
Likelihood of exam in a year (%)	32.6	25.7	6.9
% insurers ever restated	35.5	28.6	6.9
% exams with restatements	30.8	21.4	9.4
(c) Consumer complaints	Demotech (1)	Traditional (2)	Difference (1) - (2)
Share of complaints	87.9	12.1	75.9***
Likelihood of any complaints in a year (%)	79.7	48.5	31.2***

▶ Back

Demotech insurers dominate the depopulation program

- | 40 insurers participate, of which 39 are Demotech.
- | Participating insurers have higher insolvency rates and counterfactual AM Best rating C++.
- | Depopulation: shift from a high quality to a low quality insurer.

▶ Back

Citizens to Demotech policy flows

- | Assumption: Policies transferred to Demotech insurers come from Citizens.
 - | Challenge: we observe total transfers at an insurer-county-year level; not policy level data.
 - | Almost one-for-one relation between policies transferred from Citizens to policies received by Demotech insurers

On-balance sheet conforming loans Back

(i) Share of conforming mortgages retained/ sold (HMDA)

(ii) Time to GSE sale (McDash)

- | Significant heterogeneity in time-to-securitization for conforming loans (Keys, Seru & Vig, 2012)
- | Time-to securitization is longer for better mortgages (Adelino, Gerardi & Hartman-Glaser, 2019)
- | Banks retain higher share of conforming loans when capital improves (Eschak, Matvos, Piskorski & Seru, 2022)

Effect of depopulation on number of loans securitized

	(1)	(2)	(3)
Depopulated Policies	0.0639*** (0.00913)	0.0714*** (0.00971)	0.0623*** (0.00847)
Year FE	N	Y	N
Controls	N	N	Y
Sample	2009-2018	2009-2018	2010-2018
Obs	670	670	596

$$\text{Num GSE}_{c;t} = \alpha + \beta \text{ Num Depopulated}_{c;t} + \gamma_t + X_{ct} + \epsilon_{c;t}$$

- Magnitudes: 6 out of 100 depopulated policies are sold to GSEs. Assuming banks retain 20% mortgages! purchase rate of 30% [▶ Back](#)

Delinquency trends by exposure to Irma

- | Serious delinquencies: 90+ DPD, foreclosures, REO.
- | Exposed: Counties receiving Presidential disaster declaration [▶ Back](#)

Demotech insurers have lower premiums

	Premium		Premium growth	
	(1)	(2)	(3)	(4)
Demotech	69.66*** (11.3)	-38.08** (18.2)	0.0002 (0.002)	-0.013*** -0.002
Year FE	Y	Y	Y	Y
County FE	N	Y	N	Y
Risk controls	N	Y	N	Y
N	46,313	46,311	39,555	39,554

$$Y_{i;c;t} = \text{Demotech}_i + \alpha_t + \beta_c + \text{Risk controls}_{i;c;t} + \epsilon_{i;c;t}$$

- On average higher because they serve riskier households. Lower after controlling for risk.
- Magnitudes: Demotech policies are 38% cheaper and premium growth is 1.3% lower per year (controlling for risk using coverage as a proxy).

Back

Traditional insurers exit after climate events

(i) Cancellations by climate risk

(ii) Event study: hurricane Irma

Traditional insurers exit after climate events

(i) Cancellations by climate risk

(ii) Event study: hurricane Irma

		Cancellation Rate			
		(1)	(2)	(3)	(4)
Post _{Irma}	Traditional	0.119*** (0.0194)	0.0993*** (0.0184)	0.326*** (0.0241)	
Post _{Irma}	Traditional High Risk				0.0796** (0.0319)
	County FE	Y	Y	Y	N
	Year FE	Y	Y	Y	N
	Insurer FE	Y	Y	Y	N
	County-Year FE	N	N	N	Y
	Insurer-Year FE	N	N	N	Y
	County-Insurer FE	N	N	N	Y
	Observations	18414	17083	1330	18050
	Adj R-squared	0.0822	0.0906	0.109	0.422
	Sample	All	Low Risk	High Risk	All

I High cancellations, particularly in riskier counties which rise even further after natural disasters.

Demotech insurers are worse on observables (1/3)

1. Riskier liabilities: Demotech insurers underwrite more in high risk counties.

	Share underwritten in high risk counties		
	Premiums (1)	Number of Policies (2)	Coverage (3)
Demotech	0.0242*** (0.00505)	0.0243*** (0.00488)	0.0215*** (0.00504)
Observations	924	924	924
Adjusted R ²	0.022	0.025	0.017
yearfe	Y	Y	Y

Note: High risk counties are those classified by FEMA as being in risk categories 3, 4, and 5.

Back

Demotech insurers are worse on observables (2/3)

2. **Poor diversification:** Demotech insurers are significantly less diversified across geographies, business lines, and group structure.

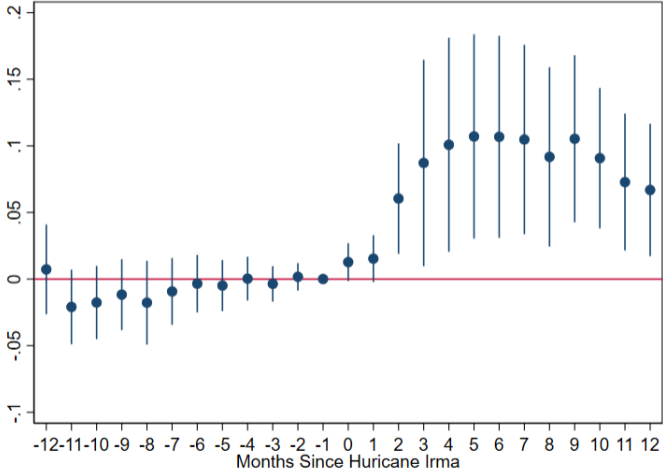
	Demotech (1)	Traditional (2)	Difference (1) - (2)
No. states selling HO	3.45 (0.73)	27.7 (2.87)	-24.2***
% of insurers selling in only 1 state	0.56 (0.06)	0.1 (0.04)	0.46***
% premium from HO	0.70 (0.03)	0.24 (0.03)	0.45***
No. insurers in the group	5.9 (1.0)	18.5 (2.2)	-12.6***
% belonging to a 2 or less insurer group	0.46 (0.06)	0.04 (0.03)	0.42***

Demotech insurers are worse on observables (3/3)

3. **Solvency and reinsurance:** Demotech insurers have less capital relative to risks, rely more on reinsurance, and have riskier and concentrated reinsurance relationships.

	Demotech (1)	Traditional (2)	Difference (1) - (2)
<hr/> (a) Balance sheet and solvency <hr/>			
Assets (\$ million)	312.4 (150.4)	3914.6 (1020)	-3602.3***
RBC ratio	2173 (517.1)	3790 (876.3)	-1617*
<hr/> (b) Reinsurance <hr/>			
% premiums reinsured	0.47 (0.03)	0.15 (0.04)	0.32***
% reinsurance partners rated above A	0.33 (0.01)	0.39 (0.04)	-0.07*
Fraction of premiums ceded to largest partner	0.13 (0.02)	0.04 (0.01)	0.09***

Dynamic treatment effect of insurer insolvencies



▶ Back

Conforming loans default more after storms

	Share Seriously Delinquent (%)			
	(1)	(2)	(3)	(4)
conforming=1	0.00732*** (0.000987)	0.00561*** (0.00152)	0.00791*** (0.00132)	-0.0233 (0.0214)
post_irma=1 × conforming=1	0.0213*** (0.00177)	0.0357*** (0.0121)	0.0470*** (0.00433)	-0.0200 (0.0951)
post_irma=1 × log_damages	0.000807*** (0.000283)	0.00226 (0.00150)	0.000874 (0.000587)	0.0224 (0.0135)
Constant	0.00325*** (0.000904)	0.0181*** (0.00267)	0.0125*** (0.00285)	0.0462 (0.0455)
County FE	Y	Y	Y	Y
Year-month FE	Y	Y	Y	Y
Number of Observations	Y	Y	Y	Y
Adjusted R-squared	1Y	FULL	FULL	FULL
Sample	FULL	FULL	Insolvency Exposure (top 25%)	Insolvency Exposure (bottom 25%)
N	2250	6840	2812	988
r2_a	0.806	0.385	0.843	0.273

- | Conforming loans default more after Irma than jumbo loans, over the short and long-term
- | This result is driven by counties exposed to the insolvent insurers