

# Climate, Amenities and Banking: El Niño in the US

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Harnessing Finance for Climate

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# Climate and Banking

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Physical risk from weather events relevant for financial institutions

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Limited evidence on physical climate risk except for natural disasters (Cortes and Strahan, 2017; Ouazad and Kahn, 2022; Nguyen et al., 2022)

Government intervention and insurance after disasters. Impact of non-destructive climate shocks not well understood

# Our Contribution

Propose and test a new mechanism:

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(Focus on short-term fluctuations, not long-term)

# Mechanism



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## Bank

Assets	Liabilities

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Loans	Deposits
Mortgages	Borrowings
Bonds	Bonds
Cash	Equity
& more...	& more...

# Mechanism

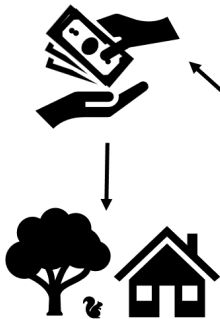


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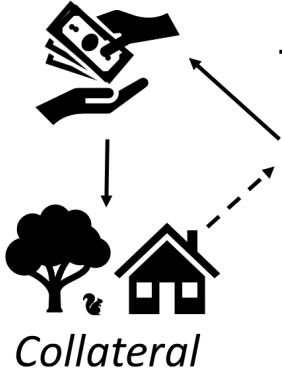


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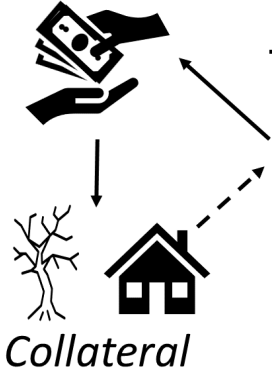
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*Collateral* ↓

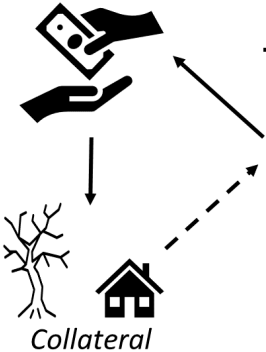
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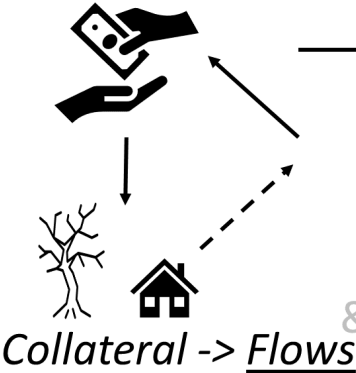


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Bank



Also Stock  
of Existing  
Mortgages

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# Mechanism

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Transmit to  
Balance  
Sheet

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- 5 Demand vs supply → **bank factors are key**
- 6 A LASSO analysis of climate resilience → **not today**

# Literature: Climate Change & Finance

- 1 **Climate risk priced in asset prices:** Baldauf et al., 2020; Engle et al. 2020; Painter, 2020; Bolton and Kacperczyk, 2021, 2022; Giglio et al. 2021; Goldsmith-Pinkham et al., 2021; Acharya et al., 2022
- 2 **Banks and natural disasters:** Cortés and Strahan, 2017; Ouazad and Kahn, 2019; Nguyen et al. 2022; Blickle et al, 2022; Sastry, 2022
- 3 **Banks and transition risk:** Ivanov et al., 2022; Kacperczyk and Peydro, 2022; Oehmke and Opp 2022; Correa et al., 2022, Degryse et al. 2023a,b; Giannetti et al., 2023; Accetturo et al., 2022
- 4 **El Niño and other outcomes:** Brunner, 2002; Hsiang et al., 2011; Novy-Marx, 2014; Dingel et al., 2019

# Identification Strategy

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- 3 *Heterogeneous cross-section*
  - ▶  $\neq$  exposure across counties (warmer, colder or zero)

# ENSO - El Niño Southern Oscillation

Fluctuation of the ocean-atmospheric system (wind+surface temperature) in the tropical Pacific, affecting weather worldwide



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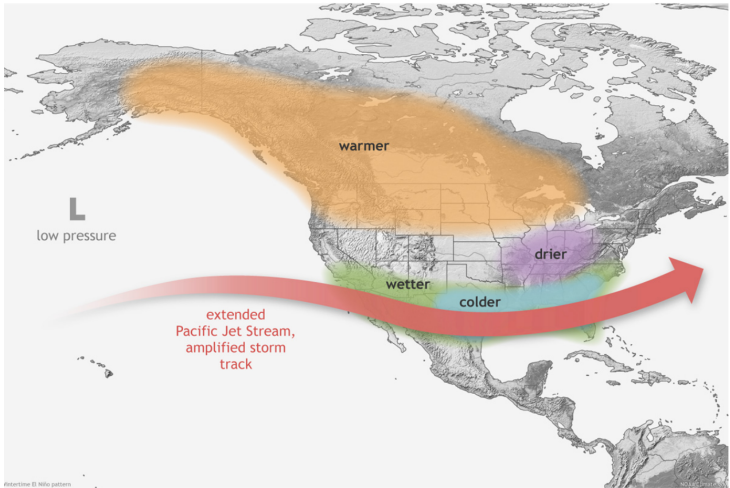
Increase in ocean temperature + weakening of the westward winds  $\Rightarrow$  warm water spills eastward towards Americas

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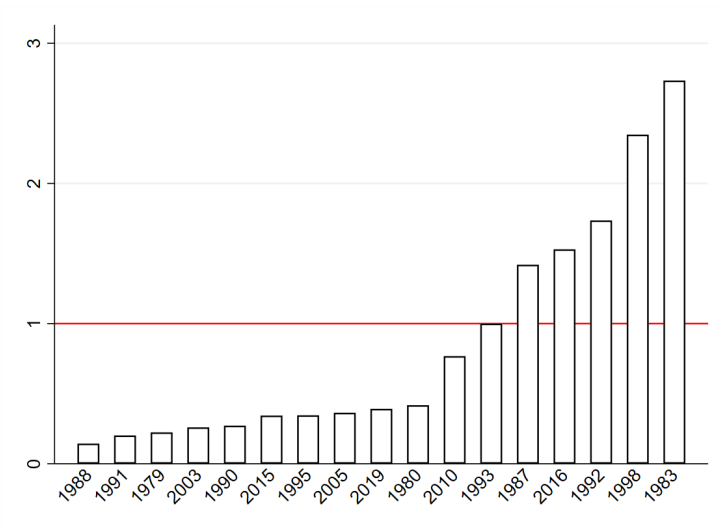
Increase in ocean temperature + weakening of the westward winds  $\Rightarrow$  warm water spills eastward towards Americas

Most significant impact of El Niño in US is due to a shift in the location of the jet stream (heterogeneity across US ares)



Note: Source NOAA (2021)

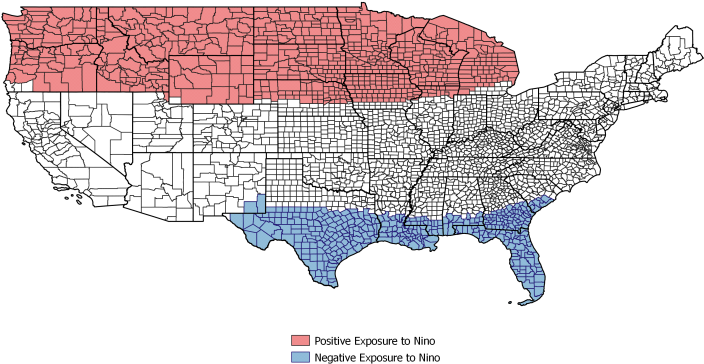
# Oceanic temperature index (MEI v2)



Focus on the “top 5” Niño events: 1983, 1987, 1992, 1998, 2016 ( $\geq 1^\circ$ )



# Cross-Section



Note: authors map based on NOAA (2021)

# Data

Sample period: 1981-2019 (bank balance sheet data from 1993)

- *Temperatures*: NOAA weather stations
- *Natural disasters*: FEMA Disaster Declarations Summary
- *House Prices*: county-level House Price index from Federal Housing Finance Agency (FHFA)
- *Mortgage lending*: Home Mortgage Disclosure Act (HMDA). Merged with Call Reports using the Avery file
- *Natural Amenities*: Natural Amenities Scale from USDA + water and soil salinity from Thorslund and van Vliet (2020) and Ivushkin et al. (2019)

# Empirical Analysis and Results

# 1. Climate and El Niño



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County and year fixed effects ( $\alpha_c \gamma_t$ ). std.err. clustered at county

Table 2a: Climate and El Niño

Variables	(1)	(2)	(3)
	Average Temperatures		
<i>Positive Exposure<sub>c</sub></i> × <i>El Nino<sub>t</sub></i>	0.629*** (0.0163)		0.575*** (0.0168)
<i>Negative Exposure<sub>c</sub></i> × <i>El Nino<sub>t</sub></i>		-0.506*** (0.0151)	-0.362*** (0.0153)
County FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Obs.	122,883	122,883	122,883
Adj. R sq.	0.962	0.962	0.962
Mean Dep. Var.	12.90	12.90	12.90

Table 2b: Climate and El Niño

Variables	(1)	(2)	(3)
	Probability of Disaster		
<i>Positive Exposure<sub>c</sub></i> ×	-0.0380***		-0.0189**
<i>El Nino<sub>t</sub></i>	(0.00871)		(0.00877)
<i>Negative Exposure<sub>c</sub></i> ×		0.135***	0.131***
<i>El Nino<sub>t</sub></i>		(0.00913)	(0.00921)
County FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Obs.	127428	127428	127428
Adj. R sq.	0.202	0.203	0.203
Mean Dep. Var.	0.306	0.306	0.306

## 2. County Lending and House Prices

Table 3: County Mortgage Lending and El Niño

Variables	(1)	(2)	(3)
		Lending	
<i>Positive Exposure<sub>c</sub></i> × <i>El Niño<sub>t</sub></i>	-0.116*** (0.0170)		-0.112*** (0.0173)
<i>Negative Exposure<sub>c</sub></i> × <i>El Niño<sub>t</sub></i>		0.0537*** (0.0186)	0.0274 (0.0190)
County FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Obs.	91,596	91,596	91,596
Adj. R sq.	0.916	0.916	0.916
Mean Dep. Var.	10.45	10.45	10.45

## 2. County Lending and House Prices

Table 3: County House Price Index and El Niño

Variables	(1)	(2)	(3)
	House Price Index		
<i>Positive Exposure<sub>c</sub></i> × <i>El Nino<sub>t</sub></i>	-0.0140*** (0.00252)		-0.0139*** (0.00259)
<i>Negative Exposure<sub>c</sub></i> × <i>El Nino<sub>t</sub></i>		0.0041 (0.0036)	0.0007 (0.0037)
County FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Obs.	79,481	79,481	79,481
Adj. R sq.	0.875	0.875	0.875
Mean Dep. Var.	108.62	108.62	108.62



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First test: see if El Niño effects are stronger in high amenities area

Natural Amenities Scale from USDA combining six measures of climate, air, topography, and water surfaces

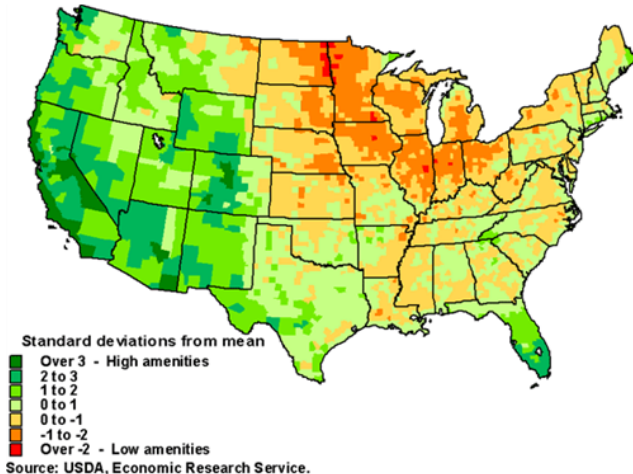
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Only cross-sectional variation (not time varying)



Note: map from USDA - ERS

Variables	(1)	(2)	(3)
		House Prices	
<i>Positive Exposure<sub>c</sub></i>	-0.0140***		-0.0136***
× <i>El Nino<sub>t</sub></i>	(0.00252)		(0.00272)
<i>Natural Amenities<sub>c</sub></i>		-0.0306***	-0.0296***
× <i>El Nino<sub>t</sub></i>		(0.00227)	(0.00260)
<i>Positive Exposure<sub>c</sub></i> × <i>Natural Amenities<sub>c</sub></i> × <i>El Nino<sub>t</sub></i>			-0.0168*** (0.00494)
County FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Obs.	79,481	79,481	79,481
Adj. R sq.	0.858	0.858	0.858
Mean Dep. Var.	1.068	1.068	1.068

Variables	(1)	(2)	(3)
	Mortgage Lending		
<i>Positive Exposure<sub>c</sub></i> × <i>El Nino<sub>t</sub></i>	-0.116*** (0.0170)		-0.102*** (0.0213)
<i>Natural Amenities<sub>c</sub></i> × <i>El Nino<sub>t</sub></i>		-0.0135 (0.0135)	-0.0191 (0.0147)
<i>Positive Exposure<sub>c</sub></i> × <i>Natural Amenities<sub>c</sub></i> × <i>El Nino<sub>t</sub></i>			-0.0613* (0.0346)
County FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Obs.	91,596	91,596	91,596
Adj. R sq.	0.916	0.916	0.916
Mean Dep. Var.	10.47	10.47	10.47

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Use data on both water (Thorslund and van Vliet, 2020) and soil salinity (Ivushkin et al., 2019)

### 3. Natural Amenities and El Niño

Variables	(1)	(2)	(3)	(4)	(5)	(6)
		Water Salinity			Soil Salinity	
<i>Pos Exp<sub>c</sub></i> × <i>El Nino<sub>t</sub></i>	0.134*** (0.029)		0.0809*** (0.026)	0.0413*** (0.004)		0.0345*** (0.004)
<i>Neg Exp<sub>c</sub></i> × <i>El Nino<sub>t</sub></i>		-0.395*** (0.120)	-0.374*** (0.121)		-0.054*** (0.008)	-0.046*** (0.008)
County FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	53,838	53,838	53,838	21,756	21,756	21,756
Adj. R sq.	0.724	0.724	0.724	0.741	0.741	0.741
Mean Dep. Var.	1.045	1.045	1.045	0.160	0.160	0.160

## 4. Bank-level analysis and El Niño

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Do the county effects aggregate at bank-level?

$$Y_{bt} = \alpha_b + \gamma_t + \beta \text{Bank Exposure}_b \times \text{El Nino}_t + \varepsilon_{bt}$$

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$Y_{bt}$  are bank-level balance sheet characteristics (loans, deposits etc)

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$$\text{Bank Exposure}_b = \sum_c \text{Exposure}_c \times \text{Share}_{bc}$$

Bank and year fixed effects ( $\alpha_b \gamma_t$ ). std.err clustered at bank level

Table 4: Bank level effects of El Niño

Variables	(1) Loans	(2) Deposits	(3) Assets
$Bank\ Exposure_b \times El\ Nino_t$	-0.0133*** (0.0050)	-0.0087** (0.0038)	-0.0089** (0.0035)
Bank FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Obs.	85,616	85,616	85,616
Adj. R sq.	0.911	0.930	0.945
Mean Dep. Var.	11.76	12.15	12.32



Table 5: The Transmission of El Niño on Bank Lending

Variables	(1) Real Estate	(2) Commercial and Industrial	(3) Consumer Lending
$Bank\ Exposure_b \times El\ Niño_t$	-0.0101* (0.00580)	-0.0135** (0.00588)	0.00208 (0.00680)
Bank FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Obs.	85,802	85,540	85,536
Adj. R sq.	0.921	0.888	0.877
Mean Dep. Var.	11.41	9.791	8.844

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Alternatively: bank-year ( $\gamma_{bt}$ ) or county-year ( $\alpha_{bt}$ ) fixed effects

Variables	(1)	(2)	(3)
	Log(Mortgage Lending)		
<i>Positive Bank Exposure<sub>b</sub></i> ×	-0.217***	-0.240***	
<i>El Nino<sub>t</sub></i>	(0.075)	(0.079)	
<i>Negative Bank Exposure<sub>b</sub></i> ×	0.004	0.017	
<i>El Nino<sub>t</sub></i>	(0.053)	(0.052)	
<i>Positive County Exposure<sub>c</sub></i> ×	-0.115***		0.034
<i>El Nino<sub>t</sub></i>	(0.040)		(0.030)
<i>Negative County Exposure<sub>c</sub></i> ×	-0.001		0.002
<i>El Nino<sub>t</sub></i>	(0.024)		(0.023)
Bank FE	Yes	Yes	
County FE	Yes		Yes
Year FE	Yes		
Bank × Year FE			Yes
County × Year FE		Yes	
Obs.	2,409,405	2,409,405	2,409,405



Table 7: County Exposure, Bank Exposure and El Niño

Variables	(1)	(2)
		Lending
<i>Positive Bank Exposure<sub>b</sub></i> × <i>El Nino<sub>t</sub></i>	-0.224** (0.113)	<b>-0.250***</b> (0.0977)
County	Exposed	<b>Non-Exposed</b>
Bank FE	Yes	Yes
County × Year FE	Yes	Yes
Obs.	739,025	1,665,920

# Additional

- 1 A “Placebo”: La Niña La Niña
- 2 Event Study Specification Event
- 3 Clustering at state or spatially Clustering
- 4 Demand and Supply using CRA data CRA
- 5 Including all Niños through MEI MEI
- 6 Niño and Precipitation Precipitations

# Concluding Remarks

We study the financial transmission of a climate shock

New mechanism: amenities, house prices & mortgage lending

Banks with lower operating fixed costs are more climate-resilient

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Future research: Effects of El Niño in US likely a lower bound because of low intensity of climate shock and developed financial system

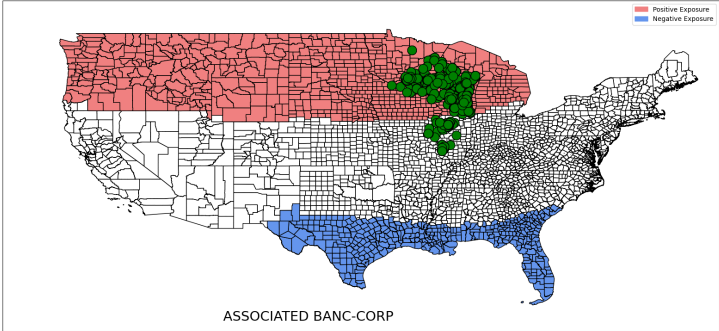
Expect larger impact in low and middle-income countries

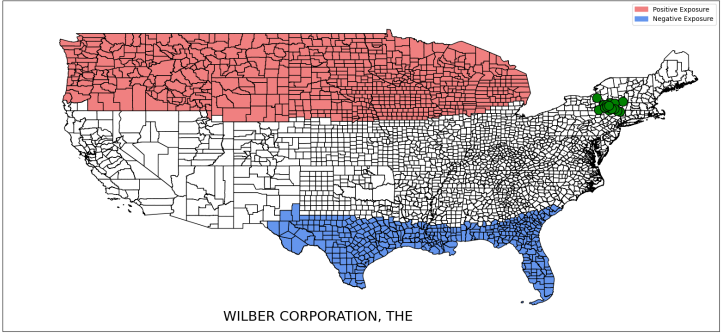
# Appendix

Table 1: Summary Statistics

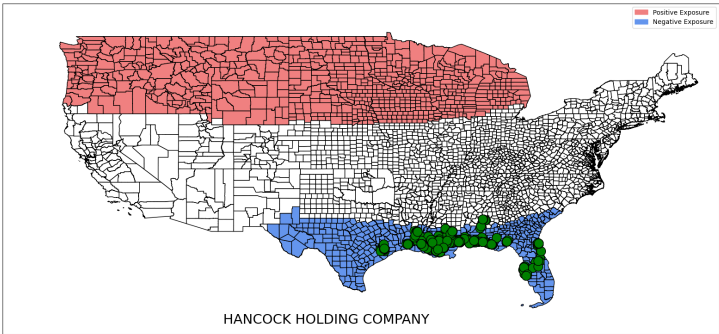
Variable	(1) Obs.	(2) Mean	(3) S.D.	(4) Min	(5) Max
Panel A - County-Level Climatic Variables					
<i>Average Temperatures<sub>cy</sub></i>	122,757	12.90	4.46	5.73	20.26
<i>Volatility of Temperatures<sub>cy</sub></i>	122,757	1.45	0.74	0.48	2.83
Panel B - County-Level HMDA Lending, House Prices and Amenities					
<i>Lending<sub>cy</sub></i>	91,597	10.45	2.592	0	19.32
<i>House Price Index<sub>cy</sub></i>	79,481	108.62	35.97	40.49	207.15
<i>Amenities Rank<sub>c</sub></i>	3,111	3.492	1.042	1	7
Panel C - Bank-Level Exposure to El Nino					
<i>Exposure<sub>b</sub></i>	6,567	0.0645	0.559	-1	1
Panel D - Bank-Level Variables					
<i>Lending<sub>by</sub></i>	85,887	11.76	1.526	-4.605	20.49
<i>Deposits<sub>by</sub></i>	85,887	12.15	1.394	0	21.01
<i>Assets<sub>by</sub></i>	85,887	12.32	1.430	7.947	21.50
<i>RE Lending<sub>by</sub></i>	85,802	11.41	1.571	0	20.00
<i>CI Lending<sub>by</sub></i>	85,540	9.791	1.685	0	19.42
<i>Ind. Lending<sub>by</sub></i>	85,536	8.844	1.704	0	18.99
<i>ROE<sub>by</sub></i>	85,887	0.117	5.603	-1,638	27.49
<i>NIM<sub>by</sub></i>	85,886	0.0563	0.0782	-0.397	4.654
<i>Interest Income<sub>by</sub></i>	85,880	8.725	1.378	1.099	17.36
Panel D - Bank-Level Variables selected by LASSO					
<i>Operating Leverage<sub>b</sub></i>	6,234	0.00232	0.00108	0.0000179	0.0298
<i>Leverage<sub>b</sub></i>	6,234	0.840	0.0651	0.0932	0.972
<i>Unused Commitments<sub>b</sub></i>	6,233	0.0155	0.0191	0	0.237
<i>Operating Capital<sub>b</sub></i>	6,234	0.00578	0.00548	0.000717	0.347
<i>Dividends<sub>b</sub></i>	6,234	0.00214	0.00242	0	0.0533
<i>ROA<sub>b</sub></i>	6,234	0.0123	0.0282	-0.163	0.773







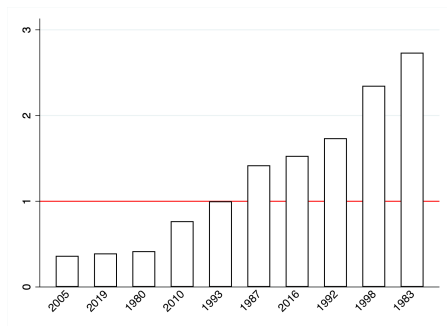




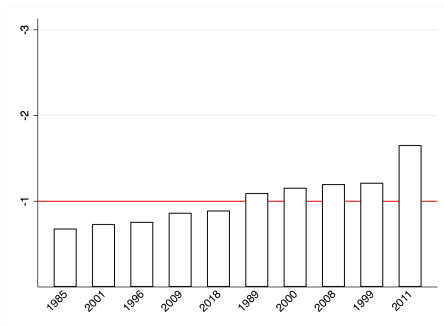
# La Niña: Different time-series and geography

# El Niño vs La Niña - time series [Back](#)

Intensity of La Niña is weaker



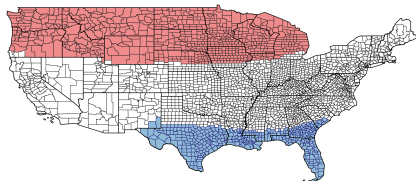
(a) El Niño



(b) La Niña

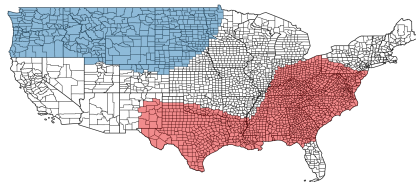
# El Niño vs La Niña - cross section Back

Geography is different (not south vs. north)



Positive Exposure to Niño  
Negative Exposure to Niño

(a) El Niño



Positive Exposure to Niño  
Negative Exposure to Niño

(b) La Niña

# El Niño vs La Niña: No Effects Back

Variables	(1) Loans	(2) Deposits	(3) Assets
$Bank\ Niña\ Exposure_b \times$ $La\ Niña_t$	0.002 (0.007)	0.002 (0.006)	0.003 (0.005)
Bank FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Obs.	85,887	85,887	85,887
Adj. R sq.	0.911	0.930	0.945
Mean Dep. Var.	11.76	12.15	12.32

# 1. Event Study Specification Back

El Niño is almost as good as randomly assigned, benefit of event-study not clear

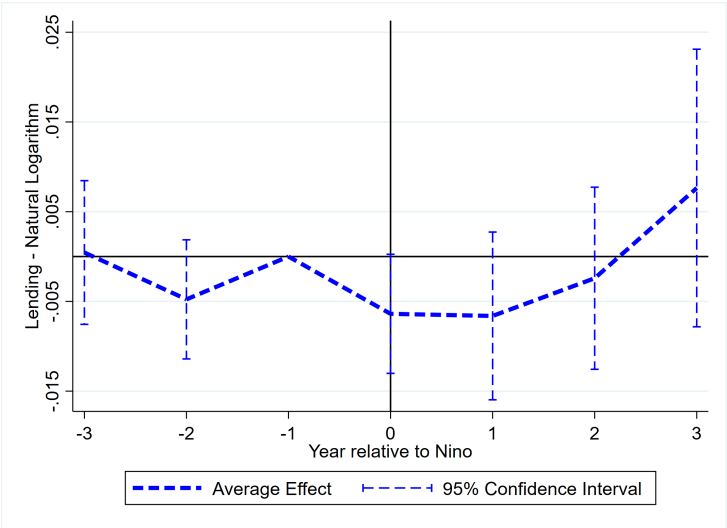
# 1. Event Study Specification Back

El Niño is almost as good as randomly assigned, benefit of event-study not clear

However, its repercussions may last longer so we test:

$$Y_{bt} = \alpha_b + \gamma_t + \sum_{j=-3}^3 \beta_j \text{Bank Exposure}_b \times \text{Nino}_{tj} + \varepsilon_{bt}$$

in a 3 years window for loans, deposits and assets



Back





## 2. State or Spatial clustering [Back](#)

Variables	(1)	(2)	(3)	(4)	(5)	(6)
	Average Temperatures			Volatility of Temperatures		
$PosExp_c$	0.518***		0.462***	0.072**		0.067**
$\times El Nino_t$	(0.068)		(0.069)	(0.030)		(0.031)
$NegExp_c$		-0.479***	-0.362***		-0.048*	-0.031
$\times El Nino_t$		(0.071)	(0.069)		(0.029)	(0.029)
County FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	108761	108761	108761	108752	108752	108752
R sq.	0.00561	0.00293	0.00722	0.000481	0.000130	0.000533
Mean Dep. Var.	12.86	12.86	12.86	1.674	1.674	1.674

### 3. Demand and Supply with CRA data Back

Issue: fewer obs (2.5 M vs 0.6 M), same coefficients but less power

Variables	(1)	(2)	(3)
		Lending	
<i>Positive Bank Exposure<sub>b</sub></i> × <i>El Nino<sub>t</sub></i>	-0.225 (0.175)	-0.208 (0.174)	
<i>Negative Bank Exposure<sub>b</sub></i> × <i>El Nino<sub>t</sub></i>	-0.0372 (0.0796)	-0.000943 (0.107)	
<i>Positive County Exposure<sub>c</sub></i> × <i>El Nino<sub>t</sub></i>	-0.152 (0.106)		-0.174* (0.0970)
<i>Negative County Exposure<sub>c</sub></i> × <i>El Nino<sub>t</sub></i>	-0.0620 (0.0415)		-0.0637 (0.0491)
Bank FE	Yes	Yes	
County FE	Yes		Yes
Year FE	Yes		
Bank × Year FE			Yes
County × Year FE		Yes	
Obs.	608,106	608,106	608,106

Back



## 4. Ninos through MEI [Back](#)

Use a continuous measure of Niño with MEI index instead of top5 dummy

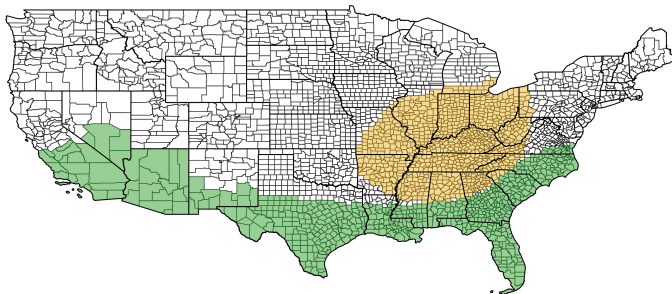
This includes many events that are weak or neutral

Magnitudes weaker, but in line



# 5. Precipitation

El Niño affects precipitation too:



Positive (Wet) Exposure to Nino  
Negative (Dry) Exposure to Nino



Controlling for temperature exposure, no effect of precipitation:

Variables	(1) Loans	(2) Deposits	(3) Assets
$Bank\ Exposure_b \times El\ Nino_t$	-0.0131*** (0.00508)	-0.00658* (0.00386)	-0.00754** (0.00356)
$Bank\ Prec.\ Exposure_b \times El\ Nino_t$	0.00108 (0.00824)	0.0107 (0.00653)	0.00674 (0.00598)
Bank FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Obs.	85887	85887	85887
Adj. R sq.	0.945	0.911	0.911
Mean Dep. Var.	11.76	12.15	12.32

Back