Climate, Amenities and Banking: El Niño in the US

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Climate and Banking

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Policy makers want to assess banks' preparedness to manage climate risk (e.g. climate stress testing)

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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 complicate analysis. Impact of non-destructive climate shocks not well understood

Our Contribution

Propose and test a new mechanism:

climate shocks $\Rightarrow$ natural amenities $\Rightarrow$ house prices $\Rightarrow$ mortgages

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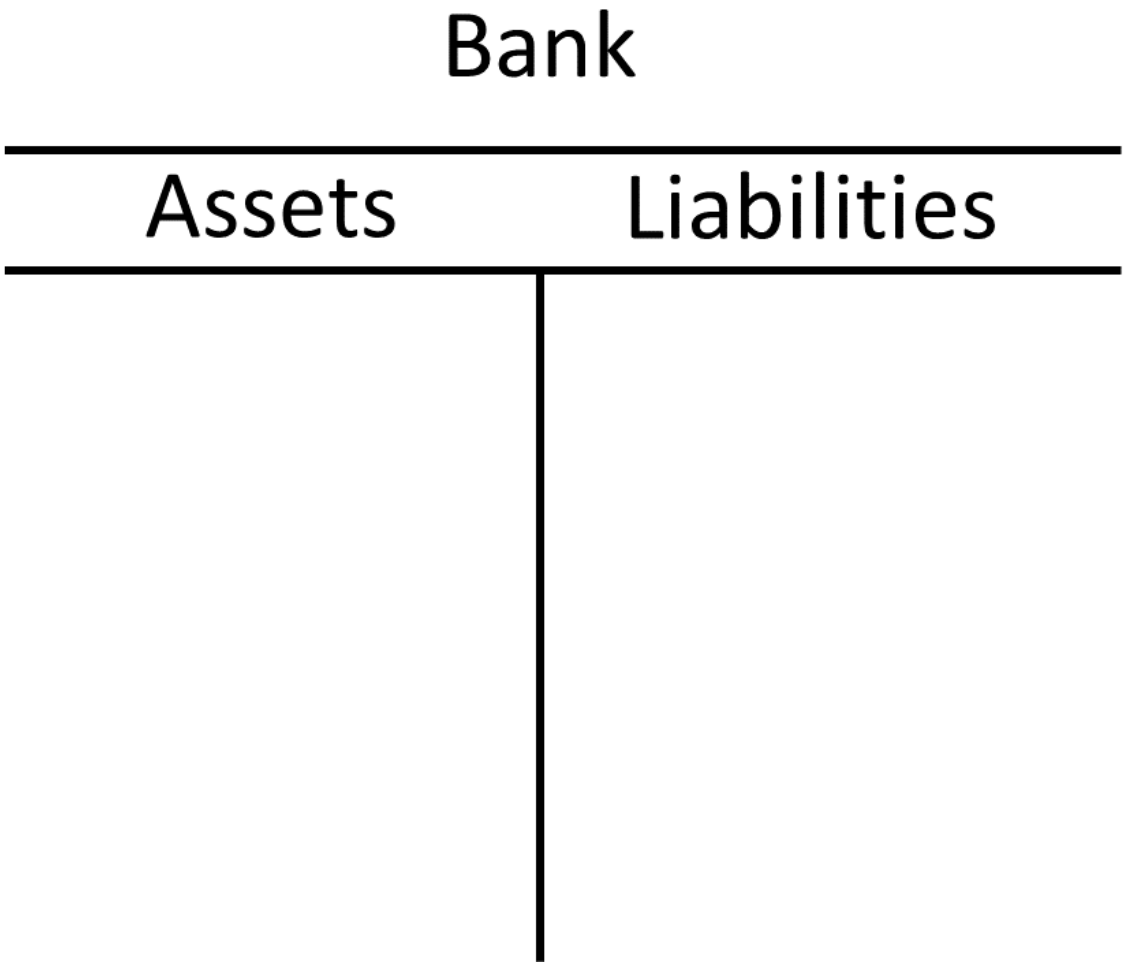
El Niño is an unpredictable atmospheric phenomenon with heterogeneous impact on temperatures across US regions

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

Mechanism

Mechanism



Mechanism

Bank

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

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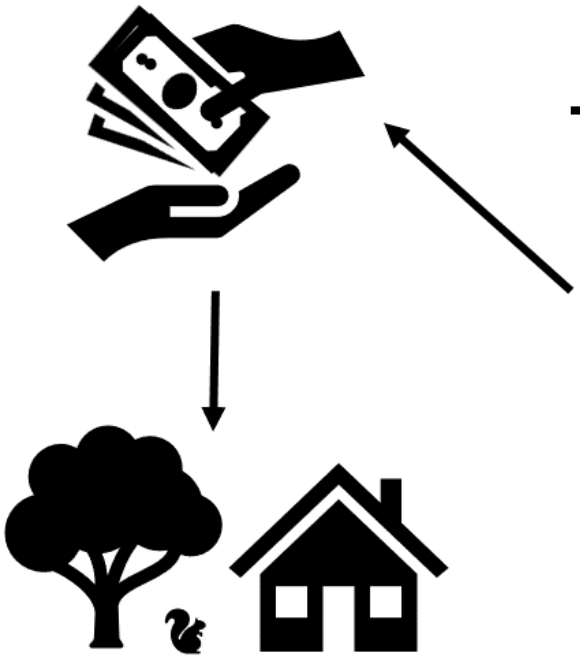

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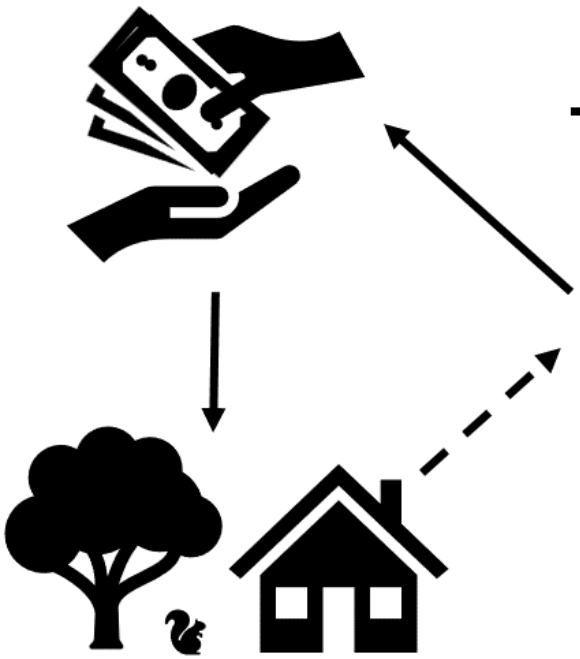

Collateral

Bank

Assets	Liabilities
Loans	Deposits
Mortgages	Borrowings
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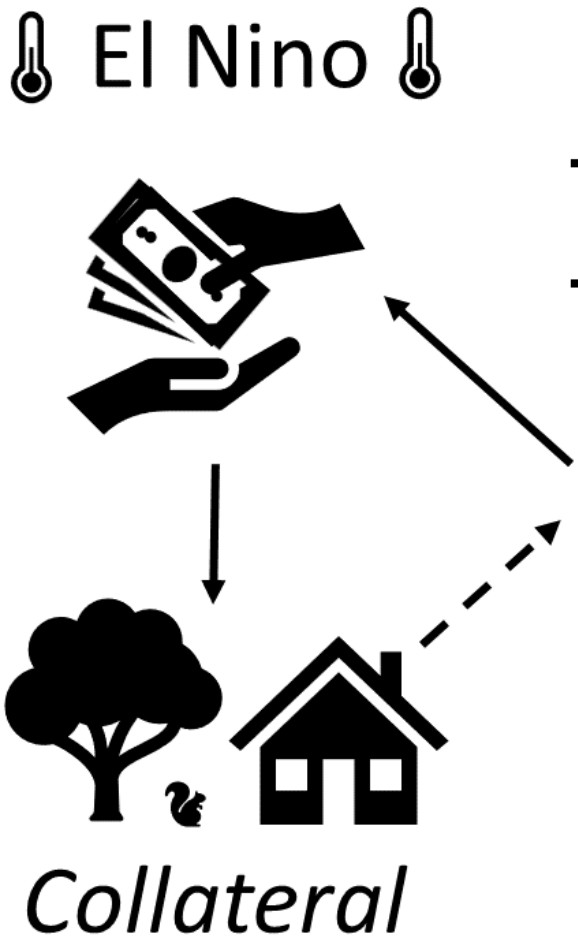
& more...	& more...

Mechanism



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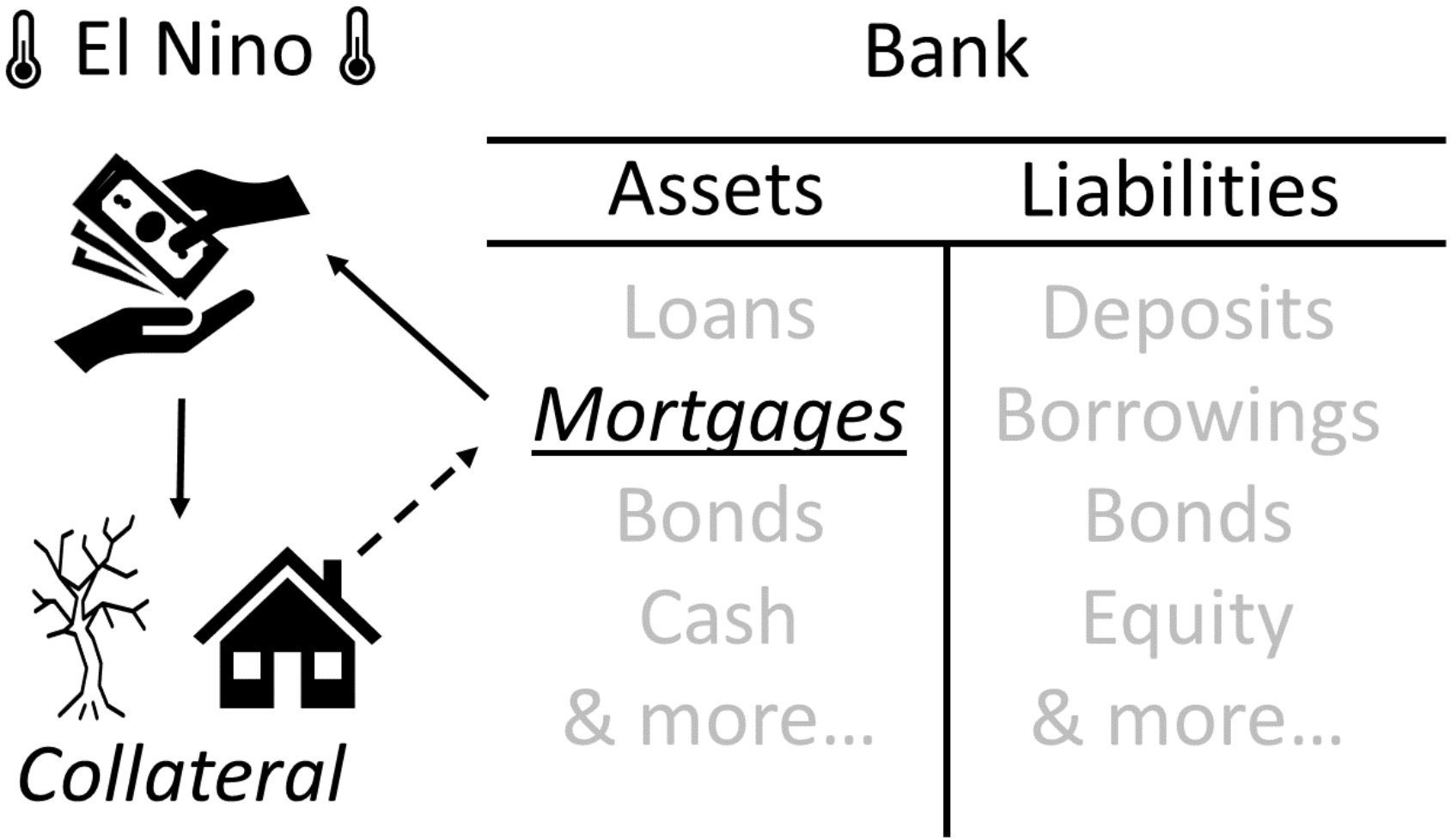
El Nino
Bank
Assets
Liabilities
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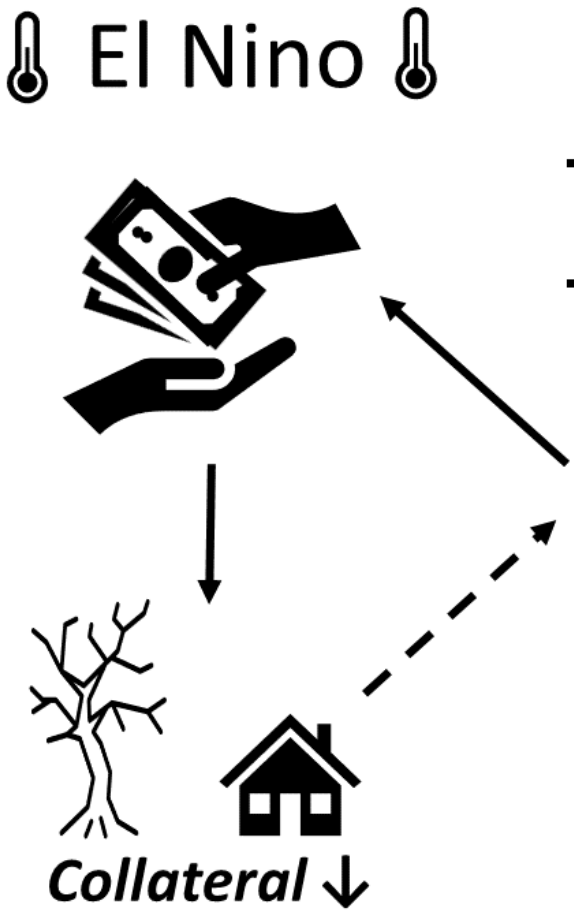
Collateral

Mechanism



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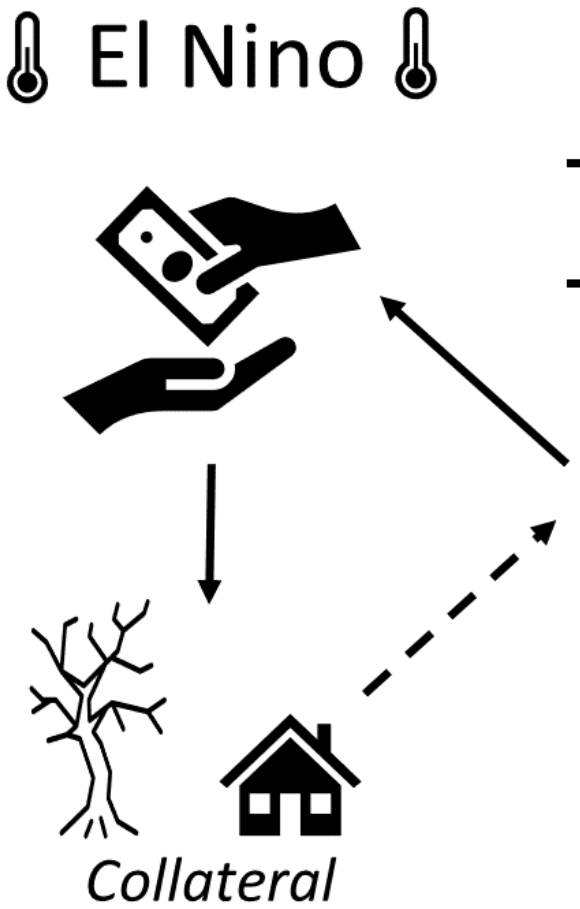

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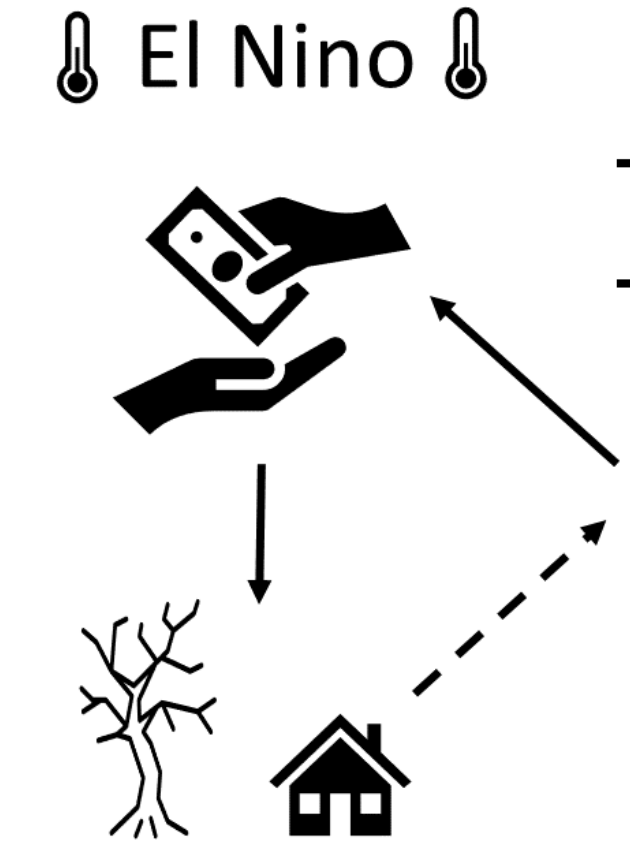

Bank

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

Collateral -> Flows

Mechanism

El Nino

Also Stock of Existing Mortgages

Bank

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

Mechanism

El Nino

Transmit to Balance Sheet

Bank

Assets	Liabilities
Loans	**Deposits**
Mortgages	**Borrowings**
Bonds	**Bonds**
Cash	**Equity**
& more...	**& more...**

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5. Demand vs supply $\rightarrow$ **bank factors are key**
6. A LASSO analysis of climate resilience $\rightarrow$ **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

A Recurring Natural Experiment

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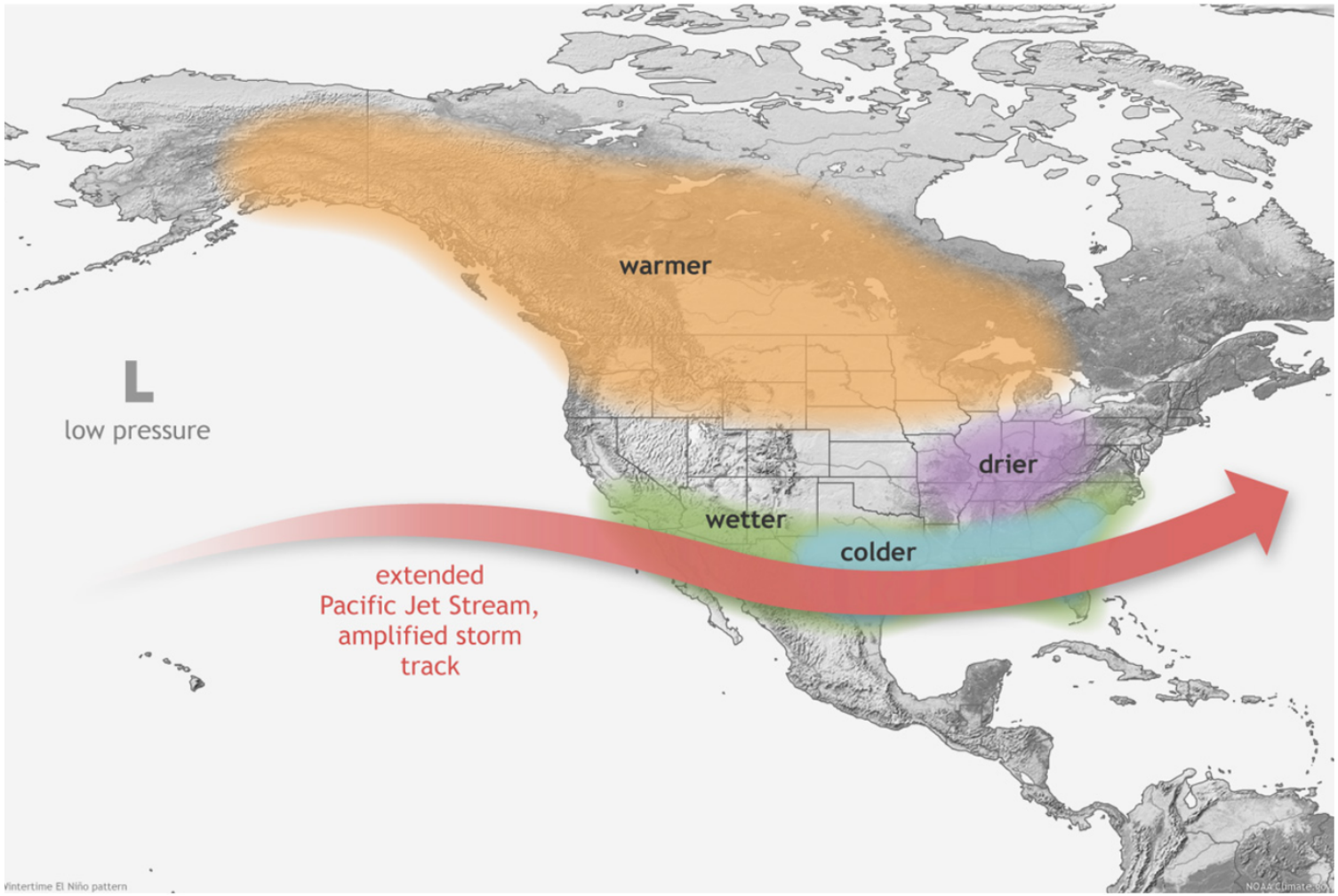
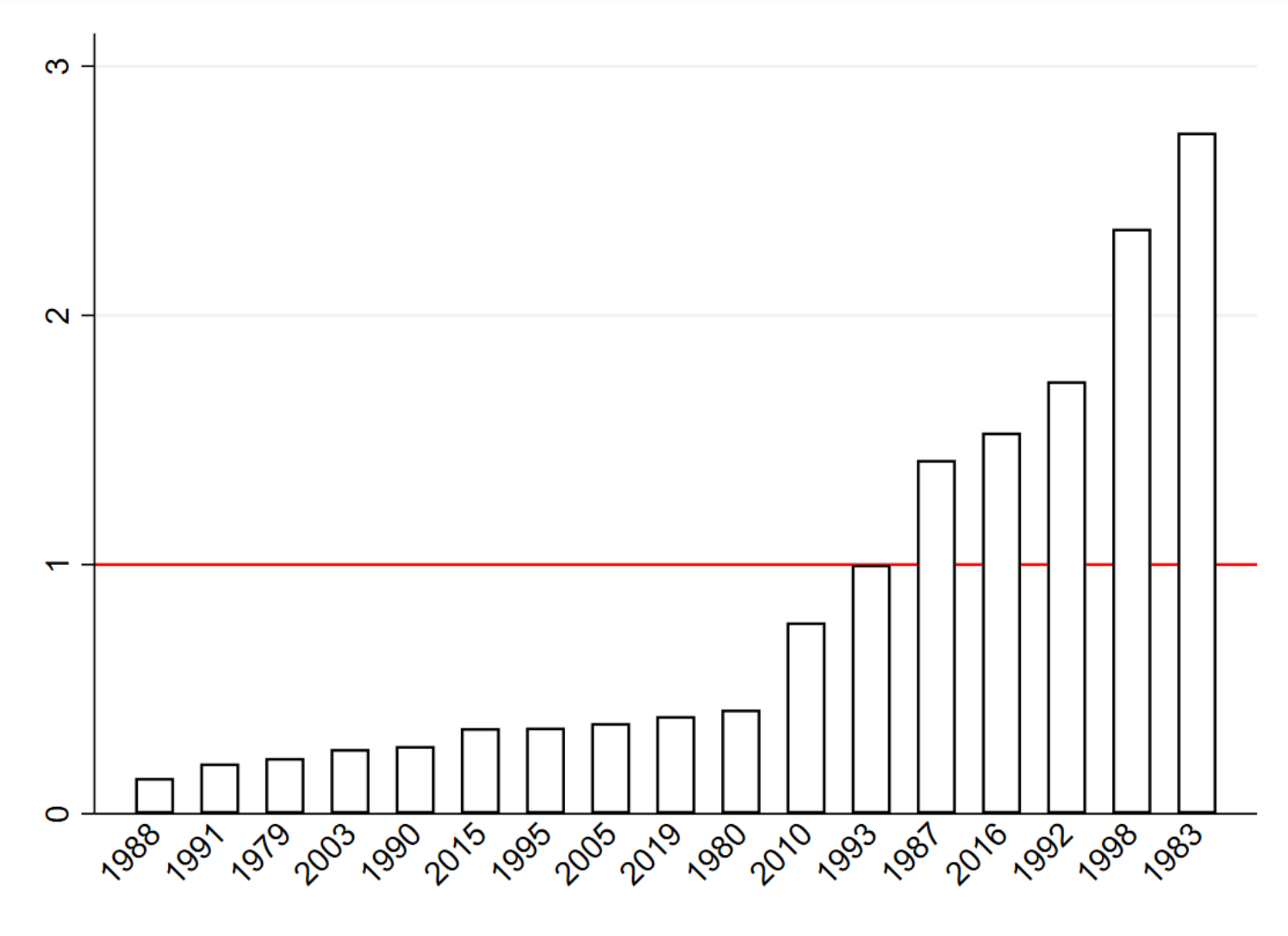
Most significant impact of El Niño in US is due to a shift in the location of the jet stream (heterogeneity across US ares)



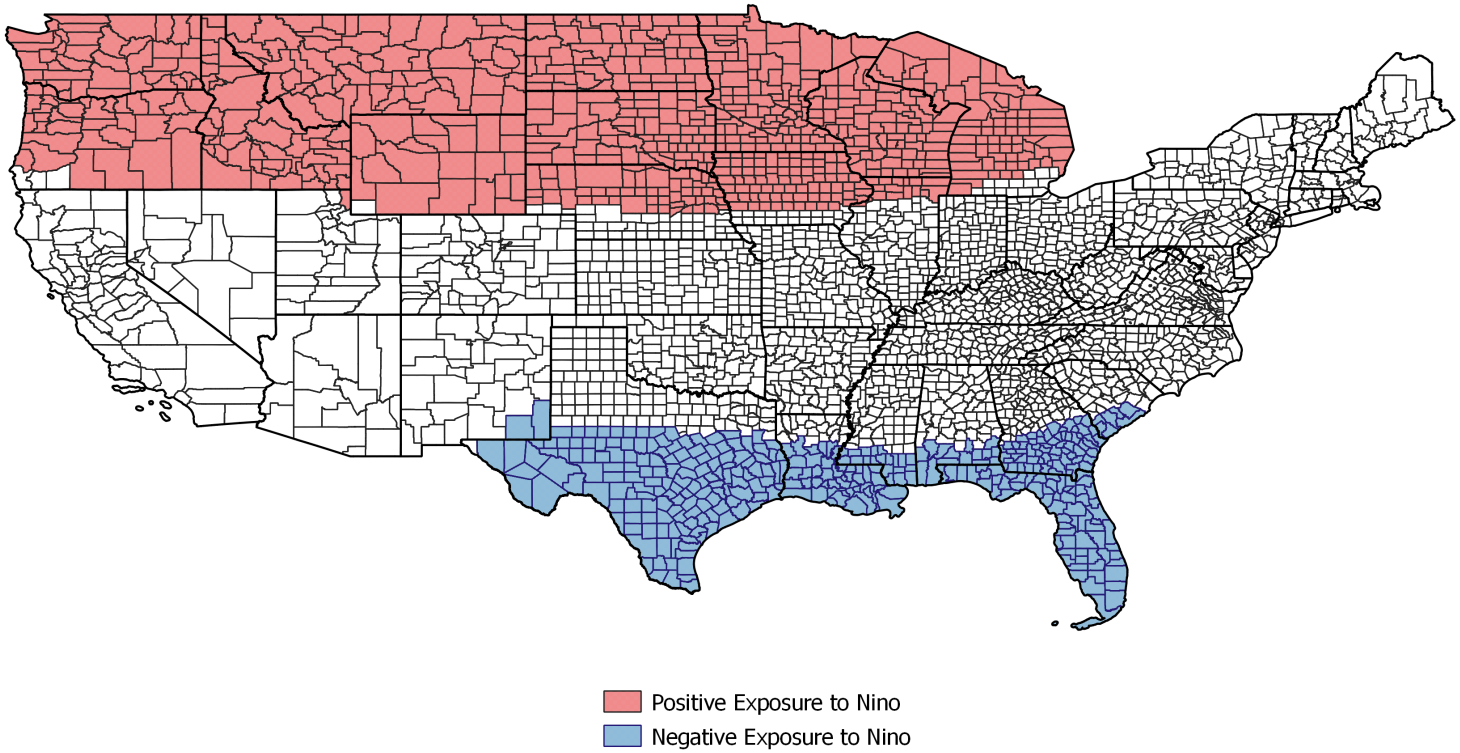
Note: Source NOAA (2021)

Oceanic temperature index (MEI v2)



Focus on the "top 5" Nino 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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$$Y_{ct} = \alpha_c + \gamma_t + \sum_{i=P,N} \beta_i Exposure_{ic} \times El\ Nino_t + \varepsilon_{ct}$$

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County and year fixed effects (α_c γ_t). std.err. clustered at county

Table 2a: Climate and El Niño

Variables	(1)	(2)	(3)
	Average Temperatures		
Positive Exposure$_c$ ×	0.629***		0.575***
El Nino$_t$	(0.0163)		(0.0168)
Negative Exposure$_c$ ×		-0.506***	-0.362***
El Nino$_t$		(0.0151)	(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		
Positive Exposure$_c$ ×	-0.0380***		-0.0189**
El Nino$_t$	(0.00871)		(0.00877)
Negative Exposure$_c$ ×		0.135***	0.131***
El Nino$_t$		(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

	(1)	(2)	(3)
Variables		Lending	
Positive Exposure$_c$ ×	-0.116***		-0.112***
El Nino$_t$	(0.0170)		(0.0173)
Negative Exposure$_c$ ×		0.0537***	0.0274
El Nino$_t$		(0.0186)	(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		
Positive Exposure$_c$ ×	-0.0140***		-0.0139***
El Nino$_t$	(0.00252)		(0.00259)
Negative Exposure$_c$ ×		0.0041	0.0007
El Nino$_t$		(0.0036)	(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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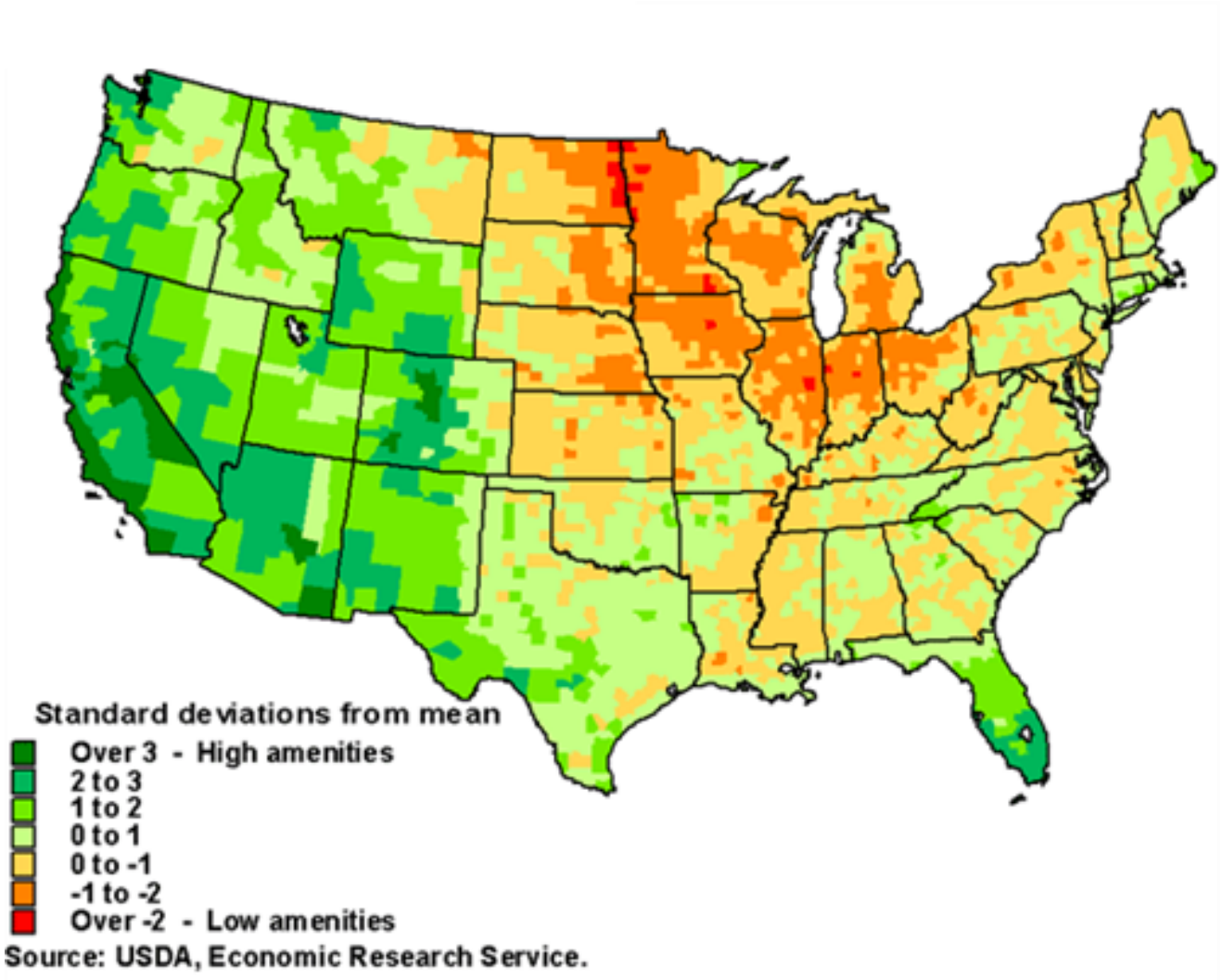
Only cross-sectional variation (not time varying)



Note: map from USDA - ERS

Variables	(1)	(2) House Prices	(3)
Positive Exposure$_c$	-0.0140***		-0.0136***
$\times$ *El Nino*$_t$	(0.00252)		(0.00272)
Natural Amenities$_c$		-0.0306***	-0.0296***
$\times$ *El Nino*$_t$		(0.00227)	(0.00260)
Positive Exposure$_c$ $\times$			-0.0168***
Natural Amenities$_c$ $\times$			(0.00494)
El Nino$_t$			
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		
Positive Exposure$_c$	-0.116***		-0.102***
$\times$ *El Nino*$_t$	(0.0170)		(0.0213)
Natural Amenities$_c$		-0.0135	-0.0191
$\times$ *El Nino*$_t$		(0.0135)	(0.0147)
Positive Exposure$_c$ $\times$			-0.0613*
Natural Amenities$_c$ $\times$			(0.0346)
El Nino$_t$			
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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Hypothesis: value of natural amenities decreases in El Niño years

Need time-varying measure: use salinity of soil and water

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Rising temperatures strengthen water evaporation, which increases the presence of salt in the soil, leading to aridification

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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	
$Pos\ Exp_c$	0.134***		0.0809***	0.0413***		0.0345***
$\times El\ Nino_t$	(0.029)		(0.026)	(0.004)		(0.004)
$Neg\ Exp_c$		-0.395***	-0.374***		-0.054***	-0.046***
$\times El\ Nino_t$		(0.120)	(0.121)		(0.008)	(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?

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

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

$$Bank\ Exposure_b = \sum_c Exposure_c \times Share_{bc}$$

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

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

Bank and year fixed effects (α_b γ_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***	-0.0087**	-0.0089**
	(0.0050)	(0.0038)	(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
$Bank\ Exposure_b \times El\ Nino_t$	-0.0101*	-0.0135**	0.00208
	(0.00580)	(0.00588)	(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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Decline in lending and house prices at county level could be due to demand and/or supply

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$$Y_{cbt} = \alpha_{ct} + \gamma_{bt} + \sum_{i=b,c} \sum_{j=P,N} \beta_{ij} Exposure_{ij} \times Nino_t + \varepsilon_{cbt}$$

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Y_{cbt} stands for HMDA lending from b in c at t

$Exposure_{ij}$ - dummy for positive (negative) bank b or county c

5. El Niño - supply and demand

Decline in lending and house prices at county level could be due to demand and/or supply

Simple test: see if bank or county exposure matters for bank-county lending controlling for county-year or bank-year FE

$$Y_{cbt} = \alpha_{ct} + \gamma_{bt} + \sum_{i=b,c} \sum_{j=P,N} \beta_{ij} Exposure_{ij} \times Nino_t + \varepsilon_{cbt}$$

Y_{cbt} stands for HMDA lending from b in c at t

$Exposure_{ij}$ - dummy for positive (negative) bank b or county c

Alternatively: bank-year (γ_{bt}) or county-year (α_{bt}) fixed effects

Variables	(1)	(2)	(3)
	Log(Mortgage Lending)		
Positive Bank Exposure$_b$ ×	-0.217***	-0.240***	
El Nino$_t$	(0.075)	(0.079)	
Negative Bank Exposure$_b$ ×	0.004	0.017	
El Nino$_t$	(0.053)	(0.052)	
Positive County Exposure$_c$ ×	-0.115***		0.034
El Nino$_t$	(0.040)		(0.030)
Negative County Exposure$_c$ ×	-0.001		0.002
El Nino$_t$	(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) Lending	(2) Lending
Positive Bank Exposure$_b$ × *El Nino*$_t$	-0.224**	-0.250***
	(0.113)	(0.0977)
County	Exposed	Non-Exposed
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

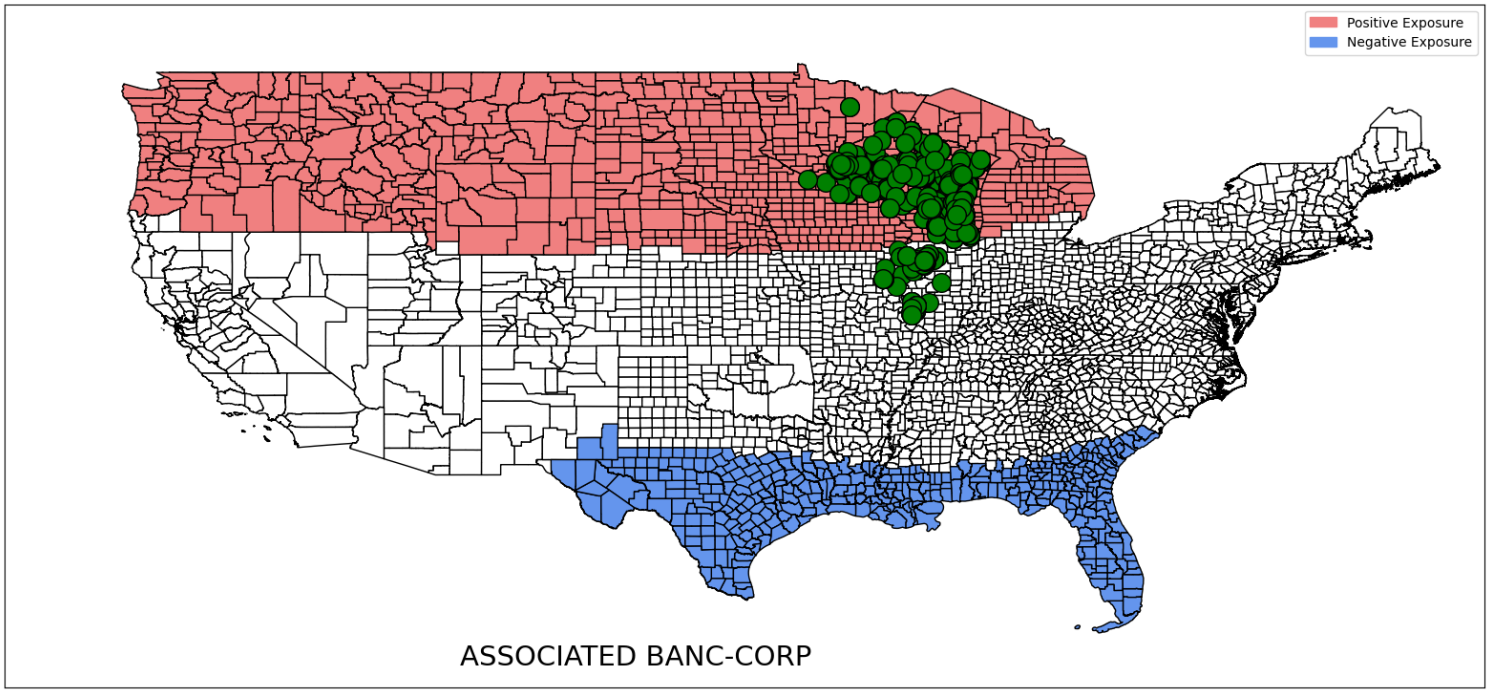
New mechanism: amenities, house prices & mortgage lending

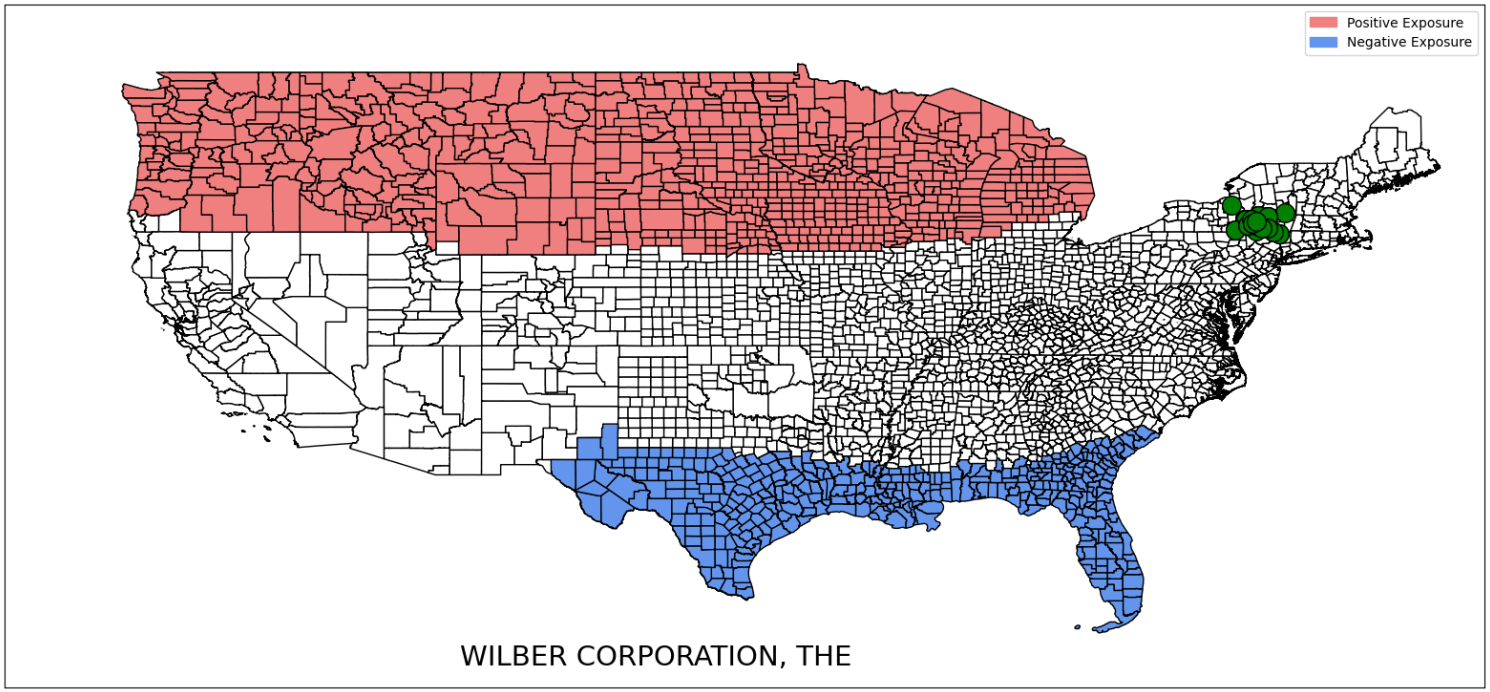
Banks with lower operating fixed costs are more climate-resilient

Appendix

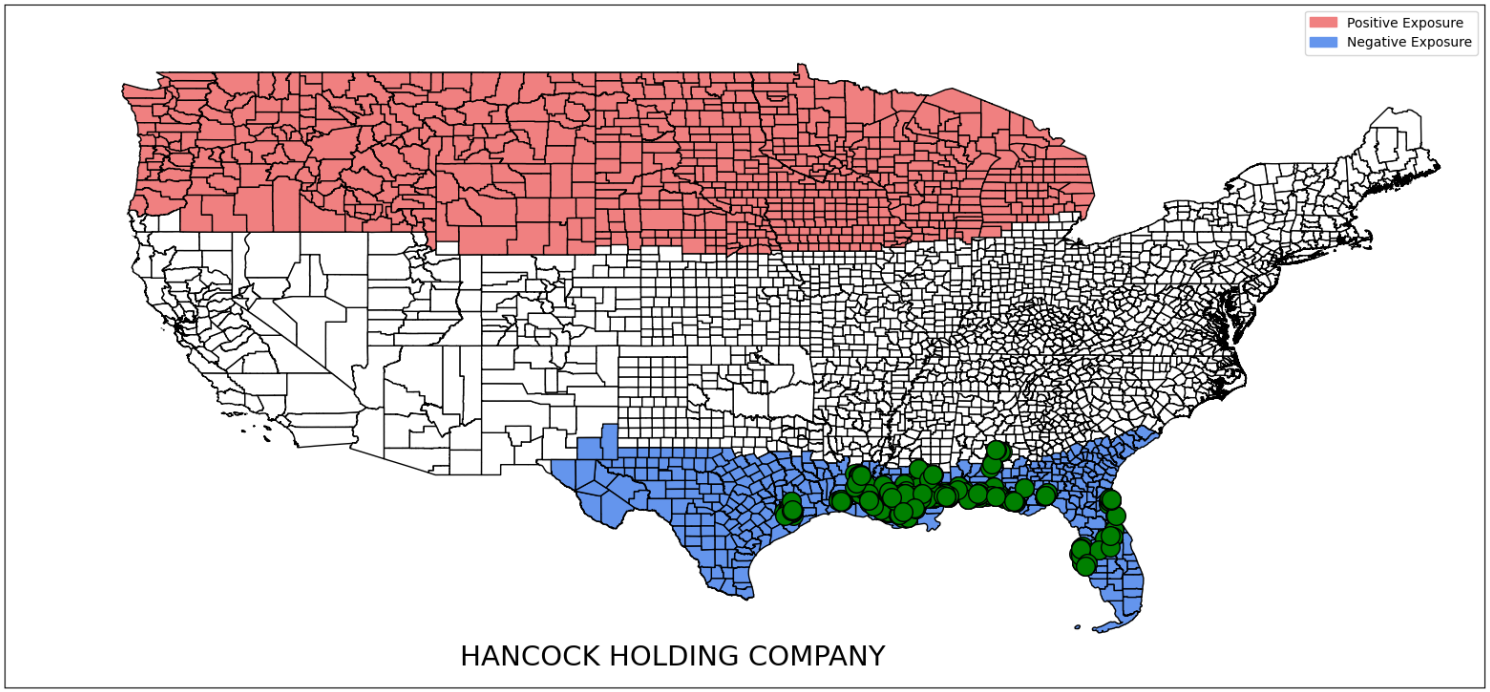
Table 1: Summary Statistics

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


Positive Exposure
Negative Exposure
ASSOCIATED BANC-CORP



WILBER CORPORATION, THE

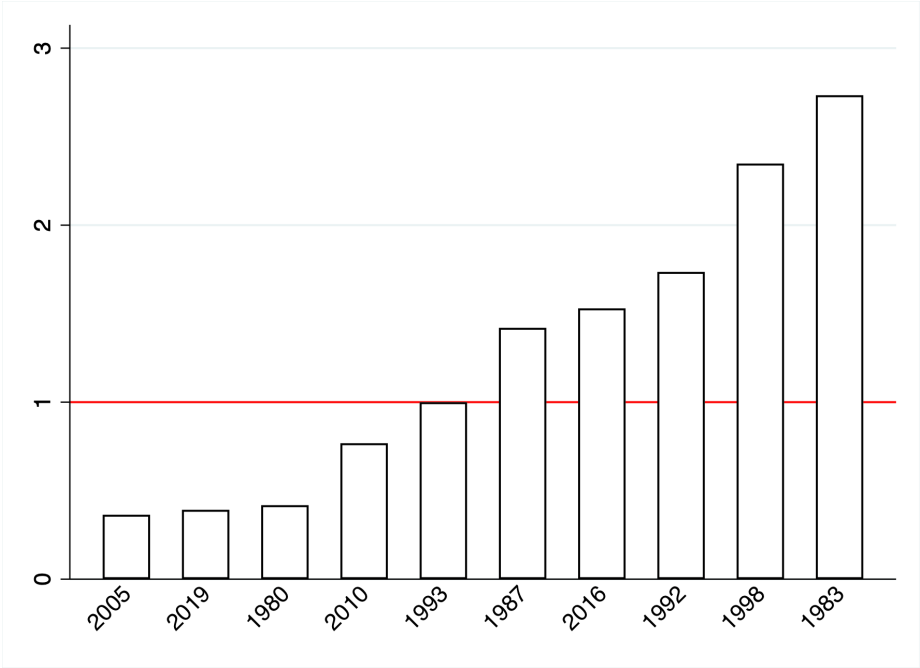


HANCOCK HOLDING COMPANY

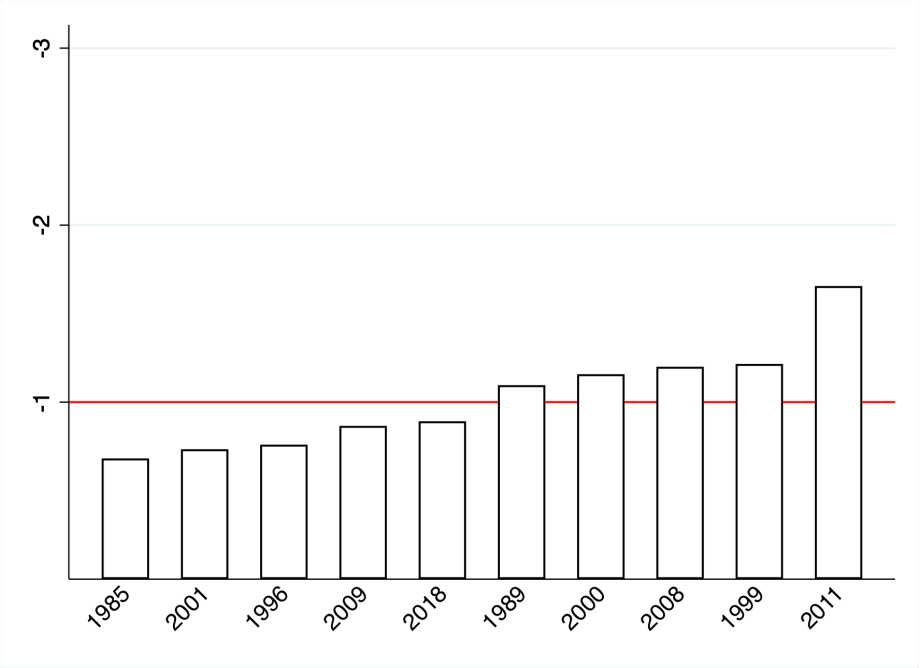
La Niña: Different time-series and geography

El Niño vs La Niña - time series Back

Intensity of La Niña is weaker



(a) El Niño

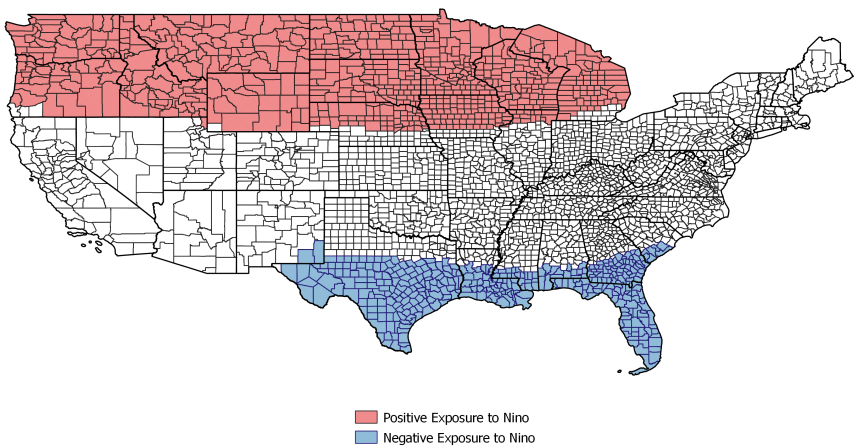


(b) La Niña

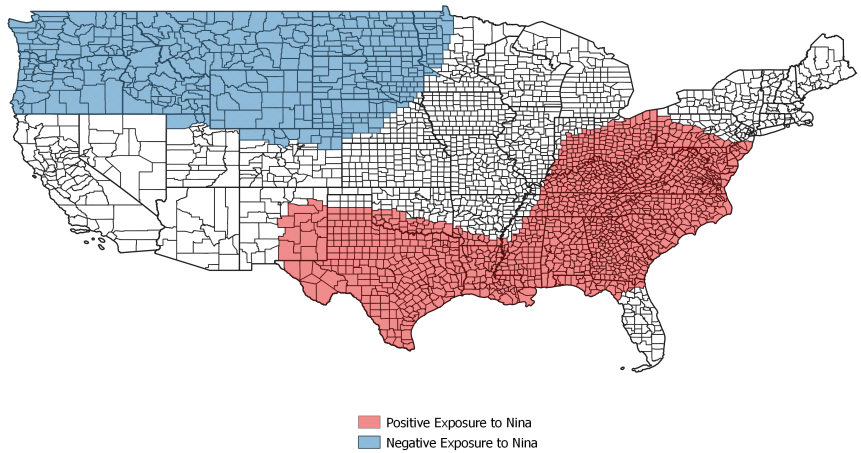
El Niño vs La Niña - cross section

Back

Geography is different (not south vs. north)



(a) El Niño



(b) La Niña

El Niño vs La Niña: No Effects Back

Variables	(1) Loans	(2) Deposits	(3) Assets
Bank Nina Exposure$_b$ ×	0.002	0.002	0.003
La Nina$_t$	(0.007)	(0.006)	(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

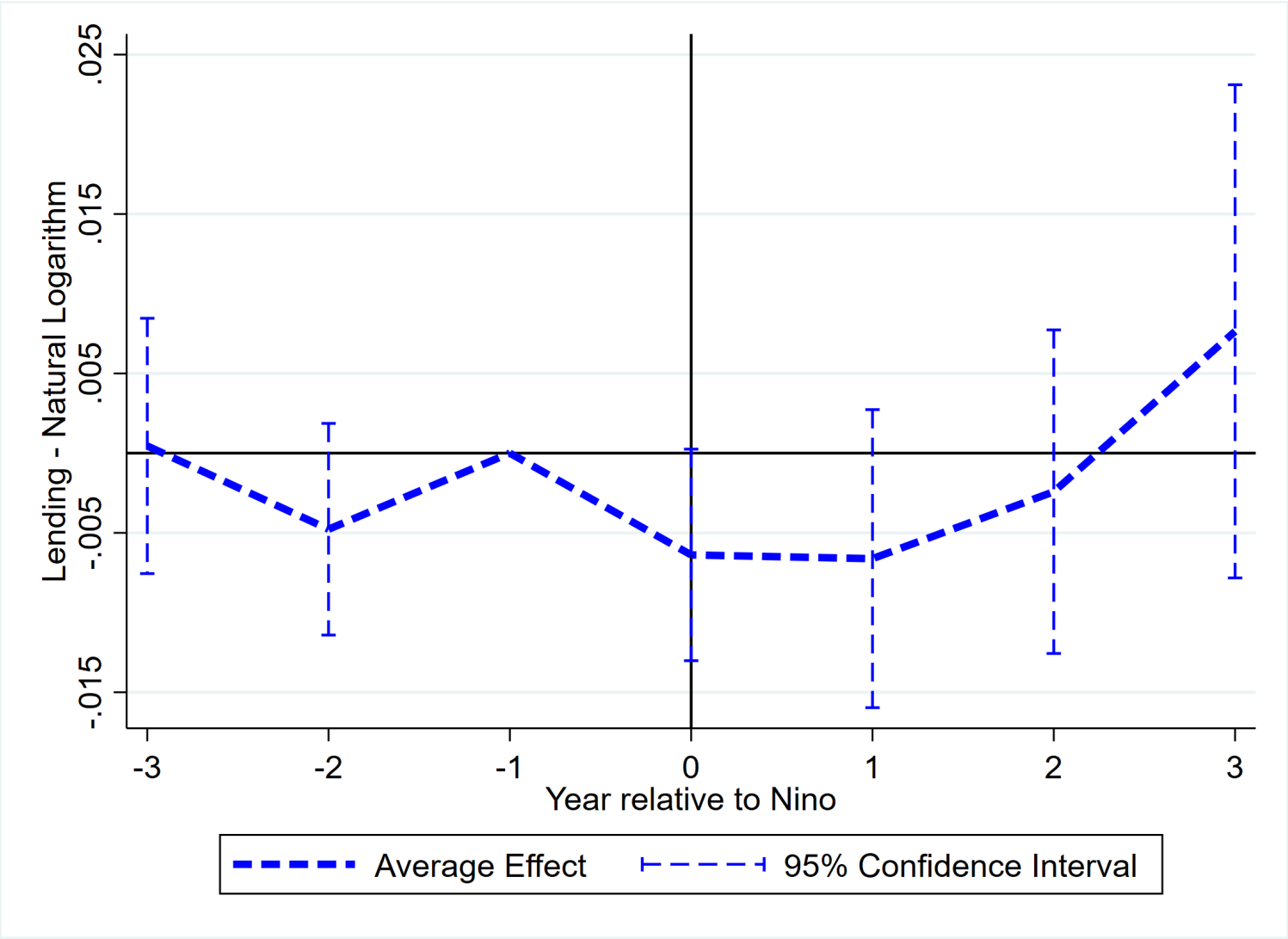
Back

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

However, its repercussions may last longer so we test:

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

in a 3 years window for loans, deposits and assets


Lending - Natural Logarithm
.025
.015
.005
-.005
-.015
-3
-2
-1
0
1
2
3
Year relative to Nino
Average Effect
95% Confidence Interval

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

	(1)	(2)	(3)
Variables		Lending	
Positive Bank Exposure$_b$ ×	-0.225	-0.208	
El Nino$_t$	(0.175)	(0.174)	
Negative Bank Exposure$_b$ ×	-0.0372	-0.000943	
El Nino$_t$	(0.0796)	(0.107)	
Positive County Exposure$_c$ ×	-0.152		-0.174*
El Nino$_t$	(0.106)		(0.0970)
Negative County Exposure$_c$ ×	-0.0620		-0.0637
El Nino$_t$	(0.0415)		(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

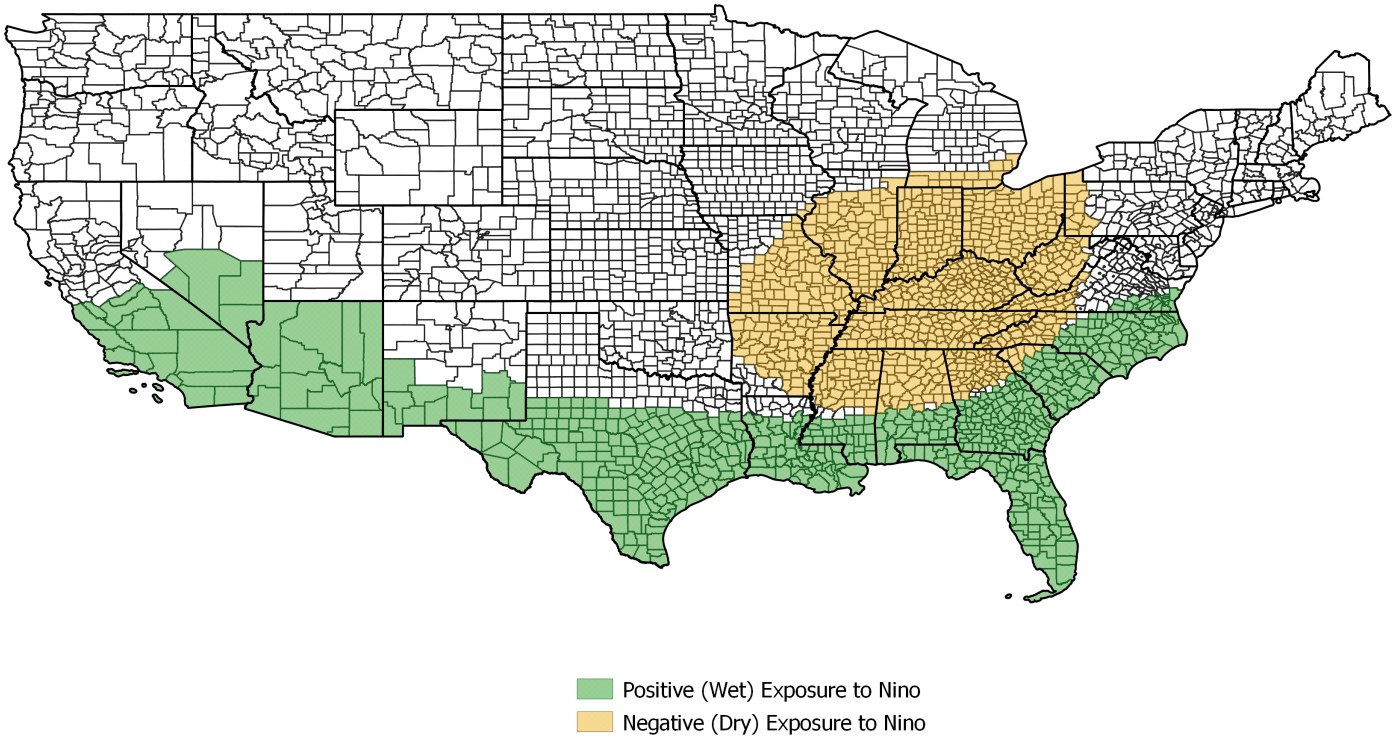
Magnitudes weaker, but in line

Variables	(1) Loans	(2) Deposits	(3) Assets	(4) Loans	(5) Deposits	(6) Assets
$Bank\ Exposure_b \times$	-0.003	-0.002	-0.001			
$MEI\ Nino\ Index_t$	(0.002)	(0.002)	(0.002)			
$Positive\ Bank\ Exposure_b \times$				-0.012**	-0.007*	-0.003
$MEI\ Nino\ Index_t$				(0.005)	(0.004)	(0.003)
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	85616	85616	85616	85616	85616	85616
Adj. R sq.	0.911	0.930	0.945	0.911	0.911	0.945
Mean Dep. Var.	11.76	12.15	12.32	11.76	12.15	12.32

Back

5. Precipitation

El Niño affects precipitation too:



Controlling for temperature exposure, no effect of precipitation:

Variables	(1) Loans	(2) Deposits	(3) Assets
$Bank\ Exposure_b \times El\ Nino_t$	-0.0131***	-0.00658*	-0.00754**
	(0.00508)	(0.00386)	(0.00356)
$Bank\ Prec.\ Exposure_b \times$	0.00108	0.0107	0.00674
$El\ Nino_t$	(0.00824)	(0.00653)	(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