Climate, Amenities and Banking: El Niño in the US

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Climate and Banking



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Physical risk from weather events relevant for financial institutions

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

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Physical risk from weather events relevant for financial institutions

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

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:

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

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Exploit a recurring natural phenomenon: El Niño

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

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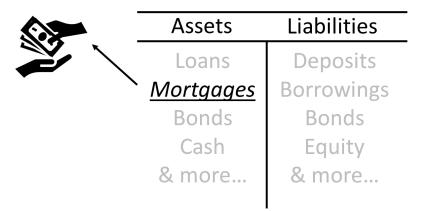
El Niño is an unpredictable atmospheric phenomenon with heterogeneous impact on temperatures across US regions

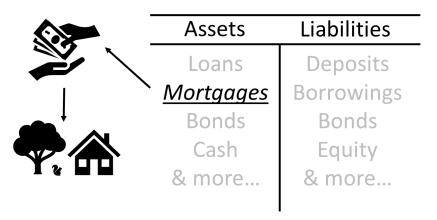
(Focus on short-term fluctuations, not long-term)

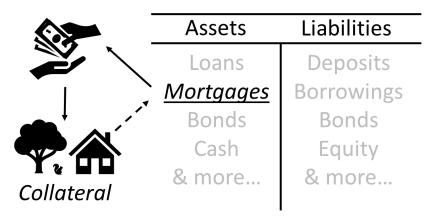


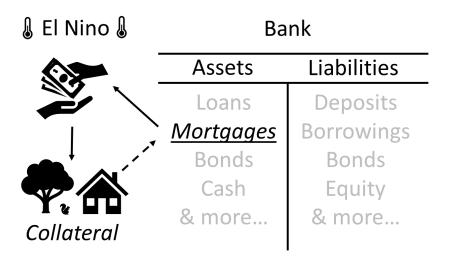
Bank Liabilities **Assets**

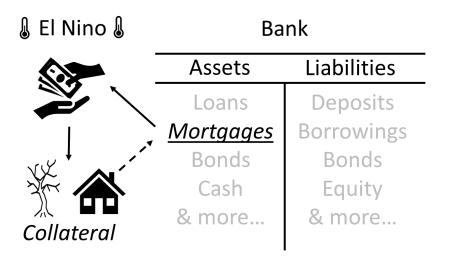
Assets	Liabilities
Loans	Deposits
Mortgages	Borrowings
Bonds	Bonds
Cash	Equity
& more	& more

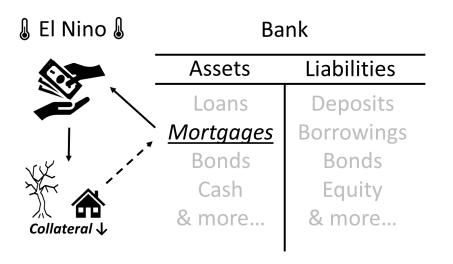


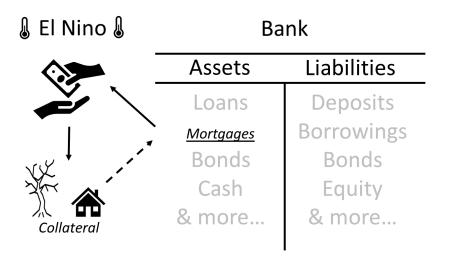


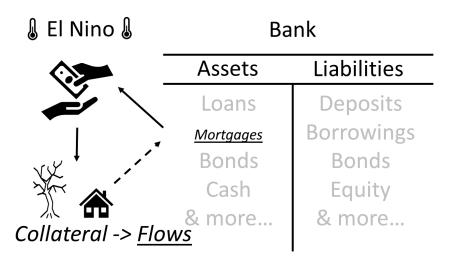




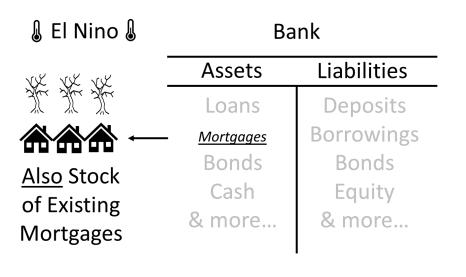


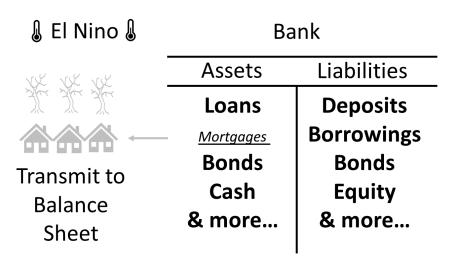














We study how a climate shock affects the banking system through:

County climate

- County climate
- County house prices and mortgages

- County climate
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- Natural Amenities

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- 2 County house prices and mortgages
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- **3** Natural Amenities o worsen when temperatures \uparrow
- lacktriangledown Bank-level analysis o aggregate effects on balance sheet
- **5** Demand vs supply \rightarrow bank factors are key
- lacktriangledown A LASSO analysis of climate resilience ightarrow **not today**

Identification Strategy

A Recurring Natural Experiment

We study the effects of **El Niño** on banking in the US. Why ideal?

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- Heterogeneous cross-section
 - $ightharpoonup \neq$ 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

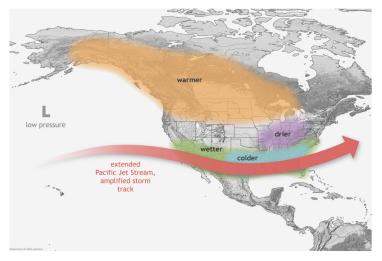
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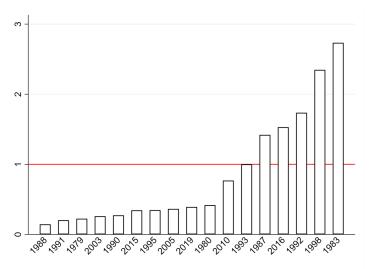
Most significant impact of El Niño in US is due to a shift in the location of the jet stream (heterogeneity across US ares)





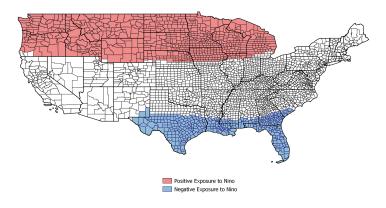
Note: Source NOAA (2021)

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

We validate the climate patterns presented by NOAA

$$Y_{ct} = \alpha_c + \gamma_t + \sum_{i=P,N} \beta_i Exposure_{ic} \times El \ Nino_t + \varepsilon_{ct}$$

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



Table 2a: Climate and El Niño

rable 2a. Chinate and El Tanio				
	(1)	(2)	(3)	
Variables	Average Temperatures			
Positive Exposure _c \times	0.629***		0.575***	
El Nino _t	(0.0163)		(0.0168)	
Negative Exposure $_c$ $ imes$		-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

rable 25. Chinate and El Timo				
	(1)	(2)	(3)	
Variables	Probability of Disaster			
Positive Exposure _c \times	-0.0380***		-0.0189**	
El Nino _t	(0.00871)		(0.00877)	
Negative Exposure _c \times		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

Tuble 5. County Wortgage Lending and El Mile			
(1)	(2)	(3)	
	Lending		
-0.116***		-0.112***	
(0.0170)		(0.0173)	
	0.0537***	0.0274	
	(0.0186)	(0.0190)	
Yes	Yes	Yes	
Yes	Yes	Yes	
91,596	91,596	91,596	
0.916	0.916	0.916	
10.45	10.45	10.45	
	(1) -0.116*** (0.0170) Yes Yes 91,596 0.916	(1) (2) Lending -0.116*** (0.0170) 0.0537*** (0.0186) Yes Yes Yes Yes 91,596 91,596 0.916 0.916	

2. County Lending and House Prices

Table 3: County House Price Index and El Niño

	(1)	(2)	(3)
Variables	House Price Index		
Positive Exposure _c \times	-0.0140***		-0.0139***
El Nino _t	(0.00252) (0.00259)		
Negative Exposure _c \times		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



Our mechanism: El Niño lowers house prices by deteriorating natural amenities (desirable characteristics of a location)

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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

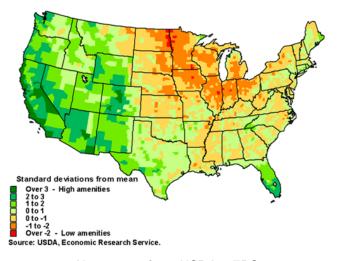


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Only cross-sectional variation (not time varying)



Note: map from USDA - ERS



	(1)	(2)	(3)
Variables		House Prices	
Positive Exposure _c	-0.0140***		-0.0136***
$ imes$ 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 $_c \times$ El Nino $_t$			(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



	(1)	(2)	(3)
Variables	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 × El Nino₊			(0.0346)
Li ramo _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

Hypothesis: value of natural amenities decreases in El Niño years

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



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Key input of natural amenities. A stable amount of salt in the soil helps vegetation grow and provides micro-nutrients to plants

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)



	(1)	(2)	(3)	(4)	(5)	(6)
Variables		Water Salinit	.y		Soil Salinity	
Pos Exp _c × El Nino+	0.134*** (0.029)		0.0809*** (0.026)	0.0413*** (0.004)		0.0345*** (0.004)
Neg Exp _c × El Nino _t	(0.023)	-0.395*** (0.120)	-0.374*** (0.121)	(0.001)	-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



Do the county effects aggregate at bank-level?

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



Table 4: Bank level effects of El Niño

	Table II Ballik level effects of El Millo			
	(1)	(2)	(3)	
Variables	Loans	Deposits	Assets	
Pank Evnasura V El Nina	-0.0133***	-0.0087**	-0.0089**	
$Bank\ Exposure_b \times El\ Nino_t$	(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

140.0 01 1110 11410111001011 01 21 111110 011 24111 201411.6				
	(1)	(2)	(3)	
Variables	Real	Commercial and	Consumer	
Variables	Estate	Industrial	Lending	
Pank Evnasura, V El Nina	-0.0101*	-0.0135**	0.00208	
Bank Exposure _b × El Nino _t	(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	

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

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



	(1)	(2)	(3)	
Variables	Log(Mortgage Lending)			
Positive Bank Exposure _b \times	-0.217***	-0.240***		
El Nino _t	(0.075)	(0.079)		
$NegativeBankExposure_b imes$	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 \times	-0.001		0.002	
El Nino _t	(0.024)		(0.023)	
D FE	V	V		
Bank FE	Yes	Yes		
County FE	Yes		Yes	
Year FE	Yes			
Bank imes Year FE			Yes	
County $ imes$ Year FE		Yes		
Obs.	2,409,405	2,409,405	2,409,405	

Table 7: County Exposure, Bank Exposure and El Niño						
	(1)	(2)				
Variables	Lending					
Positive Bank Exposure _b \times	-0.224**	-0.250***				
El Nino _t	(0.113)	(0.0977)				
County	Exposed	Non-Exposed				
Bank FE	Yes	Yes				
County $ imes$ Year FE	Yes	Yes				
Obs.	739,025	1,665,920				

Additional

- 1 A "Placebo": La Niña La Niña
- Event Study Specification Event
- Clustering at state or spatially Clustering
- Openand and Supply using CRA data CRA
- Including all Niños through MEI
- 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

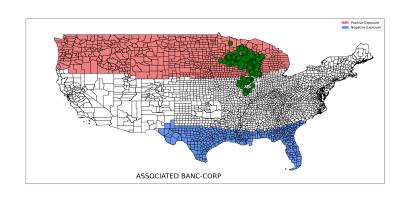
Expect larger impact in low and middle-income countries

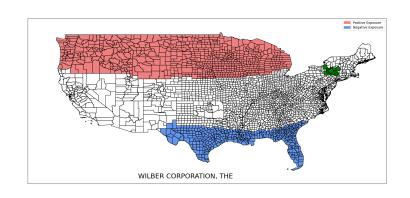


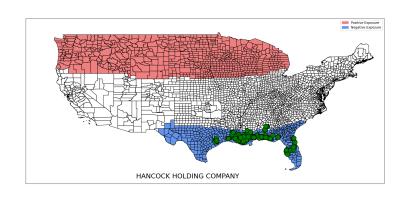
Appendix



Table 1: Summary Statistics						
	(1)	(2)	(3)	(4)	(5)	
Variable	Obs.	Mean	S.Ď.	Min	Max	
Panel	A - County-l	Level Climat	ic Variables			
Average Temperatures _{cv}	122,757	12.90	4.46	5.73	20.26	
Volatility of Temperatures _{cv}	122,757	1.45	0.74	0.48	2.83	
Panel B - County-L						
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-Le	vel Exposure	to El Nino			
Exposure _b	6,567	0.0645	0.559	-1	1	
ı	Panel D - Ba	nk-Level Va	riables			
Lending _{bv}	85,887	11.76	1.526	-4.605	20.49	
Deposits _{bv}	85.887	12.15	1.394	0	21.01	
Assets _{bv}	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 _{bv}	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	
meerest meeme _{by}	00,000	0.120	1.070	1.055	11.00	
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	



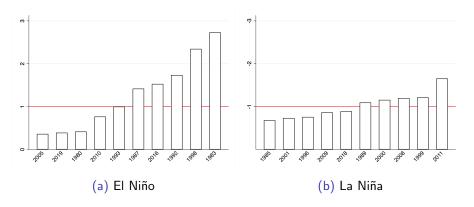




La Niña: Different time-series and geography



Intensity of La Niña is weaker



Geography is different (not south vs. north)





(a) El Niño

(b) La Niña

El Niño vs La Niña: No Effects 🔤

	(1)	(2)	(3)
Variables	Loans	Deposits	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)

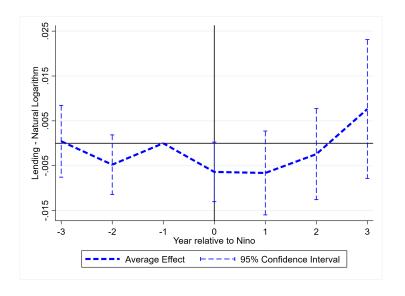
El Niño is almost as good as randomly assigned, benefit of event-study not clear

However, its repercussions may last longer so we test:

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

in a 3 years window for loans, deposits and assets





Back



2. State or Spatial clustering Back

	(1)	(2)	(3)	(4)	(5)	(6)	
Variables	Ave	rage Temperatures		Volatil	ity of Tempe	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	
×El Ninot		(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

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

	(1)	(2)	(3)
Variables	(-)	Lending	(5)
Positive Bank Exposure _b ×	-0.225	-0.208	
El Ninot	(0.175)	(0.174)	
$NegativeBankExposure_b \times$	-0.0372	-0.000943	
El Nino _t	(0.0796)	(0.107)	
Positive County Exposure _c \times	-0.152	, ,	-0.174*
El Ninot	(0.106)		(0.0970)
$Negative County Exposure_c \times$	-0.0620		-0.0637
El Nino _t	(0.0415)		(0.0491)
Bank FE	Yes	Yes	
County FE	Yes		Yes
Year FE	Yes		
$Bank \times Year \; FE$			Yes
County × Year FE		Yes	
Obs.	608,106	608,106	608,106
		4 □ →	< □ > < □ > <

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

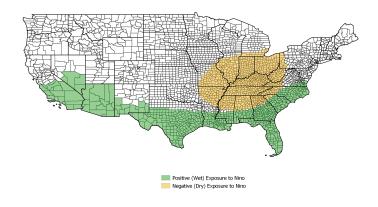
	(1)	(2)	(3)	(4)	(5)	(6)
Variables	Loans	Deposits	Assets	Loans	Deposits	Assets
Bank Exposure _b ×	-0.003	-0.002	-0.001			
MEI Nino Inde x_t	(0.002)	(0.002)	(0.002)			
Positive Bank Exposure _b ×				-0.012**	-0.007*	-0.003
MEI Nino Indext				(0.005)	(0.004)	(0.003)
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Year 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:

	(1)	(2)	(3)
Variables	Loans	Deposits	Assets
Pank Evnagura V El Nina	-0.0131***	-0.00658*	-0.00754**
Bank Exposure _b × El Nino _t	(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



