It's not what you don't know that kills you, it's what you know for sure that ain't true.

— Mark Twain

Bank Capital Redux: Solvency, Liquidity, and Crisis

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What we know

- Credit booms are precursor of systemic crises and severe recessions (Schularick and Taylor 2012; Mian, Sufi and Verner 2017)

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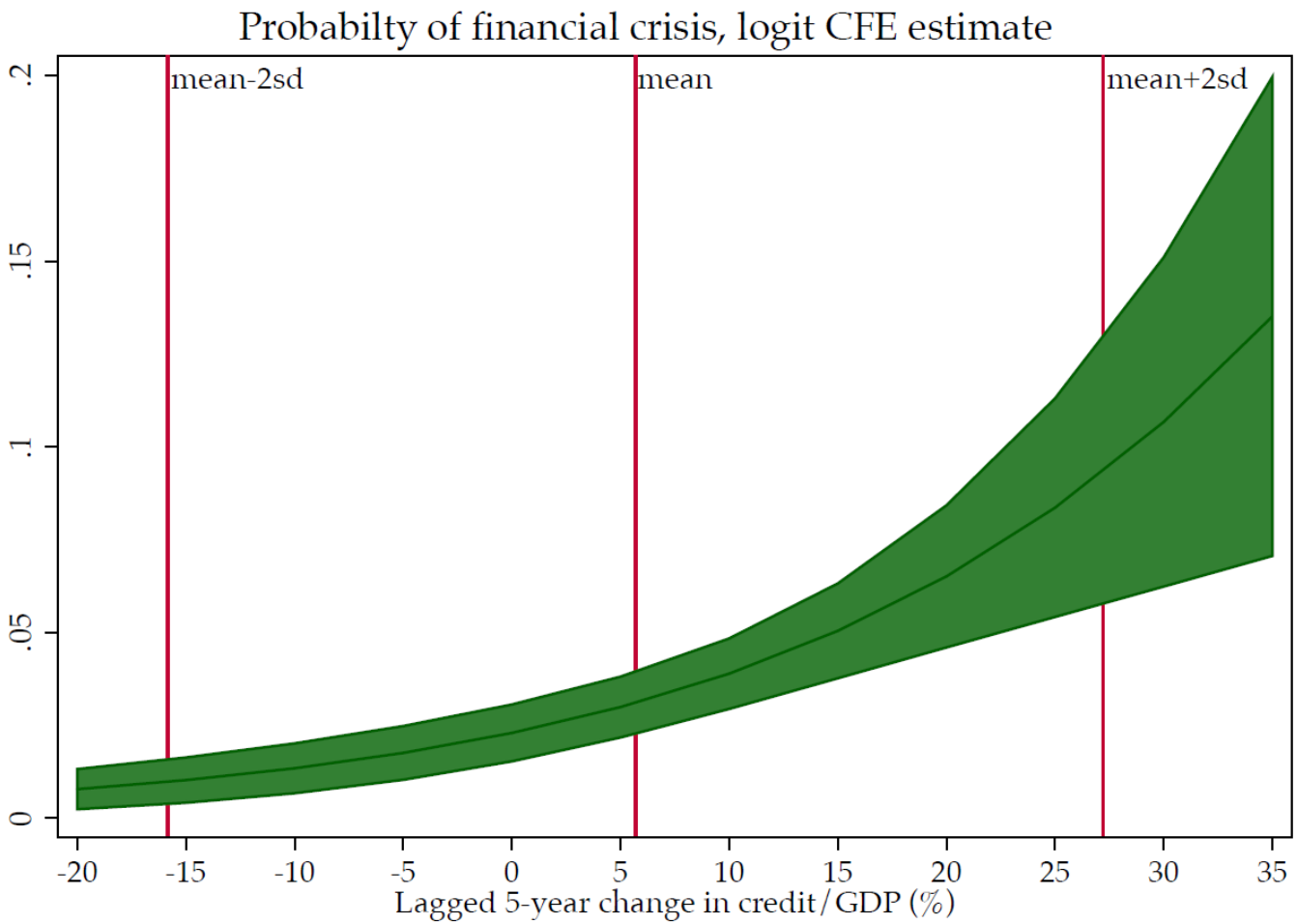
- Credit risk is typically mispriced in lending booms before crises (Krishnamurty and Muir 2017)

Credit and crisis risk



From: Latest data, 1870–2015 excluding world wars, Jordà, Schularick, and Taylor, Macrohistory Database (http://macrohistory.net)

What we don't know

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- What's driving repeated excessive risk-taking in credit markets?
- Incentives or behavioral factors?
- Can more bank capital prevent crises or alleviate their economic fallout?

What we ask

- What is the evidence that more capital makes systemic banking crises less *likely*?

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- What is the evidence that more capital makes systemic banking crises less *likely*?
- What is the evidence that more capital makes crises less *severe*?

What we do

- We study these questions using a comprehensive new dataset for the liability side of banks' balance sheets for 17 advanced economies from 1870-2015.
- First quantitative study of funding structure of the modern banking system: capital, deposits and non-core (wholesale) liabilities.
- This complements the work of Schularick and Taylor (2012) on bank credit as well as Jordà, Schularick and Taylor (2016) on disaggregated credit.

What we find

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    - This result holds across different regulatory regimes, controlling for asset risk, for the book/market value of capital, and in macro and micro data.
    - The asset side (loan growth) drives *ex ante* crisis risk, not the funding mix.
    - Moreover, we argue it's causal.

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   - This result holds across different regulatory regimes, controlling for asset risk, for the book/market value of capital, and in macro and micro data.
   - The asset side (loan growth) drives *ex ante* crisis risk, not the funding mix.
   - Moreover, we argue it's causal.
2. Yet there is robust evidence that higher capital ratios make crises less severe.

What this means

For our understanding of the causes of financial crises:

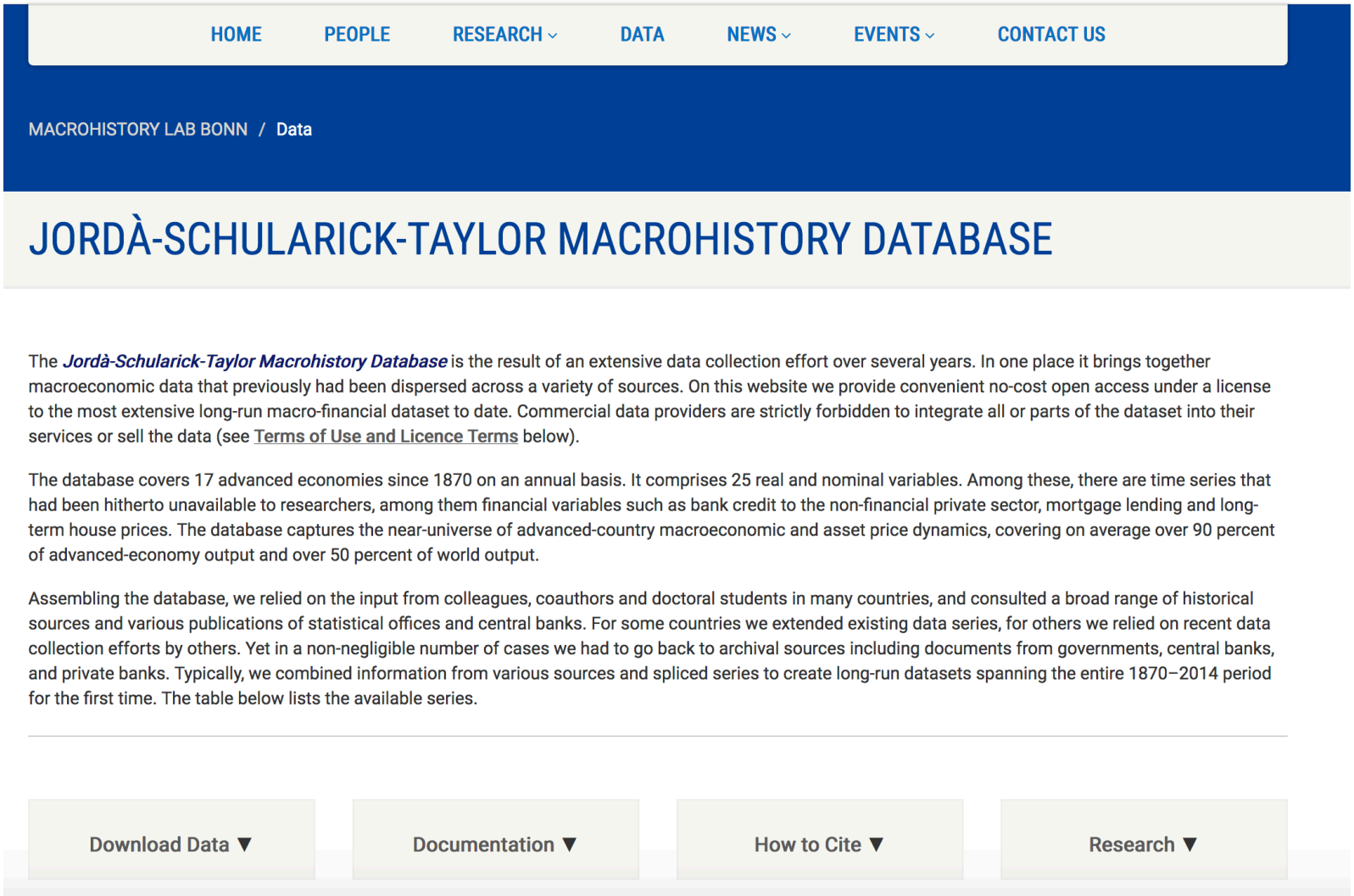
- More “skin in the game” does not necessarily make financial systems less crisis-prone.
- Excessive risk taking by rational agents does not appear central to crisis dynamics.
- Evidence is compatible with the view that crises are driven by over-optimism, neglect of crash risk, or group think (e.g., Gennaioli, Shleifer, Vishny 2013; Barberis 2012; Benabou 2012; Baron and Xiong 2016).

Three parts

1. New data and stylized facts
2. Capital and crisis probability
3. Capital and crisis severity

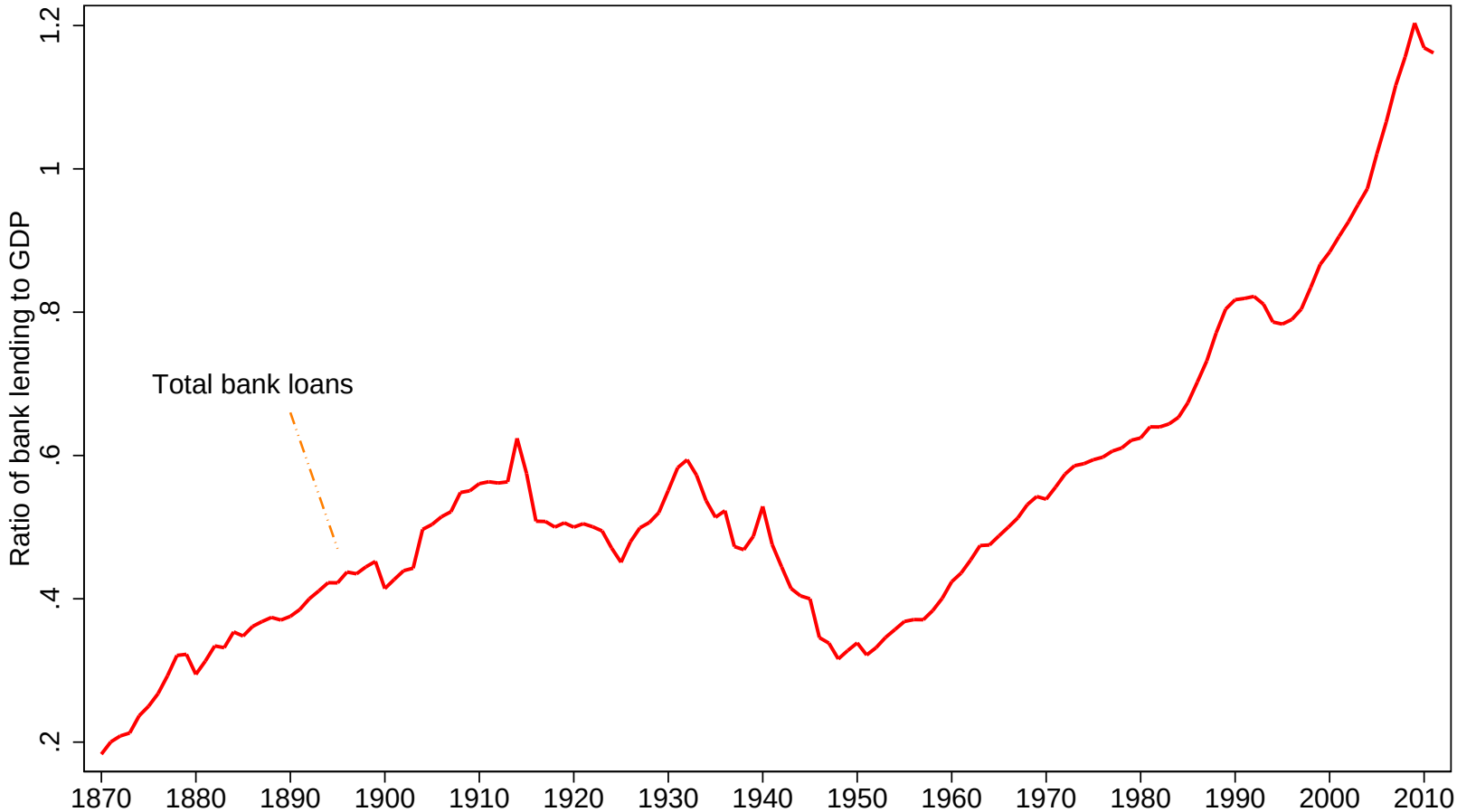
New data and stylized facts

www.macrohistory.net/data



The asset side: the financial hockey stick

Total bank credit to the non-financial private sector, 17 countries, 1870-2010



Source: Schularick, Moritz and Alan M. Taylor, Credit Booms Gone Bust: Monetary Policy, Leverage Cycles and Financial Crises 1870-2012, American Economic Review, 2012.

The liability side

Banks: Monetary financial institutions (MFIs), including commercial banks, savings banks, postal banks, building societies

Capital: Shareholders funds that allow to absorb losses:

- Common stock (paid-up capital), including the share premium
- Retained earnings
- Disclosed reserves
- No adjustment for double liability

Deposits: Term and sight deposits, checking and saving accounts by non-financial residents

Non-core: Other liabilities such as bonds, repo and interbank funding

Balance sheet ratios

An unweighted capital ratio (in the spirit of the Basel III leverage ratio):

$$\text{Capital Ratio} = \frac{\text{Capital}}{\text{Total Assets}}$$

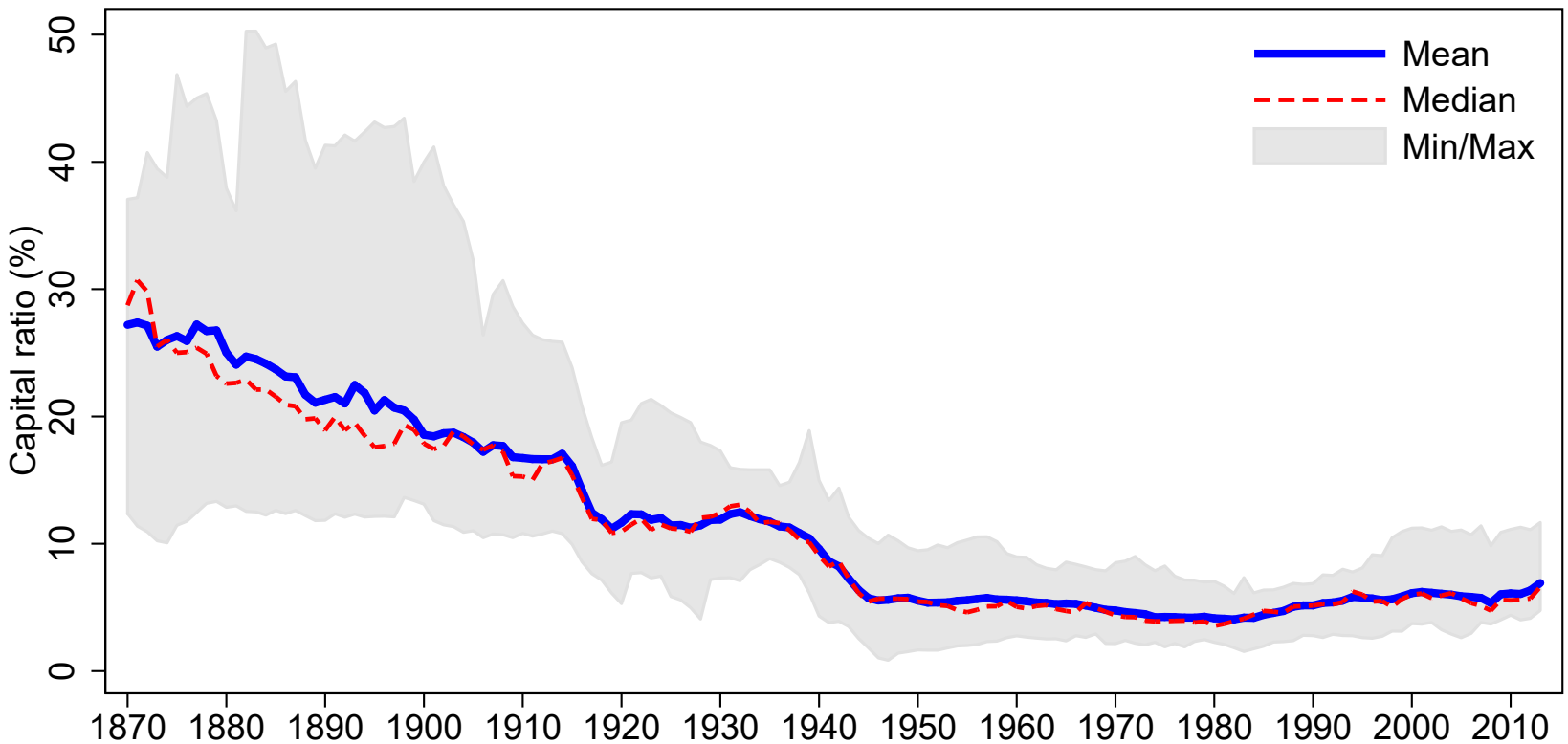
The loan-to-deposit ratio as a liquidity measure:

$$\text{LtD Ratio} = \frac{\text{Loans}}{\text{Deposits}}$$

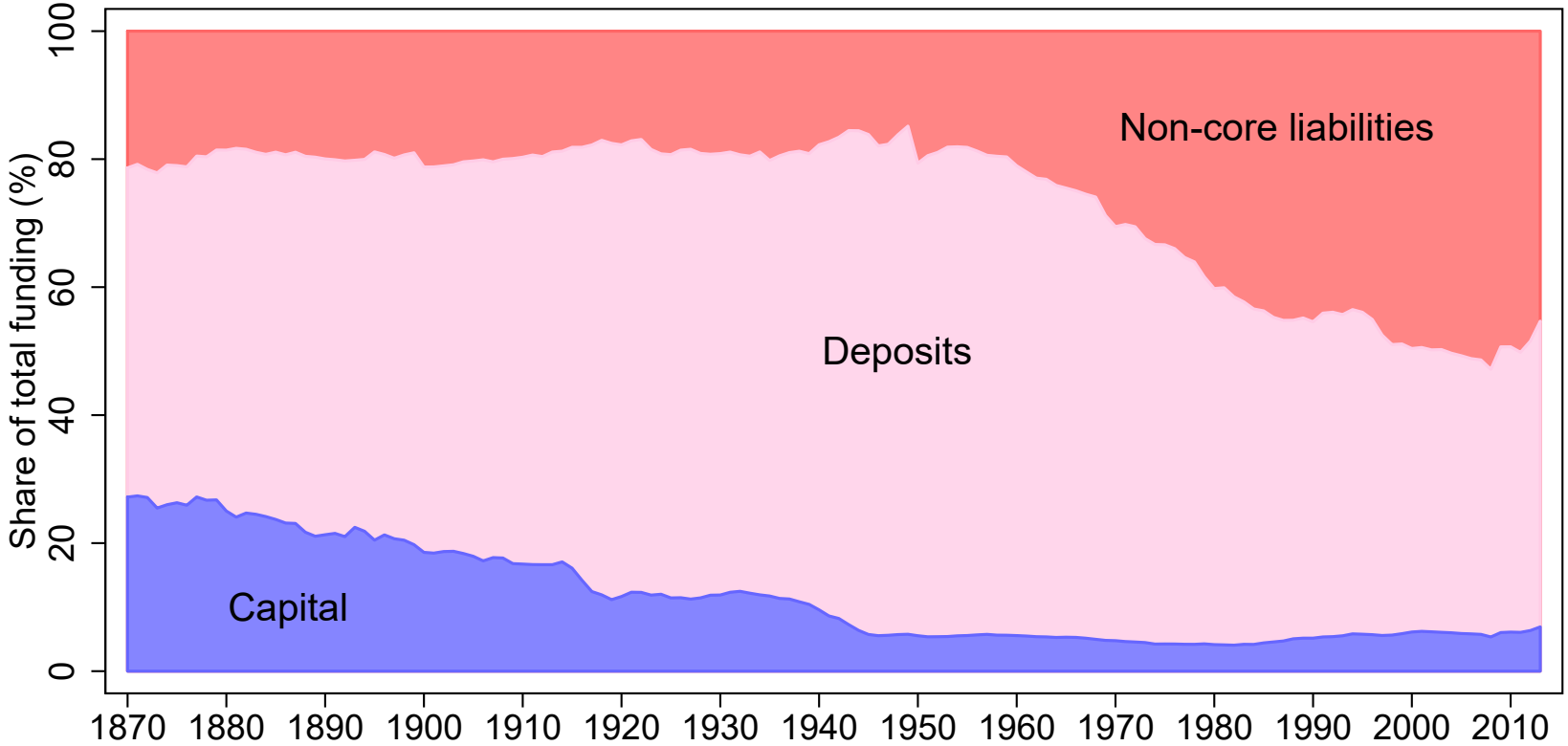
The reliance on non-core debt funding:

$$\text{Noncore Share} = \frac{\text{Noncore liabilities}}{\text{Deposits+Noncore Liabilities}}$$

Aggregate capital ratio from 1870 to 2015



Composition of funding



Capital and crisis probability

Two views on the origins of financial crisis

The capital view

- Agency frictions: large role for incentive problems leading to excessive risk-taking of rational agents (Merton 1977; Allen and Gale 2000)
- Close correlation between “skin in the game” and risk taking

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The Minsky/Kindleberger view (and updates)

- Crises driven by behavioral factors such as over-optimism followed by violent repricing of mispriced assets (e.g., Bordalo, Gennaioli, Shleifer 2017; Baron and Xiong 2016; Greenwood, Hanson, Jin 2018)
- Crises are orthogonal to bank capital. Everyone is caught in the same heuristic bubble.

Rethinking the effectiveness of equity governance

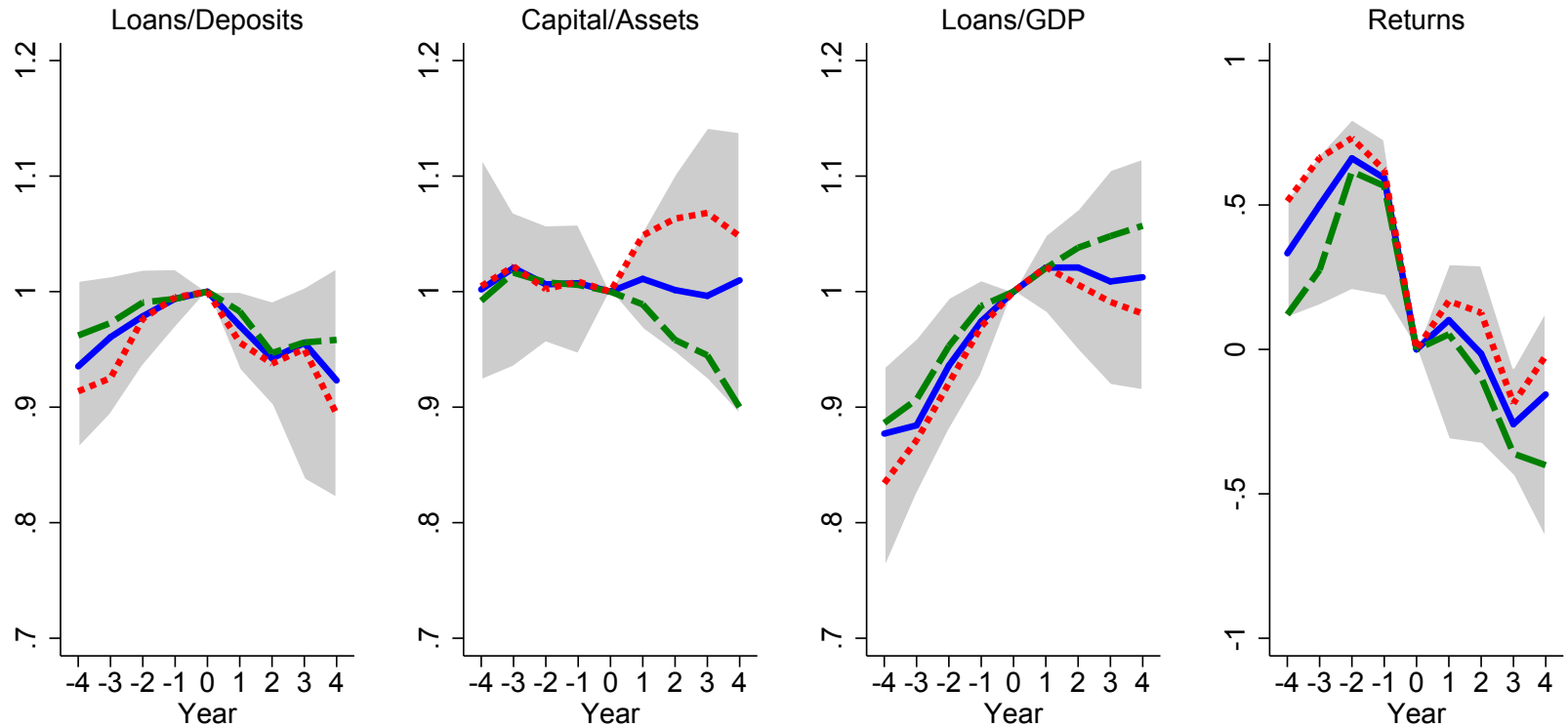
- Rajan (2018): first losses borne by equity, but "if there is no discipline on the banker, these losses can be enormous."
- Basel Committee (2018): "Benefits of capital are derived from lowering the crisis cost rather than risk."
- Haldane (2010): pre-GFD capital ratios uncorrelated with failure risk
- Anderson, Barth, and Choi (2018): double-liability banks no less risky in Great Depression.

Crisis definition

Definition of systemic financial crises follows Laeven/Valencia: "major bank failures, substantial losses, recapitalization, or government intervention..."

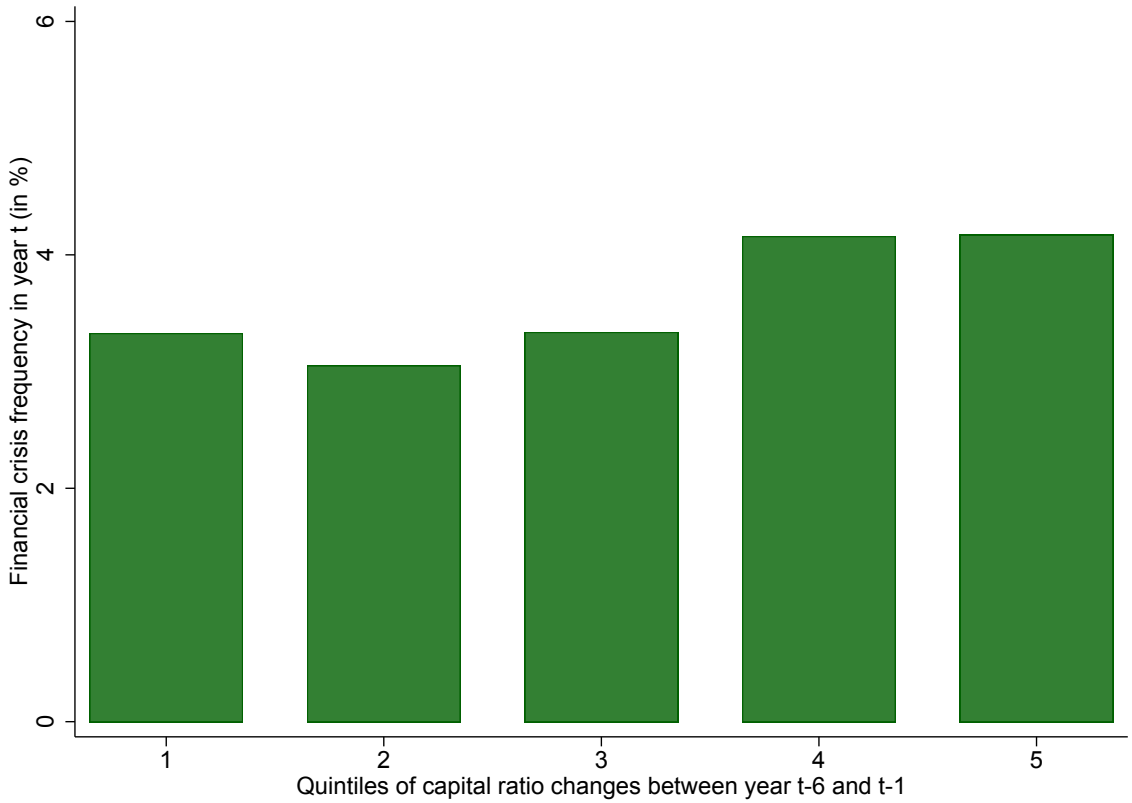
AUS:	1893, 1989.
BEL:	1870, 1885, 1925, 1931, 1934, 1939, 2008.
CAN:	1907.
CHE:	1870, 1910, 1931, 1991, 2008.
DEU:	1873, 1891, 1901, 1907, 1931, 2008.
DNK:	1877, 1885, 1908, 1921, 1931, 1987, 2008.
ESP:	1883, 1890, 1913, 1920, 1924, 1931, 1978, 2008.
FIN:	1878, 1900, 1921, 1931, 1991.
FRA:	1882, 1889, 1930, 2008.
GBR:	1890, 1974, 1991, 2007.
ITA:	1873, 1887, 1893, 1907, 1921, 1930, 1935, 1990, 2008.
JPN:	1871, 1890, 1907, 1920, 1927, 1997.
NLD:	1893, 1907, 1921, 1939, 2008.
NOR:	1899, 1922, 1931, 1988.
PRT:	1890, 1920, 1923, 1931, 2008.
SWE:	1878, 1907, 1922, 1931, 1991, 2008.
USA:	1873, 1893, 1907, 1929, 1984, 2007.

Event windows centered on crisis year



Notes: This figure presents the path of key variables around financial crises. Year 0 corresponds to a systemic financial crisis. The values of the respective ratio are scaled to equal 1 in year 0 in the first three panels. The fourth panel shows cumulative log excess returns on the bank index relative to year 0. The solid blue line corresponds to the median over all financial crises and the grey bands to the interquartile range. The dashed red (green) line shows the median for financial crises when the lagged level of the capital ratio was below (above) the median of all financial crisis observations.

Capital ratio and crisis frequency



Notes: The figure shows the relationship between changes in capital ratios and financial crisis frequencies. Observations are sorted into five equal-sized bins according to the change in the capital ratio over the years $t-6$ to $t-1$. Vertical bars indicate the frequency of financial crises in year t for each of the bins.

Binary classification model

Probit classification model: probability of a crisis conditional on observables $X_{i,t}$ is represented in terms of the Cumulative Distribution Function of the standard normal (Φ):

$$Pr[S_{i,t} = 1|\alpha_i, X_{i,t}] = \Phi(\alpha_i + \boldsymbol{\beta} X_{i,t}) \,,$$

for all years t and countries i in the sample, α_i is a country fixed effect. $S_{i,t}$ is an indicator variable for the start of a systemic financial crisis (Jordà et al. 2016).

$X_{i,t}$ includes balance sheet ratios, and the average annual change over the previous 5-year window (denoted Δ_5) of the ratio of credit to GDP.

Probit model

	(1) Full	(2) Post	(3) Full	(4) Post
Δ_5 Loans/GDP	0.85***	0.62***	0.84***	0.64***
	(0.11)	(0.07)	(0.11)	(0.07)
Capital ratio	0.17***	0.04		
	(0.03)	(0.23)		
Δ_5 Capital ratio			0.04	1.44
			(1.09)	(2.13)
AUC	0.75	0.74	0.71	0.75
	(0.03)	(0.05)	(0.03)	(0.05)
Observations	1735	1004	1720	998

Clustered standard errors in parentheses. $^{*}p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Control for asset risk

1. Market assessment of bank risk: risk premia on banking sector stock index from Baron and Xiong (2017).

2. Macro risks: 5-year/10-year moving standard deviations of gdp, inflation, and interest rates. (NB: also tried forward looking.)

3. House price booms: run-up in real house prices over preceding 5-year period. (NB: also tried deviations from trend.)

Controlling for asset risk

	(1) Full	(2) Full	(3) Post	(4) Post	(5) Full	(6) Full	(7) Post	(8) Post
Δ_5 Loans/GDP	0.93***	0.70***	0.40***	0.25*	0.94***	0.71***	0.42***	0.28*
	(0.10)	(0.10)	(0.13)	(0.14)	(0.11)	(0.11)	(0.13)	(0.16)
Capital ratio	0.16***	0.16***	0.09	-0.01				
	(0.05)	(0.06)	(0.18)	(0.20)				
Δ_5 Capital ratio					0.43	0.75	0.87	1.26
					(1.21)	(1.14)	(1.86)	(1.87)
Macrocontrols	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Asset risk controls	No	Yes	No	Yes	No	Yes	No	Yes
AUC	0.74	0.80	0.80	0.83	0.72	0.79	0.80	0.83
	(0.03)	(0.03)	(0.05)	(0.04)	(0.03)	(0.03)	(0.04)	(0.04)
Observations	1582	1277	988	887	1570	1274	984	884

Marginal effects. Clustered standard errors in parentheses. $^{*}p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Market value of capital

	(1)	(2)	(3)	(4)
Δ_5 Loans/GDP	0.85***	0.11	0.98***	0.08
	(0.23)	(0.21)	(0.29)	(0.17)
Market-based capital ratio	0.03	-0.15		
	(0.12)	(0.12)		
Δ_5 Market-based capital ratio			0.62	0.30
			(0.87)	(0.54)
Macrocontrols	No	Yes	No	Yes
Asset risk controls	No	Yes	No	Yes
AUC	0.68	0.77	0.68	0.84
	(0.07)	(0.06)	(0.07)	(0.04)
Observations	413	410	348	348

Marginal effects shown. Clustered standard errors in parentheses. See text. $^{*}p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Credit growth capital interactions

	(1) Full	(2) Full	(3) Post	(4) Post	(5) Post	(6) Post
Δ_5 Loans/GDP	0.82***	0.56***	0.44	0.11	0.55	-0.09
	(0.18)	(0.18)	(0.28)	(0.23)	(0.42)	(0.33)
High capital	0.03***	0.01	-0.01	-0.01		
	(0.01)	(0.01)	(0.01)	(0.01)		
High capital (market-based)					-0.00	-0.01
					(0.03)	(0.02)
Δ_5 Loans/GDP x high capital	0.14	0.38	0.27	0.23	0.50	0.36
	(0.27)	(0.27)	(0.35)	(0.24)	(0.60)	(0.44)
Macro controls	No	Yes	No	Yes	No	Yes
Asset risks	No	Yes	No	Yes	No	Yes
AUC	0.75	0.80	0.76	0.84	0.67	0.79
	(0.03)	(0.03)	(0.05)	(0.04)	(0.06)	(0.05)
Observations	1735	1277	1004	887	410	410

Marginal effects shown. Clustered standard errors in parentheses. See text. $^{*}p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Deposit insurance

	(1) No-DI	(2) DI	(3) No-DI	(4) DI
Δ_5 Loans/GDP	0.78***	0.22**	0.94***	0.22*
	(0.13)	(0.11)	(0.15)	(0.13)
Capital ratio	0.21***	-0.22		
	(0.06)	(0.18)		
Δ_5 Capital ratio			0.74	-0.83
			(1.13)	(1.23)
Macrocontrols	Yes	Yes	Yes	Yes
Asset risks	Yes	Yes	Yes	Yes
AUC	0.86	0.86	0.83	0.86
	0.03	0.03	0.04	0.03
Observations	721	536	718	536

Marginal effects shown. Clustered standard errors in parentheses. Deposit insurance dates are in the appendix. See text. $^{*}p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

More checks

- Level differences in capital ratios may be the reason why some countries experience more banking crises than others: pooled regressions show same results.
- Leverage in the shadow banking sector: excluding US and UK does not change results. Also excluding the 2008 crisis does not change the results.
- Including decade fixed effects or monetary regime dummies does not affect the results.
- Results robust to different crisis chronologies (Barron and Verner; Bordo et al.; Reinhard and Rogoff)

Going micro

What if dispersion matters and a few under-capitalized banks drive crisis risk?

- We use a micro-level dataset from Italy (Historical Archive of Credit in Italy) covering the universe of Italian banks from 1890 to 1970.
- Use micro-dataset for largest banks from historical sources.
- Study effects for different percentiles of the capital ratio distribution.

Italian micro data

	5th pctile	10th pctile	25th pctile	Aggregate
Capital Ratio	1.93	1.21	0.79	0.65*
	(1.41)	(0.99)	(0.70)	(0.37)
AUC	0.68	0.65	0.64	0.71
	(0.09)	(0.09)	(0.09)	(0.11)
Observations	66	66	66	66

Marginal effects shown. Regressors are in one-period lagged levels. Robust standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Do a few large banks predict instability?

Do the capital ratios of the largest banks drive financial instability?

- We use micro data from Mazbouri et al. (2017) for the largest banks in Belgium, France, Germany, Italy, Switzerland and the UK for the period 1890 to 1970.
- We extended the coverage of the data series using data for the same set of banks in France, Germany, Italy, Switzerland and the UK to 2015.
- We then test the capital-instability nexus for the largest banks in each country in the sub-sample.

Largest banks

	(1) Full	(2) Full	(3) Full
Δ_5 Loans/GDP	1.27*** (0.20)	1.16*** (0.25)	0.50 (0.38)
Capital ratio	0.08** (0.04)	0.12 (0.07)	
High capital			-0.00 (0.02)
Δ_5 Loans/GDP x high capital			1.40*** (0.53)
Macro controls	No	Yes	Yes
House price changes	No	Yes	Yes
Excess stock returns	No	Yes	Yes
AUC	0.72 (0.04)	0.78 (0.04)	0.80 (0.04)
Observations	809	627	627

Marginal effects shown. Clustered standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Causality

Is this causal?

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- So far: causal interpretation under the assumption that, conditional on controls, variation in capital is exogenous. May be too strong.
- Instrumental variable approach: we instrument changes in bank capital with lagged changes in returns on assets
  - **Relevance:** retained earnings are a major source of bank capital
  - **Exclusion restriction:** change in RoA and future crisis risk

IV regression

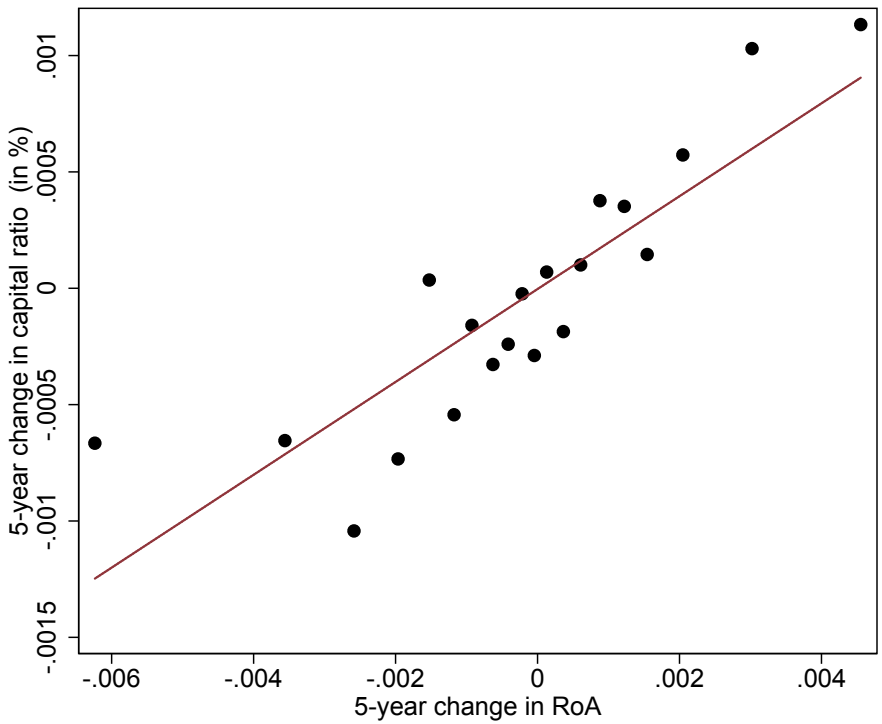
- **First stage OLS:** Instrument changes in capital with lagged change in RoA.

$$\Delta_5 Capital\ Ratio_{i,t-1} = \alpha_i + \sum_{j=1}^{5} \Delta RoA_{i,t-j} + \Delta_5 Loans/GDP_{i,t-1} + RiskPremium_{i,t-1} + \epsilon_{i,t-1}$$

- **Second stage probit:**

$$\Phi^{-1}(Crisis_{i,t}) = \alpha_i + z_{i,t-1} + \Delta_5 Loans/GDP + RiskPremium_{i,t-1} + \epsilon_{i,t}$$

First stage



Notes: The figure shows binned scatterplots for 5-year average changes in capital ratios and 5-year average changes in RoA. Observations are collapsed into 20 equal sized bins according to 5-year average changes in RoA. Each point represents the group specific means of 5-year average changes in capital ratios and 5-year average changes in RoA. A fitted regression line is shown in red.

Second stage: IV probit

	(1) No Cap	(2) Cap	(3) IV	(4) No Cap	(5) Cap	(6) IV
Δ_5 Loans/GDP	0.72***	0.72***	0.73**	0.69***	0.69***	0.70***
	(0.09)	(0.09)	(0.30)	(0.09)	(0.09)	(0.22)
Δ_5 Capital ratio		0.21	-0.21		0.02	-0.10
		(2.17)	(7.90)		(2.02)	(8.99)
Bank risk premia	No	No	No	Yes	Yes	Yes
AUC	0.75	0.75	0.72	0.76	0.76	0.75
se	0.06	0.06	0.06	0.05	0.05	0.06
Observations	844	844	844	844	844	844

Marginal effects shown. All models include country fixed effects. Clustered standard errors in parentheses.
$^{*}p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Build-up of risks orthogonal to bank capital

- There is little evidence that excessive risk taking by rational agents is at the heart of crisis risk.
- More “skin in the game” not effective in taming risk-taking. (NB: think about equity market bubbles.)
- Next: the role of capital in alleviating the cost of crises.

CAPITAL AND THE COST OF CRISES

Do capital ratios impact the cost of crises?

- Consider a country i coming out of a business cycle expansion p and entering a recession at time $t(p)$
- ... when there was a financial crisis in a window +/- 2 years
- ... hitting an economy with a banking sector that had a capital ratio lower than the average capital ratio at the start of all such recessions
- ... how does this change the expected path of the economy through recession and recovery $(y_{t(p)}, ..., y_{t(p)+h})$?

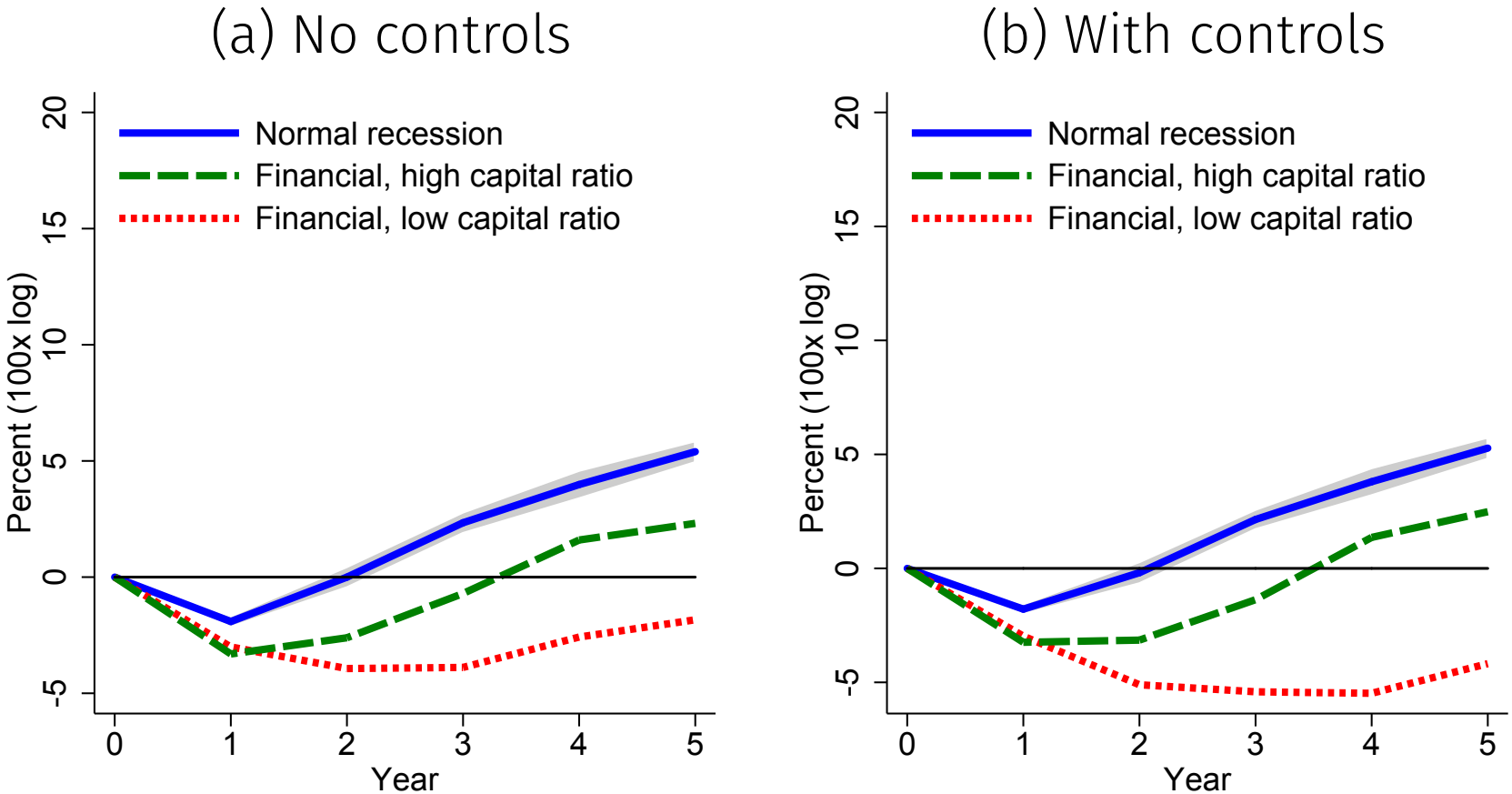
Model specification

$$\Delta_h y_{i,t(p)} = \overbrace{\sum_{i=1}^{I} \alpha_{i,h} D_{i,t(p)}}^{country-indicators} + \overbrace{\mu_h}^{\text{avg. path}} + \gamma_h^{HI} d_{i,t(p)} \times \delta_{i,t(p)}$$
$$+ \gamma_h^{LO} d_{i,t(p)} \times (1 - \delta_{i,t(p)}) + X_{i,t(p)} \Psi + \epsilon_{i,t(p)}$$
$$\text{for } h = 1, ..., 5$$

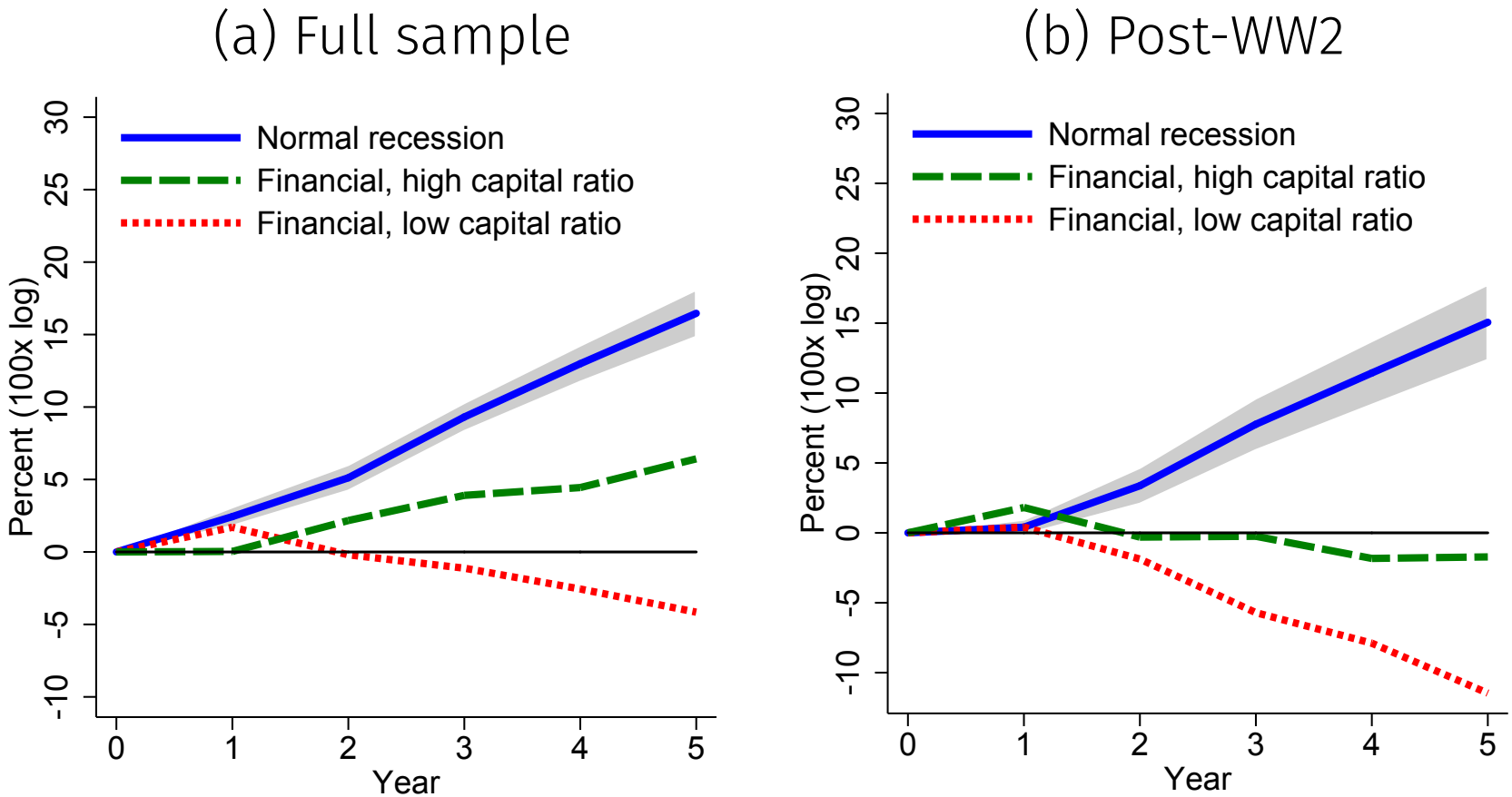
Controls X at time $h = 0, -1$:

1. real GDP per capita growth rate
2. real investment per capita growth rate
3. CPI inflation rate
4. short-term interest rate
5. long-term interest rate
6. current account to GDP ratio

Slower recovery with low capital



Slower credit growth with low capital



Conclusions

- The balance sheet structure of banks changed substantially between 1870 and today, but the large decline in capital occurred before WW2, not afterwards.
- Capital reduces the cost, not the risk of a crisis.
- Capital matters: financial crises are less costly when capital ratios are high.