The Shifts and the Shocks: Bank Risk, Leverage, and the Macroeconomy

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Motivation

- Two-way interplay between banks and the macroeconomy
  - Banks are exposed to macro risk
  - Bank shocks affect real activity
- This interplay depends on banking sector structure
- Bank structure has changed materially over the long run
  - Increases in leverage, size, mortgage lending
- Have the risks banks are exposed to, and those they generate, changed as a result?

What we do

- Theory: Banks lever up against exogenous risk, generate endogenous risk
- We use data for 17 countries, 1870–2016, to study trends in
  1. Bank asset risk
  2. Its amplification through leverage
  3. Macro effects of bank asset losses

What we find

1. Large long-run decline in bank asset risk
   - RoA volatility $\downarrow$ 5x 1870–1950, $\uparrow$ 2x 1950–2016
2. Long-run increases in equity and default risk
   - Small asset risks amplified by high leverage
3. Increases in output gaps after bank asset losses
   - Before 1945: Bank asset returns have no excess predictive power for future GDP
   - After 1945: Asset returns robustly predict future GDP
   - Evidence linking this change to the decline in asset risk, and increased leverage amplification

Contribution

1. Long-run trends in banking: size (Schularick and Taylor, 2012; Philippon, 2015), leverage (Jordà et al., 2021)
   - We focus on bank risk and its broader implications
2. Links between banks and the macroeconomy
   - Theory: amplification and leverage (Kiyotaki and Moore, 1997; Brunnermeier and Sannikov, 2014)
   - Empirics: macro effects of bank equity shocks (Jordà et al., 2013; Baron et al., 2021)
   - We separate bank asset shocks & their amplification, document amplification increases linked to leverage

The Shifts:

Changes in risk within banking

Data

17 advanced economies (Europe, USA, Canada, Australia, Japan), 1870–2016

- Market returns on bank and non-financial equity
  (Baron, Verner, and Xiong, 2021)
- Bank balance sheets
  (Jordà, Richter, Schularick, and Taylor, 2021)
- Bank profit and loss accounts
  (Richter and Zimmermann, 2020)

Measuring bank asset risk

1. Volatility of the (monthly) unlevered equity return

$$\text{Volatility}\left(R^{\text{asset}}\right)_t = \text{Std. dev.}\Big(\underbrace{R^{\text{asset}}}_{\text{Capital Ratio} * R^{\text{bank equity}}}\Big)_{t-5,t+5}$$

2. Beta of the (monthly) unlevered equity return

$$\beta_t^{\text{market}} = \text{Cov}\left(R^{\text{asset}}, R^{\text{nonf equity}}\right)_{t-5,t+5} / \text{Var}\left(R^{\text{nonf equity}}\right)_{t-5,t+5}$$

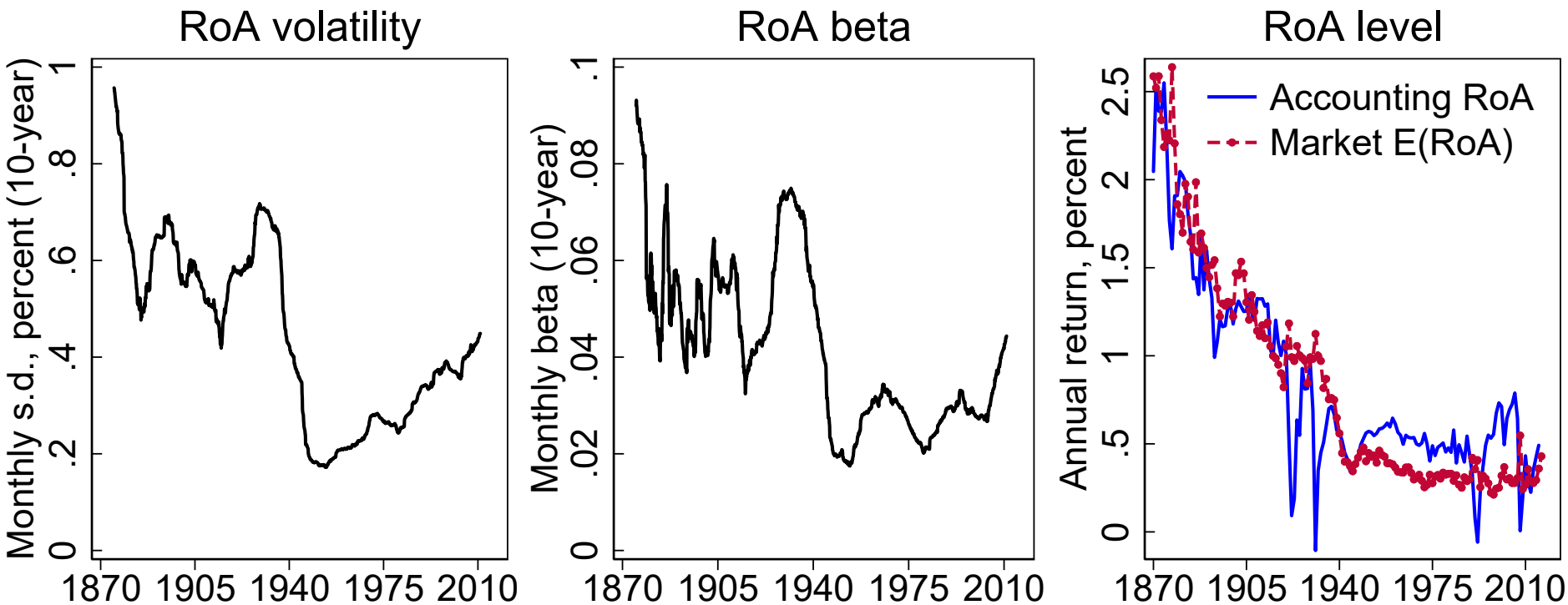
3. Level of the asset return

$$\text{RoA}_t = \text{Net Profits}_t / \text{Total Assets}_t$$

$$\mathbb{E}\left(R_{t+1}^{\text{asset}}\right) = \text{Capital Ratio}_t * \underbrace{\mathbb{E}(R_{t+1}^{\text{bank equity}})}_{(D_t/P_t + \overline{g})}$$

Trends in bank asset risk

- Strong decline 1870–1950, moderate increase afterwards



Why did asset risk decline?

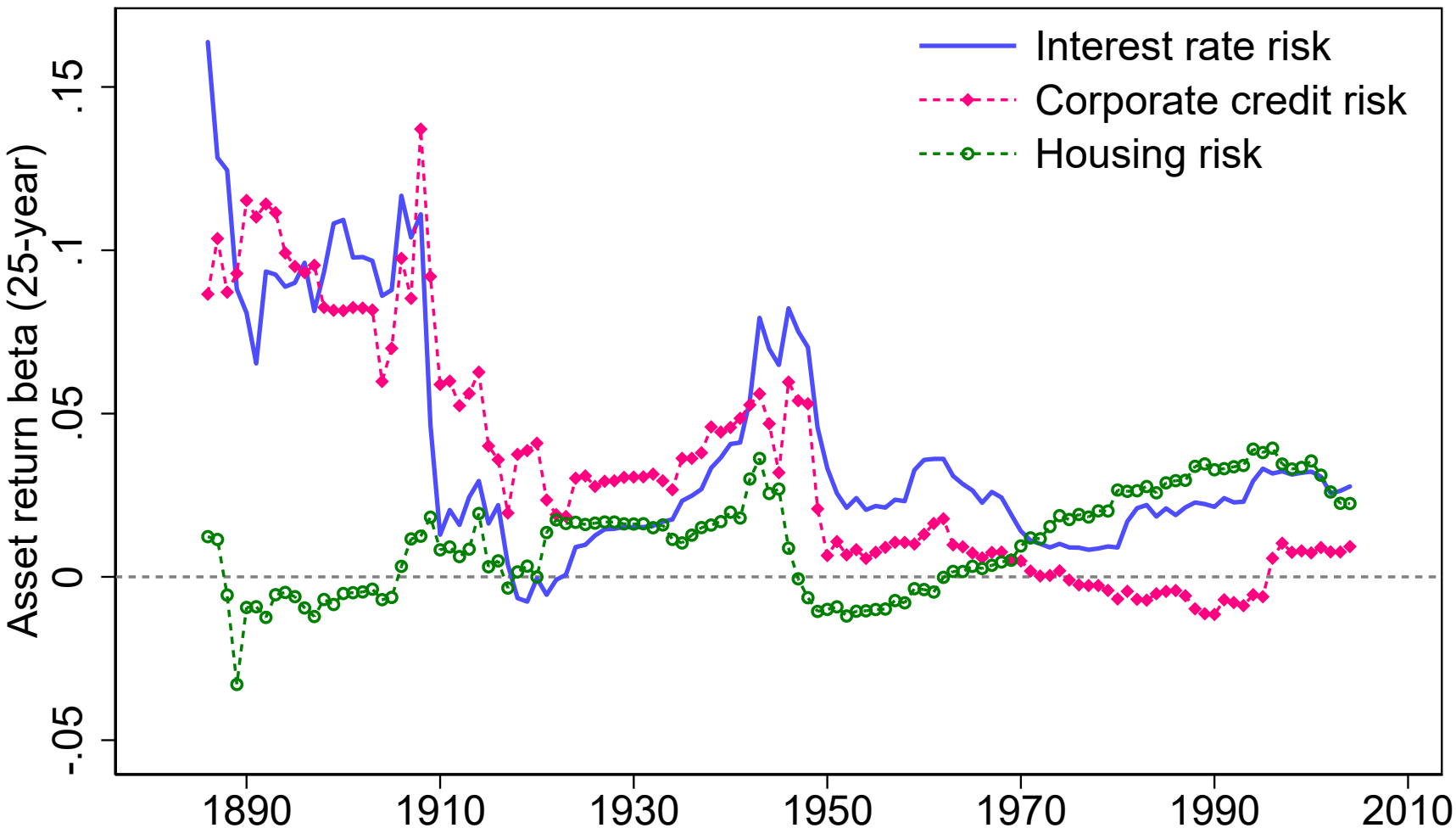
Potential explanations:

1. Lower exposures to a given macro risk
   - Drivers: risk management, diversification, shift towards government debt and mortgages
2. Lower macro risks
   - Drivers: recessions, deflation, high inflation

   (Fisher, 1933; Nagel and Purnanandam, 2020; Agarwal and Baron, 2021)

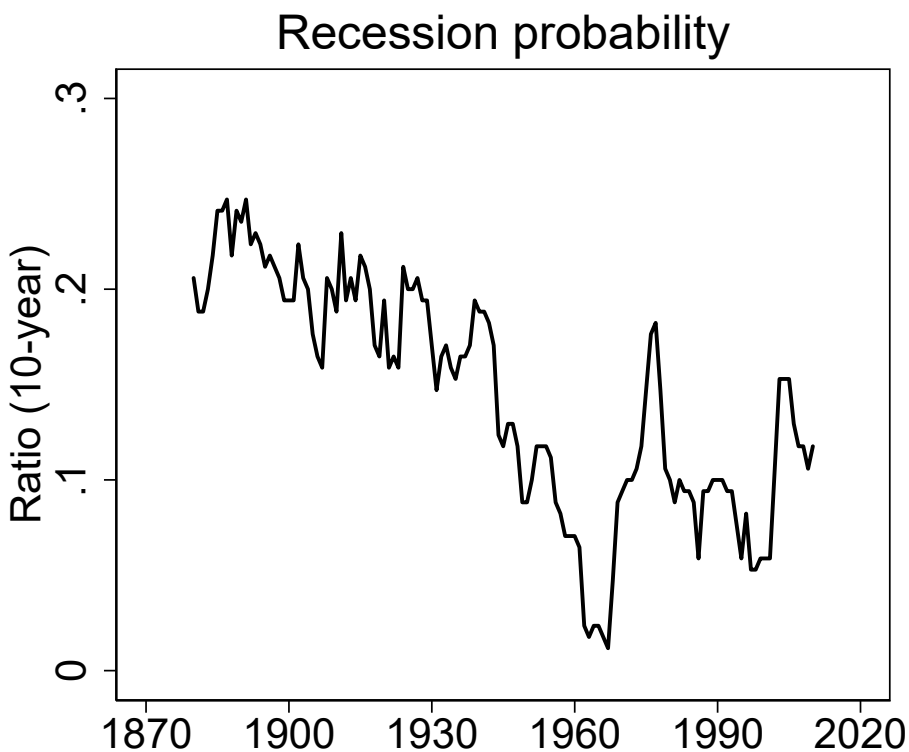
Trends in bank asset risk exposures (betas)

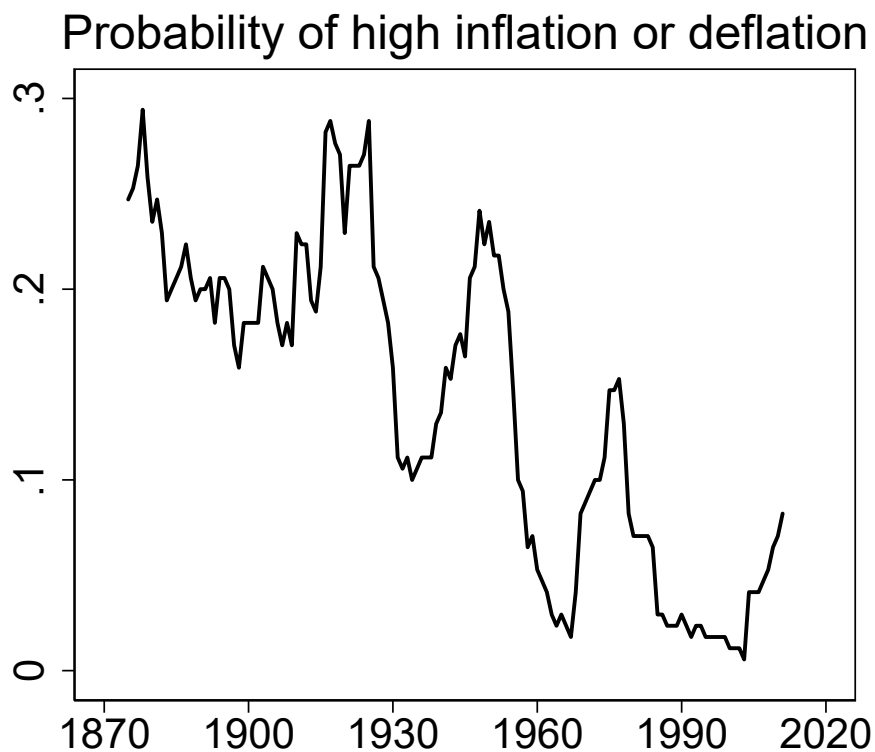
$$R_{i,t}^{asset} = \alpha_i + \beta^{mkt} R_{i,t}^{eq} + \beta^{irate} R_{i,t}^{gbond} + \beta^{credit} R_{i,t}^{corpbond} + \beta^{hous} R_{i,t}^{hous} + u_{i,t}$$



Trends in macro risks relevant for banking

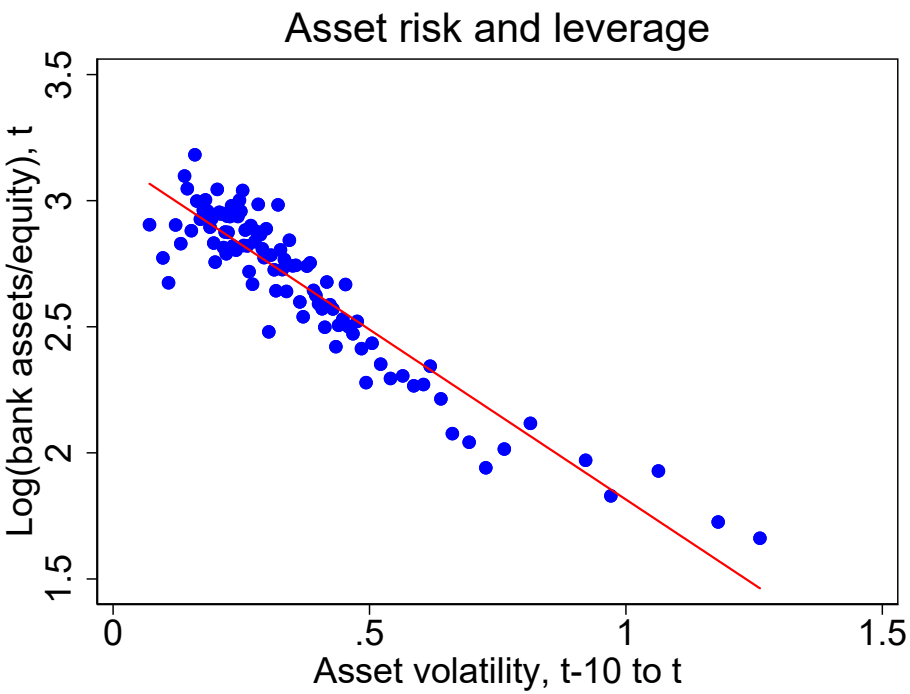
- 1870s vs today: less frequent recessions, lower price level related risks (esp. deflation)

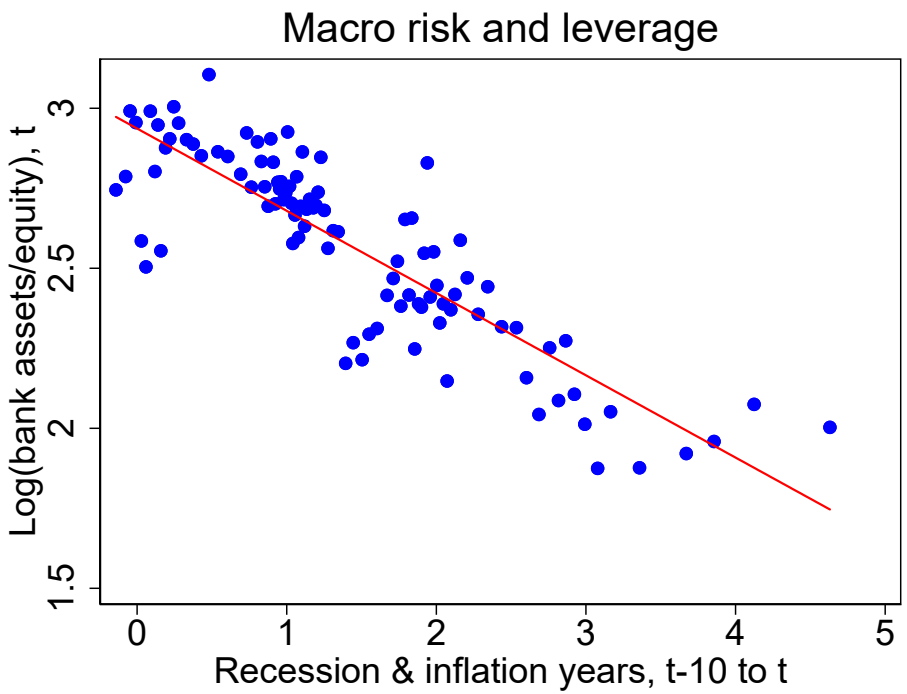




How did banks respond to lower macro risk?

- Theory: banks lever up against lower exogenous risk
- Data: asset and macro risk negatively correlated with bank leverage ▸ Regressions

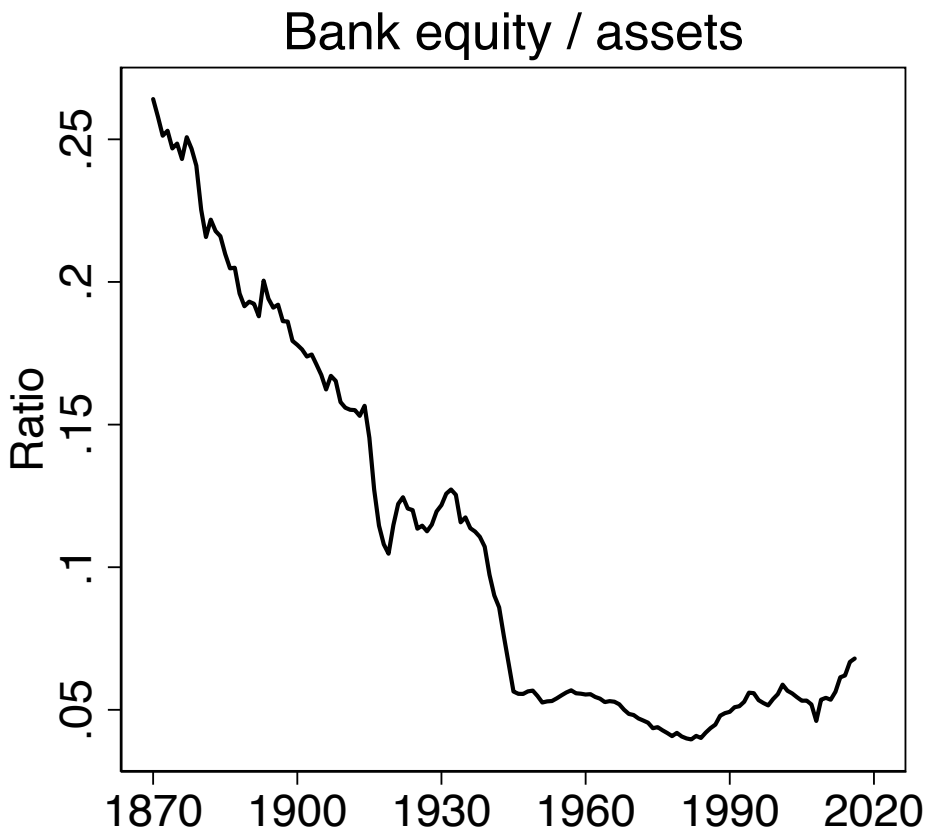


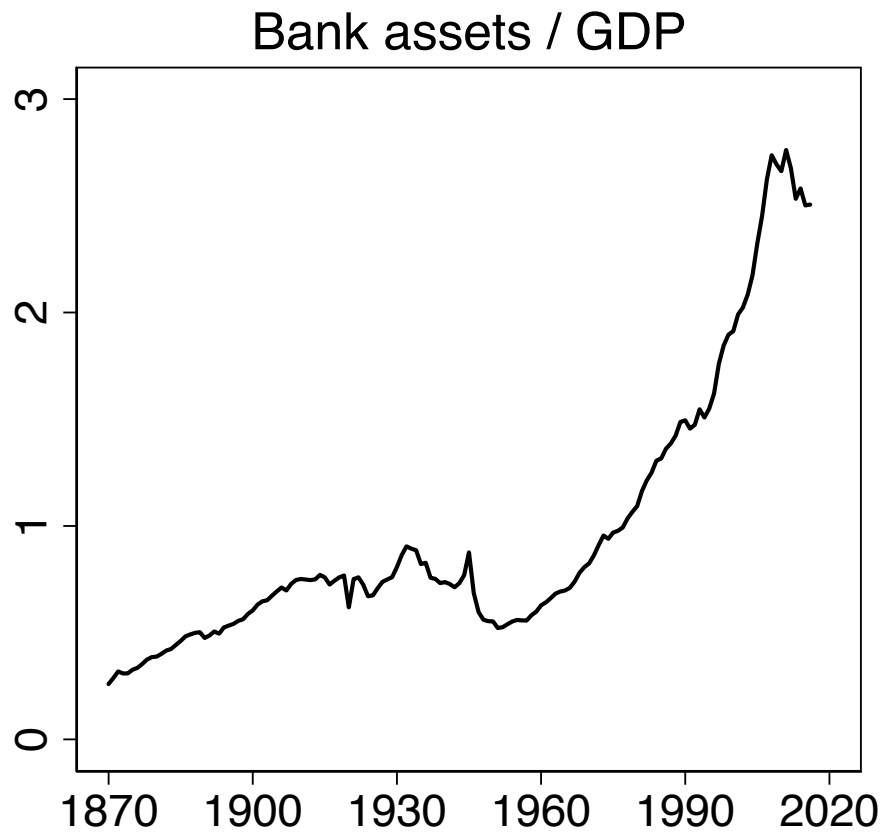


Country fixed effects and controls included

Trends in banking system leverage

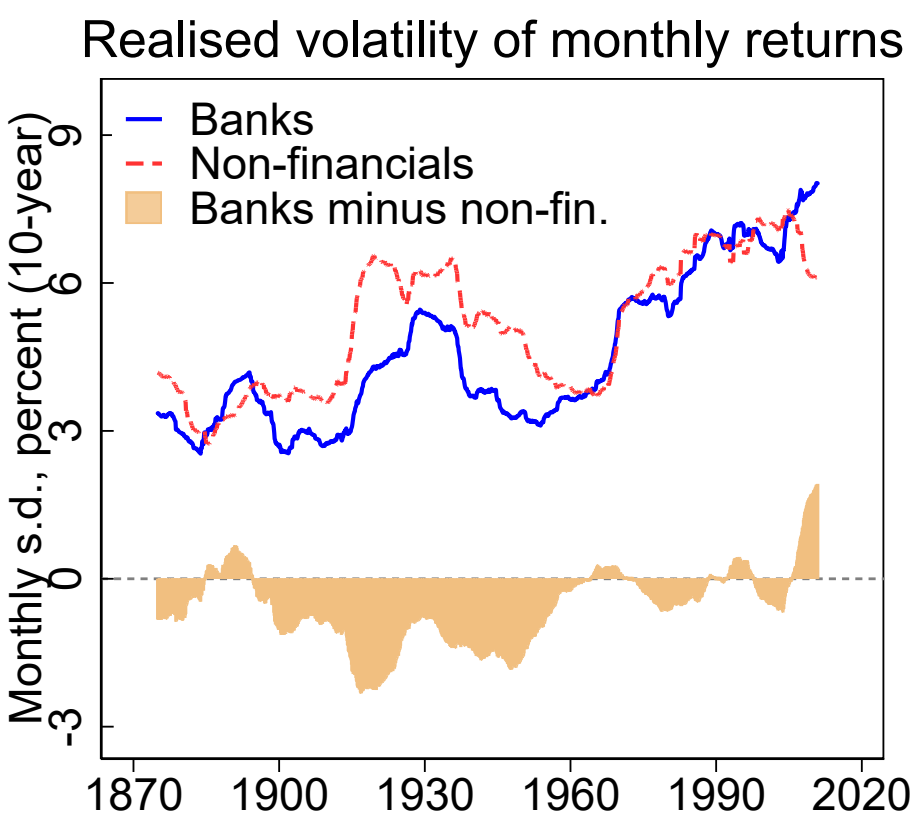
- Leverage increases of 3x–6x over the long run

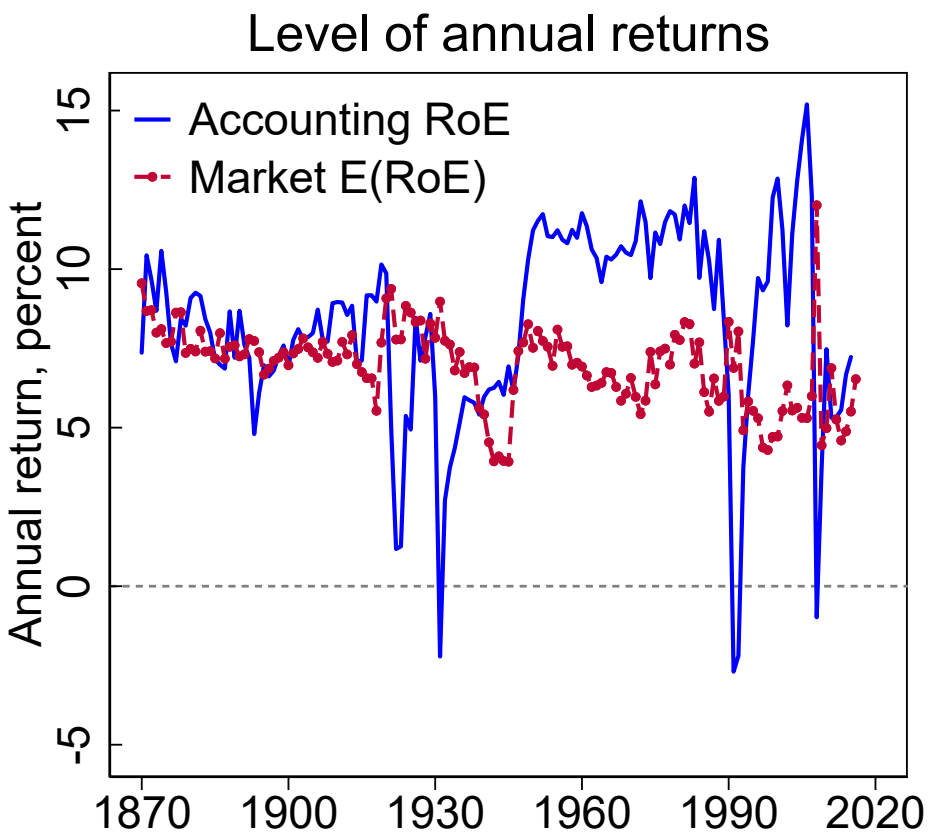




Trends in bank equity risk

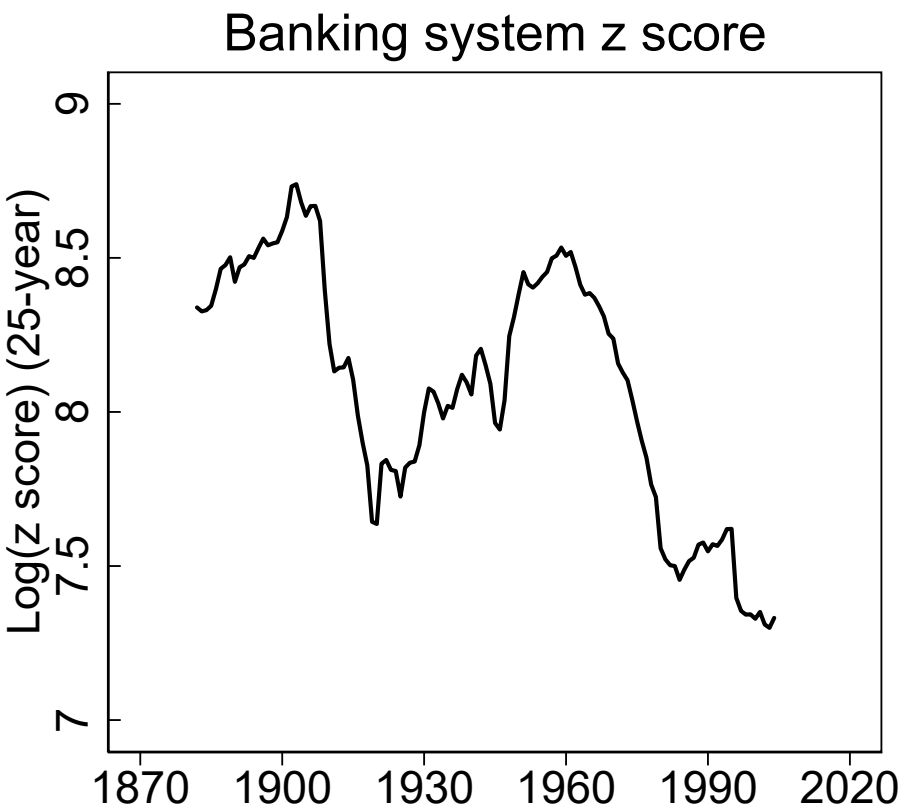
- Higher leverage amplifies the risks of bank assets
- Bank equity risk flat before 1950 despite falls in asset risk, increasing afterwards



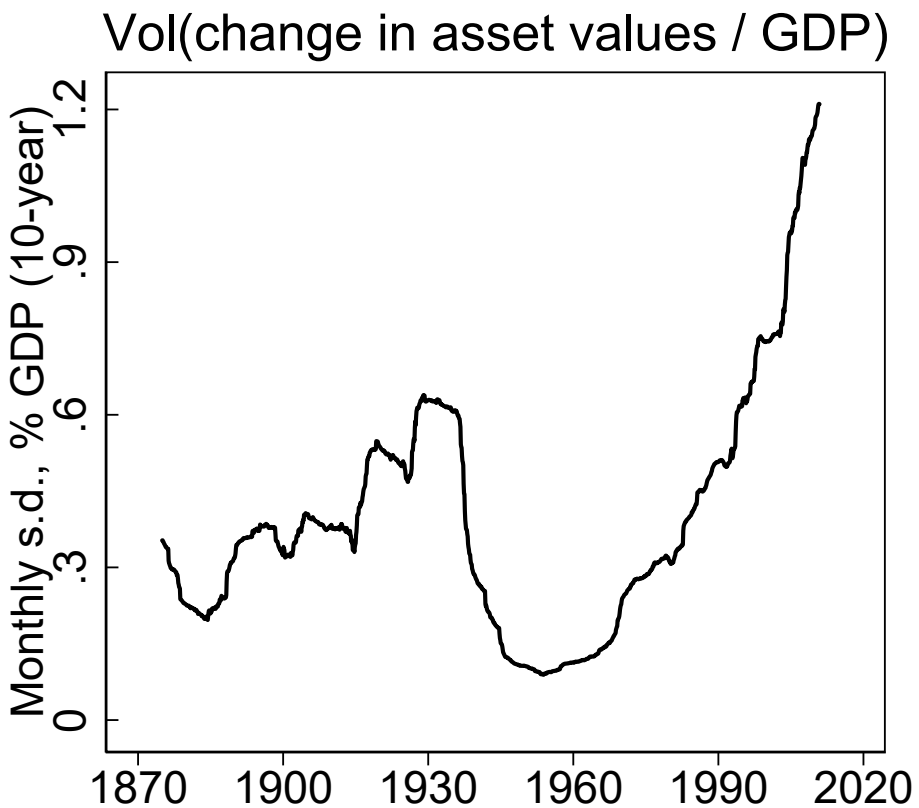


Combined measures of banking system risk

- Banking system at higher risk of default, assets more volatile relative to economic income



$$\frac{\text{RoA} + \text{Capital Ratio}}{\text{Std.dev(RoA)}}$$



$$\text{Std.dev}\left(\frac{R^{\text{asset}} * \text{Bank Assets}}{\text{GDP}}\right)$$

The long-run transformation of banking

	Level			Relative change	
	1880	1950	2010	1880–1950	1950–2010
Market RoA volatility	0.65	0.24	0.40	-63%	+66%
Acounting RoA	1.88	0.52	0.49	-72%	-6%
Bank capital ratio	0.23	0.06	0.06	-73%	-7%
Bank assets / GDP	0.40	0.62	2.43	+55%	+293%
Market RoE volatility	3.15	3.48	7.26	+11%	+108%
Accounting RoE	8.39	9.34	8.64	+11%	-7%

- 1880: risky banking with high capital
- 1950: safe banking with low capital
- 2010: risky banking with low capital

The Shocks:

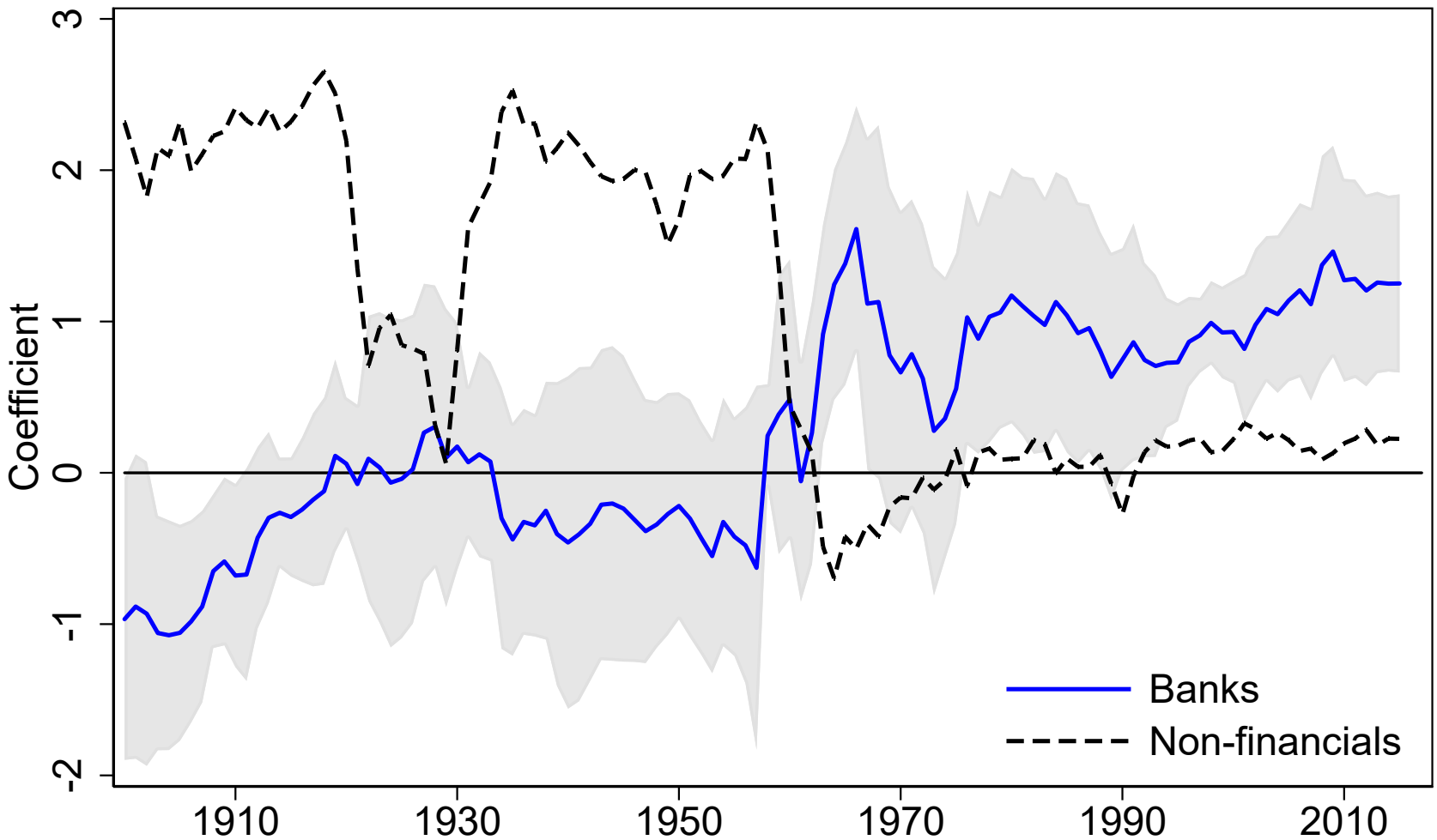
Macro risks arising from banking

What happens when bank risks materialise?

- Baron et al. (2021): negative bank equity returns are followed by lower GDP growth
- Studying equity risks combines asset risk with its leverage amplification. We disentangle the two.
  1. Do bank asset returns predict future GDP?
  2. Has this predictive power changed over time?
  3. Does it vary with leverage and macro risk?

Bank asset returns, non-financial returns, and future GDP growth (rolling 30-year windows)

$$\Delta_3 y_{i,t+3} = \alpha_i + \beta^{\text{bank}} R^{\text{bank assets}}_{i,t} + \beta^{\text{nonf}} R^{\text{nonf equity}}_{i,t} + \epsilon_{i,t+3}.$$



Returns and future GDP growth, conditional LP

	Year 1	Year 2	Year 3	Year 4	Year 5
Δ Bank asset values, pre-1945	0.23	-0.31	-0.34	-0.39	-0.48
	(0.21)	(0.26)	(0.38)	(0.44)	(0.43)
Δ Bank asset values, post-1945	0.61***	1.03***	1.05***	1.10***	0.92*
	(0.18)	(0.25)	(0.29)	(0.36)	(0.47)
Δ Non-financial equity, pre-1945	1.76***	2.43***	1.89***	1.51*	1.02
	(0.50)	(0.78)	(0.71)	(0.82)	(0.87)
Δ Non-financial equity, post-1945	0.31***	0.01	-0.32	-0.57	-0.51
	(0.09)	(0.15)	(0.24)	(0.35)	(0.38)
R^2	0.20	0.19	0.17	0.17	0.16
P-value, bank, Pre=Post	0.16	0.00	0.00	0.01	0.03
P-value, non-fin, Pre=Post	0.00	0.00	0.00	0.03	0.12
Country fixed effects	✓	✓	✓	✓	✓
Control variables	✓	✓	✓	✓	✓
Observations	1517	1517	1517	1517	1517

Bank asset risks and future economic activity

- Late 19th century: High asset risk, low leverage, low predictive power of returns for GDP
- Late 20th century: Low asset risk, high leverage, high predictive power of returns for GDP
- One interpretation: amplification of bank shocks to the real economy has become stronger over time

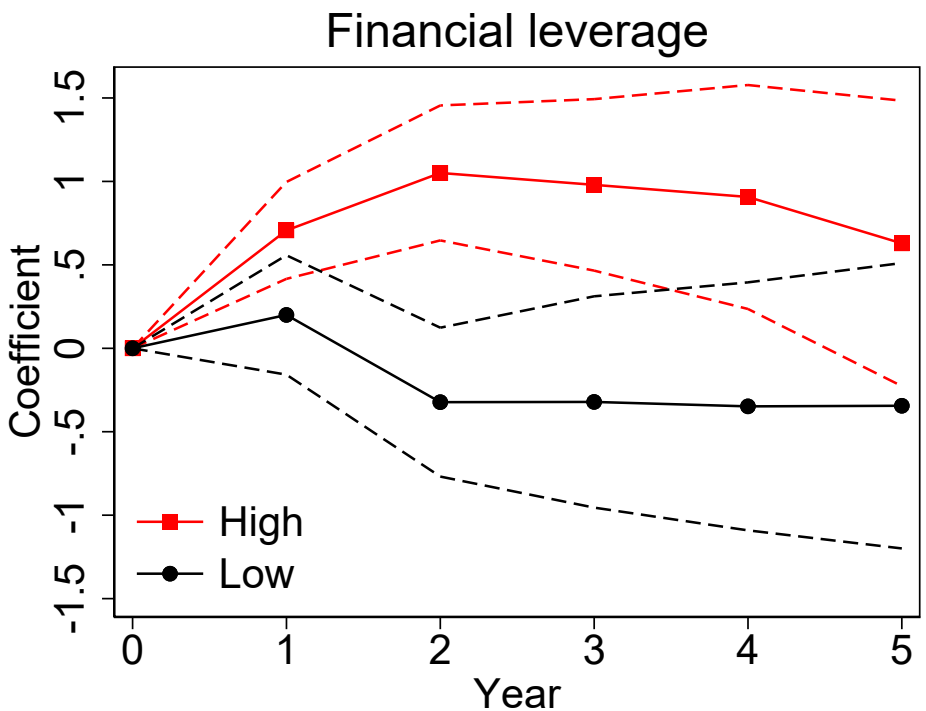
  ▸ Dividend predictability

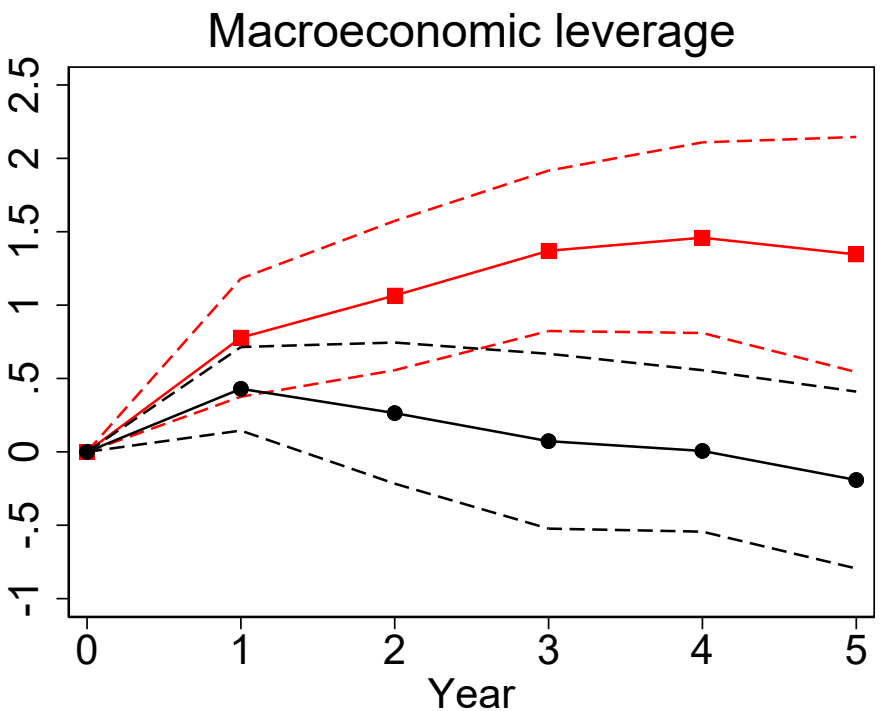
- Potential amplification mechanisms: leverage, macro risk ("volatility paradox")

Predictive power across leverage regimes

- When leverage is high, asset returns predict future GDP
- When leverage is low, they do not

$$\Delta_h y_{i,t} = \alpha_{i,h} + \beta_h^{\text{bank, low}} R_{i,t}^{\text{bank assets}} \times \mathbb{1}\left(\text{lev}_{i,t} \leq \overline{\text{lev}}\right) + \beta_h^{\text{bank, high}} R_{i,t}^{\text{bank assets}} \times \mathbb{1}\left(\text{lev}_{i,t} > \overline{\text{lev}}\right) + \Phi X_{i,t} + \epsilon_{i,t+h}$$





Predictive power across leverage regimes: table

	Year 1	Year 2	Year 3	Year 4	Year 5
Low assets / equity	0.20	-0.32	-0.32	-0.35	-0.34
	(0.21)	(0.27)	(0.38)	(0.44)	(0.51)
High assets / equity	0.71***	1.05***	0.98***	0.91**	0.63
	(0.17)	(0.24)	(0.31)	(0.40)	(0.51)
R^2	0.19	0.18	0.16	0.17	0.16
P-value, High=Low	0.06	0.00	0.01	0.05	0.22
Low assets / GDP	0.43**	0.26	0.07	0.01	-0.19
	(0.17)	(0.29)	(0.35)	(0.33)	(0.36)
High assets / GDP	0.78***	1.07***	1.37***	1.46***	1.35***
	(0.24)	(0.30)	(0.33)	(0.39)	(0.48)
R^2	0.18	0.17	0.16	0.16	0.15
P-value, High=Low	0.22	0.05	0.01	0.00	0.00
Country fixed effects	✓	✓	✓	✓	✓
Control variables	✓	✓	✓	✓	✓
Observations	1517	1517	1517	1517	1517

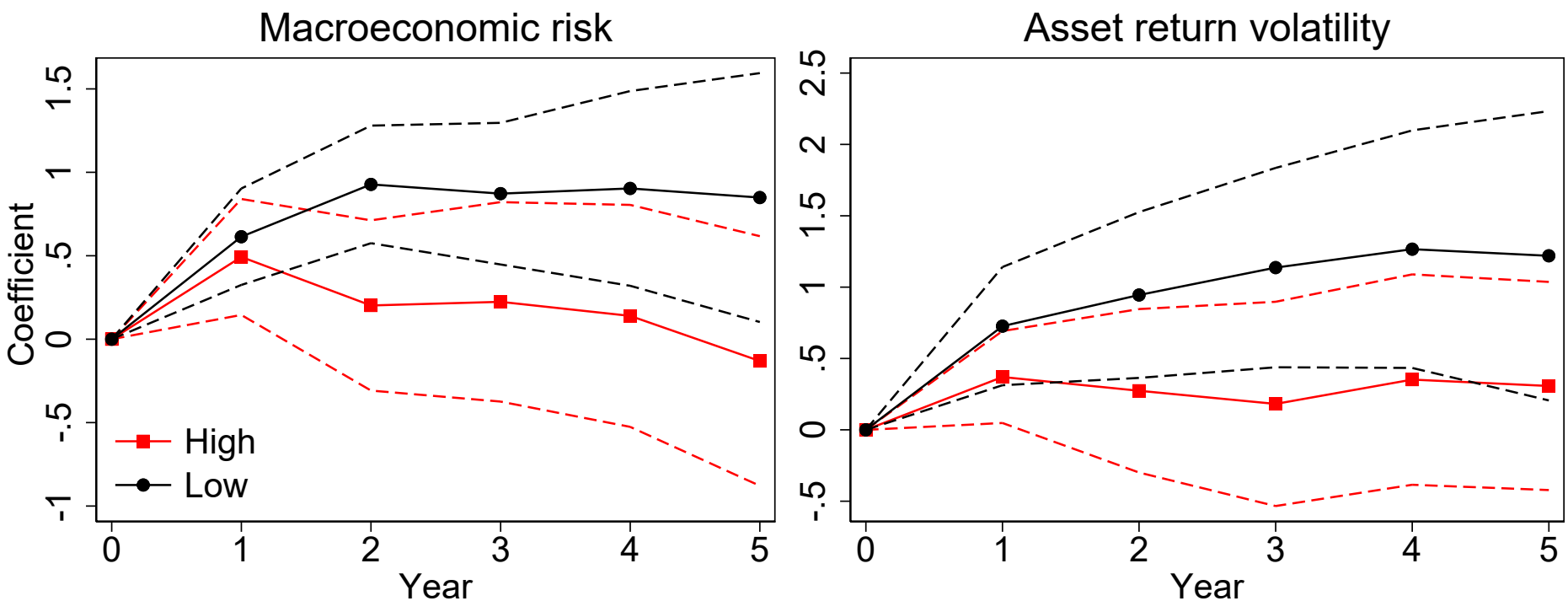
Predictive power of bank equity returns

- The leverage state dependencies go beyond mechanical amplification; hold for a given return on bank equity

	Year 1	Year 2	Year 3	Year 4	Year 5
Δ Bank equity, low assets / equity	0.59*	-0.37	-0.53	-0.93	-0.60
	(0.33)	(0.46)	(0.62)	(0.68)	(0.91)
Δ Bank equity, high assets / equity	0.46***	0.74***	0.77***	0.71***	0.52
	(0.11)	(0.18)	(0.22)	(0.27)	(0.32)
R^2	0.19	0.20	0.19	0.19	0.19
P-value, High=Low	0.71	0.03	0.05	0.03	0.28
Country fixed effects	✓	✓	✓	✓	✓
Control variables	✓	✓	✓	✓	✓
Observations	1628	1628	1628	1628	1628

Predictive power across risk regimes

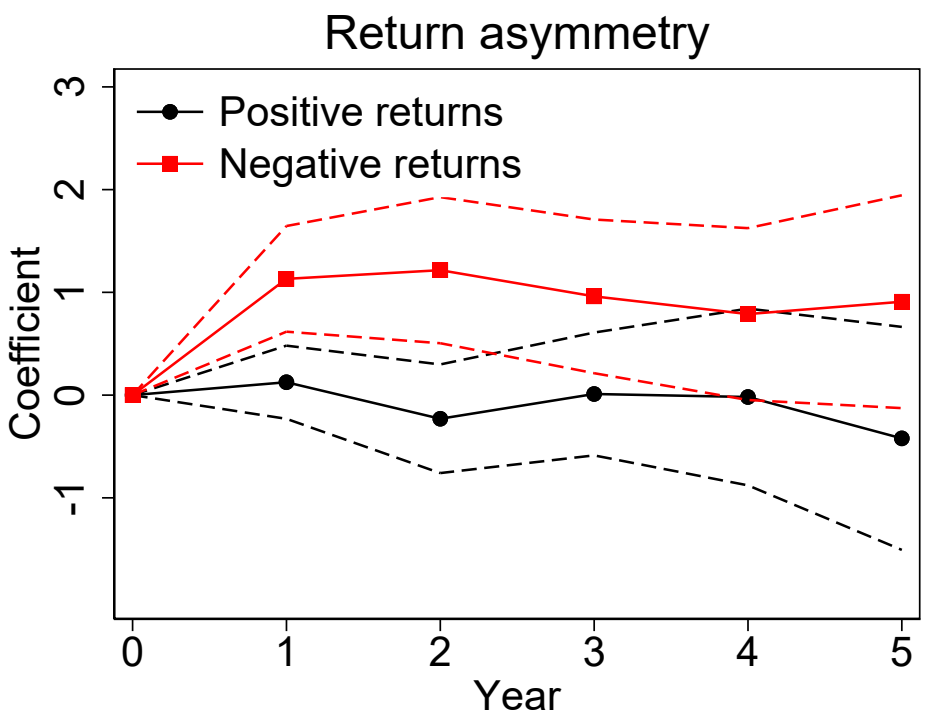
- Bank asset losses associated with larger output gaps when past risks are low
- Consistent with “volatility paradox” in Brunnermeier and Sannikov (2014)

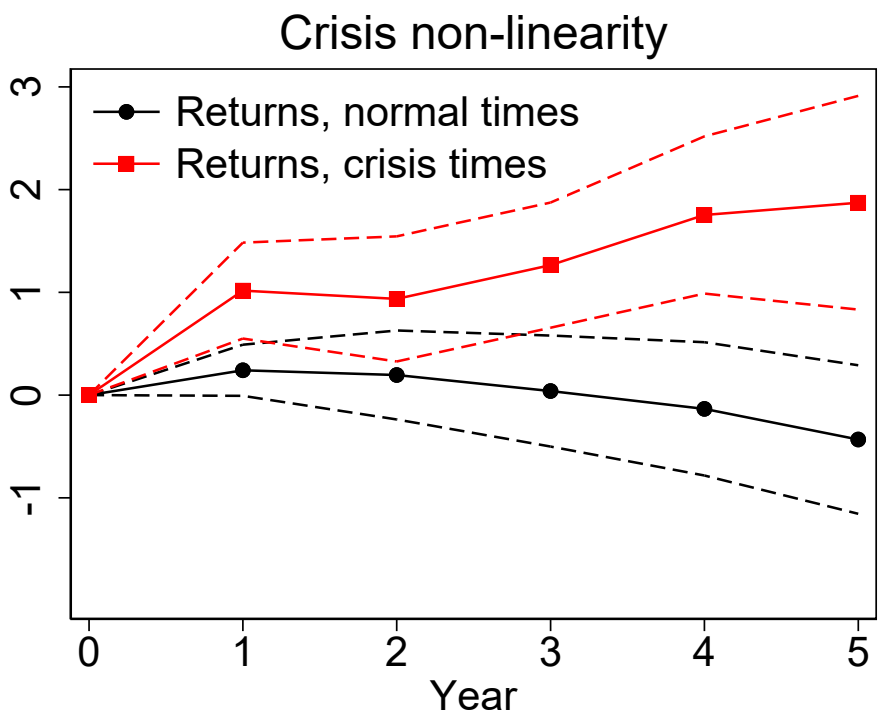


Exploring the underlying mechanisms

- Theoretical amplification mechanisms:
  1. Asymmetry: larger effects for negative returns
  2. Non-linearity: larger effects in a crisis
  3. Leverage amplification: 1. and 2. increase in leverage
- Predictive power driven by negative returns in crisis states

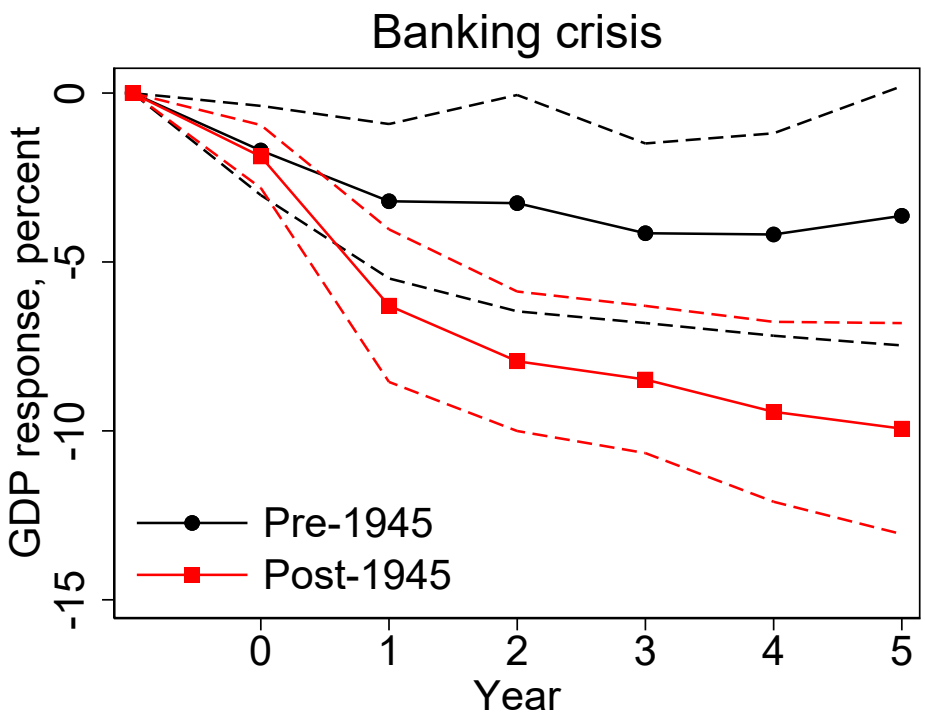
▸ More

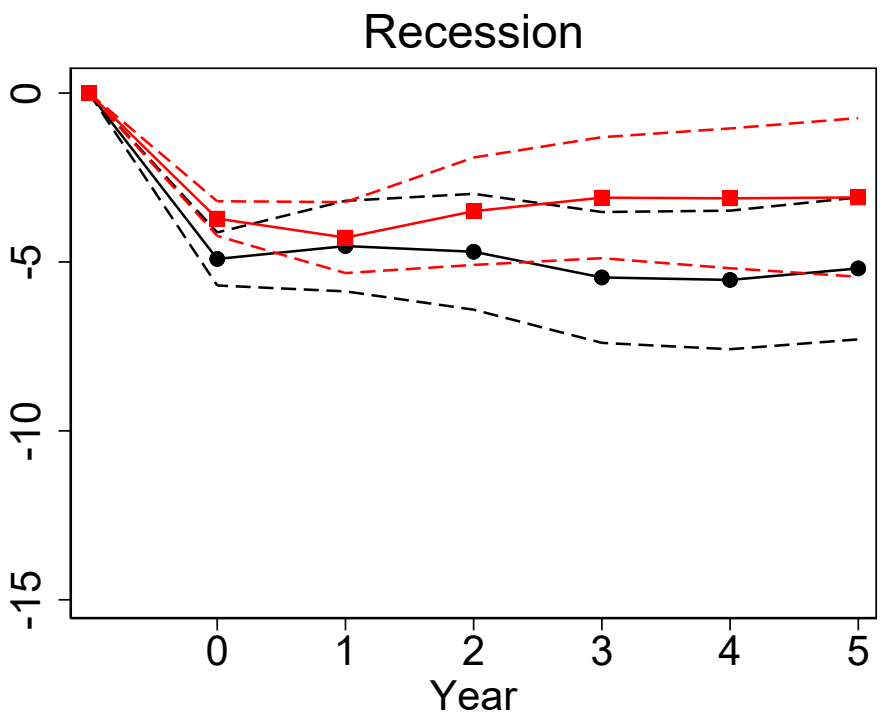




Time-varying costs of banking crises

- An alternative measure of amplification: crisis costs
- Crises have become much more costly after WW2, are more costly at high macro-financial leverage ▸ Leverage results





Conclusion

- Over the long run, bank assets have become safer, but asset losses are followed by much poorer economic performance
- These two trends are not coincidental: low risk regimes are associated with high leverage and strong amplification
- Points to a dark side of bank asset risk reductions, unintended consequences of financial innovation

Appendix

Bank asset risk, equity risk, and leverage

back

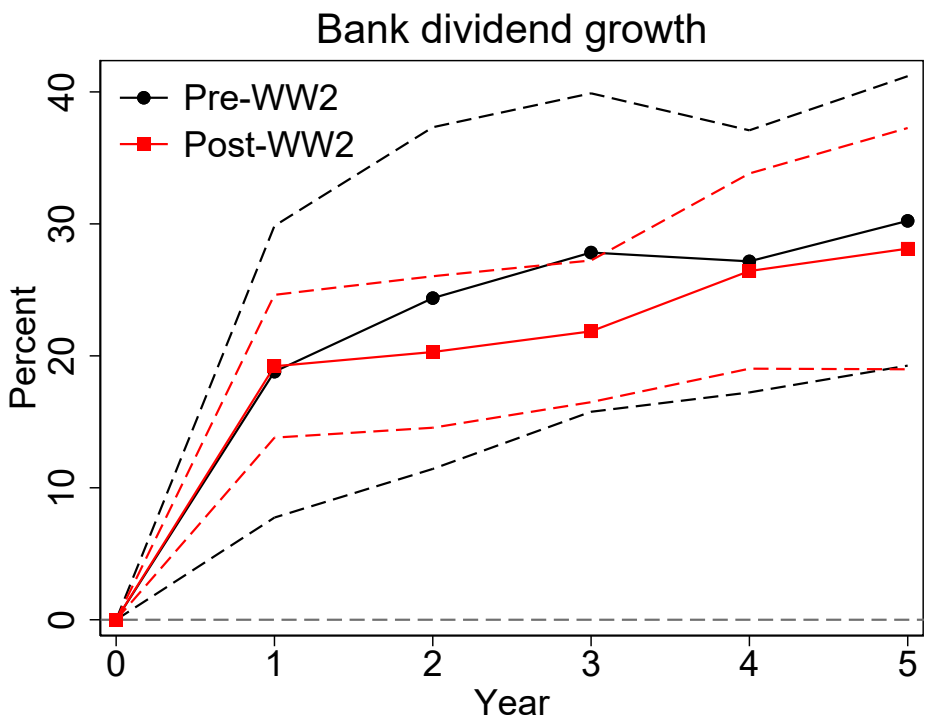
	ln(Vol)	Δln(Vol)	ln(β)	Δln(β)	ln(R)	Δln(R)
			Panel A. Asset risk and leverage			
$\ln\left(\frac{\text{Assets}}{\text{Equity}}\right)$	-0.59***	-0.64***	-0.15***	-0.17***	-0.04***	-0.03***
	(0.08)	(0.10)	(0.02)	(0.03)	(0.00)	(0.01)
R^2	0.32	0.45	0.27	0.29	0.42	0.20
Observations	1637	1461	1421	1224	2156	2003
			Panel B. Equity risk and leverage			
$\ln\left(\frac{\text{Assets}}{\text{Equity}}\right)$	0.39***	0.05	0.28***	-0.12	0.01**	-0.07
	(0.08)	(0.10)	(0.06)	(0.10)	(0.01)	(0.05)
R^2	0.17	0.37	0.12	0.22	0.02	0.14
Observations	1639	1463	1429	1231	2156	2003
Country FE	✓	✓	✓	✓	✓	✓
Year FE		✓		✓		✓

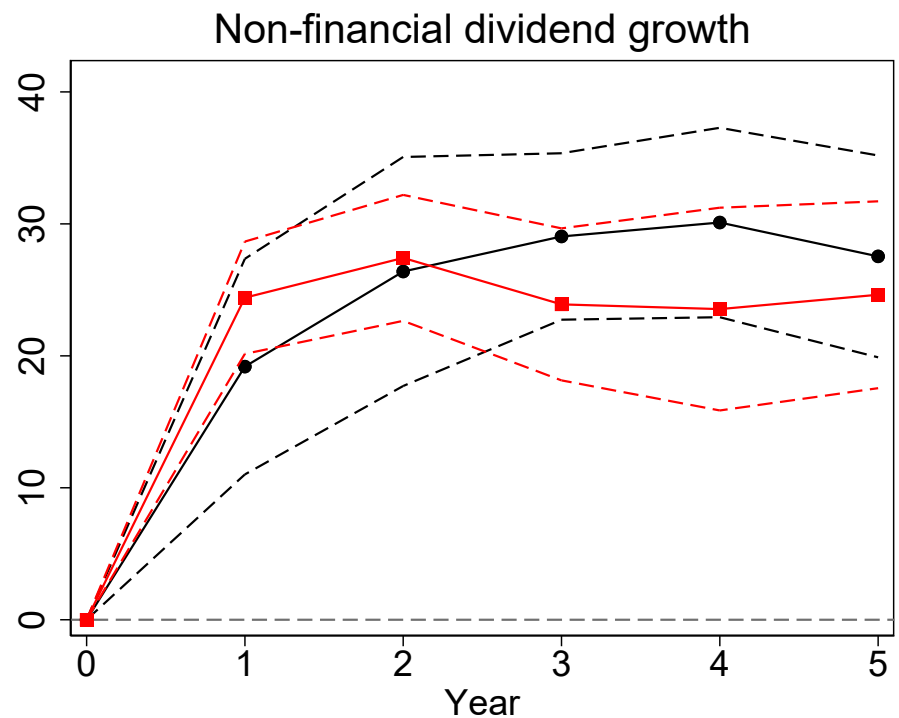
Bank and non-financial dividend predictability

back

$$\Delta_h D_{i,t}^{\text{bank}} = \alpha_{i,h} + \beta_h^{\text{bank, pre}} \left(\frac{D}{P}\right)_{i,t}^{\text{bank equity}} \times \mathbb{1}(\text{year} \leq 1945) +$$

$$\beta_h^{\text{bank, post}} \left(\frac{D}{P}\right)_{i,t}^{\text{bank equity}} \times \mathbb{1}(\text{year} > 1945) + \Phi X_{i,t} + \epsilon_{i,t+h}$$





Interaction of asymmetries with leverage

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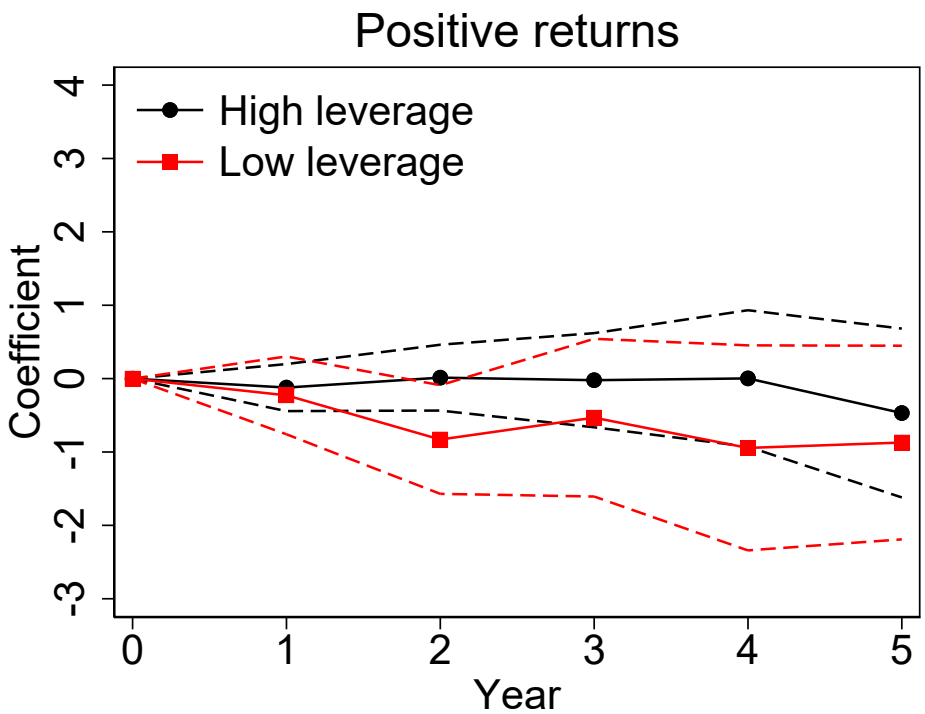

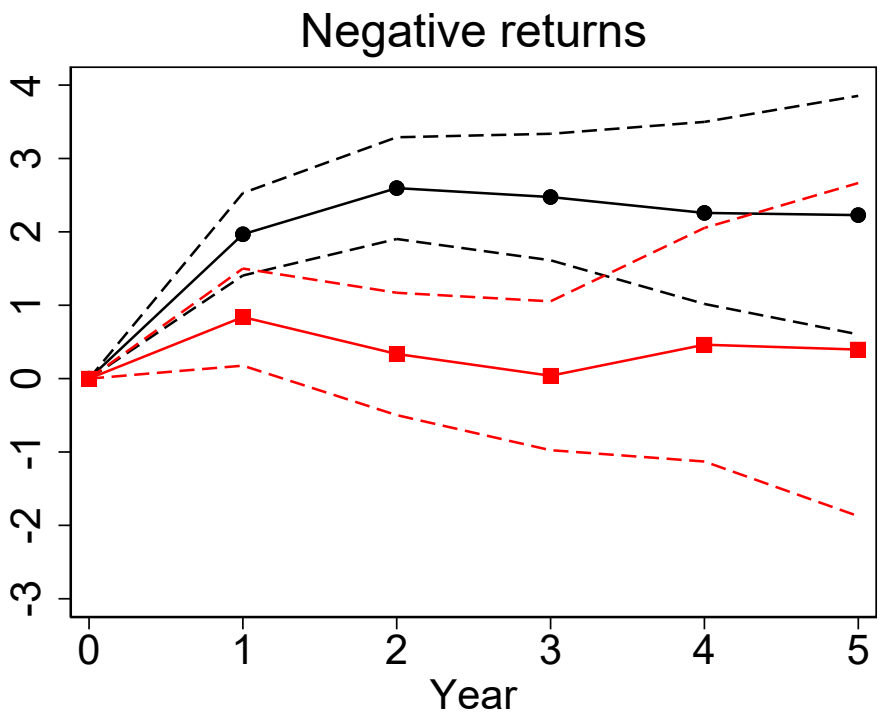

Interaction of non-linearities with leverage

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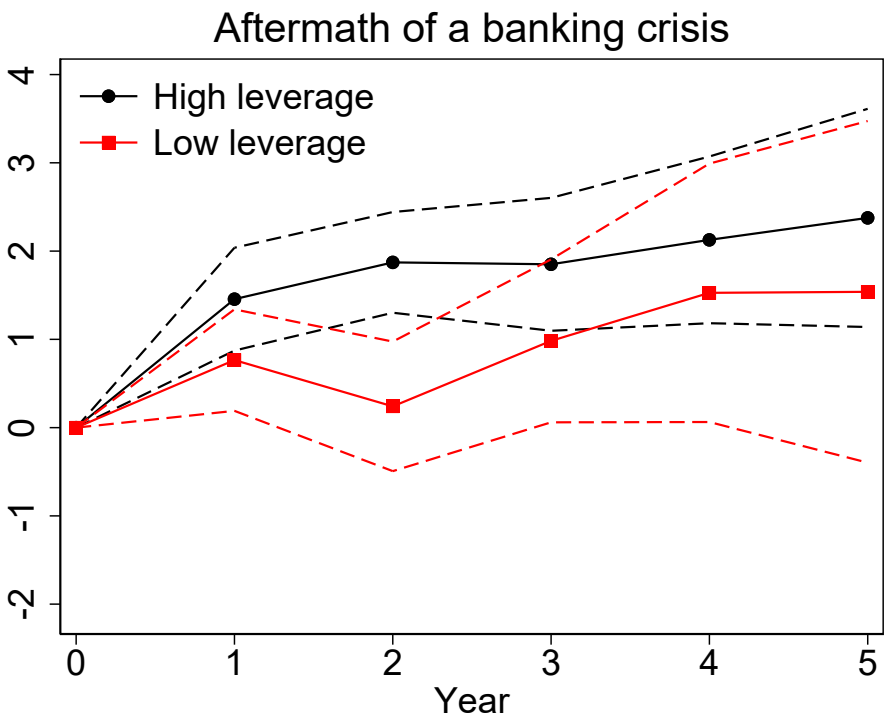

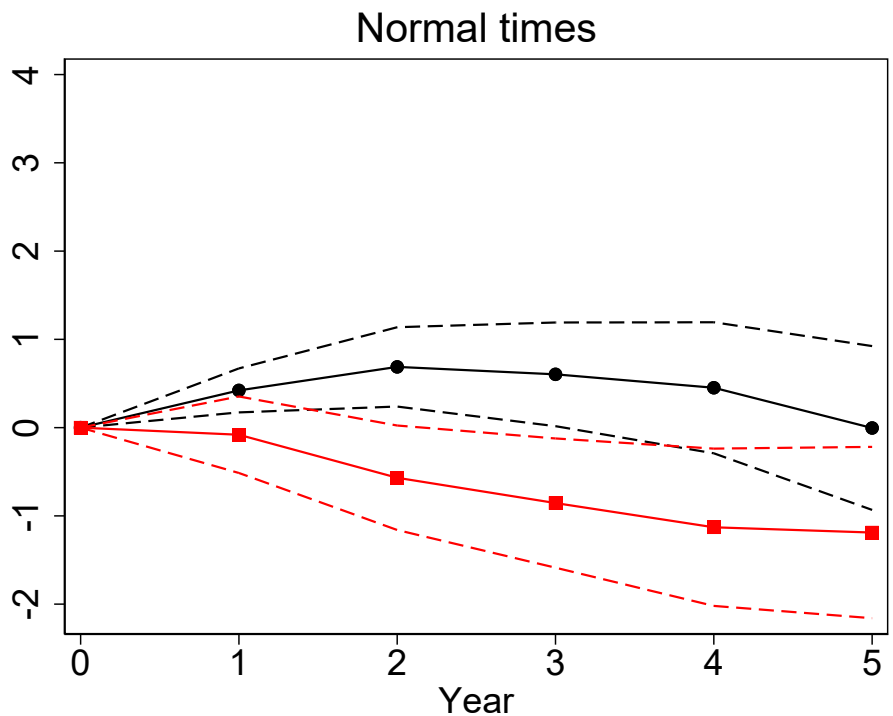

Crisis costs and leverage

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