

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 their macro consequences, changed as a result?
- We use data for 17 countries, 1870–2016, to study trends in (i) bank asset risk, (ii) its amplification through leverage, and (iii) macro effects of bank asset losses

Findings

- 1 Large long-run decline in bank asset risk
 - RoA volatility ↓ 5x 1870–1950, ↑ 2x 1950–2016
- 2 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 (Philippon, 2015), leverage (Jordà et al., 2021), asset composition (Jordà et al., 2016)
 - We document the trend in bank risk, and study its macroeconomic implications
- 2 Macroeconomic effects of banking disruption
 - Theory: amplification and leverage key (Kiyotaki and Moore, 1997; Brunnermeier and Sannikov, 2014)
 - Empirics focus on bank equity losses (Jordà et al., 2013; Baron et al., 2021)
 - We separate asset losses & 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

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

- 2 Beta of the (monthly) unlevered equity return

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

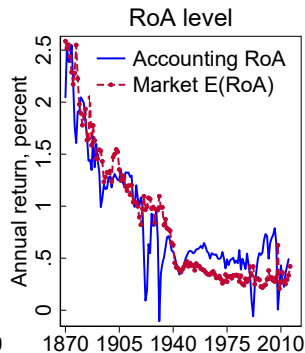
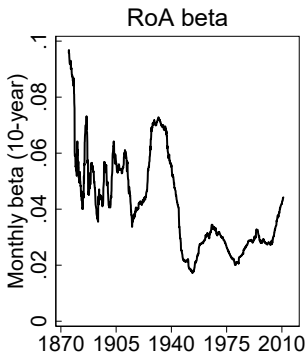
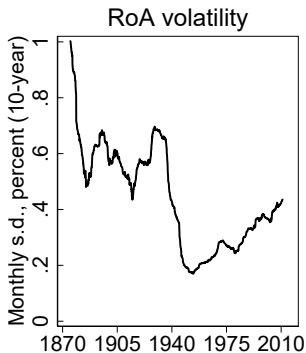
- 3 Level of the asset return

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

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

Trends in bank asset risk

- Strong decline 1870–1950, moderate increase afterwards

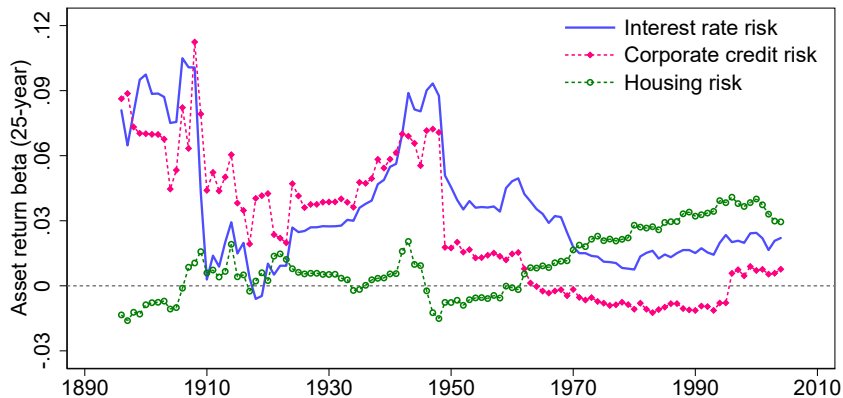


▶ Robustness

Why did bank asset risk decline?

1. Lower risk exposures (betas)

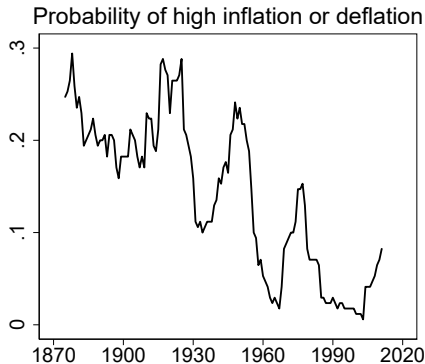
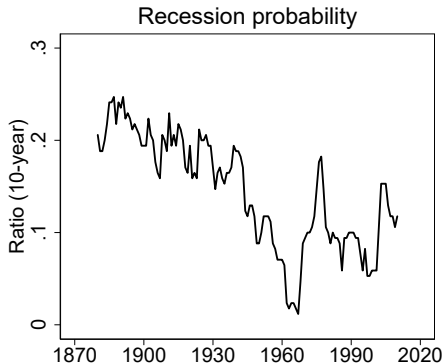
$$R_{i,t}^{\text{asset}} = \alpha_i + \beta^{\text{mkt}} R_{i,t}^{\text{req}} + \beta^{\text{irate}} R_{i,t}^{\text{gbond}} + \beta^{\text{credit}} R_{i,t}^{\text{corpbond}} + \beta^{\text{hous}} R_{i,t}^{\text{hous}} + U_{i,t}$$



Why did bank asset risk decline?

2. Lower macro risks relevant for banking

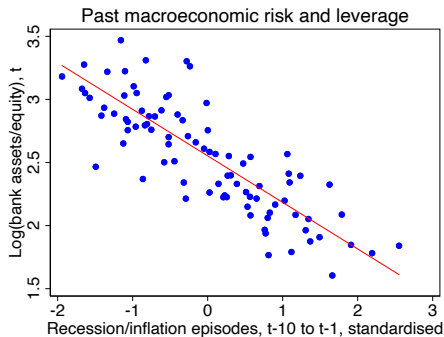
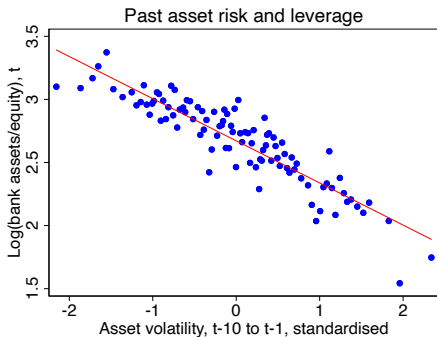
- 1870s vs today: less frequent recessions, lower price level related risks (esp. deflation)



How did banks respond to lower risk?

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

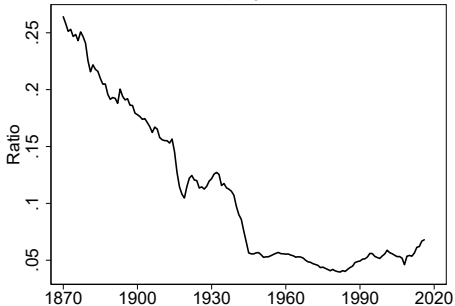
▶ Table



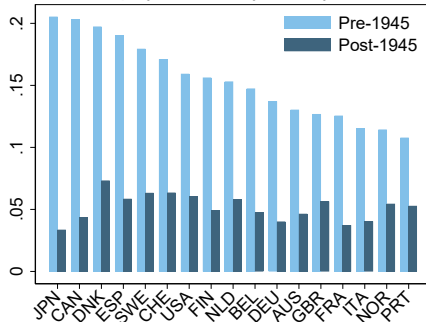
Trends in banking system leverage

- Fourfold leverage increase over the long run

Bank equity / assets

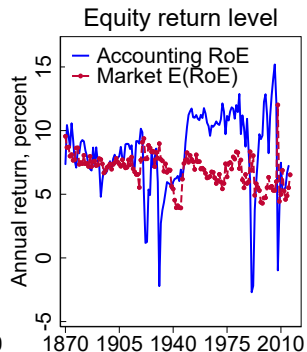
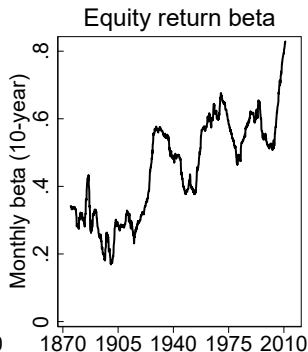
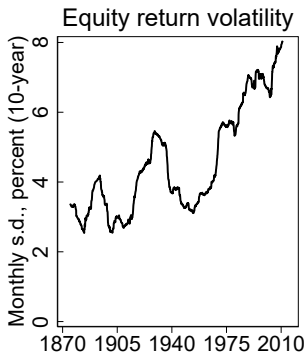


Bank equity / assets, by country and time



Trends in bank equity risk

- Higher leverage amplifies the risks of bank assets
- Bank equity risk increases, especially after 1950 ▶ betas
- Also, increases in default risk (z score, crash frequency) ▶ default risk



The long-run transformation of banking

	Level			Relative change	
	1880	1950	2010	1880-1950	1950-2010
RoA volatility	0.66	0.24	0.39	-63%	+62%
RoA beta	0.06	0.03	0.03	-54%	+17%
RoA level	1.88	0.52	0.49	-72%	-6%
Bank capital ratio	0.23	0.06	0.06	-73%	-7%
RoE volatility	3.15	3.48	7.26	+11%	+108%
RoE beta	0.32	0.46	0.63	+42%	+38%
RoE level	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

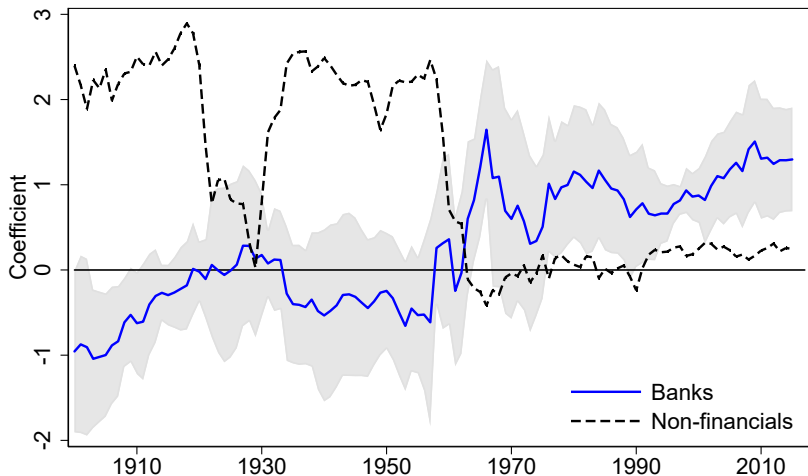
What happens when bank risks materialise?

- 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 risk?

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

▶ Robustness

$$\Delta 3y_{i,t+3} = \alpha_i + \beta^{\text{bank}} R_{i,t}^{\text{bank assets}} + \beta^{\text{nonf}} R_{i,t}^{\text{nonf equity}} + \epsilon_{i,t+3}$$



Exploring the mechanisms

- One interpretation of higher predictive power: stronger macroeconomic amplification of bank shocks
- Potential mechanisms: leverage, risk (“volatility paradox”)
- Does predictive power differ by leverage / volatility?

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

- $\Delta_h y_{i,t}$: real GDP growth from t to $t + h$
- $X_{i,t}$: 4 lags of return interactions, Δ GDP, short-term rates
- Finally, look at asymmetries in amplification

Predictive power across leverage regimes

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

	Year 1	Year 2	Year 3	Year 4	Year 5
High leverage	0.64*** (0.19)	0.99*** (0.24)	1.03*** (0.31)	0.98** (0.39)	0.79 (0.49)
Low leverage	0.22 (0.17)	-0.32 (0.28)	-0.36 (0.38)	-0.51 (0.42)	-0.48 (0.46)
R ²	0.20	0.19	0.17	0.17	0.16
P-value, High=Low	0.09	0.00	0.01	0.01	0.08
Country fixed effects	✓	✓	✓	✓	✓
Control variables	✓	✓	✓	✓	✓
Observations	1517	1517	1517	1517	1517

Predictive power across risk regimes

- Bank asset returns predict future output only when past realised risks are low
- Consistent with “volatility paradox” in Brunnermeier and Sannikov (2014)

	Year 1	Year 2	Year 3	Year 4	Year 5
Low volatility	0.67** (0.28)	0.67* (0.35)	0.94** (0.41)	0.95** (0.46)	0.95* (0.55)
High volatility	0.24 (0.19)	0.06 (0.30)	-0.18 (0.46)	-0.11 (0.50)	-0.17 (0.42)
R ²	0.18	0.19	0.17	0.16	0.15
P-value, High=Low	0.21	0.18	0.07	0.10	0.11
Country fixed effects	✓	✓	✓	✓	✓
Control variables	✓	✓	✓	✓	✓
Observations	1132	1132	1132	1132	1132

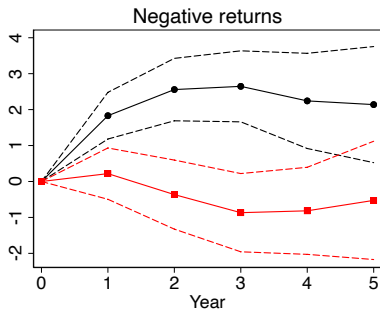
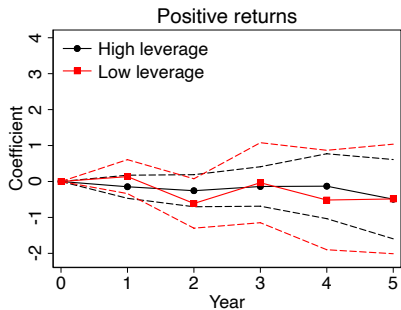
Return asymmetries

- Negative bank asset returns predict low future GDP growth
- Positive returns do not predict future growth

	Year 1	Year 2	Year 3	Year 4	Year 5
Δ Bank asset values, negative	1.06*** (0.31)	1.06** (0.43)	0.80* (0.44)	0.65 (0.47)	0.66 (0.64)
Δ Bank asset values, positive	0.13 (0.20)	-0.28 (0.29)	-0.08 (0.36)	-0.31 (0.53)	-0.64 (0.67)
R^2	0.21	0.19	0.17	0.17	0.17
P-value, positive=negative	0.01	0.00	0.10	0.18	0.18
Country fixed effects	✓	✓	✓	✓	✓
Control variables	✓	✓	✓	✓	✓
Observations	1517	1517	1517	1517	1517

Interaction of asymmetries with leverage

- Predictive power is driven by negative bank asset returns in highly leveraged banking systems
- Consistent with larger leverage amplification for negative shocks



Robustness

- Bank equity returns [▶ Results](#)
 - Predictive power of bank equity returns stronger in high leverage regimes
- Alternative leverage measures [▶ back](#)
 - Results hold for splits on bank assets / GDP and past macro risk
- Other return measures as controls [▶ Results](#)
 - Predictive power & state-dependencies of bank asset returns hold conditional on corporate bond & housing r
 - High leverage / low risk not associated with greater predictive power for these other return measures
- Relative size of returns across volatility regimes [▶ Results](#)
 - State-dependencies hold after normalising bank asset returns within volatility / leverage bins

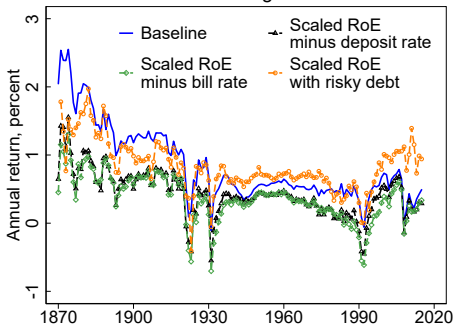
Conclusion

- Over the long run, bank assets have become safer, but asset losses are followed by poorer macro outcomes
- 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

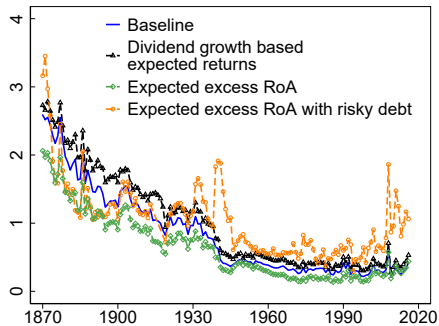
Appendix

Alternative RoA measures [▶ back](#)

Accounting RoA



Market RoA



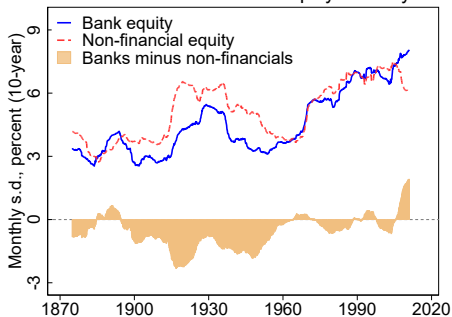
Risk and leverage – regressions ▶ Back

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable: $\ln(\text{Assets}/\text{Equity})_t$								
Macro risk $_{t-10,t-1}$	-0.36*** (0.05)	-0.05** (0.02)						
Asset volatility $_{t-10,t-1}$			-0.33*** (0.04)	-0.15*** (0.02)				
Asset beta $_{t-10,t-1}$					-0.28*** (0.04)	-0.13*** (0.02)		
ROA $_{t-10,t-1}$							-0.44*** (0.04)	-0.15*** (0.02)
Country fixed effects	✓	✓	✓	✓	✓	✓	✓	✓
Year fixed effects		✓		✓		✓		✓
R ²	0.32	0.81	0.37	0.84	0.28	0.85	0.51	0.83
Observations	2199	2199	1535	1535	1467	1467	1902	1902

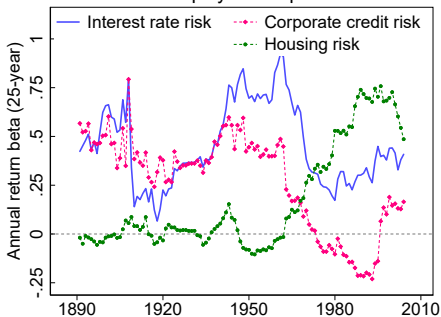
Equity risk: comparison to non-financials, and betas

▶ Back

Bank and non-financial equity volatility

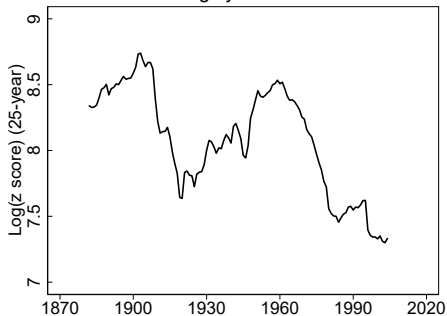


Bank equity risk exposures



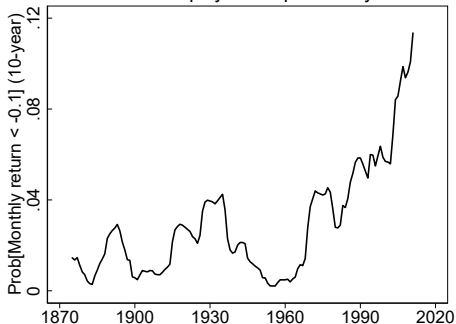
Trends in banking system default risk [▶ Back](#)

Banking system z score



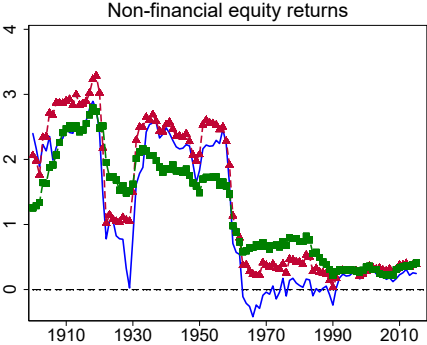
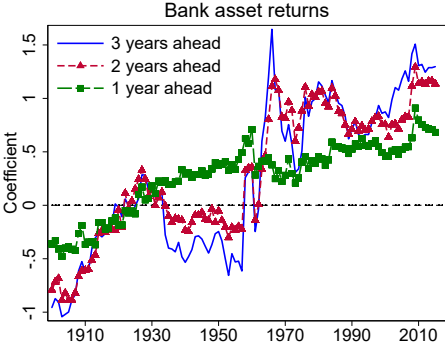
$$\frac{\text{RoA} + \text{Capital Ratio}}{\text{Std.dev}(\text{RoA})}$$

Bank equity crash probability



$$\text{Probability} \left(R^{\text{bank equity}} < -10\% \right)$$

Rolling Regression for different horizons [▶ back](#)



Returns and future GDP growth, conditional LP [▶ back](#)

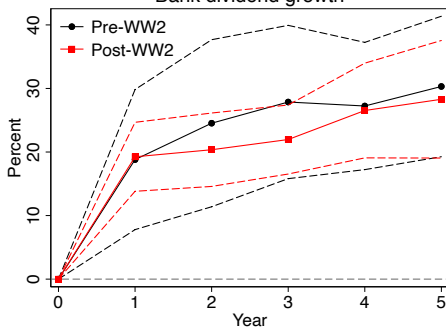
	Year 1	Year 2	Year 3	Year 4	Year 5
Δ Bank asset values, post-1945	0.56*** (0.18)	0.98*** (0.26)	1.00*** (0.31)	1.03*** (0.38)	0.85* (0.49)
Δ Bank asset values, pre-1945	0.19 (0.18)	-0.38 (0.26)	-0.42 (0.39)	-0.61 (0.43)	-0.65 (0.43)
Δ Non-financial equity, post-1945	0.36*** (0.09)	0.08 (0.14)	-0.26 (0.24)	-0.47 (0.34)	-0.43 (0.38)
Δ Non-financial equity, pre-1945	2.04*** (0.41)	2.73*** (0.64)	2.29*** (0.69)	2.00** (0.90)	1.41 (1.06)
R^2	0.21	0.19	0.17	0.17	0.16
P-value, bank, Pre=Post	0.13	0.00	0.00	0.01	0.02
P-value, non-financial, Pre=Post	0.00	0.00	0.00	0.01	0.11
Country fixed effects	✓	✓	✓	✓	✓
Control variables	✓	✓	✓	✓	✓
Observations	1517	1517	1517	1517	1517

Bank and non-financial dividend predictability ▶ back

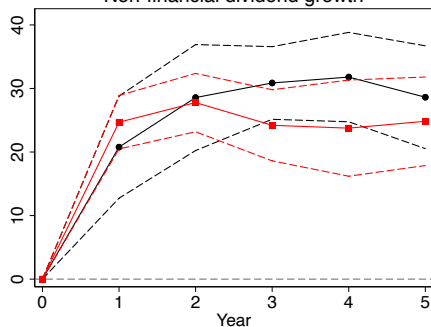
$$\Delta_h D_{i,t}^{\text{bank}} = \alpha_{i,h} + \beta_h^{\text{bank, pre}} \left(\frac{D}{P} \right)_{i,t}^{\text{bank equity}} \times \mathbb{1}(\text{year} \leq 1945) +$$

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

Bank dividend growth



Non-financial dividend growth



Predictive power of bank equity returns [▶ back](#)

	Year 1	Year 2	Year 3	Year 4	Year 5
Δ Bank equity, high leverage	0.41*** (0.11)	0.63*** (0.17)	0.68*** (0.21)	0.65*** (0.25)	0.48 (0.30)
Δ Bank equity, low leverage	0.46 (0.29)	-0.60 (0.49)	-1.15** (0.57)	-1.61** (0.73)	-1.59* (0.88)
R ²	0.21	0.21	0.19	0.20	0.19
P-value, High=Low	0.87	0.02	0.00	0.00	0.03
Country fixed effects	✓	✓	✓	✓	✓
Control variables	✓	✓	✓	✓	✓
Observations	1517	1517	1517	1517	1517

Alternative leverage and risk measures [▶ back](#)

Panel A: Returns binned by macroeconomic leverage					
	Year 1	Year 2	Year 3	Year 4	Year 5
Δ Bank asset values, low assets / GDP	0.41** (0.17)	0.15 (0.28)	-0.01 (0.34)	-0.22 (0.33)	-0.37 (0.34)
Δ Bank asset values, high assets / GDP	0.72*** (0.26)	1.05*** (0.30)	1.34*** (0.36)	1.46*** (0.41)	1.30*** (0.49)
R ²	0.19	0.19	0.18	0.18	0.18
P-value, High=Low	0.30	0.02	0.00	0.00	0.00
Observations	1513	1513	1513	1513	1513
Panel B: Returns binned by macroeconomic risk					
Δ Bank asset values, low macro risk	0.58*** (0.18)	0.89*** (0.20)	0.78*** (0.24)	0.76** (0.33)	0.71* (0.42)
Δ Bank asset values, high macro risk	0.52** (0.20)	0.30 (0.32)	0.31 (0.39)	0.14 (0.41)	-0.12 (0.44)
R ²	0.20	0.20	0.18	0.18	0.18
P-value, High=Low	0.80	0.10	0.26	0.20	0.13
Observations	1490	1490	1490	1490	1490

Returns on other asset classes [▶ back](#)

	Year 1	Year 2	Year 3	Year 4	Year 5
△ Bank asset values, high leverage	0.44*** (0.14)	0.67*** (0.20)	0.69*** (0.24)	0.73** (0.31)	0.61* (0.33)
△ Bank asset values, low leverage	0.28 (0.21)	-0.03 (0.42)	-0.39 (0.51)	-0.41 (0.51)	-0.59 (0.52)
△ Non-financial equity, high leverage	0.29*** (0.09)	0.04 (0.16)	-0.27 (0.25)	-0.58 (0.38)	-0.64 (0.44)
△ Non-financial equity, low leverage	1.72*** (0.32)	2.23*** (0.58)	1.62** (0.77)	1.05 (0.98)	1.15 (1.00)
△ Corporate bond values, high leverage	0.38*** (0.10)	0.39*** (0.13)	0.35* (0.20)	0.36 (0.27)	0.47 (0.31)
△ Corporate bond values, low leverage	0.32 (0.30)	0.89*** (0.30)	1.54*** (0.32)	1.85*** (0.42)	1.69*** (0.55)
△ Housing values, high leverage	0.38*** (0.13)	0.52*** (0.19)	0.30 (0.24)	0.18 (0.36)	0.13 (0.44)
△ Housing values, low leverage	0.48** (0.23)	0.33 (0.41)	0.46 (0.47)	0.69 (0.46)	1.19** (0.49)
R ²	0.29	0.25	0.21	0.20	0.20
Country fixed effects	✓	✓	✓	✓	✓
Control variables	✓	✓	✓	✓	✓
Observations	1069	1069	1069	1069	1069

Volatility split - standardised returns [▶ back](#)

	Year 1	Year 2	Year 3	Year 4	Year 5
Δ Bank asset values, high leverage	0.41*** (0.12)	0.64*** (0.16)	0.66*** (0.20)	0.63** (0.25)	0.51 (0.32)
Δ Bank asset values, low leverage	0.17 (0.13)	-0.24 (0.21)	-0.27 (0.28)	-0.38 (0.32)	-0.36 (0.35)
R ²	0.20	0.19	0.17	0.17	0.16
P-value, High=Low	0.16	0.00	0.01	0.01	0.08
Country fixed effects	✓	✓	✓	✓	✓
Control variables	✓	✓	✓	✓	✓
Observations	1517	1517	1517	1517	1517
	Year 1	Year 2	Year 3	Year 4	Year 5
Δ Bank asset values, low volatility	0.37** (0.16)	0.37* (0.19)	0.52** (0.23)	0.53** (0.26)	0.53* (0.31)
Δ Bank asset values, high volatility	0.18 (0.14)	0.05 (0.22)	-0.13 (0.33)	-0.08 (0.36)	-0.12 (0.30)
R ²	0.18	0.19	0.17	0.16	0.15
P-value, High=Low	0.34	0.25	0.11	0.15	0.13
Country fixed effects	✓	✓	✓	✓	✓
Control variables	✓	✓	✓	✓	✓
Observations	1132	1132	1132	1132	1132