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

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Abstract

This paper studies long-run trends in bank risk and their macroeconomic implications. We show that across advanced economies, bank asset risk declined materially between 1870 and 2016. But this trend was accompanied by large increases in leverage, which meant that bank equity risk increased. Moreover, losses on bank assets have become to be associated with increasingly large output gaps. Before 1945, bank asset returns had no excess predictive power for real activity, while afterwards, they have outperformed non-financial returns as a predictor of GDP. We show that this higher predictive power is linked to the secular increases in bank leverage.

Keywords: bank risk, leverage, financial shocks, macro-financial linkages, long-run trends
JEL classification codes: G01, G15, G21, E44, N20, O16

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1. Introduction

The interplay between banks and the macroeconomy has been of central interest to economists since at least the Great Depression (Fisher, 1933; Friedman and Schwartz, 1963; Bernanke, 1983). This interplay is two-fold. On the one hand, banks are exposed to macroeconomic risk through their loan and security portfolios. On the other, shocks to the banking sector can impair credit supply and money creation, with potentially adverse macroeconomic effects (Chodorow-Reich, 2014; Huber, 2018; Baron, Verner, and Xiong, 2021). But both banks' risk exposures, and their transmission through the financial system, depend crucially on the structure of the banking sector. Over the past 150 years, this structure has changed materially, with banks becoming larger, more levered, and shifting their lending towards mortgages (Philippon, 2015; Jordà, Schularick, and Taylor, 2016; Jordà, Richter, Schularick, and Taylor, 2021). This means that both banks' exposure to macroeconomic risk, and their capacity to withstand and amplify macroeconomic shocks, may have changed as a result.

This paper studies the long-run evolution of bank risk and its links to the macroeconomy. Our analysis covers 17 advanced economies for years 1870–2016, and combines three novel datasets on the market returns on bank equity (Baron, Verner, and Xiong, 2021), bank balance sheets (Jordà, Richter, Schularick, and Taylor, 2021), and bank profits and losses (Richter and Zimmermann, 2020). We use these data to map out the long-run trend in bank asset risk, and study its macroeconomic implications. We start by showing that across a variety of measures, bank asset risk declined by a factor of 2–3 between 1870 and 2016. This decline in asset risk was, however, accompanied by an increase in banking system leverage of similar magnitude, which meant that bank equity and default risks did not decline, and even increased somewhat after the 1950s.

In the second part of the paper, we further show that losses on bank assets have become to be associated with increasingly large output gaps. Conditional on non-financial returns, bank asset returns (which we measure as the unlevered return on bank equity) had no excess predictive power for macroeconomic outcomes historically, but robustly predict GDP growth in the post World War II period. We link these changes to the trends documented in the first part of the paper, showing that the predictive power of bank asset returns is much stronger when banking system leverage is high, or past realised asset risks are low. These findings are consistent with the model of Brunnermeier and Sannikov (2014), where low levels of exogenous risk faced by banks lead to increases in leverage and higher levels of endogenous risk generated by the banking system. Our results suggest that the importance of this "volatility paradox" goes beyond explaining cyclical fluctuations in real activity. Ultimately, similar economic mechanisms can help us understand the drivers of long-run trends in bank risk and leverage, as well as their macroeconomic implications.

Our paper makes several contributions. First, we contribute to the literature on long-run trends in banking. Previous studies have documented long-run increases in banking system size (Schularick and Taylor, 2012; Philippon, 2015), leverage (Jordà et al., 2021), and changes the composition of bank credit, or firm and household borrowing more generally (Jordà et al., 2016, Müller and Verner, 2021, Benmelech, Kumar, and Rajan, 2020).[1] We add to this literature by documenting the evolution of bank asset risk, and studying the macroeconomic implications of this trend. Our results suggest that the trends documented in previous studies reflect some specific dimensions of bank risk, with changes in asset composition contributing to the changing risk of bank assets, and increases in leverage – to the macroeconomic risks related to banking. They also, however, suggest that individual risk measures should not be studied in isolation. When we study bank asset risk and leverage jointly, we find that they moved in opposite directions before 1950. As a result, equity and default risk changed little during this time. Yet even this more holistic view may not reflect the risks we ultimately care about. From the perspective of the policymaker, our paper highlights that the macroeconomic risks arising from bank asset losses can be very different from the riskiness of the underlying assets, with these two risk measures trending in opposite directions over our sample period.

The trends that we document also provide insights into the nature of linkages between banks and the real economy. The theoretical literature has shown that banks can transmit and amplify macroeconomic shocks through changes in net worth, credit frictions, and prices of risky assets (Kiyotaki and Moore, 1997; Bernanke, Gertler, and Gilchrist, 1999; Brunnermeier and Pedersen, 2008; He and Krishnamurthy, 2013). Previous empirical studies have focussed on the impact of changes in bank net worth in the form of systemic crisis events (Reinhart and Rogoff, 2009; Jordà, Schularick, and Taylor, 2013; Romer and Romer, 2017) and equity returns (Baron et al., 2021; Ottonello and Song, 2022). The change in net worth, however, combines the underlying asset shock with its leverage amplification. By separating the two, we are able to show that amplification is important, and that the macroeconomic consequences of small asset losses at high levels of leverage are generally more severe than those of large asset losses at low leverage levels.[2] Finally, our results suggest that this amplification has become stronger over time, as bank asset risks declined and leverage increased.

We start by studying the long-run trends in three measures of bank asset risk: i). the realised volatility of the unlevered monthly market return on bank equity, ii). the beta of the unlevered bank equity return against the non-financial stock return, and iii). the level of the accounting and market returns on bank assets.[3] We show that bank asset (i.e., unlevered equity) return volatility fell from about 1ppt per month in the 1870s to about 0.2ppts per month in 1950, and gradually increased since then, to about 0.4ppts in 2010. The market bank asset return beta follows a similar trajectory, falling between 1870 and 1950, and increasing somewhat thereafter. We further show that

[1] Jordà et al. (2016) document a shift towards mortgage lending, Müller and Verner (2021) towards household credit and, within firms, towards non-tradable industries, both after the 1950s. Benmelech et al. (2020) document a shift from secured to unsecured firm borrowing over the course of the 20th century.

[2] The state-dependencies that we document for bank asset returns are consistent with the recently documented state-dependencies for banking crisis probabilities and costs, with Jordà et al. (2021) showing that crisis costs are higher when banks are more levered, and Danielsson, Valenzuela, and Zer (2018, 2021) showing that periods of low stock market volatility predict a higher likelihood of future crises, and lower GDP growth.

[3] All other things being equal, riskier assets should provide higher returns. Meiselman, Nagel, and Purnanandam (2020) show that in a cross-section of banks, accounting profitability offers a good proxy for systematic risk exposure.

both accounting and market-implied returns on bank assets have declined by a similar amount to volatility over the long run, consistent with banks receiving less compensation for the lower asset risks. Taken together, all three of these risk measures point to large asset risk declines before 1950, and moderate increases thereafter which did not fully compensate for the historical declines.

We link these asset risk declines to, first, lower bank exposures to macro-financial risk, and, second, a less risky macroeconomic environment. Banks' exposures to interest rate risk and corporate credit risk – measured as market betas of asset returns on the relevant risk factors – experienced sharp declines in the period before 1930, and remained low thereafter. Unlike these risk exposures, the exposure to housing risk was close to zero historically and increased after 1970, consistent with the increasing importance of real estate backed loans on bank balance sheets (Jordà et al., 2013). We then turn to examine the trends in two macroeconomic risks relevant for banking: downside risk (Nagel and Purnanandam, 2020) in the form of recessions, and the risk of high inflation or deflation, which can exacerbate the asset-liability interest rate mismatches and affect the real burden of debt (Fisher, 1933; Bernanke and James, 1991; Agarwal and Baron, 2021). Between 1870 and 1950, both the recession probability and the probability of high or negative inflation more than halved.

The falls in bank asset risk were accompanied by sharp increases in leverage, measured as the ratio of bank assets to equity liabilities. In the data, low levels of macroeconomic or bank asset risk are strongly negatively correlated with future banking system leverage levels. Between 1870 and 1950, while asset risk declined, bank leverage increased by a factor of four, to the extent that bank equity return volatility, beta, and the return on bank equity did not decrease during this time period. After 1950, the increases in asset return volatility alongside already high leverage levels meant that equity risks increased, as did the more direct measures of banking system default risk such as the z-score and the frequency of bank equity crashes.

In the second part of the paper, we investigate how the long-run changes in asset risk and leverage affected the links between bank asset value fluctuations and macroeconomic outcomes. Higher levels of bank leverage not only increase the level of bank equity risk for a given risk of bank assets, but can also amplify the impact of bank asset shocks on real activity. We start by examining the predictive power of realised bank asset returns for future GDP growth, controlling for returns on non-financial equity and other macroeconomic covariates. In this, we follow the methodology of Baron et al. (2021) who show that bank equity returns predict future macroeconomic outcomes, but instead of focussing on the overall equity return, we separately study the underlying bank asset return and its amplification through leverage.

We find that, on average, negative bank asset returns are followed by low GDP growth even after controlling for the returns of non-financials. But this impact varies substantially over time, and depends on banking sector leverage and asset risk. Starting with the time dimension, we show that bank asset returns had no excess predictive power over non-financials before 1945 – a period of low leverage and high asset risk – but became a strong predictor of macro fundamentals after 1945, with a one standard deviation decline in bank asset values followed by 1% lower real GDP growth over the following 5 years. Non-financial equities, on the contrary, strongly predicted GDP growth before

1945, but lost their excess predictive power afterwards.

We link these changes in predictive power to the long-run shifts in banking system structure documented in the first part of the paper. We show that when leverage is high, or when past asset volatility is low, bank asset returns have strong excess predictive power for future economic activity. When leverage is low or past volatility is high, this predictive power is absent. These state dependencies hold conditional on changes in housing and corporate bond values, and are specific to the returns on bank assets. This suggests that the links between bank asset returns and future economic activity represent a mechanism that is distinct or complementary to those documented in the existing literature for other asset classes (Gilchrist and Zakrajšek, 2012; Jordà, Schularick, and Taylor, 2015; López-Salido, Stein, and Zakrajšek, 2017; Krishnamurthy and Muir, 2017). We further show that the leverage state dependencies are also present for bank equity (rather than asset) returns, which are strongly correlated with future GDP growth in high leverage regimes, but not in low leverage regimes.

These findings align with theoretical models where the impact of bank shocks is amplified by banks levering up against low measured risks. A number of these theories (e.g., He and Krishnamurthy, 2013; Brunnermeier and Sannikov, 2014; Krishnamurthy and Li, 2020) feature important asymmetries where leverage amplification is much more important for negative than for positive shocks. We find evidence for these asymmetries in our data, showing that the predictive power of negative changes in bank asset values is larger than that of positive ones. This finding is in line with Baron et al. (2021), who show that negative bank equity returns are more correlated with future GDP growth than positive returns. Importantly, we also show that this asymmetry depends on leverage. While negative bank asset returns in high-leverage regimes are strongly positively correlated with future output gaps, negative returns in low leverage regimes, and positive returns in both high and low leverage regimes are not. This suggests that the interaction between return asymmetries and leverage amplification forms an important mechanism through which bank shocks transmit to real activity.

Other things being equal, the long-run decline in bank asset risk should have created a safer and more stable banking system. But in reality, this shift was accompanied by large increases in leverage, and much larger output gaps in the aftermath of bank asset losses. One economic interpretation of these results is that in the earlier historical period, banks were highly exposed to macroeconomic risks but did not amplify them. Over recent decades, however, banks have begun to amplify economic shocks, with negative changes in bank asset values followed by lower GDP growth above and beyond what we would expect based on information contained in non-financial equities and other risky asset classes.

2. The shifts: changes in risk within banking

2.1. Measuring bank asset risk

Most bank assets are not traded, and hence their market prices and corresponding volatilities are not directly observable. To overcome this difficulty, we infer the riskiness of bank assets by combining information on bank equity prices, which are observable, and bank capital structure. To further guard against the potential measurement uncertainties, we construct three different measures of bank asset risk. Higher risk should make bank asset returns more volatile – both in terms of unconditional variance, and covariance with market risk factors – and higher, to compensate investors for this risk (see, e.g., Meiselman et al., 2020). To this end, we estimate proxies for bank asset return volatility, beta, and the level of bank asset return. We complement these market-based estimates with an accounting-based measure of bank asset return which has a broader coverage, but is less timely and potentially less responsive to changes in risk than the market-based measures.

1. Volatility of bank asset returns: Our first proxy for asset risk is the volatility of banking sector asset returns. To do this, we follow Doshi, Jacobs, Kumar, and Rabinovitch (2019) and unlever the monthly excess market return on bank equity. To calculate this measure, we first compute the realised excess return on bank equity as the sum of the capital gain and dividends paid on listed bank stocks minus the government bill rate, and multiply it by the bank capital ratio to unlever it:

$$\begin{aligned} R^{\text{asset}}_{i,j,t} &= \text{Capital Ratio}_{i,t-1} * R^{\text{bank equity}}_{i,j,t}, \\ \text{where } R^{\text{bank equity}}_{i,j,t} &= P_{i,j,t}/P_{i,j-1,t} + \text{Dividend}_{i,j,t}/P_{i,j-1,t} - R^{\text{safe}}_{i,j,t}, \\ \text{and Capital Ratio}_{i,t-1} &= \frac{\text{Equity Liabilities}_{i,t-1}}{\text{Total Liabilities}_{i,t-1}}. \end{aligned} \tag{1}$$

Above, i, j, and t are country, month and year indices respectively, R^{asset} is the realised excess return on bank assets, $R^{\text{bank equity}}$ is the realised total return on bank equity, R^{safe} is the nominal short-term government bill rate, and the capital ratio is computed as the equity liabilities of the banking system divided by total (equity and debt) liabilities. In terms of timing, we compute the equity return from month $j-1$ to month j, and unlever it using the previous year's capital ratio.[4]

We then compute the standard deviation of the monthly market return within a 10-year rolling window:

$$\text{Volatility}\left(R^{\text{asset}}\right)_{i,t} = \text{Std. dev.}\left(R^{\text{asset}}_{i,j,t}\right)_{t-5,t+5}. \tag{2}$$

2. Bank asset return beta: In most standard asset pricing models, investors are compensated for exposures to systematic risk, rather than total volatility. To construct a measure of the systematic risk exposure of bank assets, we compute the beta of the asset return with respect to the monthly

[4] Unlevering using the current rather than previous year's capital ratio leaves the results unchanged.

excess return on non-financial equity:

$$\beta^{\text{market}}_{i,t} = \frac{\text{Cov}\left(\text{R}^{\text{asset}}_{i,j,t}, \text{R}^{\text{nonf equity}}_{i,j,t}\right)_{t-5,t+5}}{\text{Var}\left(\text{R}^{\text{nonf equity}}_{i,j,t}\right)_{t-5,t+5}}. \tag{3}$$

Above, Cov() is the covariance between the monthly realised excess return on bank assets and the excess return on non-financial equity, and Var() is the variance of non-financial stock returns, within a 10-year centered rolling window.

3. Level of bank asset returns: Alternatively, we can study the level of returns to infer the bank risk profile, with higher returns implying a compensation for a higher level of risk. We start with the standard accounting RoA measure calculated as net profits over assets:

$$\text{RoA}_{i,t} = \frac{\text{Net Profits}_{i,t}}{\text{Total Assets}_{i,t}}. \tag{4}$$

Above, net profits are the total profits of all domestic banks in country i and year t net of taxes and depreciation, and total assets are equal to the sum of bank equity and debt liabilities.[5]

Accounting standards differ across time and countries. Our data adjust for these differences when the required information is available, but some variation in accounting standards is likely to remain. Accounting data may also be slow to respond to new information and may therefore not reflect the full range of risks faced by banks in a timely manner. To this end, we complement the accounting RoA with a more timely and forward-looking measure based on market data. Realised market returns, however, only provide a noisy proxy for the investor compensation demanded for bearing risk. This is because they include unanticipated shocks in the form of new information – the unexpected return – as well as the expected return required as compensation for future anticipated risks. In fact, most realised return variation reflects unexpected rather than expected returns, and realised and expected returns often move in opposite directions over the long and medium run (Elton, 1999; Fama and French, 2002).[6] In line with existing literature (Blanchard, 1993; Fama and French, 2002), we instead compute a direct estimate of the expected return on bank assets to measure the long-run trend in risk compensation. To do this, we first use the simple Gordon (1962) dividend discount model to compute the expected equity return as the sum of the dividend yield and long-run dividend growth, and then unlever it as follows:

[5] Unlike the excess market return measure, the accounting RoA measures total returns, gross of the safe interest rate. This is primarily because computing a comparable safe rate for accounting data is much more difficult than for market data. To be consistent, our market-based return level measure in equation (5) is also based on total returns. Appendix Figure A.2 shows several alternative proxies for accounting and market-based excess returns, which all display the same trend as our baseline measure.

[6] For example, Fama and French (2002) show that the expected US stock return declined between 1951 and 2000, and this decline pushed up realised equity returns by increasing the discounted value of dividends and, hence, stock prices.

$$\mathbb{E}\left(\mathrm{R}_{i,t}^{\text{asset}}\right) = \text{Capital Ratio}_{i,t-1} * \mathbb{E}(\mathrm{R}_{i,t}^{\text{bank equity}}), \tag{5}$$
$$\text{where } \mathbb{E}(\mathrm{R}_{i,t}^{\text{bank equity}}) = \text{Dividend}_{i,t}/\mathrm{P}_{i,t} + \overline{g_i}.$$

Above, $\overline{g_i}$ is the long-run real dividend growth rate. Because historical bank dividend growth rates are very volatile, this biases up the estimates of $\overline{g_i}$ based on arithmetic averages of past dividend growth data. Within the framework of the Gordon model, $\overline{g_i}$ is equal to the average real capital gain, and we estimate it as the mean real capital gain on bank stocks in country i. Using historical averages of dividend growth rates instead of capital gains, however, leaves the trends in our data unchanged (see Appendix Figure A.2).[7]

Other risk exposures Bank assets are exposed to risks relating to changes in interest rates, borrower creditworthiness, and the quality of loan collateral. To provide further insights into the drivers and magnitudes of bank risk variation, we calculate the banking sector exposures to these three different risk factors by measuring the beta of the realised bank asset return with respect to returns on government bonds (for interest rate risk), corporate bonds (for credit risk), and real estate (for collateral risk), using the following regression:

$$\mathrm{R}_{i,t}^{\text{asset}} = \alpha_i + \beta^{\text{mkt}}\mathrm{R}_{i,t}^{\text{eq}} + \beta^{\text{irate}}\mathrm{R}_{i,t}^{\text{gbond}} + \beta^{\text{credit}}\mathrm{R}_{i,t}^{\text{corpbond}} + \beta^{\text{housing}}\mathrm{R}_{i,t}^{\text{housing}} + \mathrm{u}_{i,t}. \tag{6}$$

Above, $\mathrm{R}^{\text{asset}}$ is the realised market return on bank assets from equation (1), $\mathrm{R}^{\text{gbond}}$ is the excess return on long-term government bonds (relative to the bill rate), $\mathrm{R}^{\text{corpbond}}$ is the difference between the corporate bond return and the government bond return, and $\mathrm{R}^{\text{housing}}$ is the excess return (capital gain plus rental yield) on residential real estate. All betas are computed conditional on the exposure to market risk captured by the stock market return R^{eq}. We run these regressions on centered, rolling 25-year windows between years 1882 and 2004, and require a minimum of 50 country-year observations in each rolling window sample. This method for estimating risk exposures has a long tradition in finance (Flannery and James, 1984; Fama and French, 1993), with similar methods – albeit applied to more granular data – used in several recent studies of compute banks' risk exposures (Begenau, Piazzesi, and Schneider, 2015; Begenau and Stafford, 2021; Drechsler, Savov, and Schnabl, 2021). We construct similar risk exposure measures for bank equity risk, replacing $\mathrm{R}^{\text{asset}}$ on the left-hand side of equation (6) with the excess return on bank equity.

Data To construct these asset risk measures, we combine three novel long-run datasets on market returns on bank equity, bank balance sheets, and bank profitability. The market returns data come from Baron et al. (2021), and cover the capital gains and dividends on listed bank and non-financial stocks. We slightly extend these data using our own estimates of bank and non-financial equity returns for Portugal and Switzerland, sourced from hand-collected archival data for the stock listings

[7] In our baseline measures, we assume a zero risk premium on bank debt. Appendix Figure A.2 shows that allowing for a positive risk premium on non-deposit bank debt liabilities does not change our results.

on the Lisbon and Zurich stock exchanges. The bank balance sheet data come from Jordà et al. (2021), and consist of aggregate assets and liabilities of the banking sector, with liabilities broken down into capital (book equity), deposits and non-deposit debt. Book equity (or capital) normally consists of common stock (paid-up capital), reserves, and retained earnings, and can be divided by total assets to compute a capital ratio. The bank profit and loss data come from Richter and Zimmermann (2020), and cover the aggregate accounting profits of the banking sector, both in nominal terms and as a ratio to bank equity or assets. The accounting (bank profit and balance sheet) data are annual, whereas the market data are available at both annual and monthly frequency. For measuring banks' credit and housing risk exposures, we additionally use the corporate bond return data from Kuvshinov (2020), and the housing return data from Jordà et al. (2019).

The broad scope of these datasets allows us to construct these measures of bank asset risk for years 1870 to 2016, for the following 17 advanced economies: Australia, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom, and the United States.

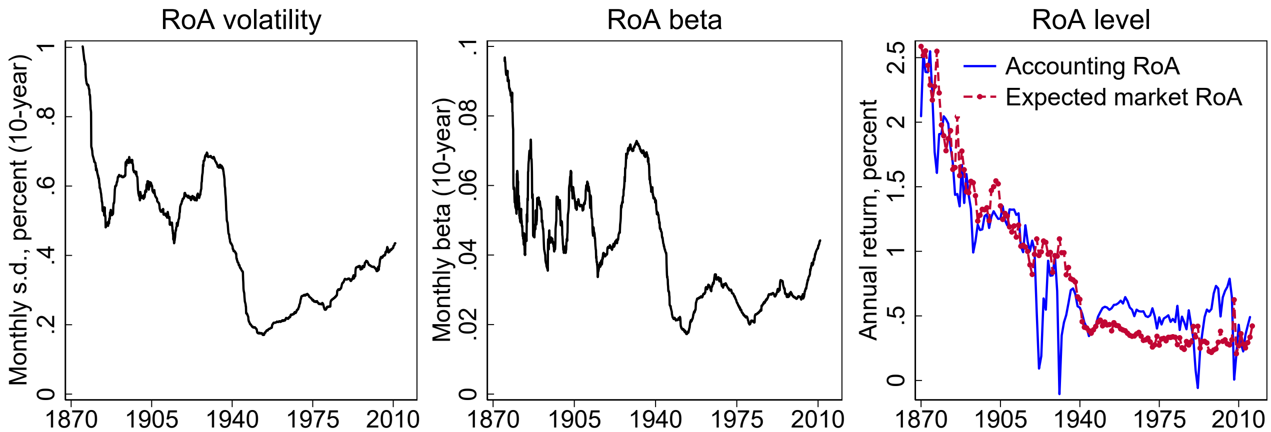
2.2. Trends in the risk of bank assets

Figure 1 plots the long-run evolution of our main measures of bank asset risk. The left-hand panel shows the overall volatility of our proxy for the realised excess market return on bank assets [equation (2)]. The middle panel shows the part of this volatility that corresponds to systematic risk and should therefore require compensation in the form of higher returns, the monthly asset return beta [equation (3)]. The right-hand panel shows the actual compensation in the form of the accounting, and the expected market return on bank assets [equations (4) and (5)].

All three of these risk measures suggest that over the long run, the riskiness of bank assets has declined considerably. Between 1870 and 1950, the volatility of the realised monthly market return on bank assets declined by a factor of five, from about 1% to 0.2%. Asset volatility increased after 1950, but remains considerably below its historical levels at the end of our sample. The asset return beta declined by a factor of about 4 between 1870 and 1950, and doubled between 1950 and 2010. Consistent with these declines in observed realised asset risk, the risk compensation in the form of bank asset returns also fell by a similar amount. Both the accounting and the market-based RoA declined from about 2.5% per year in 1870 to 0.5% per year in 1950, and remained low thereafter, with the accounting RoA registering a small increase after 1980.

Taken together, these various measures all point to sharp declines in bank asset risk between 1870 and 1950 followed by modest increases between 1950 and 2016, with the 2016 levels of asset risk well below the levels observed in late 19th and early 20th century. Even though each of these measures is an imperfect proxy for asset risk, Appendix Figure A.1 shows that in the underlying country-level data, all three measures of RoA volatility, beta and level are strongly positively correlated, painting a consistent picture of the underlying trends. Appendix Figure A.2 further shows that the time series patterns shown in Figure 1 hold for several alternative asset return measures, which calculate the

Figure 1: *Long-run trends in the risk of bank assets*



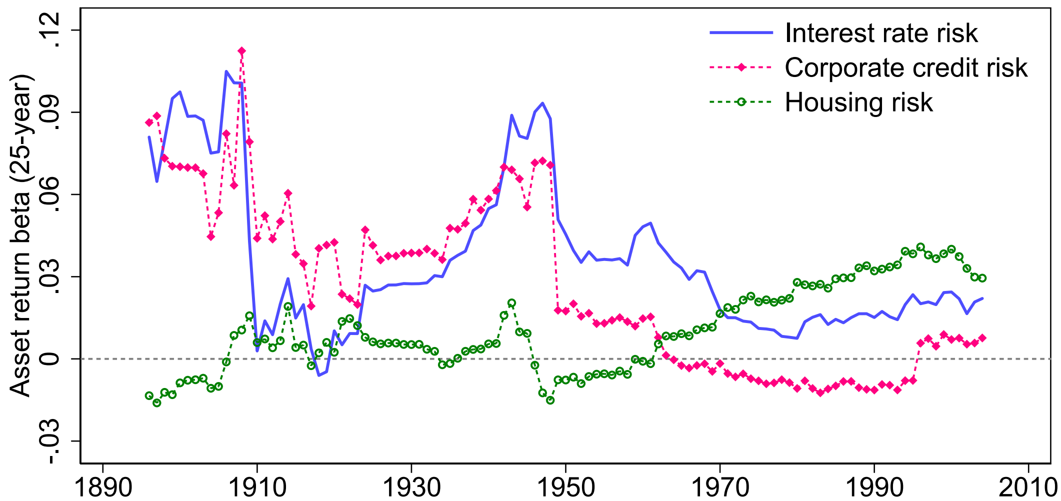
Notes: Left-hand panel: Standard deviation of the realised monthly market RoA, 10-year centered windows of pooled data for 17 countries. Realised RoA is the excess return on listed bank equity times the bank capital ratio (equity/assets). Middle panel: Monthly beta is the covariance of the realised monthly market return on bank assets and the return on non-financial equity, divided by the variance of the non-financial equity return, using 10-year centered windows of pooled data. Right-hand panel: Averages of 17 countries. Accounting RoA is net profits divided by total assets. Expected market RoA is the expected return on bank equity – equal to the dividend-price ratio plus country-average real capital gain – multiplied by the bank capital ratio.

excess RoA by unlevering the excess rather than total return on bank equity, use realised dividend growth rather than capital gains as a proxy for $\bar{g}$ in equation (1), or account for the riskiness of bank debt.

The decline in bank asset risk can be driven by lower exposures of bank assets to the underlying macroeconomic risks, for example, through changes in asset composition, diversification, and better risk management. Alternatively, it can be driven by reduction in the riskiness of the macroeconomic environment, for example, lower incidence of recessions and more stable inflation. There is evidence for both falls in risk exposures, and declining macroeconomic risk, in driving the long-run fall in the overall risk of bank assets. We start by looking at the long-run trends in banks' macro-financial risk exposures, measured as the market betas of realised bank asset returns on the returns of assets corresponding to the relevant macro-financial risk factors: interest rate risk proxied by the excess government bond return; credit risk proxied by the corporate bond return; and housing risk proxied by the housing return (Section 2.1 and equation (6) provide more details on the estimation). We plot the betas estimated on 25-year centered rolling windows of pooled cross-country data in Figure 2.

Figure 2 shows that exposures to interest rate risk and corporate credit risk were high historically, but declined markedly between 1890 and 1930. World War II an saw spikes in both of these risk exposures, while the post-1950 period saw stable and low interest rate risk exposures accompanied by further declines in the exposure to credit risk. Similarly to us, Drechsler et al. (2021) document a low interest rate risk exposure for US banks during the 1994–2017 time period, and attribute it to the stability of the banks' deposit franchise. Our evidence suggests that the post-1990 low levels of interest rate risk exposure extend to countries outside of the US, but not to the longer run historical

Figure 2: *Trends in bank asset risk exposures*



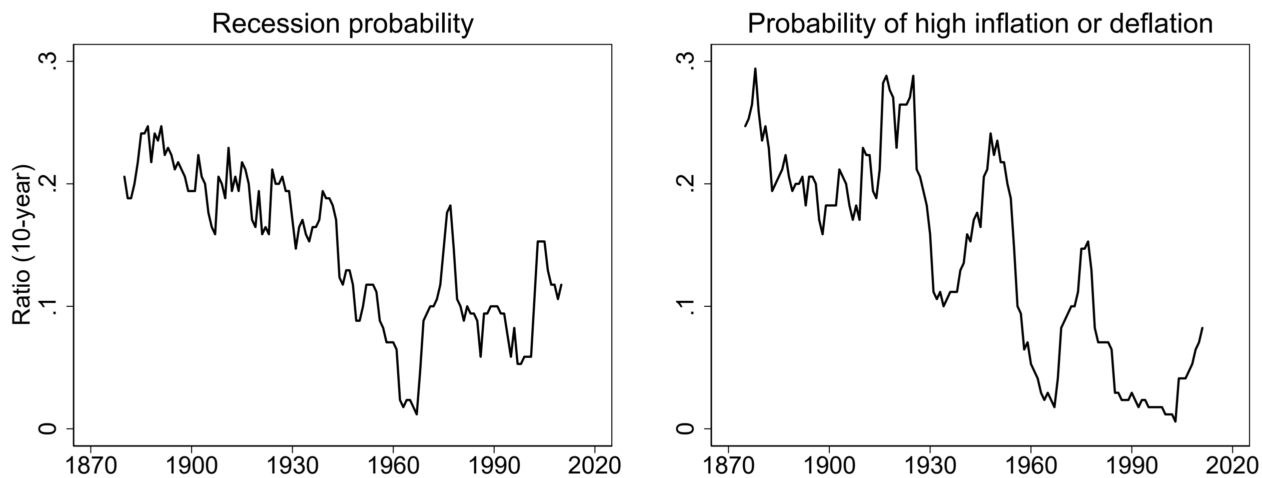
Notes: The risk exposures are time-varying betas obtained from regressing the realised excess market return on bank assets on excess government bond returns (interest rate risk), the difference between corporate and government bond returns (corporate credit risk), and the excess housing return (housing risk), controlling for the aggregate market return, estimated on centered rolling 25-year windows of annual data.

period. In particular, interest rate risk exposures were high during the pre-1930 period before the introduction of deposit insurance. While banks were not exposed to housing risk historically, the post-1950s shift from business to mortgage lending was accompanied by increases in the exposure to housing risk.

One reason for the decline in bank asset risk, therefore, comes from the lower exposures to credit and interest rate risks, which could have come about from changes in asset composition, diversification, and risk management. Another reason why asset risk has declined is that the macroeconomic environment itself has become less risky throughout our sample period. While the late 19th and early 20th century period was characterised by frequent crises and recessions, the 1980s and 1990s were a period of the "great moderation" in macroeconomic risk (Stock and Watson, 2002; Sims and Zha, 2006). We next trace out the long-run evolution of two simple measures of macroeconomic risk that proxy for the risk environment in banking: the risk of recessions, and that of very high or negative inflation. Recession risk is a proxy for the downside risk of the macroeconomy, a likely driver of bank credit risk (Nagel and Purnanandam, 2020). Deflation can increase the real value of bank loans, making it more difficult for borrowers to repay them and increasing credit risk (Fisher, 1933; Bernanke and James, 1991; Eggertsson and Krugman, 2012), while high inflation can increase the mismatch between nominal interest rates paid on bank assets and liabilities, thereby raising the risks from maturity transformation (Agarwal and Baron, 2021).

Figure 3 plots the long-run trends in these two macroeconomic risk measures. We calculate the recession probability as the share of business cycle peaks within a centered 10-year window of pooled 17-country data. We define years with above 10% CPI growth (this threshold is in line with Agarwal and Baron, 2021) as inflationary and country-year observations with negative CPI growth

Figure 3: *Trends in macroeconomic downside risk*



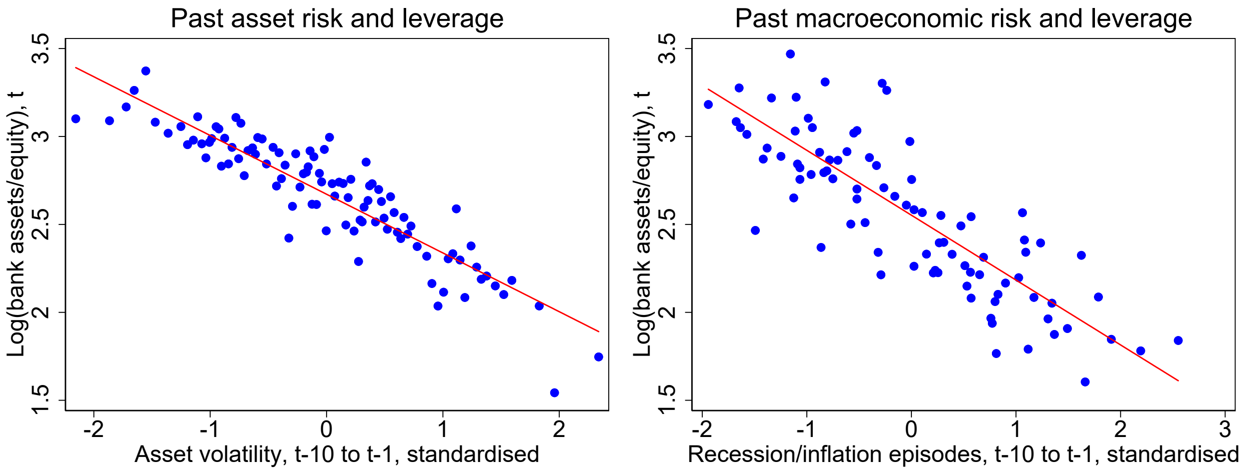
Notes: Rolling centered 10-year windows of cross-country data. Recession probability is the share of business cycle peaks within the window. Price level instability is the share of years where an inflationary or deflationary period started. Deflation is defined as years in which CPI growth was less than zero and inflationary periods are years with CPI growth greater than 10%.

as deflationary and calculate the probability of a start of an inflationary or deflationary period again using 10-year centered windows. Both, recession and price level risks have declined over the long run, with the bulk of the decline occurring during the pre-1950 period that also saw the strongest reductions in bank asset risk. Between 1870 and the second half of the 20th century, the probability of the economy being hit by a recession roughly halved, from more than 20% to about 10%, and the probability of high or negative inflation episodes fell from 20–25% in the late 19th century to below 10% in the post-1945 period. The decline in price level risk between 1870 and 1960 is due to a reduction in deflation episodes, while the post-1980s further decline is coming from a reduction in high inflation episodes. Both macro risk measures display a recent uptick due to the global financial crisis relative to the low levels in previous decades. Taken together, the declines in risk exposures and macroeconomic risk levels documented in Figures 2 and 3 help rationalise why bank assets became safer.

2.3. Trends in bank equity and default risk

The riskiness of bank assets has declined over the long run. This does not, however, mean that banking system risk has decreased along all dimensions. Since asset risk is an important determinant of capital structure (see, e.g., Berg and Gider, 2017), decreases in risk may have increased the debt capacity and, hence, the leverage of the financial sector. At higher levels of leverage, any given change in asset values has a larger effect on equity values and, hence, default risk (Modigliani and Miller, 1958). The leverage amplification may even go above and beyond these direct effects, for example, increasing the likelihood of liquidity dry-ups and costly asset fire sales which further destabilise the financial system (Shleifer and Vishny, 1992; Brunnermeier and Pedersen, 2008).

Figure 4: *Correlations between asset risk, macroeconomic risk, and leverage*



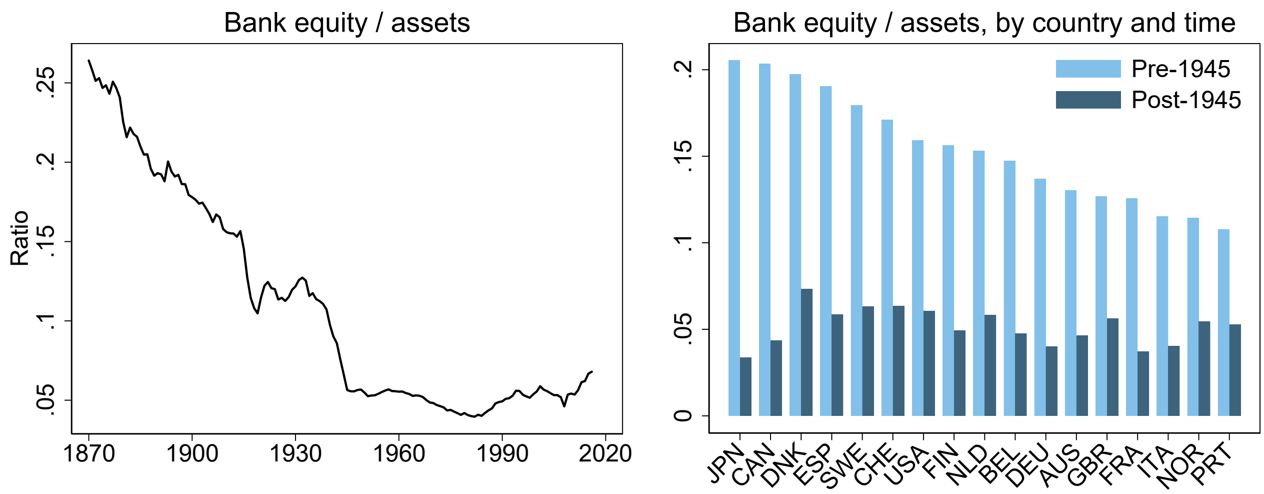
Notes: Binned scatter plots, 100 bins. Leverage (y-axis) is measured as the log of bank equity / assets for the entire banking system. Asset risk (x-axis, left panel) is the volatility of the monthly bank asset return during the previous 10 years, for the specific country. Macroeconomic risk (x-axis, right panel) is the number of recessions, deflation, or high (above 10%) inflation periods during the past 10 years, for the specific country. Asset and macroeconomic risk are standardised to mean zero and standard deviation of 1 within the full sample.

Figure 4 shows that, indeed, measures of bank asset risk and leverage are strongly negatively correlated in our data. The left panel shows that banking system leverage, computed as the ratio of total banking system assets to equity liabilities, is strongly negatively correlated with past asset return volatility. The right panel shows that it is also negatively correlated with past realised macroeconomic risk in the form of recessionary, inflationary, and deflationary episodes. Appendix Table A.1 shows that these regressions hold for other measures of asset risk, beta and RoA level, and when controlling for common cross-country trends and country-specific factors in the form of year and country fixed effects.

Together with the previously documented trend decline in bank asset risk, these strongly negative correlations suggest that banking system leverage has increased over the long run. This is indeed what we observe in the data. The left-hand panel of Figure 5 shows that the cross-country average bank capital ratio (the inverse of leverage) declined by around three-quarters between 1870 and 1950 and stayed at these low levels since then, as also shown by Jordà et al. (2021). The right-hand panel shows that these declines in bank capital ratios (and hence, increases in leverage) took place in every country in our sample, comparing the pre- and post 1945 average levels by country.

To gauge the combined effect of increases in bank leverage and declines in bank asset risk on the overall default risk of the banking system, we start by mapping out the long-run trend in the risk of bank equity. The left-hand panel of Figure 6 plots the 10-year rolling monthly bank equity return volatility. Despite the long-run reduction in asset return volatility, equity return volatility did not decline between 1870 and 1950, and even increased between 1950 and 2016. The left panel of

Figure 5: *Trends in banking system leverage*



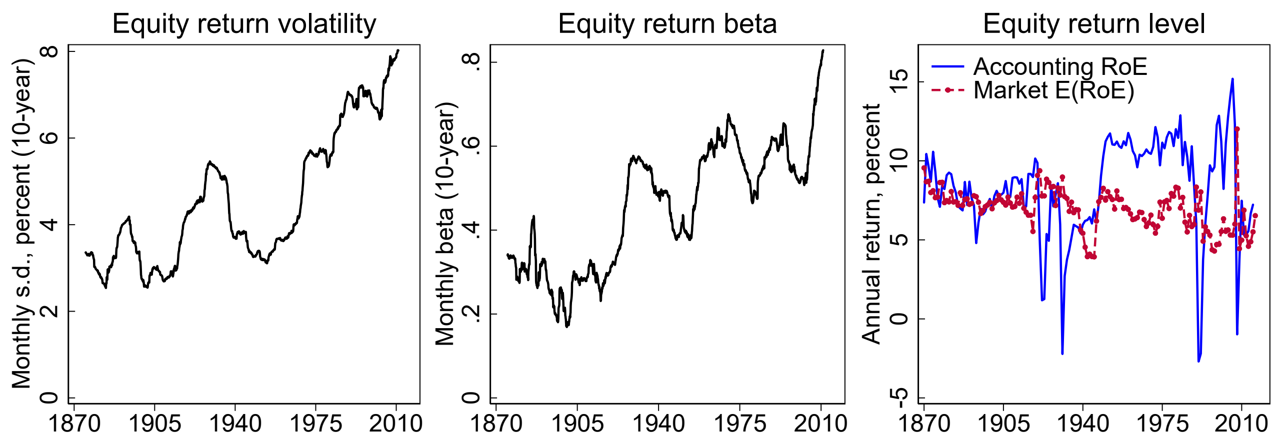
Notes: Left panel: Annual data, unweighted averages of 17 countries. Right panel: time period averages of annual country-level data.

Figure 7 shows that some of the post-1950 increase was mirrored in non-financial equity returns suggesting that it relates to economy-wide rather than bank-specific factors. Still, even conditional on this non-financial equity volatility increase, the beta of bank stocks shown in the middle panel of Figure 6 increased over the long run and stands at its highest level since 1870 at the end of our sample in 2016. The right-hand panel of Figure 6 shows two measures of the level of bank equity returns, i.e. the implicit compensation for bank equity risk. Both the accounting-based measure, equal to net profits over equity liabilities, and the market-based measure, equal to the sum of the dividend yield and country-average real capital gain, have not declined over the long run, with the accounting RoE measure increasing after 1950.

To gain a better understanding of the potential drivers of the post-1950 increases in equity risk, the right-hand panel of Figure 7 shows the time trends in bank equity exposures to the macro-financial risk factors specified in equation (6). There is no clear trend in interest rate risk exposures, and if anything, the interest rate beta declined after 1950. Similarly, credit risk exposures are stable in the early sample period, and decline to around zero during the period of increasing equity return volatility. A different picture emerges for housing risk. Bank equity returns were uncorrelated with housing returns historically, but are strongly correlated with them today (a beta of 0.5–0.75). The trends in equity risk exposures are consistent with the idea that banks substituted away from some of their traditional risks associated with credit provision and maturity transformation, at the same time as shifting the composition of their lending, and the underlying risks, towards loans backed by real estate collateral. In terms of overall risk, the declines in interest rate and credit risk exposures did not fully compensate for the increased exposures to other types of risk, with equity return volatility increasing sharply between 1950 and 2016.[8]

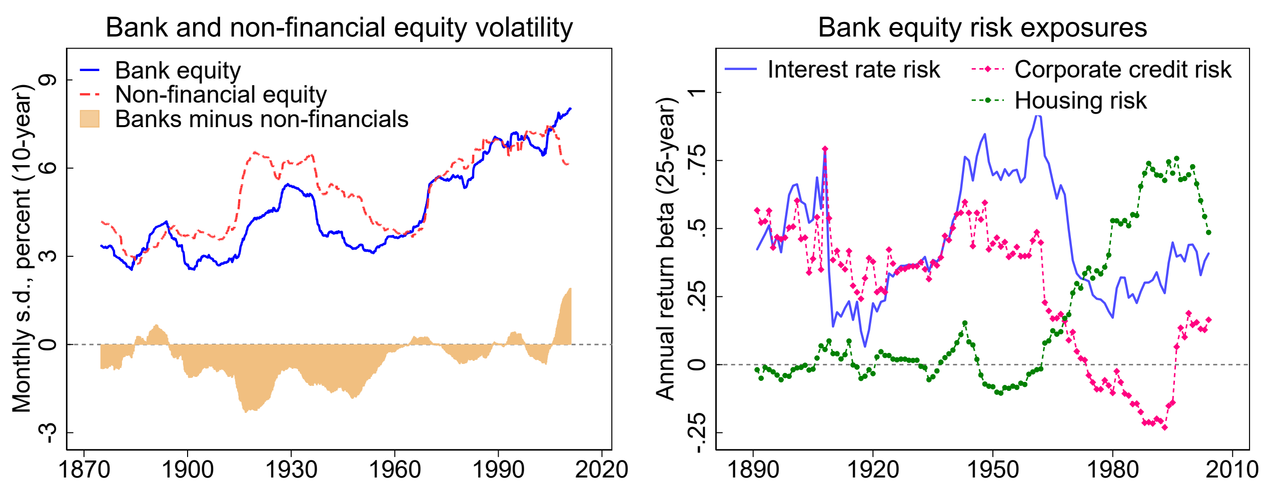
[8]Another driver of the increase in equity volatility is an increase in the idiosyncratic risk of bank equity,

Figure 6: *Trends in bank equity risk*



Notes: Left-hand panel: Standard deviation of the monthly excess market return on bank equity. Middle panel: Monthly beta is the covariance of the realised monthly returns on bank and non-financial equity divided by the variance of the non-financial equity return. The volatility and beta are calculated for centered 10-year windows of pooled 17-country data. Right-hand panel: Annual averages of 17 countries. Accounting RoE is net profits divided by equity liabilities. Expected return on bank equity is the bank dividend yield plus country-average capital gain.

Figure 7: *Risk exposures and comparison to non-financial equity risk*



Notes: Left-hand panel: Realised volatility is the standard deviation of monthly returns within a centered 10-year rolling window of pooled 17-country data. Right-hand panel: The risk exposures are time-varying betas obtained from regressing bank stock returns on contemporaneous excess government bond returns (interest rate risk), the difference between corporate and government bond returns (corporate credit risk), and the excess housing return (housing risk), controlling for the exposure to market risk (all-equity excess return). Excess returns are the total return minus the short-term bill rate. Annual betas estimated on centered 25-year windows of pooled 17-country data.

Table 1: *Long-run changes in bank asset risk, leverage, and equity risk*

	(1)	(2)	(3)	(4)	(5)
	Level			Relative change	
	1880	1950	2010	1880–1950	1950–2010
Asset risk:					
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%
Equity risk:					
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%

Notes: Columns 1–3: pooled averages of annual data for 17 countries in the 20-year centered window around the year (e.g., 1880 refers to the 1870–1890 average). The underlying annual return volatilities and betas are constructed using 10-year centered rolling windows of monthly market data. Columns 4 and 5 calculate the relative change between the corresponding benchmark years, with +100% a doubling and -50% a halving.

Table 1 summarises the long-run changes in bank asset risk, leverage, and equity risk. Bank asset risk shows a pronounced decline in the pre-1950 period, but this decline is almost matched by an increase in leverage, with all three of RoA volatility, RoA level, and bank capital ratios falling by between two-thirds and three-quarters between 1880 and 1950. As a result, bank equity risk remained virtually unchanged throughout this period, with the return on bank equity and its volatility showing modest relative increases of around one-tenth. After 1950, bank asset risk increased, but bank leverage did not respond to these increases and remained historically high. As a result, bank equity risk in the form of realised return volatility increased substantially.

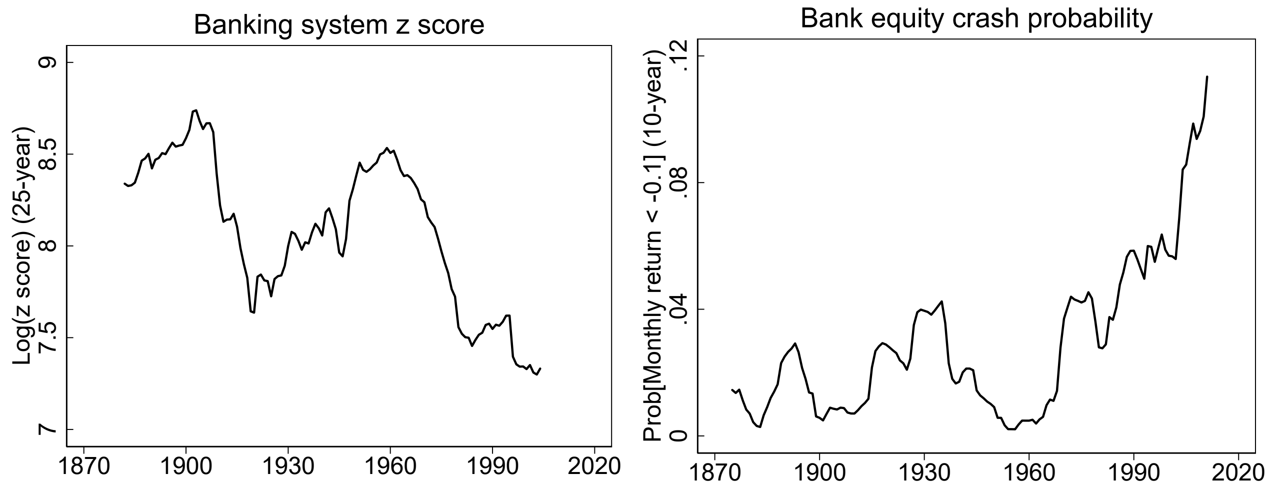
The broad trends in Table 1 suggest that between 1870 and 1950, changes in leverage offset the reductions in bank asset risk, leaving the riskiness of the banking system largely unchanged. After 1950, increases in asset risk at constant leverage led to increases along some dimensions of bank risk. To map out these developments more formally, we construct two measures of banking system default risk, based on accounting and market data. The accounting-based measure is the banking system z-score (Boyd and Graham, 1986), which tracks the probability of bank equity liabilities being wiped out by shocks to bank assets, calculated as follows:

$$z_{i,t} = \frac{\text{RoA}_{i,t} + \text{Capital Ratio}_{i,t}}{\text{Std.dev}(\text{RoA}_{i,t})_{t-12,t+12}} \tag{7}$$

Above, $\text{RoA}_{i,t}$ is the accounting return on bank assets in country i and year t, and $\text{Std.dev}()_{t-12,t+12}$ is its 25-year rolling standard deviation. The second measure is the probability of large monthly

with the sum of squared residuals from the rolling regressions in (6) rising substantially since the 1960s.

Figure 8: *Banking system default risk*



Notes: Left-hand panel: Averages of 17 countries. z score is the capital ratio plus RoA divided by the standard deviation of RoA, using centered rolling 25-year windows of annual accounting data. Right-hand panel: Standard deviation of nominal changes in bank asset valuations – calculated as market RoA times total bank assets – divided by nominal GDP, computed using 10-year rolling windows of pooled monthly market data.

declines in market values of bank equity, or bank equity crashes. To calculate it, we divide the number of months with a monthly bank equity return of -10% or below by the total number of months with non-missing bank equity return observations within a centered 10-year rolling window of pooled 17-country data.

Figure 8 plots the long-run evolution of these two measures of banking system default risk. Between 1870 and 1960, both variables show a relatively stable trend level punctuated by some medium-run cycles, with both risk measures peaking before the Great Depression – indicating a low z score and high equity crash risk – and improving afterwards. After 1960 however, both of these measures point to increases in the default risk of the banking system, as asset volatility increased alongside already high levels of leverage in the banking sector. This suggests that the combined impact of the observed trends in bank asset risk and leverage was far from neutral. Between 1870 and 1950, increases in bank leverage meant that despite declines in macroeconomic risk and macro-financial risk exposures, bank equity did not become safer. Between 1950 and 2016, the relatively small increases in the risk of bank assets and some types of risk exposures (e.g., housing risk) were amplified by the already high levels of bank leverage, such that combined measures of banking system default risk actually increased.

3. The shocks: macro risks associated with banking

In the first part of the paper, we showed that the riskiness of bank assets declined between 1870 and 2016. During the same time period, however, leverage increased by a factor of 4. This means that even though shocks to bank asset values are, on average, smaller, their amplification through the banking system may be stronger. Baron et al. (2021) showed that bank equity returns are positively correlated with future economic outcomes, even conditional on the returns on non-financial equity. This points to a potential link between changes in bank asset values and future GDP. Assessing the impact of equity returns, however, combines the underlying bank asset value change with its leverage amplification. In this section, we study the two separately, and investigate how and why the links between bank asset returns and economic activity changed over time.

3.1. Bank asset returns and future macroeconomic outcomes

We first assess how the predictive power of changes in bank asset values for future economic activity has changed over time. We measure the medium-term performance of the real economy as the three-year-ahead growth in real GDP and denote it by $\Delta_3 y_{i,t+3}$. We then estimate the following predictive regression over rolling 30-year windows:

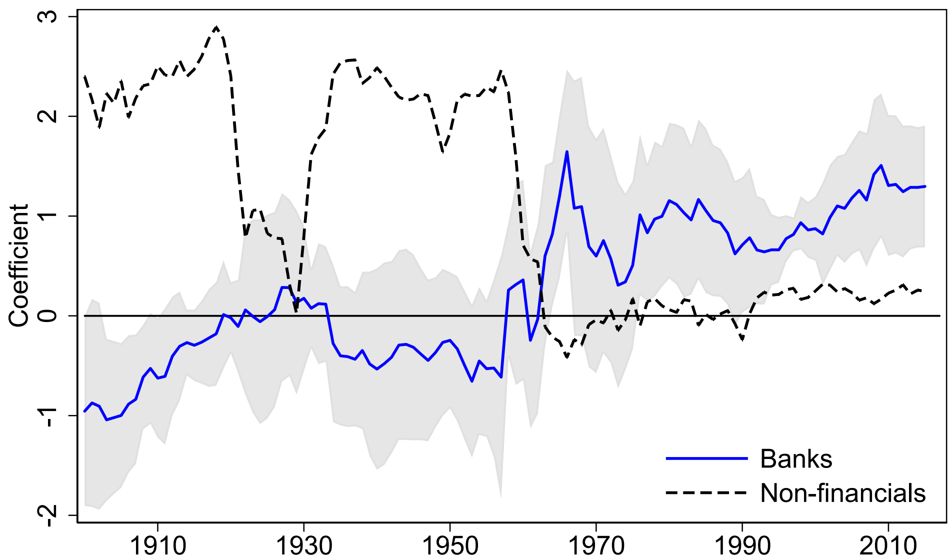
$$\Delta_3 y_{i,t+3} = \alpha_i + \beta^{\text{bank}} R_{i,t}^{\text{bank assets}} + \beta^{\text{nonf}} R_{i,t}^{\text{nonf equity}} + \epsilon_{i,t+3}. \quad (8)$$

Above, $R_{i,t}^{\text{bank assets}}$ is the realised total return on bank assets calculated as the realised total bank equity return (capital gain plus dividend yield) times the lagged capital ratio, and α_i is a country fixed effect. To compare the predictive ability of bank returns to those of non-financials, we additionally include $R_{i,t}^{\text{nonf equity}}$, the total return on non-financial stocks, in the regression. This is important because bank asset valuations depend on general current and future economic conditions as well as the current and future shocks to the banks' loan and security portfolios. Controlling for non-financial returns allows us to control not only for current but also for expected future conditions of non-financial listed firms, and leaves the coefficient β^{bank} to capture the bank-specific effects. Because market values of bank assets and equity are forward-looking, this coefficient captures both the impact of the contemporaneous shock to asset values on GDP growth, and the association between expected future bank losses and GDP. All return variables are winsorized at the 1% level to avoid large outliers driving the results.

The estimated coefficients for β^{bank} (solid line) and β^{nonf} (dashed line) are shown in Figure 9. The first estimates reported are from the year 1900 (based on a regression using data from 1870 to 1900). The figure also shows a 90% confidence band around the estimated coefficient for bank asset returns. In the late 19th century, non-financial returns predicted three-year-ahead output growth, but bank asset returns did not provide any additional information on future medium-term economic performance. The β^{bank} coefficient is either zero or negative at the beginning of the sample. β^{nonf}, on the other hand, is significantly positive. Fast-forwarding to the 21st century, the relationship has reversed: bank asset returns are a significant predictor of economic activity, with higher bank asset returns associated with higher three-year-ahead output growth. Non-financial returns, on the contrary, contain no additional information on future output.

Linking the start and end of our sample, Figure 9 shows that there has been a continuous

Figure 9: *Bank asset returns, non-financial returns, and future GDP growth: rolling regression coefficients*



Notes: Coefficients from a rolling (30-year backward-looking windows) predictive regression of cumulative future three-year real GDP growth (t to $t+3$) on the bank asset return and non-financial equity returns ($t-1$ to t). The coefficients correspond to the percentage point impact of a one standard deviation change in returns. The regressions include changes in bank asset values (solid line), changes in non-financial equity values (dashed line) and country fixed effects. The shaded area is a 90% confidence interval around the bank asset value coefficients calculated using standard errors dually clustered on country and year. Underlying return data are standardised by country with mean of zero and standard deviation of one.

improvement in the ability of bank asset returns to predict economic activity. Non-financial equity returns lost their additional predictive ability relative to bank asset returns shortly after World War II. A similar pattern emerges when we look at different prediction horizons, forecasting one- and two-year ahead growth, shown in the Appendix Figure A.3. These results suggest that the relationship between macroeconomic performance, bank returns and non-financial returns has changed materially over time.

We confirm and generalise this stylised fact by employing local projections (Jordà, 2005) to fully characterise output dynamics following bank asset return innovations. More specifically, we run a sequence of h regressions where the dependent variable is defined as the difference in log real GDP levels between years $t+h$ and t, that is $\Delta_h y_{i,t} = y_{i,t+h} - y_{i,t}$. Based on the finding above, we distinguish between a pre- and post-WW2 sample and compare bank asset returns to non-financials. In the specification, we therefore interact realised bank asset returns $R_{i,t}^{\text{bank assets}}$ and non-financial equity returns $R_{i,t}^{\text{nonf equity}}$ with indicators for the pre- and post-1945 period, as follows:

$$\begin{aligned}\Delta_h y_{i,t} = {} & \alpha_{i,h} + \beta_h^{\text{bank, pre}} R_{i,t}^{\text{bank assets}} \times \mathbb{1}(year \leq 1945) + \beta_h^{\text{bank, post}} R_{i,t}^{\text{bank assets}} \times \mathbb{1}(year > 1945) \\ & + \beta_h^{\text{nonf, pre}} R_{i,t}^{\text{nonf equity}} \times \mathbb{1}(year \leq 1945) + \beta_h^{\text{nonf, post}} R_{i,t}^{\text{nonf equity}} \times \mathbb{1}(year > 1945) \\ & + \gamma_h \mathbb{1}(year > 1945) + \Phi X_{i,t} + \epsilon_{i,t+h}\,, \end{aligned} \tag{9}$$

Table 2: *Bank asset returns and future GDP growth: before and after 1945*

	Year 1	Year 2	Year 3	Year 4	Year 5
Δ Bank asset values, post-1945	0.56***	0.98***	1.00***	1.03***	0.85*
	(0.18)	(0.26)	(0.31)	(0.38)	(0.49)
Δ Bank asset values, pre-1945	0.19	-0.38	-0.42	-0.61	-0.65
	(0.18)	(0.26)	(0.39)	(0.43)	(0.43)
Δ Non-financial equity, post-1945	0.36***	0.08	-0.26	-0.47	-0.43
	(0.09)	(0.14)	(0.24)	(0.34)	(0.38)
Δ Non-financial equity, pre-1945	2.04***	2.73***	2.29***	2.00**	1.41
	(0.41)	(0.64)	(0.69)	(0.90)	(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

Notes: This table reports regressions of real GDP growth from t to $t+h$ on $R^{\text{assets}}_{i,t}$ and $R^{\text{nonf equity}}_{i,t}$ (returns from $t-1$ to t). Changes in bank asset values and non-financial equity returns are interacted with indicators for the pre- and post-1945 periods. All specifications include a post-1945 dummy, country fixed effects and control for contemporaneous GDP growth, changes in short-term interest rates and four lags of the interaction and control variables. Return data are standardised by country with mean of zero and standard deviation of one. Driscoll-Kraay standard errors in parentheses are adjusted for autocorrelation of $1.5 \times h$ lags rounded down to the nearest integer. *, **, and *** indicate significance at the 0.1, 0.05, and 0.01 levels, respectively.

for horizons $h = 1, ..., 5$. In addition to our return measures, we add an indicator for the post-1945 period to control for the increase in average GDP growth during this time, and a vector of control variables $X_{i,t}$ that includes contemporaneous GDP growth and changes in short-term interest rates, as well as four lags of all variables (bank asset and non-financial equity returns interacted with pre- and post-1945 dummies, GDP growth, and changes in short-term rates).

The results shown in Table 2 confirm the visual impression from Figure 9. Non-financial equity return innovations predict economic activity in the pre-WW2 period: high returns predict higher cumulative growth rates over all horizons h. This result seems intuitive: non-financial equities contain information about future cash flows of listed non-financial firms and thereby proxy for economic conditions (Stock and Watson, 2003). However, this predictive ability vanishes in the second half of our sample, and the coefficient is insignificant and close to zero in the post-WW2 period. Since non-financial returns and bank asset returns are included jointly in this regression, our results suggest that after 1945, non-financial returns contain little information on future growth beyond the information contained in bank asset returns. Turning to bank asset returns, we find no predictability in the pre-WW2 period. If anything, the coefficient is slightly negative at longer horizons. Again, this implies that bank asset returns contain no information beyond the information contained in non-financial equities in the first half of our sample. After 1945, bank asset returns emerge as a significant predictor of future growth.

One interpretation of these correlations is that shocks to bank asset values had little macroeconomic consequence before WW2, but had large macroeconomic effects in the post-WW2 period. An alternative interpretation is that bank equity prices were simply uninformative about fundamentals – reflected in future dividends or GDP growth – before WW2, but informative afterwards, with the reverse true for non-financials. To evaluate this alternative hypothesis, we turn to the standard framework of dividend predictability regressions (Campbell and Shiller, 1988; Cochrane, 2008), and test the predictive power of bank and non-financial equity valuations (measured as the price-dividend ratio) for their own fundamentals (dividends), before and after WW2. Appendix Figure A.4 shows that both bank and non-financial equity valuations predict their own fundamentals equally strongly both before and after WW2, which suggests that the results in this section are not fully attributable to changes in bank equity price informativeness.

3.2. Mechanisms

3.2.1 Leverage and volatility

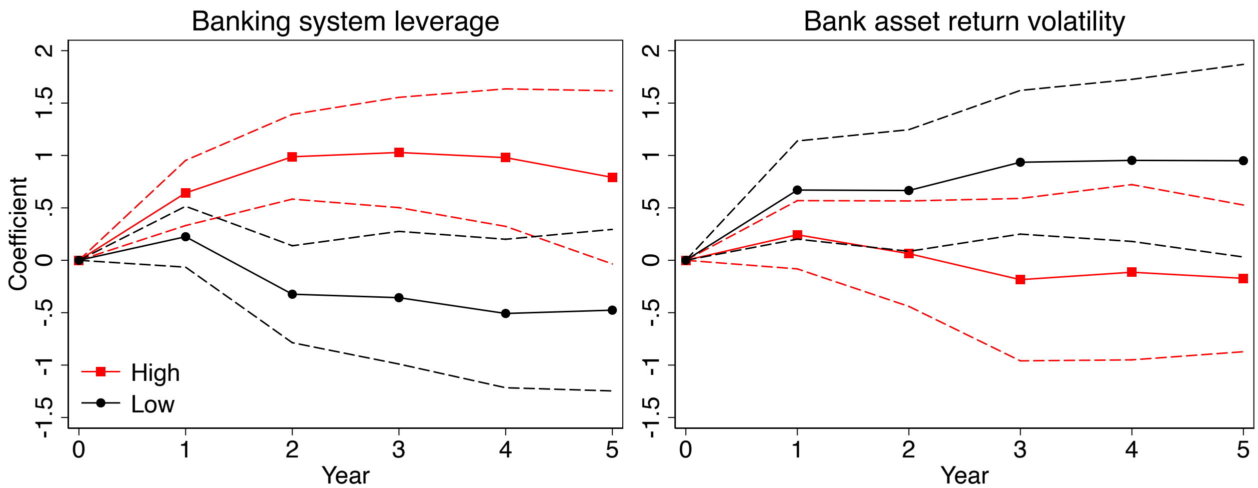
Why did bank asset returns become a better predictor of economic growth after WW2? In the model of Brunnermeier and Sannikov (2014), shocks to the banking sector have more pronounced effects when banks are levering up against low measured risks. In the data, the post-1945 period was characterised by low macroeconomic risk, low bank asset risk, and high leverage of the banking sector. To more formally evaluate the link between bank risk, leverage, and the macroeconomy, we test whether the predictive power of changes in bank asset values for future economic activity varies across different leverage and volatility regimes.

We use a similar specification to equation (9), but we now split the sample by the level of leverage and volatility before the asset value change materialises. For the leverage specification, we interact returns with an indicator for whether leverage, $lev_{i,t-1}$, was above or below its full-sample mean $\overline{lev}$. For the volatility specifications, we interact returns with an indicator of whether past 10-year bank asset return volatility, $vol_{i,t-1}$ (where the $t-1$ index refers to the window from $t-10$ to $t-1$), was above or below its sample mean $\overline{vol}$.

$$\begin{aligned}\text{Leverage:}\quad \Delta_h y_{i,t} = {} & \alpha_{i,h} + \beta_h^{\text{bank, low}} R_{i,t}^{\text{bank assets}} \times \mathbb{1}(lev_{i,t-1} \leq \overline{lev}) + \beta_h^{\text{bank, high}} R_{i,t}^{\text{bank assets}} \times \mathbb{1}(lev_{i,t-1} > \overline{lev}) \\ & + \beta_h^{\text{nonf, low}} R_{i,t}^{\text{nonf equity}} \times \mathbb{1}(lev_{i,t-1} \leq \overline{lev}) + \beta_h^{\text{nonf, high}} R_{i,t}^{\text{nonf equity}} \times \mathbb{1}(lev_{i,t-1} > \overline{lev}) \\ & + \gamma_h \mathbb{1}(year > 1945) + \theta_h \mathbb{1}(lev_{i,t-1} > \overline{lev}) + \Phi X_{i,t} + \epsilon_{i,t+h}. \end{aligned} \tag{10}$$

$$\begin{aligned}\text{Volatility:}\quad \Delta_h y_{i,t} = {} & \alpha_{i,h} + \beta_h^{\text{bank, low}} R_{i,t}^{\text{bank assets}} \times \mathbb{1}(vol_{i,t-1} \leq \overline{vol}) + \beta_h^{\text{bank, high}} R_{i,t}^{\text{bank assets}} \times \mathbb{1}(vol_{i,t-1} > \overline{vol}) \\ & + \beta_h^{\text{nonf, low}} R_{i,t}^{\text{nonf equity}} \times \mathbb{1}(vol_{i,t-1} \leq \overline{vol}) + \beta_h^{\text{nonf, high}} R_{i,t}^{\text{nonf equity}} \times \mathbb{1}(vol_{i,t-1} > \overline{vol}) \\ & + \gamma_h \mathbb{1}(year > 1945) + \theta_h \mathbb{1}(vol_{i,t-1} > \overline{vol}) + \Phi X_{i,t} + \epsilon_{i,t+h}. \end{aligned} \tag{11}$$

Figure 10: *Bank asset returns and future GDP growth: different leverage and volatility regimes*



Notes: This figure plots regression coefficients of real GDP growth from t to $t+h$ on $R_{i,t}^{\text{bank assets}}$ in different leverage and volatility regimes. We bin observations based on the mean banking system leverage (high if equity/assets at $t-1$ is below full-sample average) and volatility (high if bank asset return standard deviation between $t-10$ and $t-1$ is above average), and include interactions of changes in bank asset values and non-financial equity values with high (above mean) and low (below mean) leverage and volatility dummies. All specifications include a post-1945 dummy, country fixed effects, and control for contemporaneous GDP growth, changes in short-term interest rates and four lags of the interaction and control variables. Return data are standardised by country with mean of zero and standard deviation of one. Dashed lines are 90% confidence intervals around the coefficient estimates based on Driscoll-Kraay standard errors adjusted for autocorrelation of $1.5 \times h$ lags rounded down to the nearest integer.

Above, high leverage is defined as a below-sample-mean bank capital (equity / assets) ratio, and low leverage is defined as an above-sample-mean capital ratio. Volatility is measured as the backward-looking 10-year standard deviation of annual bank asset returns $R^{\text{bank assets}}$ (we use annual rather than monthly return volatilities to increase the coverage of the data). As in the time period split specification in equation (9), we control for a post-WW2 indicator, and contemporaneous values and four lags of GDP growth and short-term rates. We additionally control for the leverage (or volatility) indicator, and four lags of interactions between returns and leverage (or volatility).

Figure 10 shows the results of these regressions, with the corresponding coefficients and significance tests shown in Table 3. The left-hand panel shows that bank asset returns positively predict macroeconomic outcomes when bank leverage is high (red squares), while there is no such relation when bank leverage is low (black circles). Turning to volatility specification, the right-hand panel shows that bank asset returns are strongly positively correlated with future economic activity at horizons of 1 to 5 years ahead when past realised risks are low (black circles). When past realised bank risk is high (red squares), bank asset returns show no excess predictive power for future GDP.

The results presented in Table 3 confirm the visual impression from Figure 10. Panel A shows that, with the exception of year five, realised bank asset risks are significantly associated with growth over the following years when bank capital ratios are low, and leverage is high. This result is in stark contrast with the relationship at low levels of leverage, which is, if anything, negative.

Table 3: *Bank asset returns and future GDP growth: different leverage and volatility regimes*

	Year 1	Year 2	Year 3	Year 4	Year 5
	Panel A: Returns binned by banking system leverage				
Δ Bank asset values, high leverage	0.64***	0.99***	1.03***	0.98**	0.79
	(0.19)	(0.24)	(0.31)	(0.39)	(0.49)
Δ Bank asset values, low leverage	0.22	-0.32	-0.36	-0.51	-0.48
	(0.17)	(0.28)	(0.38)	(0.42)	(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
Observations	1517	1517	1517	1517	1517
	Panel B: Returns binned by asset return volatility				
Δ Bank asset values, low volatility	0.67**	0.67*	0.94**	0.95**	0.95*
	(0.28)	(0.35)	(0.41)	(0.46)	(0.55)
Δ Bank asset values, high volatility	0.24	0.06	-0.18	-0.11	-0.17
	(0.19)	(0.30)	(0.46)	(0.50)	(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

Notes: This table reports regressions of real GDP growth from t to $t+h$ on $R_{i,t}^{\text{bank assets}}$ in different leverage and volatility regimes. We bin observations based on the mean banking system leverage (high if equity/assets at $t-1$ is below full-sample average) and volatility (high if bank asset return standard deviation between $t-10$ and $t-1$ is above average), and include interactions of changes in bank asset values and non-financial equity values with high and low leverage and volatility dummies. All specifications include a post-1945 dummy, country fixed effects and control for contemporaneous GDP growth, changes in short-term interest rates and four lags of the interaction and control variables. Return data are standardised by country with mean of zero and standard deviation of one. Driscoll-Kraay standard errors in parentheses are adjusted for autocorrelation of $1.5 \times h$ lags rounded down to the nearest integer. *, **, and *** indicate significance at the 0.1, 0.05, and 0.01 levels, respectively.

The hypothesis that these coefficients are equal is rejected for horizons $h = 1, ..., 5$. Turning to the volatility specification, the association between asset returns and future output growth is positive and significant at all horizons in low-volatility regimes, but is absent in high-volatility regimes. Because asset risk is difficult to measure, the uncertainty around the response estimates is somewhat larger than for the leverage specifications, with the hypothesis that low- and high-volatility coefficients are equal being rejected at the 10% level for some, but not all horizons.

3.2.2 Asymmetry

The increasing connectedness between bank asset returns and future macroeconomic outcomes can be linked to the secular increases in banking sector leverage and declines in asset risk documented in Section 2. In this section, we test whether these changes in predictive power can be linked to

Table 4: *Bank asset returns and future GDP growth: asymmetry*

	Year 1	Year 2	Year 3	Year 4	Year 5
Δ Bank asset values, negative	1.06***	1.06**	0.80*	0.65	0.66
	(0.31)	(0.43)	(0.44)	(0.47)	(0.64)
Δ Bank asset values, positive	0.13	-0.28	-0.08	-0.31	-0.64
	(0.20)	(0.29)	(0.36)	(0.53)	(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

Notes: This table reports regressions of real GDP growth from t to $t+h$ on $R^{\text{bank assets}}_{i,t}$ split into positive and negative return realisations. Non-financial returns are included as controls, and split into positive and negative returns. The specification includes a post-1945 dummy, country fixed effects, and controls for contemporaneous GDP growth, changes in short-term interest rates, and four lags of the interaction and control variables, as well as dummy variables for return variables being positive. Return data are standardised by country with mean of zero and standard deviation of one. Driscoll-Kraay standard errors in parentheses are adjusted for autocorrelation of $1.5 \times h$ lags rounded down to the nearest integer. *, **, and *** indicate significance at the 0.1, 0.05, and 0.01 levels, respectively.

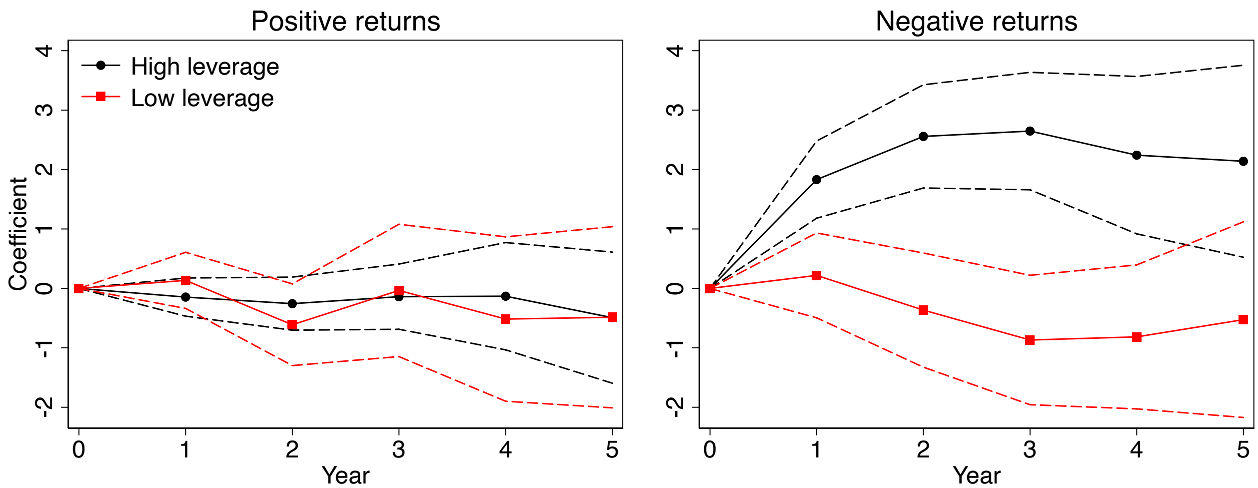
more specific amplification mechanisms in the theoretical literature. One such important mechanism relates to return asymmetry: when the banking sector faces borrowing constraints, the shock amplification and the resulting macroeconomic effects should be stronger for negative returns than for positive returns (He and Krishnamurthy, 2013; Brunnermeier and Sannikov, 2014; Krishnamurthy and Li, 2020). To assess the importance of this mechanism, we test whether negative bank asset returns have stronger predictive power for GDP than positive returns, and whether this effect is stronger when leverage is high. To test the first of these predictions, we run the following regression:

$$\begin{aligned}\Delta_h y_{i,t} = \alpha_{i,h} &+ \beta_h^{\text{bank, pos}} R_{i,t}^{\text{bank asset}} \times \mathbb{1}_{(R_{i,t}^{\text{bank asset}} \geq 0)} + \beta_h^{\text{bank, neg}} R_{i,t}^{\text{bank asset}} \times \mathbb{1}_{(R_{i,t}^{\text{bank asset}} < 0)} \\ &+ \beta_h^{\text{nonf, pos}} R_{i,t}^{\text{nonf equity}} \times \mathbb{1}_{(R_{i,t}^{\text{nonf equity}} \geq 0)} + \beta_h^{\text{nonf, neg}} R_{i,t}^{\text{nonf equity}} \times \mathbb{1}_{(R_{i,t}^{\text{nonf equity}} < 0)} \\ &+ \gamma_h \mathbb{1}_{(year > 1945)} + \theta_h^{\text{bank}} \mathbb{1}_{(R_{i,t}^{\text{bank asset}} \geq 0)} + \theta_h^{\text{nonf}} \mathbb{1}_{(R_{i,t}^{\text{nonf equity}} \geq 0)} + \Phi X_{i,t} + \epsilon_{i,t+h}. \qquad (12)\end{aligned}$$

As in the volatility and leverage splits in equations (10) and (11), we interact bank asset and non-financial equity returns with a dummy equalling 1 when these returns are either negative or positive, and control for a post-WW2 indicator, positive asset return indicator, and four lags of GDP growth, short-term rates, and interactions between returns and the positive and negative return indicators.

The results shown in Table 4 are in line with theoretical predictions. Negative asset returns are significantly associated with future output gaps, and the more negative the return, the larger the future output gap. At the same time, there is no such relationship when returns are positive. There is a large difference between positive and negative return coefficients at all regression horizons,

Figure 11: *Bank asset returns and future GDP growth: asymmetry at different leverage levels*



Notes: This figure plots regression coefficients of real GDP growth from t to $t + h$ on $R_{i,t}^{\text{bank assets}}$. Left and right panels show responses estimated from a regression that splits returns by leverage and sign. The left (right) panel shows real GDP responses to positive (negative) asset returns split by leverage (bank assets/equity). The specification includes a post-1945 dummy, country fixed effects, and controls for contemporaneous GDP growth, changes in short-term interest rates, and four lags of the interaction and control variables. Return data are standardised by country with mean of zero and standard deviation of one. Dashed lines are 90% confidence intervals around the coefficient estimates based on Driscoll-Kraay standard errors adjusted for autocorrelation of $1.5 \times h$ lags rounded down to the nearest integer.

with these differences statistically significant for years 1 to 3. This strong asymmetry suggests that the baseline relationships studied in Section 3.1 are mainly driven by negative returns. These findings are in line with evidence in Baron et al. (2021), who show that more negative bank equity return innovations are more strongly correlated with future economic activity. But is there evidence that these correlations between negative returns and future GDP growth are driven by leverage amplification of changes in bank asset values? To evaluate this hypothesis, we test whether the predictive power of negative bank asset returns is stronger when bank leverage is high.

To do this, we include the interactions of leverage regimes and asset returns split by sign in the same regression. The results from this regression are presented in the two panels of Figure 11. The left panel shows the response to positive bank asset returns at high and at low leverage levels. There is no strong relationship between positive returns and macroeconomic outcomes, neither at high nor at low leverage. The right panel shows that, similarly to positive returns, negative returns have little association with future GDP growth at low leverage levels. The relationship becomes different when a highly leveraged banking sector faces negative asset returns. In this case, the association between realisations of bank asset risk and future real economic outcomes is statistically significant and economically sizeable: a one standard deviation ($\approx$ 1.8 percentage points) more negative bank asset return is associated with almost 3 percentage point lower GDP growth over the following three years.

Our results suggest that the links between bank equity risks and future economic outcomes

Table 5: *Bank equity returns and future GDP growth: different leverage regimes*

	Year 1	Year 2	Year 3	Year 4	Year 5
Δ Bank equity, high leverage	0.41***	0.63***	0.68***	0.65***	0.48
	(0.11)	(0.17)	(0.21)	(0.25)	(0.30)
Δ Bank equity, low leverage	0.46	-0.60	-1.15**	-1.61**	-1.59*
	(0.29)	(0.49)	(0.57)	(0.73)	(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

Notes: This table reports regressions of real GDP growth from t to $t+h$ on $R_{i,t}^{\text{bank equity}}$ in different leverage regimes. We bin observations based on the mean leverage (high if assets/equity is above average), and include interactions of changes in bank and non-financial equity values with high and low leverage dummies. All specifications include a post-1945 dummy, country fixed effects, and control for contemporaneous GDP growth, changes in short-term interest rates, and four lags of the interaction and control variables. Return data are standardised by country with mean of zero and standard deviation of one. Driscoll-Kraay standard errors in parentheses adjusted for autocorrelation of $1.5 \times h$ lags rounded down to the nearest integer. *, **, and *** indicate significance at the 0.1, 0.05, 0.01 levels, respectively.

documented in previous studies (Jordà et al., 2013; Baron et al., 2021) generally arise from situations when a highly levered banking sector experiences a negative return on its assets. This means that when it comes to understanding the mechanisms behind banking sector distress and real activity, the interaction between asymmetric shocks and leverage amplification is key.

3.2.3 Alternative specifications and robustness checks

Equity returns We have decomposed bank equity returns into the underlying bank asset return and leverage components, and found that realised bank asset risks are significantly associated with economic growth when leverage is high. This larger predictive power of bank asset return innovations in high-leverage regimes may be mechanical, and arise through high leverage amplifying a given asset return to generate a larger change in the return on bank equity. Alternatively, it could be that leverage matters above and beyond the amplification from asset returns to equity returns, further strengthening the link between any given equity return realisation and future GDP.

As a test for the latter hypothesis, we now fix the size of the equity return innovation and run the same regression as in equation (10), replacing asset with equity returns. Table 5 shows the results of this exercise. When leverage is high, bank equity returns are strongly positively associated with future GDP growth, and this relationship is statistically significant for years 1 to 4. When leverage is low, the correlation between bank equity returns and future GDP growth is weak, or even negative for years 2–5. This shows that even for a given bank equity return, small changes in bank asset values at high levels of leverage have much larger predictive power for future GDP than large changes in asset values at low levels of leverage.

Table 6: *Returns on different assets and future GDP growth across leverage regimes*

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

Notes: This table reports regressions of real GDP growth from t to $t+h$ on changes in the values of bank assets, non-financial equity, corporate bonds, and housing between years $t-1$ and t. The change in corporate bond values is the corporate bond return in excess of the return on government bonds of similar maturity. The change in housing values is the total real housing return. We bin observations based on the mean banking system leverage, and include interactions of changes in the four different asset values with high and low leverage dummies. All specifications include a post-1945 dummy, country fixed effects and control for contemporaneous GDP growth, changes in short-term interest rates and four lags of the interaction and control variables. All return data are standardised by country with mean of zero and standard deviation of one. Driscoll-Kraay standard errors in parentheses are adjusted for autocorrelation of $1.5 \times h$ lags rounded down to the nearest integer. *, **, and *** indicate significance at the 0.1, 0.05, and 0.01 levels, respectively.

Different leverage and risk measures In the baseline specifications in Figure 10 and Table 3, we define bank leverage as the ratio of bank assets to bank equity, and risk as past asset return volatility. Appendix Table A.2 shows the results of our regressions in equations (10) and (11) when using different definitions of these two variables, with leverage defined as the ratio of bank assets to GDP, and past risk defined as the number of recessions, deflation, and high inflation episodes in the preceding 10 years (the sum of the two measures shown in Figure 3). These more macroeconomic definitions of risk and leverage have the advantage that they may be less endogenous to bank choices, but a disadvantage that they are more difficult to measure, and may not correspond as well to the leverage amplification mechanisms in theoretical models. Using these alternative definitions of risk and leverage, however, leaves our results unchanged.

Standardising returns within each regime Another potential concern is that bank asset returns in the different leverage and volatility regimes may be different, and in particular that a given asset return is relatively larger in the low volatility and high leverage bins than in the high volatility or low leverage bins. In Table A.3 we therefore standardise bank asset (and non-financial equity) returns within each leverage and volatility bin. The responses of GDP to bank asset returns remain significant at all horizons in the high leverage and low volatility bins, while being insignificant and often negative after periods of low leverage or high volatility.

Conditioning on other financial returns Our results show that high banking sector leverage significantly improves the predictive power of bank asset and equity returns for future macroeconomic outcomes. In order to understand the mechanism behind these correlations in the data, it is important to know whether these state dependencies are specific to returns on assets held by the banking sector, or extend to returns on other credit-related asset classes. To check this, we regress future economic activity on bank and non-financial equity returns alongside the returns on two other major risky asset classes, corporate bonds and real estate. These two asset returns have been shown to predict future economic activity, with the associated correlations often linked to variation in credit conditions and credit market sentiment (Gilchrist and Zakrajšek, 2012; Jordà et al., 2015; López-Salido et al., 2017).

The results of these regressions are shown in Table 6. Even after conditioning on these other asset returns, the predictive power of bank asset returns remains economically and statistically significant, and is much stronger in the high-leverage regime. The same state dependencies are, however, not present for the returns on other risky asset classes: while these are positively correlated with future economic activity on average or in low leverage regimes, they do not show significantly stronger predictive power at high levels of banking system leverage. Table A.4 shows that this result also holds for a split based on bank asset volatility. This suggest that the mechanisms driving the link between bank asset returns and GDP, and the leverage and volatility state dependencies, are distinct or complementary to those behind the real effects of returns on the other major risky asset classes, pertaining to, for example, time-varying credit sentiment and housing wealth effects.

4. Conclusion

We have combined three recently developed historical datasets to trace out the evolution of bank risk and its macroeconomic consequences across advanced economies. In the late 19th century, bank asset returns were volatile, but the banking sector was relatively well capitalised. In this environment, the excess predictive power of bank asset returns for future activity was negligible.

The first 80 years of our sample saw a secular decline in both bank asset risk and capital ratios, with these two trends broadly offsetting each other when it comes to the impact on bank equity and default risk. After 1950, increases in bank asset risk alongside already high levels of leverage meant that bank equity and default risks increased, and are now higher than they were in the early historical period. More importantly however, these trends in risk and leverage appear to have increased the sensitivity of macroeconomic outcomes to bank asset return fluctuations, with negative changes in bank asset values associated with increasingly large output gaps.

Our findings suggest that over the long run, bank investments became safer, but the banking sector has become more risky for the real economy. Even though it may seem paradoxical at first, this conjecture resonates well with modelling approaches in which financial intermediaries play a key role in creating and amplifying macroeconomic risk. Our findings carry several further implications for researchers and policymakers. One is that narrow measures focussed on bank asset risk may not offer a good proxy for the macroeconomic risks arising from banking, and vice versa. Going beyond the measurement of risk, a broader lesson looms in the background. The secular reductions in bank asset risk exposures suggest that, historically, advances in information technology and innovative financial contracts made it easier for banks to monitor and manage risk, thereby increasing the safety of bank assets. Through the endogenous response of the financial system, however, these innovations may have made the banking sector more risky for the economy, as anticipated prior to the global financial crisis by Rajan (2006). Going forward, new technology-driven innovations have the potential to reduce asset risks further. Systemic risks arising from banking may, however, increase even as asset risks decline – a lesson that policymakers should bear in mind.

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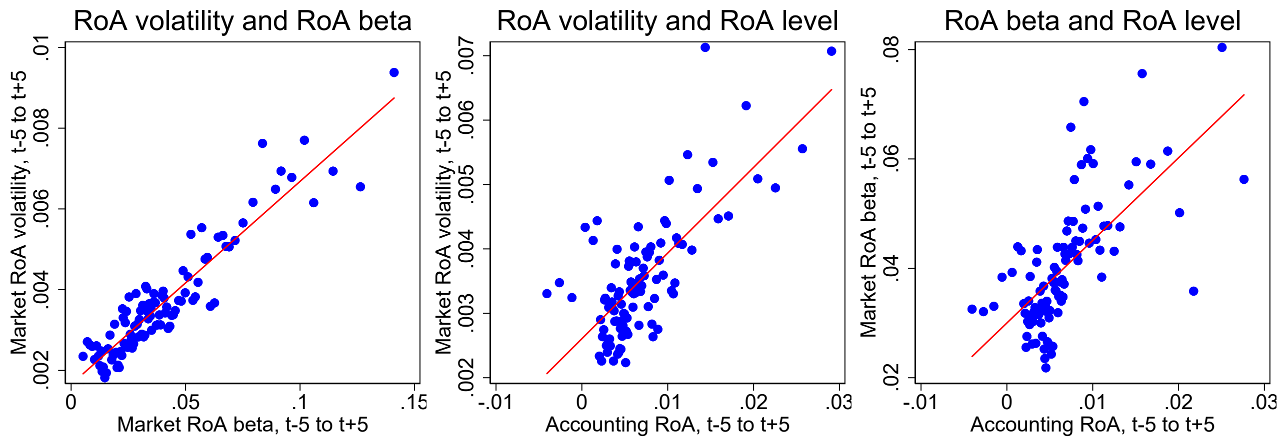
Appendix

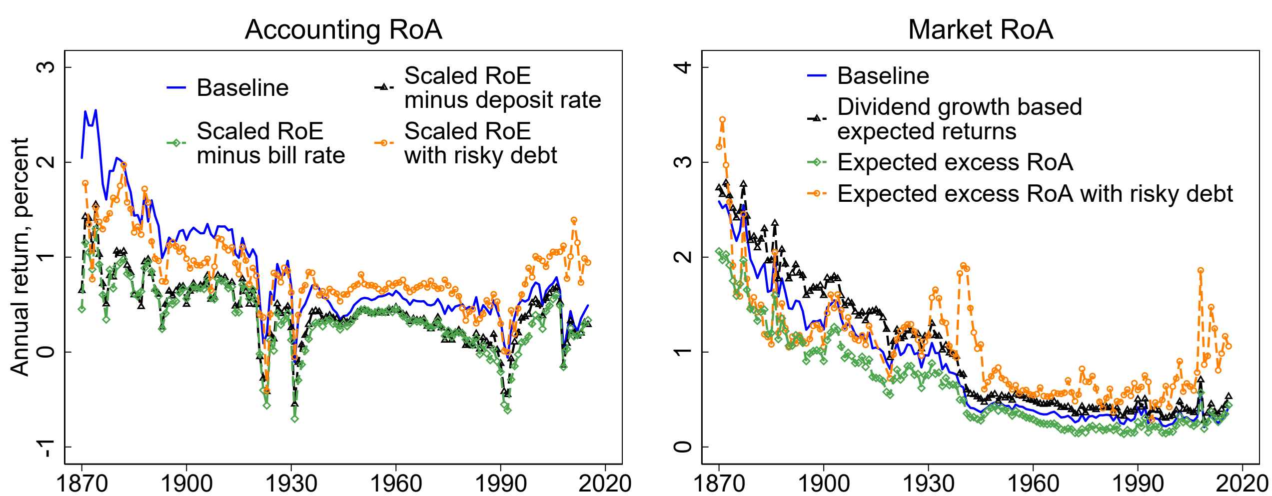
A. Risks within banking: additional material

Figure A.1: *Correlations between different measures of asset risk*



Notes: Binned scatter plots, 100 bins. Volatilities and betas are computed at country level, using 10-year windows of monthly returns. RoA level is the average accounting RoA over the same 10-year window. Underlying data are winsorised at 1% level and adjusted for country fixed effects.

Figure A.2: *Alternative bank asset return measures*



Notes: Left-hand panel: Baseline measure is equal to net profits divided by total bank assets. The scaled RoE minus deposit rate, and minus the bill rate, are calculated as the accounting RoE (net profits / equity liabilities) minus the safe rate, multiplied by the bank capital ratio, with the deposit rate and 10-year ($t-9$ to t) average government bill rate used as safe rate measures, respectively. Scaled RoE with risky debt is the scaled RoE minus the deposit rate plus the market debt risk premium (the corporate bond spread) multiplied by the share of risky debt to total equity liabilities, with risky debt set equal to all non-deposit debt liabilities of banks. Right-hand panel: Baseline measure is calculated as the bank dividend-price ratio plus country-average real capital gain, multiplied by the bank capital ratio. Dividend growth based expected returns sum the dividend yield and the country-average real dividend growth rate (winsorised at 1% level), instead of the average real capital gain. Expected excess RoA is the expected bank equity return minus the trend real safe rate calculated using the Del Negro et al. (2019) Bayesian model, multiplied by the bank capital ratio. Expected excess RoA with risky debt is the expected excess RoA plus the corporate bond spread multiplied by the ratio of non-deposit bank debt liabilities to total bank liabilities.

Table A.1: *Correlations between asset risk, macroeconomic risk, and leverage*

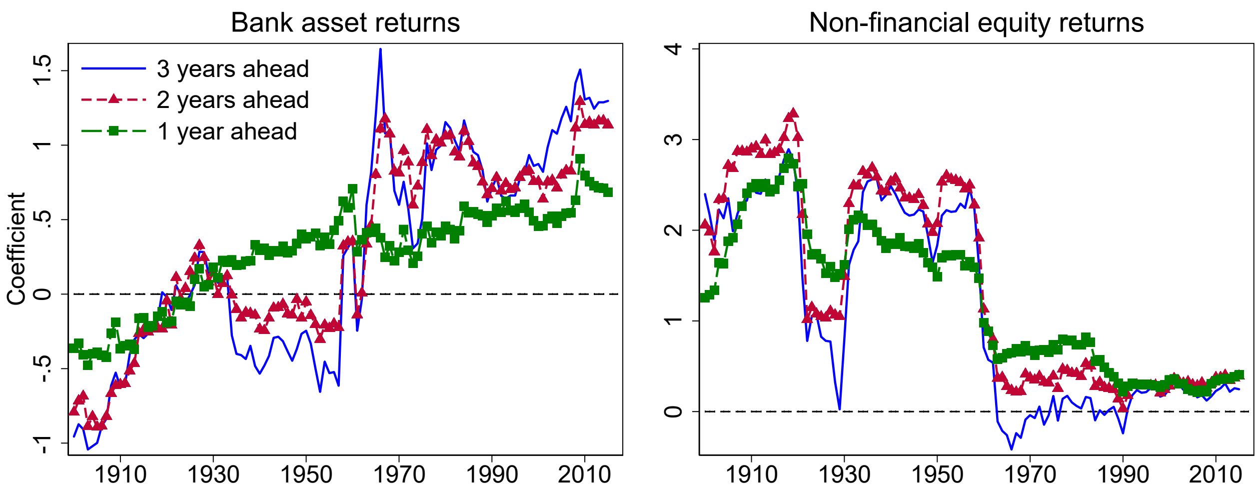
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Dependent variable: ln(Assets/Equity)$_t$							
Macro risk$_{t-10,t-1}$	-0.36***	-0.05**						
	(0.05)	(0.02)						
Asset volatility$_{t-10,t-1}$			-0.33***	-0.15***				
			(0.04)	(0.02)				
Asset beta$_{t-10,t-1}$					-0.28***	-0.13***		
					(0.04)	(0.02)		
RoA$_{t-10,t-1}$							-0.44***	-0.15***
							(0.04)	(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

Notes: This table shows the results of regressing the level of banking system leverage on the level of macroeconomic and asset risk during the previous 10 years. All coefficients are standardised to a one standard deviation increase in the risk level. Leverage is measured as the log ratio of bank assets to equity capital. Macroeconomic risk is the number of recession, high inflation, and deflation episodes in the previous 10 years. Asset risk is measured as monthly asset return volatility, beta of monthly asset returns on non-financial returns, and the level of accounting RoA. Driscoll-Kraay standard errors in parentheses are adjusted for autocorrelation of 10 lags. *, **, and *** indicate significance at the 0.1, 0.05, and 0.01 levels, respectively.

B. Macro risks arising from banking: additional material

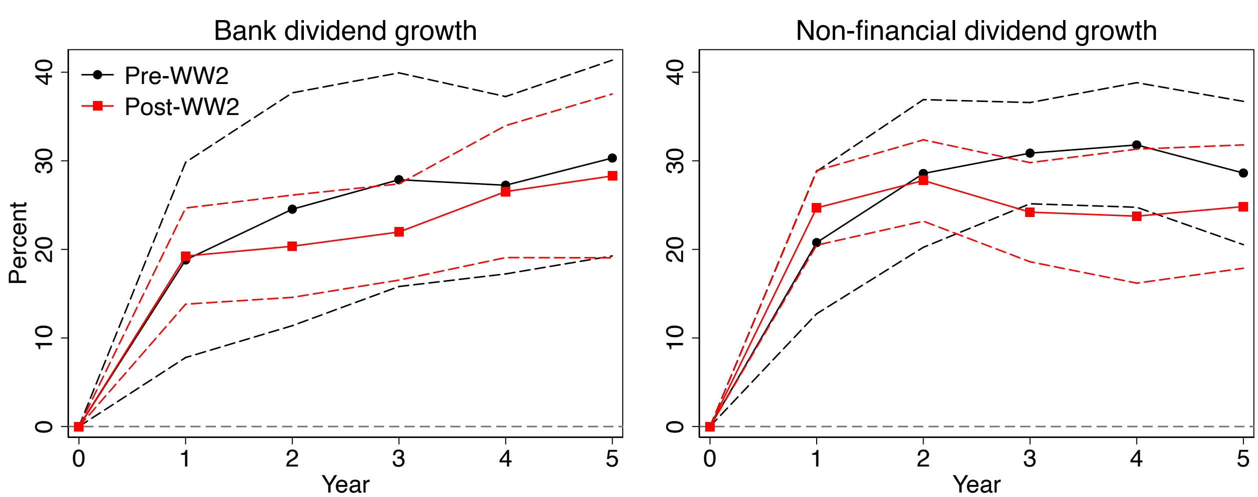
B.1 Bank asset returns and economic activity

Figure A.3: *Bank asset returns and future GDP growth, rolling regression coefficients at different horizons*



Notes: Coefficients from a rolling predictive regression of one-, two- and three-year ahead GDP growth. 30-year backward-looking windows. The regressions include changes in bank asset values (coefficients plotted in the left-hand panel), changes in non-financial equity values (coefficients plotted in the right-hand panel), and country fixed effects. Underlying return data are standardised by country with mean of zero and standard deviation of one.

Figure A.4: *Bank and non-financial dividend predictability*



Notes: This figure plots regression coefficients of real dividend growth from t to $t+h$ on the price-dividend ratio $P_{i,t}/D_{i,t}$. Price-dividend ratios are standardised by country with mean of zero and standard deviation of one. The left-hand panel shows the coefficients for future log real bank dividend growth regressed on today's bank price-dividend ratio, conditional on the non-financial price-dividend ratio. The right-hand panel shows the coefficients for non-financial dividend growth regressed on the non-financial price-dividend ratio, conditional on the bank price-dividend ratio. All data are winsorised at the 1% level. We differentiate between pre- and post-1945 as described in equation (9). All specifications include a post-1945 dummy, country fixed effects, and control for contemporaneous GDP growth, changes in short-term interest rates, and four lags of the interaction and control variables.Dashed lines are 90% confidence intervals around the coefficient estimates based on Driscoll-Kraay standard errors adjusted for autocorrelation of $1.5 \times h$ lags rounded down to the nearest integer.

B.2 Mechanisms

Table A.2: *Bank asset returns and GDP growth: different leverage and risk regimes, alternative definitions*

	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**	0.15	-0.01	-0.22	-0.37
	(0.17)	(0.28)	(0.34)	(0.33)	(0.34)
Δ Bank asset values, high assets / GDP	0.72***	1.05***	1.34***	1.46***	1.30***
	(0.26)	(0.30)	(0.36)	(0.41)	(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***	0.89***	0.78***	0.76**	0.71*
	(0.18)	(0.20)	(0.24)	(0.33)	(0.42)
Δ Bank asset values, high macro risk	0.52**	0.30	0.31	0.14	-0.12
	(0.20)	(0.32)	(0.39)	(0.41)	(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

Notes: This table reports regressions of real GDP growth from t to $t+h$ on $R_{i,t}^{\text{bank assets}}$ in different leverage and volatility regimes. We bin observations based on the mean macroeconomic leverage (total bank assets/GDP at $t-1$) and macroeconomic risk (probability of recession, high inflation or deflation in window $t-10$ to $t-1$), and include interactions of changes in bank asset values and non-financial equity values with high and low leverage and volatility dummies. All specifications include a post-1945 dummy, country fixed effects and control for contemporaneous GDP growth, changes in short-term interest rates and four lags of the interaction and control variables. Return data are standardised by country with mean of zero and standard deviation of one. Driscoll-Kraay standard errors in parentheses are adjusted for autocorrelation of $1.5 \times h$ lags rounded down to the nearest integer. *, **, and *** indicate significance at the 0.1, 0.05, and 0.01 levels, respectively.

Table A.3: *Returns on assets and future GDP growth across leverage and volatility regimes – returns standardised by leverage and volatility regime*

	Year 1	Year 2	Year 3	Year 4	Year 5
Δ Bank asset values, high leverage	0.41***	0.64***	0.66***	0.63**	0.51
	(0.12)	(0.16)	(0.20)	(0.25)	(0.32)
Δ Bank asset values, low leverage	0.17	-0.24	-0.27	-0.38	-0.36
	(0.13)	(0.21)	(0.28)	(0.32)	(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, high volatility	0.18	0.05	-0.13	-0.08	-0.12
	(0.14)	(0.22)	(0.33)	(0.36)	(0.30)
Δ Bank asset values, low volatility	0.37**	0.37*	0.52**	0.53**	0.53*
	(0.16)	(0.19)	(0.23)	(0.26)	(0.31)
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

Notes: This table reports regressions of real GDP growth from t to $t+h$ on changes in the values of bank assets and non-financial equity between years $t-1$ and t. We bin observations based on the mean banking system leverage (high if equity/assets at $t-1$ is below full-sample average) and volatility (high if bank asset return standard deviation between $t-10$ and $t-1$ is above average), and include interactions of changes in the returns with high and low leverage (volatility) dummies. Returns in the top panel are standardised to 1 standard deviation within each leverage bin, and in the low panel – to 1 standard deviation within each volatility bin. All specifications include a post-1945 dummy, country fixed effects and control for contemporaneous GDP growth, changes in short-term interest rates and four lags of the interaction and control variables. Driscoll-Kraay standard errors in parentheses are adjusted for autocorrelation of $1.5 \times h$ lags rounded down to the nearest integer. *, **, and *** indicate significance at the 0.1, 0.05, and 0.01 levels, respectively.

Table A.4: *Returns on different assets and future GDP growth across bank asset volatility regimes*

	Year 1	Year 2	Year 3	Year 4	Year 5
Bank asset returns:					
Δ Bank asset values, low volatility	0.65***	0.82***	0.99**	1.18**	1.15**
	(0.21)	(0.28)	(0.39)	(0.48)	(0.54)
Δ Bank asset values, high volatility	0.20	0.05	-0.29	-0.31	-0.44
	(0.19)	(0.50)	(0.69)	(0.77)	(0.70)
Returns on other asset classes:					
Δ Non-financial equity, low volatility	0.33***	0.18	-0.08	-0.18	-0.23
	(0.10)	(0.21)	(0.31)	(0.39)	(0.45)
Δ Non-financial equity, high volatility	0.39**	0.39	0.28	0.00	0.11
	(0.15)	(0.35)	(0.55)	(0.82)	(0.92)
Δ Corporate bond values, low volatility	0.51***	0.67***	0.59**	0.59	0.65
	(0.13)	(0.16)	(0.27)	(0.38)	(0.45)
Δ Corporate bond values, high volatility	0.20	0.39	0.57*	0.56**	0.48*
	(0.22)	(0.28)	(0.31)	(0.27)	(0.26)
Δ Housing values, low volatility	0.23	0.37	0.06	-0.30	-0.19
	(0.24)	(0.29)	(0.34)	(0.46)	(0.51)
Δ Housing values, high volatility	0.58**	0.05	-0.20	-0.42	-0.37
	(0.27)	(0.35)	(0.31)	(0.32)	(0.52)
Country fixed effects	✓	✓	✓	✓	✓
Control variables	✓	✓	✓	✓	✓
R^2	0.27	0.22	0.18	0.18	0.18
P-value, bank, High=Low	0.09	0.19	0.15	0.15	0.13
Observations	827	827	827	827	827

Notes: This table reports regressions of real GDP growth from t to $t+h$ on changes in the values of bank assets, non-financial equity, corporate bonds, and housing between years $t-1$ and t. The change in corporate bond values is the corporate bond return in excess of the return on government bonds of similar maturity. The change in housing value is the total real housing return. We bin observations based on the mean bank asset return volatility, and include interactions of changes in the four different asset values with high and low volatility dummies. All specifications include a post-WW2 dummy, country fixed effects and control for contemporaneous GDP growth, changes in short-term interest rates and four lags of the interaction and control variables. All return data are standardised by country with mean of zero and standard deviation of one. Driscoll-Kraay standard errors in parentheses are adjusted for autocorrelation of $1.5 \times h$ lags rounded down to the nearest integer. *, **, and *** indicate significance at the 0.1, 0.05, and 0.01 levels, respectively.