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When Banks Grow Too Big for their National Economies: Tail Risks, Risk Channels, and Government Guarantees

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Abstract

Banks are growing ever larger compared to their national economies. We show that increases in relative bank size (measured as a bank's liabilities divided by national GDP) are linked to banks displaying higher tail risk. This effect is not entirely due to risk channels that disproportionately expose relatively large banks to systematic tail risks, sovereign risks, or banking crises. Instead, we detect a persistent component in the tail risk of relatively large banks that is bank-specific and connected to government guarantees. Furthermore, as banks grow in relative size, tail risks are shifted to debtholders without wealth gains for shareholders.

JEL Classification: G21, G33, G01.
Keywords: Banks; Size; Tail Risk; Too-Big-to-Fail; Government Guarantees.

I. Introduction

Over recent decades, banks have grown steadily relative to their national economies. Figure 1 illustrates that, for the average listed bank, the ratio of bank liabilities to national GDP, an indicator of the potential maximum cost for the economy in the case of a bank bailout, increased from 8% to 12% between 1995 and 2012. Among those banks that have grown particularly rapidly are Wells Fargo (from 1% to 8% of U.S. GDP), Standard Chartered (5% to 25% of U.K. GDP), and Malaysia's CIMB Group (from 7% to 32% of Malaysian GDP). The Great Recession that erupted in the second half of 2007 has not halted this trend. As regulators encouraged consolidation among banks to shore up financial stability, the ratio between bank liabilities and national GDP (henceforth referred to as relative bank size) has continued to increase and is now higher than at any point in recent times.

[Figure 1]

The remarkable growth of the financial sector has also been documented elsewhere in the literature using industry output relative to GDP (Philippon (2015), Philippon and Reshef (2013)). However, what explains the recent growth in finance remains subject to debate. Leading explanations for this trend focus on higher demand for financial intermediation. Greenwood and Scharfstein (2013) identify consumer demand for financial services such as mortgages, consumer loans, and wealth management services as driving forces behind the growth in finance. Similarly, Gennaioli, Shleifer, and Vishny (2014) argue that rising wealth levels and increasing demand for services linked to wealth preservation are consistent with the growth in financial intermediation.

We build on the literature that explains the growth in finance and offer empirical support for a complementary view: that some of the growth can be attributed to supply-side factors. We use cross-sectional variation across banks to show that as banks grow in relative size, they exhibit higher tail risk exposure. Consequently, banks engage in riskier business policies and are willing to absorb larger losses as they grow relative to their national economies. We also show that the higher risk exposures of relatively large banks are partly associated with government guarantees that protect these institutions from failure. Therefore, our paper offers an explanation for the growth in the financial sector that is based on taxpayers subsidizing the extreme risk exposures of relatively large banks.

The purpose of our paper is to establish robust empirical facts regarding the relationship between relative size and the tail risk exposures of banks, not to identify unambiguous causality, which our data do not allow. However, our evidence provides insights into an important phenomenon of economic interest, namely the risk profile of banks and the role of government guarantees as banks grow in relative size, which cannot be addressed using previous theory and evidence. Indeed, the findings of some studies suggest that relatively large banks should benefit from a too-big-to-fail status that may distort manager incentives in favor of high risk-taking. For instance, Brown and Dinç (2011) document that the probability that a distressed bank is bailed

out increases the larger a bank is relative to its national economy.[1] Correa, Lee, Sapriza, and Suarez (2014) show similar results based on investor expectations of government support as embedded in credit ratings.

However, other parts of the literature suggest that higher tail risk at relatively large banks may not necessarily be the result of banks capitalizing on government guarantees. A recent literature identifies risk channels for large banks that are mostly outside the immediate control of these institutions. For instance, larger banks have been shown to be more exposed to systemic and undiversifiable risks (Acharya et al. (2017)). Larger banks also hold more domestic government bonds and this makes these institutions particularly exposed to sovereign risks (Acharya and Steffen (2015), Gennaioli, Martin, and Rossi (2016)). More generally, Gennaioli, Shleifer, and Vishny (2012) argue that if investors demand assets that are seemingly safe but neglect certain unlikely risks, this leaves banks that produce these assets vulnerable when these unlikely risks materialize. Similarly, Beltratti and Stulz (2012) argue that the exposure to extreme risks may simply be a matter of bad luck for certain banks. Therefore, the nexus between relative size, tail risk, and government guarantees is ultimately an empirical question and the main issue that we address in this paper.

[1] Anecdotal evidence from bank bailouts during the Great Recession supports the view that relatively large banks are likely to receive government support. Seven out of the ten relatively largest banks in 2007 became subject to a taxpayer-funded bailout during the recent crisis. In order of magnitude, the ten relatively largest banks (in terms of bank liabilities to GDP) in our sample during 2007 are (whether they were bailed out during the crisis is indicated in parentheses): UBS (yes), Ageas (yes), Credit Suisse Group (no), Danske Bank (yes), Dexia (yes), Arab Bank (no), Royal Bank of Scotland Group (yes), Nordea Bank (no), Depfa Bank (yes, via parent company), Bank of Ireland (yes).

Our results are as follows. We show that larger relative size is associated with higher tail risk (primarily measured using Expected Shortfall (ES)). Notably, this effect is observable after controlling for standalone bank size, changes in the sample composition and in the measure of tail risk, and various adjustments to our measure of relative size (e.g., the exclusion of foreign liabilities, inclusion of off-balance sheet items, and adjustments to different accounting standards).

Throughout our paper, we show that relatively larger banks are disproportionately exposed to a systemic risk channel. However, this is not the whole story. We consistently find evidence of a nonsystematic component in the tail risk exposures of banks. Nonsystematic tail risk, which reflects managerial discretion and incentives to speculate on potential too-big-to-fail guarantees, also increases as banks grow in relative size. This suggests that the extreme risk exposures of banks are, at least in part, bank-made and, therefore, a matter of choice for individual banks rather than a byproduct of systemic factors that result when institutions grow in relative size.

We offer a range of robustness tests to buttress our interpretation that larger relative size leads to more extreme risk exposure. To reduce the impact of endogeneity that results when size and risk decisions are jointly determined, we use relative size measures before the crisis to predict tail risk during the crisis, and we also use long lags of our size measures. Our results hold in these setups. Finally, we demonstrate that relative bank size is not associated with nonsystematic tail risk in subsamples where government guarantees are low or nonexistent. We identify subsamples where national governments will arguably struggle to fund credible

guarantees because these countries are highly indebted, have a very large banking sector, or can be described as a weak (failing) state.

The literature proposes a number of alternative explanations for the drivers of extreme loss exposure that do not rely on a bank's too-big-to-fail status distorting incentives for risk-taking. For instance, recent studies have emphasized a potential link between bank risk and sovereign risk (e.g., Acharya, Drechsler, and Schnabl (2014)). Using a similar approach to Acharya and Steffen (2015), we show that, while bank tail risk is indeed amplified by very large sovereign risk exposure, our key finding that relative size is related to higher bank tail risk is robust to controlling for sovereign risk. We then examine if relative size is linked to unforeseen risks that crystalize during banking crises (because they are partly unforeseen and arguably down to bad luck). Our results do not support this view. While the systemic risk channel increases in importance during financial crises, the impact of relative size on the nonsystematic component of tail risk (the component that is in part shaped by managerial behavior) is not confined to periods of banking crises.

In the final part of our paper, we present a rather somber assessment of the return implications that the higher tail risk exposures of relatively large banks have for their debtholders and shareholders. We show that increases in tail risk reduce debtholder returns (measured as the yearly percentage change in the market value of bank debt) and do so especially at relatively larger banks. At the same time, we do not observe evidence of a wealth transfer to the shareholders in relatively large banks. Shareholders do not gain from increasing tail risk exposures and do not benefit when banks become relatively larger.

Our paper is the first to systemically analyze the tail risk exposures of relatively large banks and is distinct from the existing body of literature that has mostly focused on how standalone bank size influences bank risk (e.g., Acharya et al. (2014), Benston, Hunter, and Wall (1995), Boyd and Runkle (1993), Gandhi and Lustig (2015), Penas and Unal (2004)). Tail risk or its potential nexus with moral hazard are also not the focus of existing studies on relative bank size (Bertay, Demirgüç-Kunt, and Huizinga (2013), Demirgüç-Kunt and Huizinga (2013)).[2]

We build on this literature and show that the tail risk exposures of relatively large banks include a meaningful component that is plausibly under manager control, detrimental to debtholder wealth, and consistent with relatively large banks capitalizing on government guarantees. We therefore contribute to the literature that explains the growth in finance based on demand-side factors (Gennaioli et al. (2014), Greenwood and Scharfstein (2013), Philippon (2015), Philippon and Reshef (2013)) by offering a supply-side view that is based on taxpayers subsidizing the extreme risk exposures of relatively large banks.

The rest of the paper is structured as follows. Section II describes the sample, how we measure bank tail risk and the econometric method. Section III offers the baseline results on the

[2] While tail risk and government guarantees are not the focus for Bertay et al. (2013) and Demirgüç-Kunt and Huizinga (2013), the findings of both studies suggest that relative size should lead to more creditor discipline (owing to the public finance risks posed by bailing out relatively large banks). However, the empirical evidence the studies report is inconclusive. For instance, neither of these two sources report evidence of a decline in risk (based on a z-score in Bertay et al. (2013) and based on CDS spreads in Demirgüç-Kunt and Huizinga (2013)) when banks become relatively larger. This is puzzling if increases in relative size were indeed to enhance market discipline by creditors. By contrast, the findings of our study show evidence of more extreme risk exposure as banks grow in relative size and that this behavior is strong when the prospect of government guarantees is high. Therefore, the results we report support the notion of less (rather than more) creditor discipline for relatively large banks.

effect of relative size on tail risk. Section IV provides evidence on the importance for alternative risk channels that may affect relatively large banks. Finally, Section V documents the return implications of relative size for debtholders and shareholders, and Section VI offers conclusions.

II. Data and Methods

A. The Sample

To build an international sample of banks, we extract accounting and income statement data for all commercial banks and bank holding companies listed on Bureau van Dijk/IFCA's Bankscope database between 1995 and 2012. We then match the resulting list of banks with Datastream to obtain market data. We use ISIN identifiers to match the two databases and, where banks have previously been delisted and ISIN identifiers are missing on Bankscope, we hand-match banks across the two data sets. This yields an initial sample of 2,169 banks.

[Table 1]

Illiquid bank stocks that do not accurately reflect information on the expected performance of a bank are unlikely to produce reliable tail risk estimates. We therefore remove 516 banks that are traded in over-the-counter markets (mostly very small U.S. banks) and exclude banks with more than 50% of zero daily stock returns per year or banks that have been listed for less than 100 trading days in a given year. Furthermore, we exclude banks where the government owns in excess of 50% of the shares. We exclude government-owned banks because the risk choices of government-owned banks are less likely to be driven by shareholder value and risk-shifting considerations and therefore differ in important ways. Finally, to limit the overrepresentation of U.S. banks in the sample, we adopt a similar approach to Beck, De Jonghe

and Schepens (2013); namely, we retain all U.S. banks that in any of the sampled years appear among the largest 50 banks (by total assets). We complement this with 100 randomly selected U.S. banks.

As reported in Table 1, the final sample contains 728 unique listed and delisted banks that are chartered in 66 countries. Panel A of Table 1 shows that the relative size of banks varies widely across sample countries with a number of small and developed economies hosting banks that are large compared to the domestic GDP. For instance, the average relative size of the sampled banks in Belgium, Ireland, Singapore, and Switzerland is 115%, 63%, 60%, and 98%, respectively. Conversely, average relative size is low in Japan (2%), China (7%) and the United States (0.4%). In terms of the geographic distribution of the sample, the United States contributes approximately 27% of the observations, while Japan contributes about 14%. To ensure that U.S. banks and Japanese banks do not drive the results, we report in the Internet Appendix (available at www.jfqa.org) regression results after excluding these banks from the sample. Finally, Panel B of Table 1 shows the sample distribution by year and highlights a steady increase in the relative size of banks across the sample period (as also depicted in Figure 1).

B. Measuring Bank Tail Risk

We use Expected Shortfall (ES) as our primary measure of bank tail risk. This metric has two key advantages for our investigation. First, it focuses on the type of extreme risk exposure that can be found in the lower tail of the return distribution. ES, therefore, indicates severe wealth losses for both shareholders and debtholders. While shareholders realize immediate and severe wealth losses in the lower return tail, debtholders are also exposed to downside risk. Debtholders hold fixed claims on a bank's cash flows and the lower end of the daily return

distribution makes it likely that debtholders will lose some of their principal. Second, ES is a market measure and, therefore, forward-looking, untainted by accounting choices (e.g., over the treatment of loan loss reserves) and compressive (e.g., it includes the impact of off-balance sheet items).

More formally, a bank's ES is defined as the average return in the lower tail of the yearly distribution of daily stock returns. Specifically, the ES corresponds to the average return that a bank has realized below the 5th percentile of the yearly distribution of daily stock returns:

$$ES^{\alpha}_{i,t} = -E\left[R_{it} | R_{i,t} < -VaR^{1-\alpha}_{i,t}\right] \qquad (1)$$

where R_{it} is the daily stock return of bank i at day t, and $VaR^{1-\alpha}_{i,t}$ is a bank's Value at Risk defined as (minus) the lowest daily return observed in 100(1-α)% trading days. ES is, therefore, the average loss suffered by a bank in the worst 100(α)% of the trading days in a year. Since returns in the lower tail are negative, ES is conventionally computed by multiplying by minus one the average returns in the tail. Therefore, higher values of ES indicate higher tail risk. Notably, as suggested by Chava, Ganduri, and Yerramilli (2014), ES is a measure of total tail risk that incorporates the influence of extreme market movements on a bank's exposure to extreme losses.

C. Methods and Control Variables

The impact of bank relative size on bank tail risk is primarily modeled by estimating the following fixed effects linear model:

$$ES^{\alpha}_{i,t} = \alpha_i + \delta \frac{Liabilities_{i,t-1}}{GDP_{k,t-1}} + \beta \boldsymbol{BC}_{i,t-1} + \gamma \boldsymbol{CC}_{k,t} + \varepsilon_{it} \qquad (2)$$

where $ES^{\alpha}_{i,t}$ is defined as above, LIABILITIES/GDP is the book value of a bank's liabilities scaled by the GDP of country k in which the bank is chartered, **BC** is a vector of bank-specific characteristics and **CC** is a vector of country-specific control variables. Variable definitions and descriptive statistics are given in Table 2.

[Table 2]

The use of a fixed effects model is motivated by the fact that differences in bank tail risk are partly due to bank characteristics that are not observable and constant across time (e.g., an institution's culture of risk management). The estimation of a separate intercept (α_i) for each bank before fitting the slope coefficients means we control for unobservable time-invariant sources of bank heterogeneity and it allows us to focus on variation in tail risk at the level of individual banks over time. Nevertheless, this approach is not without drawbacks as it substantially removes cross-sectional variation in tail risk and relative size across banks. As an additional approach that focuses on this cross-sectional variation, we therefore also employ a pooled OLS regression model (with country dummies).

In each specification, we lag all bank characteristics (including relative bank size) by one year (to reduce simultaneity and endogeneity biases) and we include year fixed effects to control for differences in tail risk across years. Furthermore, to deal with the bias resulting from within-group correlation in the sample, the standard errors are corrected for heteroscedasticity and are clustered at bank level.

Tail risk is likely to be shaped by factors other than relative bank size and we follow the literature in controlling for these factors by including the following control variables. We control for a bank's standalone size (SIZE) using the logarithmic transformation of total assets (in

thousands of US$). Bertay et al. (2013) show that the risk-return implications of growth in standalone size are different from those produced by increases in relative size.[3]

The asset profile of a bank is captured via the net loans-to-total assets ratio (LOANS) and the funding profile using the ratio of DEPOSITS to total assets. Banks that are more lending oriented and issue more deposits may be less exposed to market-wide volatility and, therefore, less risky. We control for bank leverage using the book liabilities-to-total assets ratio (LEVERAGE). When leverage is high (and the share of loss-absorbing equity low), shareholders might be incentivized to take on risk at the expense of debtholders and regulators. By contrast, more leveraged banks could be subject to more disciplinary pressures by uninsured creditors and bank regulators, and this might reduce the opportunities to engage in business choices that may generate extreme loss exposures.

We control for bank performance using the ratio of net income to total assets (ROA); higher profitability enables banks to retain earnings, build up capital, and reduce risk. We also control for a bank's book-to-market ratio (defined as the book value of equity over the market value of equity) where lower values are deemed to exercise a disciplinary effect on bank risk-taking. The ratio between noninterest and total operating income (NONINTEREST INCOME) accounts for a bank's involvement in business lines that generate commissions, fees, and trading profits. Evidence on the impact of noninterest income on bank risk is inconclusive. De Jonghe, Diepstraten, and Schepens (2015) find noninterest income lowers systemic risk in a cross-

[3] The correlation between relative size and standalone size is 0.51 and, therefore, far from perfect. Furthermore, as shown in the following sections, our key results remain qualitatively similar if we exclude standalone size from the set of bank controls.

country sample. In contrast, Brunnermeier, Dong, and Palia (2012) find that a higher ratio of noninterest to interest income is associated with higher bank systemic risk in the United States. Finally, we control for a bank's exposure to credit risk via the ratio between loan loss provisions and total loans (CREDIT RISK). We expect that more risky lending strategies should lead to a larger tail risk exposure.

The models also control for a country's macroeconomic environment by including DEVELOPMENT (the logarithmic transformation of GDP per capita), REALGDP GROWTH (the logarithmic growth of real GDP), GDP VOLATILITY (the volatility of the logarithmic growth of real GDP over a four-year period), and FISCAL CAPACITY (the difference between tax revenues and public spending provided by the World Bank). This latter variable measures a country's current ability to finance a bank bailout and may thus affect bank risk-taking behavior.

Two additional country controls we include are the ratio between private credit and domestic GDP (PRIVATE CREDIT) and FINANCIAL FREEDOM (an index of an economy's financial freedom compiled by the Heritage Foundation, with higher values denoting more financial freedom).[4] The former control variable is necessary to rule out the possibility that our results reflect differences in the financial structure across countries, while the latter variable controls for the financial environment (especially for the influence of government on bank operations).

[4] The index is in yearly frequency and it describes an economy's financial freedom on the basis of five areas: 1) the extent of government regulation of financial services, 2) the degree of state intervention in banks and other financial firms through direct and indirect ownership, 3) the extent of financial and capital market development, 4) government influence on the allocation of credit, 5) openness to foreign competition. For more details on the computation of the index, see http://www.heritage.org/index/financial-freedom.

Next, we include a binary variable (BASEL II) that indicates whether banks comply with the Basel II capital requirements (as indicated in the banks' annual reports). Since Basel II is designed to make regulatory capital requirements more risk-sensitive, it might reduce tail risk. However, Basel II, to varying degrees, also allows banks to use their own inputs to determine regulatory capital. As a result, banks may underreport risks and opt for more risk-taking under Basel II (Blum (2008), Vallascas and Hagendorff (2013)). Finally, we control for the global turmoil that erupted in the second half of 2007, with a dummy variable (GLOBAL CRISIS) that takes values equal to 1 from 2007 to 2009 and 0 otherwise.

III. Main Results: Tail Risk and Relative Bank Size

A. Baseline Specifications

This section analyzes the impact of relative bank size on tail risk. We start by estimating a baseline model with a limited number of control variables and with bank and year fixed effects. We then add further explanatory variables in an attempt to remove the influence of potentially confounding factors on the relationship between relative size and tail risk. Finally, we report the results obtained from an OLS specification that includes country dummies and allows us to infer additional indications of the cross-sectional relationship between tail risk and relative size.

[Table 3]

The results, shown in the first three columns of Table 3, indicate consistently that as a bank's liabilities grow relative to national GDP, tail risk increases (significant at the 1% level).

This finding holds irrespective of the inclusion of firm fixed effects.[5] Since higher tail risk indicates a bank's willingness to absorb larger losses, we interpret higher tail risk as being consistent with relatively larger banks engaging in riskier business policies. Interestingly, the tail risk effect linked to relative size is observable after controlling for standalone bank size. In fact, standalone size enters with a negative and highly significant coefficient in the OLS specification with country dummies reported in column (3).

The increase in tail risk linked to relative size is also economically significant. For instance, in column (2) we observe that a 1-standard-deviation increase in relative size is associated with a 0.41 percentage point increase in ES for the average bank in our sample. This is a substantial increase given that the average ES in our sample is approximately 4.7%.

In terms of the other control variables, the results are generally in line with our expectations. The tail risk of financial institutions increases as banks become less reliant on deposit funding (and, by implication, more reliant on wholesale funding), less profitable, show a higher book-to-market ratio, and show a higher exposure to credit risk. Interestingly, we also find that the leverage ratio does not significantly influence tail risk, and the share of noninterest income increases tail risk only when the model does not control for bank fixed effects. Furthermore, financial institutions are less exposed to tail risk if chartered in more developed countries, in countries with less credit intermediation (relative to GDP), and in countries with

[5] In unreported tests, we find that this result also holds when the standard errors are clustered at the country and not at the firm level.

more financial freedom and higher economic growth. In contrast, banks are riskier in countries with higher fiscal capacity and during the global financial crisis of 2007–2009.[6]

Additional tests, reported in the Internet Appendix (available at www.jfqa.org), confirm the robustness of our key findings. First, we undertake subsample analyses to deal with a possible overrepresentation of U.S. and Japanese banks in the sample, or to remove a few extremely large banks (we sequentially exclude sample banks with relative size ≥100% and ≥50% of GDP). Second, we employ two alternative measures of tail risk: Value at Risk (VaR) and the maximum drawdown (MDD).[7]

Third, we use alternative measures of relative size. We start by defining relative size as national bank liabilities (total liabilities minus international liabilities) to national GDP because our primary measure of relative size may not accurately capture incentives for banks to shift risk to the domestic safety net if a sizable share of bank liabilities are held outside the domestic economy. We then use the ratio between on- and off-balance-sheet assets scaled by national GDP to control for the possibility that the omission of off-balance-sheet items from bank liabilities leads us to underestimate relative bank size. Finally, we conduct two tests that control for the potential distortions to book liability values introduced by the International Financial

[6] Notably, the magnitude of the positive coefficient on the global crisis variable confirms the economic significance of the crisis in terms of banks' tail risk. The estimates reported in column (5) show that during 2007–2009, the average ES was 1.5 percentage points larger than during the remainder of the sample period.

[7] The first measure, the 5% VaR, is the value of the daily bank return corresponding to the 5th percentile of the yearly distribution. The second, the MDD, is the maximum decline from the historical peak in the daily value of bank equity in a given calendar year. We provide details on the calculations of these measures in the Internet Appendix (available at www.jfqa.org).

Reporting Standards (IFRS).[8] All these additional tests confirm that tail risk is positively related with relative bank size.

Our evidence so far is, however, insufficient to point to distorted incentives related to a too-big-to-fail status of relatively large banks as a driver of our results. As banks become larger relative to their national economies, they may well increase their exposure to systemic and thus undiversifiable risks. To assess whether a systemic risk channel explains our findings, we decompose total tail risk into a systematic (market-wide) and a nonsystematic component. If our results were confined to the systematic component of tail risk (which captures the role of interconnections on tail risk and less the influence of management on tail risk), the systemic risk channel would provide one explanation for our findings.

To decompose bank tail risk, we follow Chava et al. (2014) and employ a systematic tail risk measure based on an approach proposed by Acharya et al. (2016). Under this approach, a bank's exposure to extreme market-wide events is defined by the Marginal Expected Shortfall (MES); namely, the expected amount of losses of a bank when the market is under distress conditions:

$$MES_{i,t}^{\alpha} = -E\left[R_{i,t} \middle| R_{m,t} < -VaR_{m,t}^{1-\alpha}\right] \qquad (3)$$

where $R_{i,t}$ is the daily stock return of bank i at day t, $R_{m,t}$ is the daily stock return of market m at day t and $VaR_{m,t}^{1-\alpha}$ is a market Value at Risk, defined as (minus) the lowest daily

[8] First, we add to the model a dummy variable that is equal to 1 if a bank has adopted IFRS during the sample period. Second, based on Acharya, Engle, and Pierret (2014), we assume that IFRS accounting standards inflate the book value of total liabilities by up to 30% compared to previous accounting standards and discount the value of liabilities by 30% for IFRS adopters. For non-U.S. banks, this is a conservative assumption as IFRS mainly impacts on the value of derivatives that are moved on-balance sheet – this is not a major item for non-U.S. banks.

market return observed in 100(1-α)% of the trading days. We employ Datastream Total Market indices to compute domestic market returns. We then derive the nonsystematic component of a bank's expected shortfall ($ES^{\alpha}_{non\_sys\ i,t}$) as the residual of a linear regression between $ES^{\alpha}_{i,t}$ and $MES^{\alpha}_{i,t}$. More formally, the nonsystematic tail risk is defined as follows:

$$ES^{\alpha}_{non\_sys\ i,t} = ES^{\alpha}_{i,t} - \left(\hat{\alpha} + \hat{\beta} \times MES^{\alpha}_{i,t}\right) \qquad (4)$$

We then regress $MES^{\alpha}_{i,t}$ and $ES^{\alpha}_{non\_sys\ i,t}$ on bank relative size and other controls.

The results of the analysis of the impact of relative size on tail risk components are reported in the last four columns of Table 3. The findings in columns (4) and (5) demonstrate that relative size is significantly associated with the systematic component of tail risk whether or not we control for firm fixed effects. More importantly, the last two columns of Table 3 show that the link between relative size and tail risk is not confined to the systematic tail risk component and accordingly that it is not entirely driven by a systemic risk channel.

This analysis also indicates important differences in the impact that the control variables exert on the two tail risk components. For instance, while an increase in standalone size generates an increase in MES, it reduces the nonsystematic component of tail risk (suggesting diversification benefits associated with increases in standalone size). Differences also emerge when we focus on country controls. We find that a rise in GDP volatility only increases the systematic component of tail risk (confirming that this component is driven by non-firm-specific conditions) while an increase in financial freedom reduces the nonsystematic component of tail risk.

Overall, our findings show that banks engage in business choices that increase their exposure to extreme losses when they are large relative to their national economies. Our results

therefore offer some support for the view that increasing relative size is associated with a too-big-to-fail status. Therefore, our results are in conflict with the too-big-to-save view (and the disciplinary effects of market forces when banks grow in relative size) that has been proposed elsewhere in the literature (Bertay et al. (2013), Demirgüç-Kunt and Huizinga (2013)).

B. Robustness Tests of the Relationship between Relative Size and Bank Tail Risk

While our data do not allow us to identify unambiguous causality regarding the relationship between relative size and tail risk exposures, this section deepens our analysis to rule out alternative explanations for our findings. In particular, we cast some light on whether expectations of government guarantees and other distortive too-big-to-fail effects are behind the tail risk exposures of relatively large banks. After all, it could also be argued that government guarantees, whether implicit or explicit, drive both size and risk-taking.

In our first test, we follow the previous literature and use the global financial crisis of 2007–2009 as a natural experiment (e.g., Fahlenbrach and Stulz (2011), Fahlenbrach, Prilmeier, and Stulz (2012)). More precisely, we investigate whether 2006 levels of relative bank size (and other bank and country characteristics) predict average tail risk and its components between 2007 and 2009. By most accounts, the 2007–2009 crisis constituted an increase in the extreme risk exposures of banks. By focusing only on relative size before the crisis started, we reduce the impact of sources of endogeneity that result when size and risk decisions are jointly determined. The results, reported in Panel A of Table 4, confirm that pre-crisis measures of relative bank size predict total tail risk and nonsystematic tail risk during the global crisis. Relative size before the crisis does not predict systematic tail risk.

[Table 4]

In a second and related test, we follow Faleye, Kovacs, and Venkateswaran (2014) and others and regress tail risk on longer lagged values of relative size. We lag the values of relative bank size (and all other bank characteristics) by three years. By linking relative size to tail risk three years before we observe tail risk, we further reduce the potential impact of endogeneity on the size-risk relationship. Panel B of Table 4 shows that relative size predicts tail risk three years into the future.

In our final set of tests, we identify four subsamples where the credibility of bank guarantees should be weak or where guarantees should be nonexistent. If our interpretation that public guarantees drive our results is correct, the component of tail risk that is under manager control should be significantly less pronounced in the four subsamples. Table 5 shows the results of this analysis.

[Table 5]

In Panel A, we examine banks located in countries with large budget deficits, defined as the highest quintile of the country-year distribution of budget deficits. In Panel B, we examine banks located in countries with large budget deficits and a large banking sector, defined as a ratio between private credit to domestic GDP above the sample median. Since the expected fiscal costs of bank guarantees rise with the size of the domestic banking sector, we conjecture that, for the same fiscal deficit, banks located in countries with a large banking sector are less likely to benefit from rescue guarantees. In Panel C, we examine banks located in countries with large budget deficits and weak or failing states, defined as above-median values of the Fragile States Index. The index ranks countries based on 12 indicators with higher values indicating more

fragility.[9] In Panel D, we employ an alternative indicator of a country's ability to fund government guarantees. We examine banks located in countries where the stock of public debt relative to national GDP is in the highest quintile of the sample distribution.

The results in all four panels show that in countries with a low (or nonexistent) ability to fund government guarantees, relative size is not associated with nonsystematic tail risk, while it continues to be associated with systematic tail risks that are largely outside managerial control. All in all, the findings discussed in this section corroborate our interpretation that as banks grow in relative size, they take on more extreme nonsystematic risk exposures and that this behavior is associated with the too-big-to-fail status of these organizations.

IV. Distorted Incentives, Too-Big-To-Fail and Tail Risk Exposures

The literature proposes a number of other explanations for the drivers of bank tail risk that are not rooted in government guarantees and that could equally explain why relatively larger banks exhibit higher tail risk. In the following subsections, we explore these alternative explanations and demonstrate that none of them entirely explain our results.

[9] The Fragile States Index (formerly known as the Failed States Index) is compiled by Fund for Peace and is based on 12 indicators that span social (e.g., population density relative to food supplies, displacement), economic (poverty, economic decline, etc.), and political factors (lack of basic state functions, rule of law, etc.). Each indicator ranges on a scale of 0 (most stable) to 10 (least stable), creating a scale spanning 0−120. In our sample, the three most fragile countries (in descending order) are Pakistan, Kenya, and Bangladesh. The index is available online from fsi.fundforpeace.org.

A. Can the Tail Risk Effect be Explained by Sovereign Risk Exposures?

A number of recent studies emphasize the link between bank risk and domestic sovereign risk (see, for instance, Acharya et al. (2014)). Furthermore, Acharya and Steffen (2015) and Gennaioli et al. (2016) highlight that large banks hold more sovereign bonds. Therefore, the impact of relative size on tail risk, and in particular on the nonsystematic component of tail risk, could simply reflect a sovereign risk channel when relatively larger banks are exposed to more extreme losses because they hold more sovereign bonds.

[Table 6]

To ascertain the importance of a sovereign risk channel for our results, we conduct several tests. In our first test, we focus on episodes of distress in sovereign debt markets. We do so because the sovereign risks that banks are exposed to (and which may only be salient during normal market conditions) will spike and give rise to extreme risks in periods of sovereign distress. Similar to Gennaioli et al. (2016), we identify sovereign debt crises using a dummy that indicates whether a country is in default based on either Standard & Poor's definition of default[10] or based on government bond spreads (relative to the U.S. or German government bonds) that exceed 1,000 basis points. The latter captures aspects of sovereign risk not captured by Standard & Poor's classification, such as sharp increases in credit spreads and the magnitude of expected creditor losses.

[10] Standard & Poor's define default as the failure of a government to meet a principal or interest payment on the date (or within the specified grace period) specified by the original terms of the issuance. Under this definition, a debt restructuring, implying that the new debt contains less favorable terms to creditors, constitutes a default.

As reported in Panel A of Table 6, when we add the sovereign debt crisis dummy to our specifications, we consistently find evidence that during periods of sovereign distress all types of bank tail risk increase. To avoid multicollinearity between the interaction terms and their constituent variables, we mean-center relative size before adding the interaction term to the model. Importantly, the coefficient on relative size remains positive and highly significant in all specifications. The analysis therefore suggests that the impact of relative size on bank tail risk exists irrespective of the effects of sovereign debt crises on tail risk exposures.[11]

We next compute a different measure of sovereign risk that is based on the tail risk of domestic government bonds. We compute SOVEREIGN TAIL RISK as the expected shortfall of domestic sovereign bonds. Specifically, we compute the average return on the worst 5% of daily sovereign bond returns in a year. As in Gennaioli et al. (2016), we use J.P. Morgan's Global Bond Index (GBI) file to compute sovereign returns at country level for developed countries. For emerging countries, we compute country-level bond returns using J.P. Morgan's Emerging Market Global Bond Index file (EMBI GLOBAL). These indices aggregate the realized returns on sovereign bonds of different maturities and denominations in each country. As shown in Panel B of Table 6, when we control for SOVEREIGN TAIL RISK we continue to observe that an increase in relative size leads to higher tail risk (including nonsystematic tail risk). As expected, sovereign tail risk enters all specifications with a positive and highly significant coefficient, confirming that large sovereign risk exposures are associated with higher tail risk.

[11] We also find that the interaction between the debt crisis dummy and relative size is positive and significant only when the dependent variable is the nonsystematic component of tail risk. This result might also suggest that our measure of the nonsystematic component of tail risk, although by construction unrelated to stock market movement, might still be in part not fully independent from a sovereign risk channel.

Importantly, controlling for sovereign tail risk does not mute our main result that relative size increases tail risk.

In the last two tests on the role of sovereign risk in banks' tail risk, we extend our model to include a proxy for the domestic sovereign bonds held by banks in our sample. As detailed micro data on domestic sovereign bond holding are generally unavailable, we follow Acharya and Steffen (2015) and infer a bank's exposure to domestic sovereign bonds using market data. For each year, we regress daily stock returns on domestic market returns (based on Datastream domestic market indices) and domestic sovereign bond returns (using the bond indices mentioned above). We interpret the coefficient on sovereign bond returns as a proxy for the exposure of individual banks to sovereign bonds. We refer to this coefficient as SOVEREIGN BETA.

Panel C of Table 6 reports the results. Initially, we assume that the relationship between bank tail risk and sovereign exposure is linear. We then relax this assumption and control for nonlinearity by adding the squared value of SOVEREIGN BETA to the models. We control for nonlinearity in our setting to rule out that banks with extremely large sovereign exposures drive the results. For instance, some banks may aggressively load up on sovereign risk to boost their chances of receiving a bailout in times of distress. Alternatively, there is evidence consistent with governments exercising moral suasion on banks to buy sovereign bonds when demand from other investors is low (Gennaioli et al. (2016)). This could then explain why some banks exhibit very sizable government bond holdings during crisis periods when sovereign bonds are most risky. As before, we mean-center SOVEREIGN BETA when we control for nonlinearity.

In all specifications, we continue to observe that an increase in relative size is associated with an increase in tail risk. Consequently, exposure to sovereign government bonds does not seem to explain our key result that tail risk increases with relative bank size. Interestingly, we also find that moderate sovereign bond exposure is associated with lower bank tail risk (for all components of tail risk). This suggests that, on average and over our sample period, sovereign bonds are safer than the other assets held by our sample banks. However, the benefits of holding sovereign bonds become progressively lower with higher sovereign risk exposures. As the negative coefficient on SOVEREIGN BETA^2 indicates, very high exposure to sovereign bonds are linked to higher tail risk.[12]

In sum, the tests discussed above show that high sovereign debt exposure increases bank tail risk. However, a sovereign risk channel does not fully explain our finding of a positive relationship between relative bank size and bank tail risk.

B. Is the Tail Risk Effect of Relative Size due to Exposure to Unforeseen Risks?

Do banks become too complex to manage as they grow in relative size? The results of some studies suggest that the exposure of banks to extreme risks may ultimately be a matter of

[12]Gennaioli et al. (2016) show that the government bond holdings of banks are related to how lending-focused institutions are. Specifically, they show that more lending-oriented banks hold fewer government bonds. Motivated by this, we repeat the analysis of the effects of SOVEREIGN BETA on tail risk after splitting the sample into lending-intensive banks (defined as banks with a value of the loan-to-asset ratio above the sample median) and the remaining banks. In unreported tests, we find that the tail-risk-reducing effect of SOVEREIGN BETA is confined to the subsample of lending-intensive banks. We do not observe lower tail risk in the rest of the sample when exposure to government bonds increases. This suggests that while sovereign bonds carry less tail risk than other assets (when the other assets are predominantly loans), they do not carry less tail risk than the assets of nonlending-focused banks. In this test too, we continue to find that tail risk increases with relative size.

bad luck (Beltratti and Stulz (2012)) or due to bank managers neglecting unlikely risks as proposed by Gennaioli et al. (2012). For instance, managers running relatively large banks may not fully grasp the tail risk effects associated with some of the business choices they make and will then be caught unawares when these effects materialize.

However, our previous results already point to complexity arguments as being unlikely factors behind our findings. A priori standalone size (not relative size) should be the most appropriate indicator of the potential complexity of a bank's business model. Yet, as we demonstrated earlier, standalone size reduces nonsystematic tail risk (consistent with size-related risk-diversification benefits), while nonsystematic tail risk increases in relative size.

Table 7 offers additional evidence in conflict with the notion that our results are down to bad luck or neglected risks. The tests are motivated by Gennaioli et al. (2012), who argue that neglected risks that affect financial institutions surfaced during the global financial crisis. Therefore, if we were to find that relative size affects tail risk only during the global crisis, this would question our interpretation of our results based on risk-taking incentives and moral hazard. To examine the effects of the global crisis on the tail risk exposures of banks, we include an interaction between relative size and the global crisis dummy. This analysis differs from our previous analysis (in Section III.B), which is also based on the global crisis. Our previous analysis tested if pre-crisis levels of relative size predict tail risk exposures during the crisis. We now analyze how the tail risk exposures of banks change during crisis episodes. As previously, we avoid multicollinearity between the interaction terms and their constituent variables by mean-centering relative size before computing the interaction term and adding it to the model.

[Table 7]

The results reported in column (1) of Table 7 demonstrate that the impact of relative size on tail risk is not confined to the global crisis (though it appears significantly larger during the crisis). In column (2), we also include an interaction between local banking crises as defined by Laeven and Valencia (2013) and our measure of relative size. Under this specification, the coefficient on relative size reports the impact of relative size on tail risk in normal banking conditions.

Overall, we find that an increase in relative size amplifies tail risk during as well as outside periods of banking distress. Interestingly, we find that the impact of relative size appears much larger during local banking crises than during the global financial crisis, suggesting that banks become more interlinked with their national economies as they grow in relative size. The effects of country-bank interlinkages are also evident in the different components of tail risk. We find that crises, and especially local banking crises, amplify the impact of relative size on the systematic component of tail risk. By the same token, financial crises do not shape the impact that relative size has on nonsystematic tail risk.

In sum, the results do not support the view that relatively larger banks display higher tail risk because of plausibly unforeseen losses that crystallize during banking crises. Our findings highlight that, while the systemic risk channel increases in importance during financial crises, the impact of relative size on the nonsystematic component of tail risk (which is in part shaped by managerial behavior) is not influenced by distress within the banking industry.[13]

[13] In the interest of brevity, we do not report and discuss the results of the OLS specifications with country dummies that provide qualitatively similar findings.

V. Do Debtholders or Shareholders Benefit from Higher Tail Risk Exposures?

In this section, we examine the wealth implications of the higher tail risk exposures of relatively large banks for debtholders and shareholders. For debtholders, we expect to see lower returns when relatively large banks increase their extreme risk exposure. In line with standard risk-shifting explanations, we posit that as relatively large banks capitalize on guarantees and increase exposure to extreme risks, debtholder returns will decrease. This is because the value of the fixed claims that debt investors hold on a bank's cash flow will fall with higher bank risk.

We find evidence in support of this conjecture in Panel A of Table 8. We estimate the market value of bank debt as the difference between the market value of bank assets (computed, as described in the Internet Appendix A1 (available at www.jfqa.org), similar to Ronn and Verma (1986) and Hovakimian and Kane (2000)) and the market value of equity. For each measure of tail risk, we then estimate two regressions on the yearly percentage change in the market value of debt. The first controls for relative size and tail risk, while the second also includes an interaction between the two variables. We de-mean tail risk and relative size before computing their interactions to reduce concerns over multicollinearity. The coefficient on relative size, therefore, refers to a bank with average tail risk (namely, when the interaction term is equal to 0). Both models include the same bank and country controls we have used in the previous tests.

[Table 8]

Column 1 shows that increases in both relative size and tail risk reduce debtholder returns. Further, the addition of the interaction term in column 2 suggests that the negative impact of total tail risk on debtholder value is amplified in relatively larger banks. We find

similar results for the nonsystematic component of tail risk. When we further scrutinize the nonsystematic component of total tail risk, we find that increases in tail risk only lower debtholder returns for the debtholders of relatively larger banks. This is indicated by the negative and significant coefficient on the interaction term reported in column 6. By extension, these results imply that relative bank size facilitates risk shifting to debtholders and ultimately the taxpayers who, as shown in other parts of the literature (see Brown and Dinç (2011)), are likely to provide a fiscal backstop when relatively larger banks are financially distressed.

Furthermore, the risk-shifting behavior we document raises the possibility that bank managers at relatively larger banks increase tail risk exposures in order to maximize shareholder wealth. In particular, under the Jensen and Meckling (1976) framework, shareholders, owing to their convex claims on firm cash flows, are the primary beneficiaries of risk shifting. Therefore, higher tail risks (and in particular higher nonsystematic tail risk) might simply be the result of pressure from shareholders to engage in riskier lines of business.

Accordingly, we next examine if the propensity of relatively larger banks to opt for higher tail risk can be traced back to shareholders. We argue that if shareholders were the beneficiaries of the higher tail risk exposures and the risk shifting by relatively larger banks, we should observe shareholder wealth gains as tail risk increases. In other words, there should be a wealth transfer from debtholders to shareholders when relatively larger banks opt for more extreme loss exposures.

We use the annual bank equity return (measured as the percentage change in the market value of equity) as our proxy for shareholder wealth gains. As in the case of debtholder wealth, we initially control for relative size and tail risk and then for the interaction between these two

variables. All models include bank and country controls. Panel B of Table 8 shows the results. We do not find evidence of shareholder returns when total tail risk or nonsystematic tail risk increase. Crucially, increases in relative size lead to lower shareholder returns. Therefore, shareholders do not gain from higher tail risk exposures and do not benefit when banks become relatively larger. This does not suggest that shareholders are behind the increasing tail risk when banks grow larger compared to their national economies.

In sum, this subsection presents a somber assessment of the return implications that the higher tail risk exposures of relatively larger banks have for the debtholders and shareholders in these institutions. We show that as banks grow in relative size and take on more tail risk, they reduce bondholder returns. At the same time, this risk-shifting behavior does not appear to benefit shareholders. Further, shareholder returns suffer as banks grow in relative size and shareholders do not realize a return premium when banks exhibit more extreme risk exposure.

VI. Conclusions

In this paper, we exploit significant variation in the size of banks relative to their national economies. We refer to the liabilities-to-GDP ratio as relative size and make a number of observations that cast a worrying light on the effects that increases in relative size have on various bank stakeholders. We show that banks are more exposed to extreme losses as they grow relative to their national economies. This effect is not entirely due to risk channels that make relatively larger banks more prone to systematic tail risk exposures, sovereign risk exposures, or to unforeseen risks during banking crises. We find some evidence that relatively larger banks are exposed to higher systemic tail risks and other risk channels that disproportionately affect relatively large banks. However, this is not the whole picture. We consistently find evidence of a

nonsystematic (and partly bank-made) component in the tail risk of banks, and we show that this component grows with relative bank size.

Furthermore, our findings produce some evidence consistent with the view that distortions related to the too-big-to-fail status of a bank are one explanation for the higher tail risk exposures of relatively large banks. Jointly, our results imply that debtholders (and taxpayers who provide a fiscal backstop) are coerced into funding more of the extreme risk exposures of banks that grow in relative size. Further, the extreme risk profiles of relatively large banks come at a cost to debtholders (and possibly taxpayers) without detectable wealth gains for the shareholders in these institutions.

Our analysis implies that debtholders would benefit if prudential regulatory requirements for relatively large banks were linked to their exposure to tail risks. In any case, if regulators are not able to set ad hoc rules to help contain the additional safety net costs produced by relatively large banks, our results suggest that debtholders (and arguably taxpayers) would benefit from a decline in the number of these institutions.

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Table 1: Sample Distribution by Country and Year

	Banks		Observations		Average
	Number	Percentage	Number	Percentage	Bank Liabilities/GDP (%)
Panel A. Sample Distribution by Country					
Argentina	6	0.82	61	0.72	2.37
Australia	11	1.51	158	1.87	15.49
Austria	4	0.55	34	0.40	40.71
Bangladesh	17	2.34	178	2.11	1.19
Belgium	4	0.55	47	0.56	115.03
Brazil	9	1.24	93	1.10	6.54
Bulgaria	2	0.27	12	0.14	3.54
Canada	8	1.10	142	1.68	16.88
Chile	4	0.55	51	0.60	12.28
China	9	1.24	82	0.97	6.98
Colombia	3	0.41	26	0.31	9.18
Cyprus	2	0.27	33	0.39	72.70
Czech Republic	3	0.41	28	0.33	15.50
Denmark	17	2.34	151	1.79	17.38
Egypt	7	0.96	71	0.84	2.07
Estonia	1	0.14	7	0.08	52.62
Finland	1	0.14	16	0.19	12.82
France	7	0.96	86	1.02	27.08
Germany	10	1.37	110	1.30	17.61
Greece	11	1.51	158	1.87	11.72
Hong Kong	10	1.37	155	1.84	13.97
Hungary	2	0.27	26	0.31	15.09
Iceland	2	0.27	11	0.13	90.09
India	33	4.53	326	3.86	2.09
Indonesia	10	1.37	81	0.96	2.88
Ireland	5	0.69	62	0.73	62.55
Israel	7	0.96	104	1.23	23.39
Italy	21	2.88	255	3.02	6.19
Japan	91	12.50	1,167	13.83	1.86
Jordan	8	1.10	44	0.52	28.35
Kenya	5	0.69	71	0.84	4.63
Korea	14	1.92	157	1.86	7.42
Latvia	1	0.14	4	0.05	3.55
Lithuania	2	0.27	16	0.19	4.83
Luxembourg	2	0.27	14	0.17	147.83
Malaysia	11	1.51	149	1.77	14.93
Malta	1	0.14	10	0.12	78.40
Mexico	3	0.41	34	0.40	2.66
Morocco	4	0.55	36	0.43	16.71
Netherlands	2	0.27	27	0.32	61.37
Norway	2	0.27	17	0.20	40.54
Oman	1	0.14	7	0.08	22.94
Pakistan	15	2.06	144	1.71	1.79
Peru	2	0.27	23	0.27	6.11
Philippines	9	1.24	86	1.02	5.88
Poland	14	1.92	157	1.86	2.76
Portugal	5	0.69	71	0.84	23.35
Qatar	4	0.55	32	0.38	16.23
Romania	3	0.41	30	0.36	3.65
Russia	5	0.69	28	0.33	0.61
Saudi Arabia	8	1.10	90	1.07	4.77
Singapore	3	0.41	51	0.60	59.90
Slovakia	1	0.14	6	0.07	14.60
South Africa	9	1.24	110	1.30	17.79
Spain	10	1.37	147	1.74	15.78
Sri Lanka	7	0.96	76	0.90	3.46
Sweden	3	0.41	50	0.59	68.48
Switzerland	7	0.96	84	1.00	98.35
Taiwan	21	2.88	216	2.56	6.28
Thailand	11	1.51	140	1.66	9.50
Turkey	12	1.65	148	1.75	4.73
Ukraine	2	0.27	13	0.15	3.96
United Kingdom	11	1.51	142	1.68	29.61
USA	190	26.10	2,256	26.74	0.38
Venezuela	1	0.14	13	0.15	3.88
Vietnam	2	0.27	8	0.09	9.35
Total	728	100.00	8,438	100.00	9.96

Table 1 (continued)

	Number	Percentage	Average Bank Liabilities/GDP (%)
Panel B. Sample Distribution by Year			
1995	203	2.41	7.52
1996	224	2.65	8.11
1997	291	3.45	9.67
1998	377	4.47	7.86
1999	447	5.30	7.78
2000	475	5.63	8.41
2001	472	5.59	9.54
2002	532	6.30	8.59
2003	550	6.52	8.71
2004	558	6.61	9.10
2005	586	6.94	9.66
2006	598	7.09	10.61
2007	598	7.09	11.32
2008	557	6.60	11.79
2009	553	6.55	11.20
2010	523	6.20	11.40
2011	456	5.40	12.50
2012	438	5.19	12.18
Total	8,438	100.00	9.96

Table 2: Variable Definitions and Descriptive Statistics

		N	Mean	Median	St.Dev.	1 Pctile	99 Pctile
LIABILITIES/GDP	Book value of bank total liabilities / national GDP (%)	8,438	9.315	1.201	21.372	0.003	138.938
SIZE	Log transformation of bank total assets (thousands of US$)	8,438	16.414	16.422	1.934	12.390	21.173
ES	Average bank returns below the 5th percentile of the yearly distribution of daily returns (%), multiplied by minus one	8,438	4.786	4.219	2.356	1.516	14.395
LOANS	Net loans / total assets (%)	8,436	59.993	61.580	13.331	19.891	85.567
DEPOSITS	Deposits / total assets (%)	8,401	73.975	79.102	19.290	13.640	98.199
LEVERAGE	Total liabilities / total assets (%)	8,438	91.845	92.624	5.651	75.760	97.924
ROA	Net income / total assets (%)	8,438	0.766	0.789	1.053	-4.153	4.104
BOOK-TO-MARKET	Book value of equity / market value of equity	8,438	1.033	0.766	0.862	0.167	5.568
CREDIT RISK	Loan loss provisions / total loans (%)	8,272	0.946	0.524	1.318	-0.372	8.303
NONINTEREST INCOME	Noninterest income / total operating income (%)	8,430	31.666	30.751	15.881	2.878	79.555
DEVELOPMENT	Log transformation of GDP per capita (thousands of US$)	8,438	2.992	3.697	1.283	-0.623	4.367
REALGDP GROWTH	Log growth of real GDP (%)	8,438	3.019	2.962	3.121	-5.686	10.220
GDP VOLATILITY	Volatility of the domestic GDP over a four-year period	8,438	0.019	0.016	0.014	0.003	0.070
FISCAL CAPACITY	Tax revenues minus public spending over country GDP	8,154	-2.768	-2.874	4.176	-10.287	11.174
PRIVATE CREDIT	Bank credit to the private sector over country GDP	8,438	0.796	0.600	0.462	0.154	2.120
FINANCIAL FREEDOM	Index of Financial Freedom from Heritage Foundation	8,438	0.619	0.600	0.195	0.200	0.900
BASEL II	Equal to 1 if a bank complies with Basel II (and 0 otherwise)	8,438	0.239	0.000	0.426	0.000	1.000
GLOBAL CRISIS	Equal to 1 for the period 2007–2009 (and 0 otherwise)	8,438	0.132	0.000	0.338	0.000	1.000

Table 3: Does Bank Tail Risk Increase with Relative Size?

The table shows the regression results of the impact of the ratio **LIABILITIES/GDP** on bank tail risk. The models are estimated using the within estimator or a pooled OLS specification. Standard errors (in round brackets) have been corrected for heteroscedasticity and clustered at the bank level or at the country level. SIZE is the log of total assets measured in thousands of US dollars; LOANS is the ratio between net loans and total assets; DEPOSITS is equal to customer deposits divided by total assets; LEVERAGE is the ratio between total liabilities and total assets; ROA is the ratio between net income and total assets; BOOK-TO-MARKET is the ratio between the book value of equity and the market value of equity; CREDIT RISK is the ratio between loan loss provisions and total loans; NONINTEREST INCOME is the ratio between noninterest income and total operating income; DEVELOPMENT is the log of GDP per capita; REALGDP GROWTH is the yearly growth rate in real GDP; GDP VOLATILITY is the volatility of the domestic GDP in a four-year period; PRIVATE CREDIT is the ratio between credit to the private sector and country GDP; FINANCIAL FREEDOM is the index of financial freedom from the Heritage Foundation; BASEL II is a dummy equal to 1 if a country has adopted Basel II; GLOBAL CRISIS is a dummy equal to 1 from 2007 to 2009; FISCAL CAPACITY is the difference between tax revenues and public spending divided by country GDP. Bank characteristics are winsorized at the 1% level. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	Total Tail Risk (ES)			**Systematic Tail Risk (MES)**		**Nonsystematic Tail Risk (ES_{non_sys})**	
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
LIABILITIES/GDP	0.028***	0.019***	0.015***	0.014***	0.008***	0.010**	0.009***
	(0.006)	(0.006)	(0.003)	(0.004)	(0.002)	(0.004)	(0.002)
SIZE		-0.001	-0.002***	0.003***	0.003***	-0.003***	-0.004***
		(0.001)	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)
LOANS		0.007	0.003	0.003	-0.001	0.005*	0.004*
		(0.004)	(0.003)	(0.004)	(0.002)	(0.003)	(0.002)
DEPOSITS		-0.022***	-0.019***	-0.014***	-0.006***	-0.013***	-0.015***
		(0.004)	(0.003)	(0.003)	(0.002)	(0.003)	(0.002)
LEVERAGE		-0.007	0.009	-0.090***	-0.049***	0.049***	0.039***
		(0.020)	(0.012)	(0.016)	(0.010)	(0.013)	(0.009)
ROA		-0.283***	-0.329***	-0.059	-0.072*	-0.232***	-0.258***
		(0.058)	(0.050)	(0.045)	(0.037)	(0.041)	(0.037)
BOOK-TO-MARKET		0.005***	0.004***	0.001***	0.001**	0.004***	0.004***
		(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)
CREDIT RISK		0.146***	0.203***	0.117***	0.117***	0.055*	0.116***
		(0.038)	(0.034)	(0.030)	(0.026)	(0.029)	(0.027)
NONINTEREST INCOME		-0.002	0.007***	-0.001	0.006***	-0.002	0.002
		(0.003)	(0.002)	(0.003)	(0.002)	(0.003)	(0.002)
DEVELOPMENT	-0.047***	-0.032***	-0.034***	-0.029***	-0.029***	-0.012***	-0.013***
	(0.006)	(0.006)	(0.006)	(0.005)	(0.005)	(0.004)	(0.004)
REALGDP GROWTH	-0.128***	-0.093***	-0.105***	-0.035***	-0.047***	-0.060***	-0.063***
	(0.016)	(0.016)	(0.016)	(0.012)	(0.012)	(0.011)	(0.011)
GDP VOLATILITY	0.120***	0.037	0.048	0.113***	0.124***	-0.035	-0.028
	(0.037)	(0.040)	(0.040)	(0.028)	(0.026)	(0.028)	(0.028)
PRIVATE CREDIT	0.007***	0.007***	0.008***	-0.003**	-0.001	0.009***	0.009***
	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
FINANCIAL FREEDOM	-0.011***	-0.012***	-0.010***	0.001	0.000	-0.011***	-0.008***
	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)
BASEL II	-0.008***	-0.006***	-0.007***	-0.005***	-0.006***	-0.002**	-0.003***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
GLOBAL CRISIS	0.012***	0.015***	0.015***	0.010***	0.010***	0.008***	0.008***
	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)
FISCAL CAPACITY		0.035**	0.041***	0.002	0.007	0.035***	0.036***
		(0.016)	(0.016)	(0.010)	(0.010)	(0.012)	(0.011)
Constant	0.195***	0.168***	0.179***	0.062***	0.050***	0.090***	0.104***
	(0.018)	(0.022)	(0.016)	(0.019)	(0.012)	(0.016)	(0.012)
Observations	7,534	7,140	7,140	7,050	7,050	7,050	7,050
Bank Fixed Effects	Yes	Yes	No	Yes	No	Yes	No
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Fixed Effects	No	No	Yes	No	Yes	No	Yes
Adjusted R-squared	0.453	0.498	0.535	0.458	0.528	0.414	0.506

Table 4: Robustness Tests

The table shows the regression results of the impact of the ratio LIABILITIES/GDP on measures of bank total tail risk, systematic tail risk, and nonsystematic tail risk. Panel A reports a cross-sectional test on the impact of relative bank size and control variables measured at the end of 2006 and measures of tail risks over the period 2007–2009. Panel B lags relative size (and all control variables) by three years. Standard errors (in round brackets) have been corrected for heteroscedasticity and clustered at the bank level. In Panel B, the models are estimated using the within estimator and standard errors (in round brackets) have been corrected for heteroscedasticity and clustered at the bank level. Bank characteristics are winsorized at the 1% level. Bank and country controls include the set of variables shown in column 2 of Table 3. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	Total Tail Risk (ES)	**Systematic Tail Risk (MES)**	**Nonsystematic Tail Risk (ES_{non_sys})**
	(1)	**(2)**	**(3)**
Panel A. Predicting Tail Risk during 2007–2009			
LIABILITIES/GDP	0.005**	-0.000	0.005***
	(0.002)	(0.003)	(0.002)
Observations	520	519	519
Bank Controls	Yes	Yes	Yes
Country Controls	Yes	Yes	Yes
Bank Fixed Effects	No	No	No
Country Fixed Effects	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
Adjusted R-squared	0.550	0.580	0.497
Panel B. Three-year Lag			
LIABILITIES/GDP	0.016**	0.005	0.013**
	(0.008)	(0.004)	(0.006)
Observations	5,843	5,789	5,789
Bank Controls	Yes	Yes	Yes
Country Controls	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
Adjusted R-squared	0.501	0.486	0.354

Table 5: Relative Size and Government Guarantees

The table shows the regression results of the impact of the ratio LIABILITIES/GDP on measures of bank total tail risk, systematic tail risk, and nonsystematic tail risk for four subsamples of countries where the prospect of government guarantees is deemed to be low. These are highest quintile of the country-year distribution of budget deficits (Panel A); the highest quintile of the country-year distribution of budget deficits and a large banking sector, measured as private credit/domestic GDP over the sample median (Panel B); countries with large budget deficits and weak or failing states (defined as above-median values of the Fragile States Index (Panel C)); and banks located in countries where the stock of public debt/GDP is in the top quintile. The models are estimated using the within estimator and standard errors (in round brackets) have been corrected for heteroscedasticity and clustered at the bank level. Bank characteristics are winsorized at the 1% level. Bank and country controls include the set of variables shown in column 2 of Table 3. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	Total Tail Risk (ES)	**Systematic Tail Risk (MES)**	**Nonsystematic Tail Risk (ES_{non_sys})**
	(1)	**(2)**	**(3)**
Panel A. Top Quintile of Budget Deficit/GDP (on average 8.1%)			
LIABILITIES/GDP	0.036	0.033**	0.012
	(0.027)	(0.015)	(0.026)
Observations	1,534	1,532	1,532
Bank Controls	Yes	Yes	Yes
Country Controls	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
Adjusted R-squared	0.594	0.513	0.533
Panel B. Top Quintile of Budget Deficit/GDP and Above-median Private Credit/GDP			
LIABILITIES/GDP	0.030	0.020*	0.020
	(0.037)	(0.012)	(0.030)
Observations	921	919	919
Bank Controls	Yes	Yes	Yes
Country Controls	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
Adjusted R-squared	0.596	0.535	0.589
Panel C. Top Quintile of Budget Deficit/GDP and Above-median Fragile States Index			
LIABILITIES/GDP	0.062***	0.055***	0.015
	(0.019)	(0.015)	(0.012)
Observations	783	781	781
Bank Controls	Yes	Yes	Yes
Country Controls	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
Adjusted R-squared	0.710	0.620	0.578
Panel D: Top Quintile of Public Debt/GDP (on average 161%)			
LIABILITIES/GDP	0.075***	0.068***	0.011
	(0.018)	(0.016)	(0.010)
Observations	1,731	1,652	1,652
Bank Controls	Yes	Yes	Yes
Country Controls	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
Adjusted R-squared	0.528	0.600	0.513

Table 6: Relative Size and Sovereign Risk

The table shows the regression results of the impact of the ratio LIABILITIES/GDP on measures of bank total tail risk, systematic tail risk, and nonsystematic tail risk, and its interplay with measures of sovereign exposure and sovereign bond risk. The models are estimated using the within estimator. Standard errors (in round brackets) have been corrected for heteroscedasticity and clustered at the bank level. DEBT CRISIS is a dummy equal to 1 either if a country has experienced a sovereign default as defined by Standard & Poor's or if the sovereign bond spreads relative to the U.S. or German bonds exceed a given threshold. SOVEREIGN TAIL RISK is the expected shortfall computed for a domestic sovereign bond index as the average of the daily bond returns below the fifth percentile of the annual distribution. SOVEREIGN BETA is a proxy of a bank's domestic sovereign bond holding and is obtained by regressing bank daily stock returns on domestic market returns (based on Datastream domestic market indexes) and domestic sovereign bond returns. The set of bank controls, not reported in the interest of brevity, are as in Table 3. Bank characteristics are winsorized at the 1% level. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	Total Tail Risk (ES)		**Systematic Tail Risk (MES)**		**Nonsystematic Tail Risk (ES_{non_sys})**	
	(1)	**(2)**	**(3)**	(4)	**(5)**	**(6)**
Panel A. Debt Crisis						
LIABILITIES/GDP	0.019***	0.019***	0.014***	0.014***	0.010**	0.010**
	(0.005)	(0.005)	(0.004)	(0.004)	(0.004)	(0.004)
LIABILITIES/GDP*DEBT CRISIS		0.018		-0.009		0.022***
		(0.012)		(0.016)		(0.007)
DEBT CRISIS	0.025***	0.024***	0.008**	0.008**	0.017***	0.015***
	(0.004)	(0.004)	(0.003)	(0.004)	(0.003)	(0.003)
Observations	7,140	7,140	7,050	7,050	7,050	7,050
Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes
Country Controls	Yes	Yes	Yes	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R-squared	0.510	0.510	0.459	0.459	0.422	0.423
Panel B. Sovereign Bond Tail Risk						
LIABILITIES/GDP	0.023***	0.023***	0.016***	0.016***	0.013***	0.013***
	(0.006)	(0.006)	(0.004)	(0.005)	(0.005)	(0.005)
LIABILITIES/GDP* SOVEREIGN TAIL RISK		0.429		0.209		0.265
		(0.393)		(0.287)		(0.294)
SOVEREIGN TAIL RISK	0.253***	0.230***	0.152**	0.141**	0.138***	0.123**
	(0.073)	(0.076)	(0.061)	(0.063)	(0.049)	(0.048)
Observations	6,094	6,094	6,094	6,094	6,094	6,094
Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes
Country Controls	Yes	Yes	Yes	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R-squared	0.532	0.533	0.488	0.485	0.423	0.426
Panel C: Sovereign Bond Exposure						
LIABILITIES/GDP	0.022***	0.021***	0.016***	0.016***	0.013***	0.012**
	(0.007)	(0.007)	(0.005)	(0.005)	(0.005)	(0.005)
SOVEREIGN BETA	-0.001**	-0.001***	-0.001**	-0.001**	-0.001*	-0.001**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
SOVEREIGN $BETA^2$		0.002***		0.001***		0.001***
		(0.000)		(0.000)		(0.000)
Observations	6,009	6,009	6,009	6,009	6,009	6,009
Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes
Country Controls	Yes	Yes	Yes	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R-squared	0.561	0.565	0.521	0.523	0.450	0.453

Table 7: Unforeseen Risks? Tail Risk and Financial Crises

The table shows the regression results of the impact of the ratio LIABILITIES/GDP on measures of bank total tail risk, systematic tail risk, and nonsystematic tail risk. The models are estimated using the within estimator. Standard errors (in round brackets) have been corrected for heteroscedasticity and clustered at the bank level. SIZE is the log of total assets measured in thousands of U.S. dollars; LOANS is the ratio between net loans and total assets; DEPOSITS is equal to customer deposits divided by total assets; LEVERAGE is the ratio between total liabilities and total assets; ROA is the ratio between net income and total assets; BOOK-TO-MARKET is the ratio between the book value of equity and the market value of equity; CREDIT RISK is the ratio between loan loss provisions and total loans; NONINTEREST INCOME is the ratio between noninterest income and total operating income; DEVELOPMENT is the log of GDP per capita; REALGDP GROWTH is the yearly growth rate in real GDP; GDP VOLATILITY is the volatility of the domestic GDP in a four-year period; PRIVATE CREDIT is the ratio between credit to the private sector and country GDP; FINANCIAL FREEDOM is the index of financial freedom from the Heritage Foundation; BASEL II is a dummy equal to 1 if a country has adopted Basel II; GLOBAL CRISIS is a dummy equal to 1 from 2007 to 2009; LOCAL BANKING CRISES is a dummy equal to 1 for domestic banking crises that have occurred before 2007; FISCAL CAPACITY is the difference between tax revenues and public spending divided by country GDP. Bank characteristics are winsorized at the 1% level. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
	Total Tail Risk (ES)		**Systematic Tail Risk (MES)**		**Nonsystematic Tail Risk (ES_{non_sys})**	
LIABILITIES/GDP	0.014***	0.014***	0.010***	0.008**	0.008**	0.009**
	(0.005)	(0.005)	(0.004)	(0.004)	(0.004)	(0.003)
LIABILITIES/GDP*GLOBAL CRISIS	0.011***	0.011***	0.010***	0.011***	0.005	0.005
	(0.004)	(0.004)	(0.002)	(0.002)	(0.003)	(0.003)
LIABILITIES/GDP*LOCAL BANKING CRISES		0.069***		0.109***		-0.013
		(0.019)		(0.023)		(0.015)
LOCAL BANKING CRISES		0.006***		0.005**		0.002
		(0.002)		(0.002)		(0.002)
SIZE	-0.001	-0.001	0.003***	0.003***	-0.003***	-0.003***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
LOANS	0.008*	0.008*	0.004	0.003	0.005*	0.006**
	(0.004)	(0.004)	(0.004)	(0.004)	(0.003)	(0.003)
DEPOSITS	-0.022***	-0.021***	-0.014***	-0.012***	-0.013***	-0.013***
	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)
LEVERAGE	-0.007	-0.004	-0.091***	-0.090***	0.048***	0.050***
	(0.020)	(0.020)	(0.016)	(0.016)	(0.013)	(0.013)
ROA	-0.288***	-0.282***	-0.064	-0.060	-0.235***	-0.233***
	(0.058)	(0.059)	(0.044)	(0.045)	(0.041)	(0.041)
BOOK-TO-MARKET	0.005***	0.005***	0.001***	0.001***	0.004***	0.004***
	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)
CREDIT RISK	0.144***	0.133***	0.116***	0.102***	0.054*	0.054*
	(0.038)	(0.039)	(0.030)	(0.030)	(0.029)	(0.029)
NONINTEREST INCOME	-0.001	-0.001	-0.000	-0.000	-0.001	-0.001
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
DEVELOPMENT	-0.032***	-0.032***	-0.030***	-0.027***	-0.012***	-0.013***
	(0.006)	(0.006)	(0.005)	(0.005)	(0.004)	(0.004)
REALGDP GROWTH	-0.094***	-0.088***	-0.036***	-0.030**	-0.060***	-0.059***
	(0.016)	(0.016)	(0.012)	(0.013)	(0.011)	(0.011)
GDP VOLATILITY	0.038	0.022	0.114***	0.096***	-0.035	-0.036
	(0.040)	(0.041)	(0.028)	(0.028)	(0.028)	(0.028)
PRIVATE CREDIT	0.006***	0.006***	-0.003**	-0.001	0.009***	0.007***
	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)
FINANCIAL FREEDOM	-0.012***	-0.013***	0.001	0.001	-0.010***	-0.011***
	(0.004)	(0.004)	(0.003)	(0.003)	(0.002)	(0.002)
BASEL II	-0.007***	-0.006***	-0.006***	-0.006***	-0.002***	-0.002**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
GLOBAL CRISIS	0.015***	0.015***	0.010***	0.010***	0.008***	0.008***
	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)
FISCAL CAPACITY	0.036**	0.031*	0.003	-0.006	0.036***	0.038***
	(0.016)	(0.017)	(0.010)	(0.010)	(0.012)	(0.012)
Constant	0.170***	0.173***	0.064***	0.058***	0.091***	0.097***
	(0.022)	(0.022)	(0.019)	(0.019)	(0.016)	(0.017)
Observations	7,140	7,140	7,050	7,050	7,050	7,050
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R-squared	0.504	0.506	0.461	0.466	0.414	0.415

Table 8: Debtholder and Shareholder Returns

The table shows the regression results of the impact of the ratio LIABILITIES/GDP on the growth rate of the market value of debt (the market value assets minus the market value of equity) and on the growth rate of the market value of equity. TAIL RISK measures the total, systemic, or nonsystemic tail risk. The models are estimated using the within estimator. Standard errors (in round brackets) have been corrected for heteroscedasticity and clustered at the bank level. Panel A measures % debtholder returns using the market value of bank debt as the difference between the market value of bank assets (computed, as described in the Internet Appendix A1 (available at www.jfqa.org), as in Ronn and Verma (1986) and Hovakimian and Kane (2000)). Panel B measures the % change in the market value of equity as our proxy for shareholder wealth gains. The set of bank controls, not reported in the interest of brevity, are as in Table 3. Bank characteristics are winsorized at the 1% level. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	Total Tail Risk (ES)		**Systematic Tail Risk (MES)**		**Nonsystematic Tail Risk (ES_{non_sys})**	
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Panel A. Debtholder Returns						
LIABILITIES/GDP	-0.068**	-0.036	-0.068**	-0.019	-0.072**	-0.066*
	(0.032)	(0.037)	(0.032)	(0.037)	(0.033)	(0.036)
LIABILITIES/GDP* TAIL RISK		-1.344***		-1.615***		-1.916***
		(0.244)		(0.340)		(0.446)
TAIL RISK	-0.314**	-0.266*	-0.737***	-0.694***	-0.034	-0.030
	(0.143)	(0.142)	(0.164)	(0.164)	(0.208)	(0.208)
Observations	7,139	7,139	7,034	7,034	7,034	7,034
Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes
Country Controls	Yes	Yes	Yes	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R-squared	0.174	0.177	0.178	0.180	0.173	0.176
Panel B. Shareholder Returns						
LIABILITIES/GDP	-0.182*	-0.204**	-0.198**	-0.246***	-0.206**	-0.203**
	(0.096)	(0.091)	(0.096)	(0.095)	(0.096)	(0.091)
LIABILITIES/GDP* TAIL RISK		0.885		1.602		-0.883
		(1.189)		(1.434)		(2.119)
TAIL RISK	-0.354	-0.385	-0.861**	-0.903**	0.330	0.332
	(0.404)	(0.410)	(0.431)	(0.436)	(0.576)	(0.574)
Observations	7,140	7,140	7,035	7,035	7,035	7,035
Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes
Country Controls	Yes	Yes	Yes	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R-squared	0.364	0.364	0.373	0.373	0.373	0.373

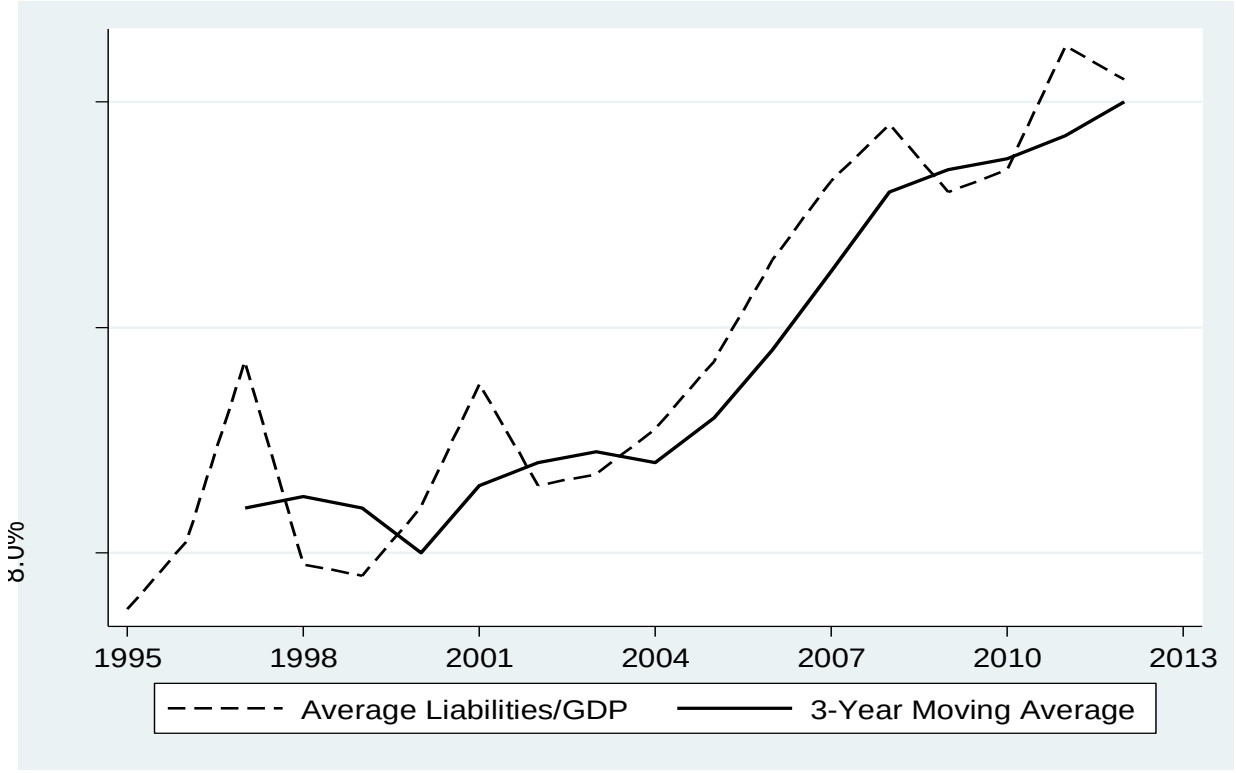

Figure 1: Relative Bank Size

The graph shows the evolution of average relative bank size (measured as bank liabilities divided by national GDP) for an international sample of 728 listed banks.

Internet Appendix

When Banks Grow Too Big for their National Economies: Tail Risks, Risk Channels, and Government Guarantees

This appendix contains information and tabulated results of additional tests on the relationship between bank relative size and tail risk.

A1 Estimation of the Market Value of Bank Assets and Bank Debts
A2 Additional Summary Statistics
A3 Additional Empirical Tests

- Subsample analysis
- Excluding relative size ≥100% (≥50%)
- Alternative measures of tail risk
- Alternative measures of relative size
- Controlling for IFRS distortions

A1: Estimation of the Market Value of Bank Assets and Bank Debts

We infer the market value of bank assets from the Merton (1974) credit risk model. In this model, a firm's equity is seen as a call option on the market value of bank assets. The value of this option corresponds to the value of a European call option with a strike price equal to the face value of the firm's debts and a maturity equal to the maturity of debts. Under this setting, the market value of assets ($V_{A,t}$) and the asset return volatility ($\sigma_{A,t}$) are obtained by simultaneously solving two equations derived from the Black and Scholes (1973) option valuation model: 1) the European call option equation; 2) the optimal hedge equation.

More formally, the market value of a firm's equity ($V_{E,t}$) is expressed as a function of the asset value by solving the following system of nonlinear equations:

$$V_{E,t} = V_{A,t} N(d_{1,t}) - X_t e^{-r_f T} N(d_{2,t}) \quad (1A)$$

$$\sigma_{E,t} = \left(\frac{V_{A,t}}{V_{E,t}} \right) N\left(d_{1,t}\right) \sigma_{A,t} \quad (2A)$$

Equation (1A) defines $V_{E,t}$ as a call option on the market value of a bank's total assets, with $d_{1,t} = \frac{\ln\left(V_{A,t} / L_t\right) + \left(r_{f_t} + 0.5\sigma_{A,t}^2\right)T}{\sigma_{A,t}\sqrt{T}}$ and $d_{2,t} = d_{1,t} - \sigma_{A,t}\sqrt{T}$. Equation (2A) is the optimal hedge equation that relates the standard deviation of a bank's equity value to the standard deviation of a bank's total asset value (both on an annualized basis).

This system of equations is solved employing as starting values for $\sigma_{A,t}$ the historical volatility of equity (computed on a yearly basis using daily data) multiplied by the ratio of the

market value of equity to the sum of the market value of equity and the book value of total liabilities, namely, $\sigma_{A,t} = \sigma_{E,t} V_{E,t} / (V_{E,t} + L_t)$.

As in Vassalou and Xing (2004), a Newton search algorithm then identifies the values for $V_{A,t}$ and $\sigma_{A,t}$. Finally, the market value of bank debt in a given year is computed as the difference between $V_{A,t}$ and $V_{E,t}$.

A2: Additional Summary Statistics

Table A1: Descriptive Statistics for Additional Variables

		N	Mean	Median	St.Dev.
Other Dependent Variables					
DEBT VALUE GROWTH	Log growth in the market value of debt over a one-year period.	7,533	10.849	7.935	14.786
EQUITY VALUE GROWTH	Log growth of the market value of equity.	7,534	7.677	7.560	43.192
Additional Controls					
LOCAL CRISIS	A dummy equal to 1 if a country has suffered from a systemic banking crisis in the period before the global turmoil.	8,438	0.050	0.000	0.218
DEBT CRISIS	A dummy equal to 1 when a country has suffered from a sovereign bond default.	8,438	0.008	0.000	0.091
SOVEREIGN TAIL RISK	The expected shortfall of sovereign bond returns computed yearly as the average of the daily returns below the 5^{th} percentile.	7,038	0.008	0.006	0.008
SOVEREIGN BETA	A proxy of a bank's sovereign bond holding based on yearly regressions of bank daily stock returns on domestic market returns (based on Datastream domestic market indexes) and domestic sovereign bond returns. Similar to Gennaioli et al. (2016) for developed countries, we use J.P. Morgan's Global Bond Index (GBI) file to compute sovereign returns. We compute bond returns for emerging countries from J.P. Morgan's Emerging Market Global Bond Index file (EMBI GLOBAL).	7,038	0.073	0.049	0.592

A3: Additional Empirical Tests

1. Subsample Analyses

We start by excluding U.S. banks from our sample. Despite our attempt to reduce the overrepresentation of U.S. banks, they still represent a large share of the sample. The removal of U.S. banks does not lead to material changes in our findings. Specifically, we still find our result that relative size shapes a bank's tail risk remains unchanged. Furthermore, the exclusion of US banks does not alter our findings as regards the determinants of bank tail risk, except in relation to the coefficient on the Basel II dummy. Across the whole sample, banks that have adopted Basel II appear less risky in the majority of the specifications. However, when excluding U.S. banks, Basel II banks are riskier ceteris paribus. This is in line with Blum (2008) and Vallascas and Hagendorff (2013), who argue that because Basel II offers banks the ability to underreport the true economic risks of their asset portfolios, it makes banks riskier by undermining their ability to withstand adverse shocks. Next, in addition to U.S. banks, we remove Japanese banks as they represent the second largest group of banks in our sample. We then repeat the analysis by removing developing countries from the sample. While these tests reduce the sample size, they all confirm a positive relationship between relative size and tail risk.

Finally, we evaluate whether our results are driven by a few extremely large banks. We sequentially remove sample banks with relative size ≥100% and ≥50% of GDP. In both cases, our finding that an increase in relative size is associated with higher tail risk remains unchanged.

Table A2: Subsample Analyses

The table shows the regression results of the impact of the ratio LIABILITIES/GDP on bank tail risk for subsamples of banks. The models are estimated using the within estimator or a pooled OLS specification. Standard errors (in round brackets) have been corrected for heteroscedasticity and clustered at the bank level or at the country level. SIZE is the log of total assets measured in thousands of US dollars; LOANS is the ratio between net loans and total assets; DEPOSITS is equal to customer deposits divided by total assets; LEVERAGE is the ratio between total liabilities and total assets; ROA is the ratio between net income and total assets; BOOK-TO-MARKET is the ratio between the book value of equity and the market value of equity; CREDIT RISK is the ratio between loan loss provisions and total loans; NONINTEREST INCOME is the ratio between noninterest income and total operating income; DEVELOPMENT is the log of GDP per capita; REALGDP GROWTH is the yearly growth rate in real GDP; GDP VOLATILITY is the volatility of the domestic GDP in a four-year period; PRIVATE CREDIT is the ratio between credit to the private sector and country GDP; FINANCIAL FREEDOM is the index of financial freedom from the Heritage Foundation; BASEL II is a dummy equal to 1 if a country has adopted Basel II; GLOBAL CRISIS is a dummy equal to 1 from 2007 to 2009; FISCAL CAPACITY is the difference between tax revenues and public spending divided by country GDP. Bank characteristics are winsorized at the 1% level. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
	No United States		**No United States and No Japan**		**No Developing Countries**	
LIABILITIES/GDP	**0.025*** **	**0.014*** **	**0.018** **	**0.014*** **	**0.020*** **	**0.015*** **
	(0.007)	**(0.003)**	**(0.008)**	**(0.003)**	**(0.006)**	**(0.003)**
SIZE	-0.000	-0.002***	-0.001	-0.002***	-0.001	-0.002***
	(0.002)	(0.000)	(0.002)	(0.000)	(0.001)	(0.000)
LOANS	0.003	0.000	-0.002	-0.008**	0.010**	0.004
	(0.005)	(0.004)	(0.005)	(0.004)	(0.005)	(0.003)
DEPOSITS	-0.018***	-0.017***	-0.016***	-0.013***	-0.020***	-0.019***
	(0.004)	(0.003)	(0.004)	(0.003)	(0.005)	(0.004)
LEVERAGE	0.013	0.009	0.022	0.014	0.023	0.013
	(0.020)	(0.014)	(0.020)	(0.015)	(0.022)	(0.014)
ROA	-0.127**	-0.216***	-0.086	-0.197***	-0.361***	-0.422***
	(0.059)	(0.050)	(0.059)	(0.051)	(0.088)	(0.080)
BOOK-TO-MARKET	0.003***	0.003***	0.003***	0.002***	0.007***	0.005***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
CREDIT RISK	0.121***	0.157***	0.114***	0.129***	0.195***	0.303***
	(0.037)	(0.033)	(0.038)	(0.034)	(0.065)	(0.065)
NONINTEREST INCOME	-0.006*	0.006**	-0.007*	0.002	0.001	0.009***
	(0.004)	(0.003)	(0.004)	(0.003)	(0.004)	(0.003)
DEVELOPMENT	-0.025***	-0.027***	-0.026***	-0.029***	-0.048***	-0.050***
	(0.007)	(0.007)	(0.008)	(0.007)	(0.010)	(0.009)
REALGDP GROWTH	-0.074***	-0.083***	-0.068***	-0.075***	-0.101***	-0.103***
	(0.016)	(0.016)	(0.016)	(0.017)	(0.024)	(0.025)
GDP VOLATILITY	0.069*	0.071*	0.111***	0.118***	-0.105*	-0.076
	(0.038)	(0.037)	(0.039)	(0.039)	(0.064)	(0.061)
PRIVATE CREDIT	0.010***	0.012***	0.018***	0.019***	0.004***	0.006***
	(0.002)	(0.001)	(0.003)	(0.003)	(0.001)	(0.001)
FINANCIAL FREEDOM	-0.004	-0.005	0.004	0.003	-0.006	-0.007
	(0.004)	(0.004)	(0.005)	(0.005)	(0.004)	(0.005)
BASEL II	0.005***	0.004***	0.005***	0.004***	-0.010***	-0.010***
	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)
GLOBAL CRISIS	0.010***	0.009***	0.012***	0.011***	0.020***	0.021***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)
FISCAL CAPACITY	0.056***	0.062***	0.050***	0.057***	0.051***	0.054***
	(0.017)	(0.017)	(0.018)	(0.018)	(0.019)	(0.019)
Constant	0.107***	0.149***	0.120***	0.157***	0.246***	0.285***
	(0.026)	(0.018)	(0.028)	(0.020)	(0.037)	(0.038)
Observations	5,863	5,863	3,790	3,790	2,073	2,073
Adjusted R-squared	0.456	0.513	0.464	0.529	0.588	0.590
Bank Fixed Effects	Yes	No	Yes	No	Yes	No
Country Fixed Effect	No	Yes	No	Yes	No	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes

Table A3: Excluding Relative Size ≥100% (≥50%)

The table shows the regression results of the impact of the ratio LIABILITIES/GDP on bank tail risk for subsamples of banks. The models are estimated using the within estimator or a pooled OLS specification. Standard errors (in round brackets) have been corrected for heteroscedasticity and clustered at the bank level or at the country level. SIZE is the log of total assets measured in thousands of U.S. dollars; LOANS is the ratio between net loans and total assets; DEPOSITS is equal to customer deposits divided by total assets; LEVERAGE is the ratio between total liabilities and total assets; ROA is the ratio between net income and total assets; BOOK-TO-MARKET is the ratio between the book value of equity and the market value of equity; CREDIT RISK is the ratio between loan loss provisions and total loans; NONINTEREST INCOME is the ratio between noninterest income and total operating income; DEVELOPMENT is the log of GDP per capita; REALGDP GROWTH is the yearly growth rate in real GDP; GDP VOLATILITY is the volatility of the domestic GDP in a four-year period; PRIVATE CREDIT is the ratio between credit to the private sector and country GDP; FINANCIAL FREEDOM is the index of financial freedom from the Heritage Foundation; BASEL II is a dummy equal to 1 if a country has adopted Basel II; GLOBAL CRISIS is a dummy equal to 1 from 2007 to 2009; FISCAL CAPACITY is the difference between tax revenues and public spending divided by country GDP. Bank characteristics are winsorized at the 1% level. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)	(4)
	No Banks with LIABILITIES/GDP>=100%		**No Banks with LIABILITIES/GDP>=50%**	
LIABILITIES/GDP	**0.025*** **	**0.020*** **	**0.029** **	**0.023*** **
	(0.008)	**(0.004)**	**(0.013)**	**(0.006)**
SIZE	-0.001	-0.002***	-0.001	-0.003***
	(0.001)	(0.000)	(0.001)	(0.000)
LOANS	0.007	0.005	0.003	0.000
	(0.004)	(0.003)	(0.005)	(0.003)
DEPOSITS	-0.021***	-0.020***	-0.018***	-0.017***
	(0.004)	(0.003)	(0.004)	(0.003)
LEVERAGE	-0.010	0.008	0.008	0.015
	(0.020)	(0.012)	(0.021)	(0.013)
ROA	-0.289***	-0.332***	-0.254***	-0.304***
	(0.058)	(0.049)	(0.057)	(0.050)
BOOK-TO-MARKET	0.005***	0.004***	0.005***	0.004***
	(0.001)	(0.001)	(0.001)	(0.001)
CREDIT RISK	0.146***	0.204***	0.116***	0.175***
	(0.038)	(0.034)	(0.039)	(0.035)
NONINTEREST INCOME	-0.001	0.007***	0.001	0.006**
	(0.004)	(0.003)	(0.004)	(0.003)
DEVELOPMENT	-0.034***	-0.034***	-0.036***	-0.036***
	(0.006)	(0.006)	(0.006)	(0.006)
REALGDP GROWTH	-0.090***	-0.102***	-0.085***	-0.094***
	(0.016)	(0.016)	(0.018)	(0.018)
GDP VOLATILITY	0.036	0.048	0.121***	0.137***
	(0.040)	(0.039)	(0.043)	(0.042)
PRIVATE CREDIT	0.007***	0.008***	0.013***	0.013***
	(0.002)	(0.001)	(0.003)	(0.002)
FINANCIAL FREEDOM	-0.012***	-0.010***	-0.003	-0.001
	(0.004)	(0.004)	(0.004)	(0.004)
BASEL II	-0.007***	-0.008***	-0.010***	-0.011***
	(0.001)	(0.001)	(0.002)	(0.002)
GLOBAL CRISIS	0.015***	0.015***	0.018***	0.017***
	(0.002)	(0.002)	(0.002)	(0.002)
FISCAL CAPACITY	0.044***	0.050***	0.051***	0.057***
	(0.014)	(0.013)	(0.014)	(0.013)
CONSTANT	0.171***	0.182***	0.180***	0.183***
	(0.022)	(0.016)	(0.023)	(0.017)
Observations	7,008	7,008	5,713	5,713
Adjusted R-squared	0.497	0.534	0.513	0.552
Bank Fixed Effects	Yes	Yes	Yes	Yes
Country Fixed Effects	No	Yes	No	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes

2. Alternative Measures of Tail Risk

We use two alternative measures of tail risk. The first is the 5% Value at Risk (VaR). VaR is the value of the daily bank return corresponding to the 5th percentile of the yearly distribution. More formally, given a probability level α, VaR is the maximum loss that a bank can suffer on 100(1- α)% of trading days:

$$VaR_{i,t}^{1-\alpha}(R_{i,t}) = -\sup\{z | Pr[R_{i,t}] < \alpha\} \quad (3A)$$

where $VaR_{i,t}^{1-\alpha}(R_{i,t})$ is the return of firm i at time t, and z identifies the percentile of the yearly distribution of daily returns that is equal to the chosen α parameter. As in Van Bekkum (2016), we calculate tail risk ex post. As a result, it is straightforward to obtain 100(1- α)% daily VaR by selecting the lowest 100α% of daily observations for each bank and year. Under the assumption that the underlying data-generating process is accurately described by realized returns, VaR is equal to the higher value of the lowest 100α% daily observations. Realized VaR is a measure of a bank's willingness to absorb extreme losses, and higher VaR values are, therefore, consistent with banks engaging in riskier business policies.[1]

The second measure is the maximum drawdown (MDD). MDD measures the maximum decline from the historical peak in the daily value of bank equity in a given calendar year. More formally, if X is the value of bank equity, MDD can be expressed as follows:

$$MDD_{i,t} = \max_{\tau \epsilon (0,T)} \left[\left(\max_{t \epsilon (0,\tau)} X(t) - X(\tau) \right) / \max_{t \epsilon (0,\tau)} X(t) \right] \quad (4A)$$

[1] It is worth noting that recent studies demonstrate that this straightforward nonparametric approach to computing VaR leads to results that are very similar to those based on more sophisticated methodologies (Bali, Dermitas, and Levy, 2009).

Essentially, MDD captures the maximum loss that an equity investor can suffer from a given maximum in the valuation of bank equity and it thus signals an extreme deterioration due to cumulative losses in the value of bank shares.

When using the above two alternative measures of tail risk, we still observe that an increase in relative size is associated with an increase in the exposure of banks to extreme losses.

Table A4: Alternative Measures of Tail Risk: Value at Risk (VaR)

The table shows the regression results of the impact of the ratio LIABILITIES/GDP on bank tail risk measured as Value at Risk (VaR). The models are estimated using the within estimator or a pooled OLS specification. Standard errors (in round brackets) have been corrected for heteroscedasticity and clustered at the bank level or at the country level. SIZE is the log of total assets measured in thousands of U.S. dollars; LOANS is the ratio between net loans and total assets; DEPOSITS is equal to customer deposits divided by total assets; LEVERAGE is the ratio between total liabilities and total assets; ROA is the ratio between net income and total assets; BOOK-TO-MARKET is the ratio between the book value of equity and the market value of equity; CREDIT RISK is the ratio between loan loss provisions and total loans; NONINTEREST INCOME is the ratio between noninterest income and total operating income; DEVELOPMENT is the log of GDP per capita; REALGDP GROWTH is the yearly growth rate in real GDP; GDP VOLATILITY is the volatility of the domestic GDP in a four-year period; PRIVATE CREDIT is the ratio between credit to the private sector and country GDP; FINANCIAL FREEDOM is the index of financial freedom from the Heritage Foundation; BASEL II is a dummy equal to 1 if a country has adopted Basel II; GLOBAL CRISIS is a dummy equal to 1 from 2007 to 2009; FISCAL CAPACITY is the difference between tax revenues and public spending divided by country GDP. Bank characteristics are winsorized at the 1% level. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
LIABILITIES/GDP	**0.019*** **	**0.013*** **	**0.013*** **	**0.013*** **	**0.013** **	**0.011*** **
	(0.004)	**(0.003)**	**(0.003)**	**(0.004)**	**(0.005)**	**(0.002)**
SIZE			-0.000	-0.000	-0.000	-0.001***
			(0.001)	(0.001)	(0.001)	(0.000)
LOANS		0.005*	0.006**	0.006*	0.006	0.003
		(0.003)	(0.003)	(0.003)	(0.004)	(0.002)
DEPOSITS		-0.014***	-0.014***	-0.014***	-0.014***	-0.013***
		(0.002)	(0.002)	(0.003)	(0.003)	(0.002)
LEVERAGE		-0.017	-0.010	-0.014	-0.014	-0.002
		(0.013)	(0.014)	(0.014)	(0.019)	(0.009)
ROA		-0.252***	-0.182***	-0.198***	-0.198***	-0.235***
		(0.031)	(0.038)	(0.039)	(0.065)	(0.035)
BOOK-TO-MARKET		0.003***	0.003***	0.003***	0.003***	0.003***
		(0.000)	(0.000)	(0.000)	(0.001)	(0.000)
CREDIT RISK			0.079***	0.087***	0.087**	0.126***
			(0.025)	(0.027)	(0.035)	(0.024)
NONINTEREST INCOME			-0.000	-0.000	-0.000	0.006***
			(0.002)	(0.002)	(0.003)	(0.002)
DEVELOPMENT	-0.032***	-0.022***	-0.020***	-0.022***	-0.022***	-0.022***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.008)	(0.004)
REALGDP GROWTH	-0.081***	-0.052***	-0.049***	-0.055***	-0.055***	-0.063***
	(0.011)	(0.010)	(0.010)	(0.010)	(0.020)	(0.010)
GDP VOLATILITY	0.087***	0.047*	0.038	0.035	0.035	0.050*
	(0.026)	(0.026)	(0.027)	(0.028)	(0.060)	(0.027)
PRIVATE CREDIT	0.005***	0.004***	0.004***	0.005***	0.005**	0.006***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
FINANCIAL FREEDOM	-0.007***	-0.007***	-0.007***	-0.008***	-0.008	-0.007***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.006)	(0.002)
BASEL II	-0.005***	-0.004***	-0.003***	-0.004***	-0.004	-0.005***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.004)	(0.001)
GLOBAL CRISIS	0.009***	0.011***	0.012***	0.012***	0.012***	0.011***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.004)	(0.001)
FISCAL CAPACITY				0.025**	0.025	0.029***
				(0.012)	(0.026)	(0.011)
Constant	0.132***	0.105***	0.102***	0.107***	0.107***	0.113***
	(0.013)	(0.013)	(0.016)	(0.016)	(0.033)	(0.011)
Observations	7,534	7,502	7,373	7,140	7,140	7,140
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	No
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Country Fixed Effects	No	No	No	No	No	Yes
Clustered SE	Bank	Bank	Bank	Bank	Country	Bank
Adjusted R-squared	0.462	0.504	0.507	0.509	0.509	0.539

Table A5: Alternative Measures of Tail Risk: Maximum Drawdown

The table shows the regression results of the impact of the ratio LIABILITIES/GDP on bank tail risk measured as maximum drawdown. The models are estimated using the within estimator or a pooled OLS specification. Standard errors (in round brackets) have been corrected for heteroscedasticity and clustered at the bank level or at the country level. SIZE is the log of total assets measured in thousands of U.S. dollars; LOANS is the ratio between net loans and total assets; DEPOSITS is equal to customer deposits divided by total assets; LEVERAGE is the ratio between total liabilities and total assets; ROA is the ratio between net income and total assets; BOOK-TO-MARKET is the ratio between the book value of equity and the market value of equity; CREDIT RISK is the ratio between loan loss provisions and total loans; NONINTEREST INCOME is the ratio between noninterest income and total operating income; DEVELOPMENT is the log of GDP per capita; REALGDP GROWTH is the yearly growth rate in real GDP; GDP VOLATILITY is the volatility of the domestic GDP in a four-year period; PRIVATE CREDIT is the ratio between credit to the private sector and country GDP; FINANCIAL FREEDOM is the index of financial freedom from the Heritage Foundation; BASEL II is a dummy equal to 1 if a country has adopted Basel II; GLOBAL CRISIS is a dummy equal to 1 from 2007 to 2009; FISCAL CAPACITY is the difference between tax revenues and public spending divided by country GDP. Bank characteristics are winsorized at the 1% level. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
LIABILITIES/GDP	**0.147*** **	**0.119*** **	**0.092** **	**0.093** **	**0.093***	**0.068*** **
	(0.041)	**(0.037)**	**(0.038)**	**(0.039)**	**(0.054)**	**(0.020)**
SIZE			0.022***	0.022***	0.022**	-0.007***
			(0.008)	(0.008)	(0.010)	(0.002)
LOANS		0.113***	0.126***	0.122***	0.122**	0.070***
		(0.032)	(0.032)	(0.032)	(0.047)	(0.021)
DEPOSITS		-0.245***	-0.227***	-0.220***	-0.220***	-0.171***
		(0.028)	(0.029)	(0.029)	(0.034)	(0.021)
LEVERAGE		-0.570***	-0.475***	-0.484***	-0.484***	-0.082
		(0.147)	(0.146)	(0.150)	(0.180)	(0.089)
ROA		-2.832***	-1.840***	-1.952***	-1.952***	-2.454***
		(0.321)	(0.415)	(0.436)	(0.602)	(0.361)
BOOK-TO-MARKET		-0.007	-0.005	-0.005	-0.005	0.007*
		(0.005)	(0.005)	(0.005)	(0.009)	(0.004)
CREDIT RISK			1.096***	1.161***	1.161***	1.417***
			(0.272)	(0.283)	(0.400)	(0.246)
NONINTEREST INCOME			0.024	0.026	0.026	0.080***
			(0.027)	(0.029)	(0.033)	(0.018)
DEVELOPMENT	-0.352***	-0.328***	-0.348***	-0.352***	-0.352***	-0.258***
	(0.042)	(0.039)	(0.041)	(0.046)	(0.081)	(0.036)
REALGDP GROWTH	-0.446***	-0.282**	-0.247**	-0.271**	-0.271	-0.363***
	(0.110)	(0.109)	(0.109)	(0.110)	(0.217)	(0.104)
GDP VOLATILITY	0.605**	0.436	0.329	0.387	0.387	0.439
	(0.286)	(0.283)	(0.287)	(0.303)	(0.532)	(0.272)
PRIVATE CREDIT	0.064***	0.045***	0.039***	0.044***	0.044	0.062***
	(0.014)	(0.013)	(0.013)	(0.013)	(0.038)	(0.011)
FINANCIAL FREEDOM	-0.006	-0.046*	-0.052**	-0.064**	-0.064	-0.036
	(0.029)	(0.027)	(0.026)	(0.027)	(0.054)	(0.026)
BASEL II	-0.003	0.008	0.015*	0.012	0.012	0.004
	(0.009)	(0.008)	(0.008)	(0.009)	(0.029)	(0.009)
GLOBAL CRISIS	0.072***	0.081***	0.091***	0.095***	0.095***	0.093***
	(0.011)	(0.011)	(0.011)	(0.011)	(0.034)	(0.011)
FISCAL CAPACITY				0.186	0.186	0.264**
				(0.127)	(0.273)	(0.115)
Constant	1.289***	1.342***	1.007***	1.035***	1.035***	1.080***
	(0.130)	(0.126)	(0.154)	(0.157)	(0.260)	(0.093)
Observations	7,534	7,502	7,373	7,140	7,140	7,140
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	No
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Country Fixed Effects	No	No	No	No	No	Yes
Clustered SE	Bank	Bank	Bank	Bank	Country	Bank
Adjusted R-squared	0.422	0.445	0.447	0.448	0.448	0.473

3. Alternative Measures of Relative Size

Our measure of relative size may not accurately capture incentives for banks to shift risk if a sizable share of bank liabilities are held outside the domestic economy. We, therefore, conduct additional tests where we define relative size as national liabilities (total liabilities minus international liabilities) to national GDP. We estimate the volume of international liabilities on the basis of the ratio between international assets and total assets provided by Worldscope. Specifically, we assume that the share of international liabilities over total liabilities is equal to the share of international assets in total assets. While, due to missing values, we are only able to construct this alternative relative size measure for a much smaller sample of banks, we still observe higher tail risks for relatively larger banks in all specifications.

Finally, another possible concern related to the ratio between total liabilities and GDP is the omission of off-balance-sheet items from bank liabilities which may well lead us to underestimate relative bank size. As an alternative measure, we employ the ratio between on- and off-balance-sheet assets scaled by national GDP. Again we find that an increase in relative size produces an increase in tail risk.

Table A6: Alternative Measures of Relative Size

The table shows the regression results of the impact of the alternative measures of relative size on bank tail risk. DOMESTIC LIABILITIES are bank liabilities net of international liabilities, estimated via the value of international assets. ON AND OFF BALANCE SHEET ASSETS is the sum of the book value of bank assets and the value of off-balance-sheet items. The models are estimated using the within estimator or a pooled OLS specification. Standard errors (in round brackets) have been corrected for heteroscedasticity and clustered at the bank level or at the country level. SIZE is the log of total assets measured in thousands of U.S. dollars; LOANS is the ratio between net loans and total assets; DEPOSITS is equal to customer deposits divided by total assets; LEVERAGE is the ratio between total liabilities and total assets; ROA is the ratio between net income and total assets; BOOK-TO-MARKET is the ratio between the book value of equity and the market value of equity; CREDIT RISK is the ratio between loan loss provisions and total loans; NONINTEREST INCOME is the ratio between noninterest income and total operating income; DEVELOPMENT is the log of GDP per capita; REALGDP GROWTH is the yearly growth rate in real GDP; GDP VOLATILITY is the volatility of the domestic GDP in a four-year period; PRIVATE CREDIT is the ratio between credit to the private sector and country GDP; FINANCIAL FREEDOM is the index of financial freedom from the Heritage Foundation; BASEL II is a dummy equal to 1 if a country has adopted Basel II; GLOBAL CRISIS is a dummy equal to 1 from 2007 to 2009; FISCAL CAPACITY is the difference between tax revenues and public spending divided by country GDP. Bank characteristics are winsorized at the 1% level. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)	(4)
DOMESTIC LIABILITIES/GDP	**0.021***	**0.025*****		
	(0.011)	**(0.006)**		
ON AND OFF BALANCE SHEET ASSETS/GDP			**0.008****	**0.010*****
			(0.004)	**(0.002)**
SIZE	-0.001	-0.002***	0.001	-0.002***
	(0.001)	(0.000)	(0.001)	(0.000)
LOANS	0.008	0.006	0.008	0.003
	(0.005)	(0.004)	(0.005)	(0.003)
DEPOSITS	-0.025***	-0.018***	-0.024***	-0.022***
	(0.006)	(0.004)	(0.004)	(0.003)
LEVERAGE	0.026	0.025	-0.009	0.004
	(0.025)	(0.017)	(0.023)	(0.014)
ROA	-0.450***	-0.413***	-0.238***	-0.318***
	(0.093)	(0.075)	(0.061)	(0.055)
BOOK-TO-MARKET	0.005***	0.005***	0.005***	0.004***
	(0.001)	(0.001)	(0.001)	(0.001)
CREDIT RISK	0.150**	0.250***	0.160***	0.208***
	(0.069)	(0.056)	(0.041)	(0.037)
NONINTEREST INCOME	-0.002	0.007**	-0.002	0.006**
	(0.004)	(0.003)	(0.004)	(0.003)
DEVELOPMENT	-0.028***	-0.032***	-0.031***	-0.031***
	(0.008)	(0.008)	(0.006)	(0.006)
REALGDP GROWTH	-0.121***	-0.143***	-0.091***	-0.109***
	(0.023)	(0.024)	(0.018)	(0.018)
GDP VOLATILITY	-0.056	-0.035	0.034	0.038
	(0.055)	(0.055)	(0.043)	(0.043)
PRIVATE CREDIT	0.004**	0.004**	0.007***	0.008***
	(0.002)	(0.002)	(0.002)	(0.001)
FINANCIAL FREEDOM	-0.015***	-0.013**	-0.014***	-0.009**
	(0.005)	(0.005)	(0.004)	(0.004)
BASEL II	-0.008***	-0.009***	-0.003**	-0.006***
	(0.002)	(0.002)	(0.002)	(0.002)
GLOBAL CRISIS	0.016***	0.016***	0.015***	0.014***
	(0.002)	(0.002)	(0.002)	(0.002)
FISCAL CAPACITY	-0.001	0.006	0.030*	0.031*
	(0.029)	(0.027)	(0.017)	(0.016)
Constant	0.188***	0.218***	0.133***	0.174***
	(0.028)	(0.034)	(0.024)	(0.018)
Observations	4,801	4,801	6,043	6,043
Adjusted R-squared	0.579	0.588	0.479	0.530
Bank Fixed Effects	Yes	Yes	Yes	Yes
Country Fixed Effects	No	Yes	No	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes

4. Potential Distortions due to International Financial Reporting Standards (IFRS)

Some banks have adopted IFRS during the sample period. IFRS adoption may have distorted the evolution of the value of relative size over time. We conduct two tests to show that the potential distortion does not affect our results. First, we add to the model a dummy variable that is equal to 1 if a bank has adopted IFRS during the sample period. Second, based on Acharya, Engle, and Pierret (2014), we assume that IFRS inflate the book value of total liabilities by up to 30% compared to previous accounting standards and discount the value of liabilities by 30% for IFRS adopters. For non-U.S. banks, this is a conservative assumption as IFRS mainly has an impact on the value of derivatives that are moved on-balance sheet; this is not a major item for non-U.S. banks. These two additional tests confirm that an increase in relative size is linked to higher tail risks.

Table A7: Controlling for IFRS Distortions

The table shows the regression results of the impact of the ratio LIABILITIES/GDP on bank tail risk controlling for IFRS distortions. The models are estimated using the within estimator or a pooled OLS specification. Standard errors (in round brackets) have been corrected for heteroscedasticity and clustered at the bank level or at the country level. SIZE is the log of total assets measured in thousands of U.S. dollars; LOANS is the ratio between net loans and total assets; DEPOSITS is equal to customer deposits divided by total assets; LEVERAGE is the ratio between total liabilities and total assets; ROA is the ratio between net income and total assets; BOOK-TO-MARKET is the ratio between the book value of equity and the market value of equity; CREDIT RISK is the ratio between loan loss provisions and total loans; NONINTEREST INCOME is the ratio between noninterest income and total operating income; DEVELOPMENT is the log of GDP per capita; REALGDP GROWTH is the yearly growth rate in real GDP; GDP VOLATILITY is the volatility of the domestic GDP in a four-year period; PRIVATE CREDIT is the ratio between credit to the private sector and country GDP; FINANCIAL FREEDOM is the index of financial freedom from the Heritage Foundation; BASEL II is a dummy equal to 1 if a country has adopted Basel II; GLOBAL CRISIS is a dummy equal to 1 from 2007 to 2009; FISCAL CAPACITY is the difference between tax revenues and public spending divided by country GDP. Bank characteristics are winsorized at the 1% level. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)	(4)
	IFRS Dummy		30% Adjustments for IFRS Banks	
LIABILITIES/GDP	**0.019*** **	**0.015*** **	**0.015** **	**0.016*** **
	(0.006)	**(0.003)**	**(0.007)**	**(0.004)**
SIZE	-0.001	-0.002***	-0.000	-0.002***
	(0.001)	(0.000)	(0.001)	(0.000)
LOANS	0.007*	0.003	0.006	0.003
	(0.004)	(0.003)	(0.004)	(0.003)
DEPOSITS	-0.022***	-0.019***	-0.023***	-0.020***
	(0.004)	(0.003)	(0.004)	(0.003)
LEVERAGE	-0.007	0.010	-0.006	0.010
	(0.020)	(0.012)	(0.020)	(0.012)
ROA	-0.282***	-0.329***	-0.281***	-0.329***
	(0.058)	(0.050)	(0.058)	(0.050)
BOOK-TO-MARKET	0.005***	0.004***	0.005***	0.004***
	(0.001)	(0.001)	(0.001)	(0.001)
CREDIT RISK	-0.002	0.007***	0.147***	0.203***
	(0.003)	(0.002)	(0.038)	(0.034)
NONINTEREST INCOME	0.146***	0.203***	-0.002	0.007***
	(0.038)	(0.034)	(0.003)	(0.002)
DEVELOPMENT	-0.032***	-0.034***	-0.032***	-0.034***
	(0.006)	(0.006)	(0.006)	(0.006)
REALGDP GROWTH	-0.093***	-0.104***	-0.091***	-0.104***
	(0.016)	(0.016)	(0.016)	(0.016)
GDP VOLATILITY	0.037	0.049	0.037	0.049
	(0.040)	(0.040)	(0.040)	(0.040)
PRIVATE CREDIT	0.007***	0.008***	0.008***	0.009***
	(0.002)	(0.001)	(0.002)	(0.001)
FINANCIAL FREEDOM	-0.012***	-0.010***	-0.013***	-0.010***
	(0.004)	(0.004)	(0.004)	(0.004)
BASEL II	-0.006***	-0.007***	-0.006***	-0.007***
	(0.001)	(0.001)	(0.001)	(0.001)
GLOBAL CRISIS	0.015***	0.015***	0.016***	0.015***
	(0.001)	(0.002)	(0.001)	(0.002)
FISCAL CAPACITY	0.035**	0.041***	0.035**	0.041**
	(0.016)	(0.016)	(0.016)	(0.016)
IFRS DUMMY	0.000	-0.000		
	(0.001)	(0.001)		
Constant	0.019***	0.015***	0.167***	0.179***
	(0.006)	(0.003)	(0.022)	(0.016)
Observations	7,140	7,140	7,140	7,140
Adjusted R-squared	0.503	0.535	0.501	0.534
Bank Fixed Effects	Yes	Yes	Yes	Yes
Country Fixed Effects	No	Yes	No	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes