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Bank Capital and Systemic Stability

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Abstract

This paper distinguishes among various types of capital and examines their effect on system-wide fragility. The analysis finds that higher quality forms of capital reduce the systemic risk contribution of banks, whereas lower quality forms can have a destabilizing impact, particularly during crisis periods. The impact of capital on systemic risk is less pronounced for smaller banks, for banks located in countries with more generous safety nets, and in countries with institutions that allow for better public and private monitoring of financial institutions. The results show that regulatory capital is effective in reducing systemic risk and that regulatory risk weights are correlated with higher future asset volatility, but this relationship is significantly weaker for larger banks. The paper also finds that increased regulatory risk-weights not correlated with future asset volatility increase systemic fragility. Overall, the results are consistent with the theoretical literature that emphasizes capital as a potential buffer in absorbing liquidity, information, and economic shocks reducing contagious defaults.

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Bank Capital and Systemic Stability

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1. Introduction

One of the important lessons of the 2008 financial crisis was that financial institutions need to be subjected to more effective capital requirements. But while regulatory consensus has been to focus on capital regulation, there has been less agreement among economic theorists on the role of capital. There is continued debate around precisely what kinds of capital requirements are needed and how to structure them. Another important development after the crisis has been a greater emphasis on systemic stability and macroprudential regulation, which requires a focus not on the risk of individual financial institutions, but on an individual bank's contribution to the risk of the financial system as a whole.

In this paper we address both policy issues by studying the empirical relationship between bank capital and systemic risk. Specifically, we distinguish between various definitions of capital and investigate their impact on measures of system-wide fragility, using a bank-level database of over 1,200 publicly traded banks in over 45 countries over the 1998 to 2012 time period. Following Anginer, Demirguc-Kunt and Zhu (2013), we use alternative measures of the correlation in the risk taking behavior of banks to capture each individual institution's contribution to the risk of the financial system as a whole. Following Demirguc-Kunt, Detragiache and Merrouche (2013), we distinguish amongst various types of capital and examine their effects on these measures of systemic fragility.

We find that greater capital reduces system-wide fragility, consistent with the theoretical literature that emphasizes capital as a potential buffer in absorbing liquidity, information and economic shocks. The empirical results suggest that Tier 1 capital, which is of higher quality, has the greatest impact on reducing systemic fragility, while Tier 2 capital – which is less able to absorb losses despite counting as part of capital – has the opposite, destabilizing effect. We find that these results are more pronounced during the crisis years and for larger banks. The link between capital and systemic risk is weaker in countries with more generous safety nets, stronger public monitoring and private information suggesting these can substitute for capital in reducing systemic fragility. We also find that higher regulatory risk-weights are associated with higher future asset volatility, indicating that risk exposure calculations under Basel rules reflect the riskiness of assets at least to some extent, although this relationship is muted for larger banks, which may be able to manipulate these weights. Finally, we find that certain elements of regulatory reforms after the 2008 crisis targeting systemic risk – such as a stronger focus on systemic supervision, conducting system-wide stress tests, and use of countercyclical regulation - have indeed led to a stronger link between capital and systemic risk.

Our paper contributes to a large and growing literature on bank capital and risk. Notwithstanding the policy consensus, economic theories are split on the impact of capital on bank risk. An important purpose of stricter capital regulations is to ensure that banks can sustain significant unexpected losses in the values of the assets they hold while still honoring deposit withdrawals and other obligations. Consistent with this argument numerous theories emphasize the role of capital as a buffer to absorb earning shocks (e.g., Repullo, 2004; Von Thadden, 2004). Hence higher capitalization reduces bank risk and increases its survival probability. Another reason why capital requirements are thought to be stabilizing is because they also make bank owners have more "skin in the game," improving their risk management, and curbing excessive risk-taking incentives due to limited liability and bailout expectations. Consistent with this argument, a number of theories emphasize how higher capitalization improves the borrower screening and risk monitoring functions of banks, thereby reducing bank riskiness (Coval and Thakor, 2005; Holmstrom and Tirole, 1997; Allen, Carletti and Marquez, 2011; Mehran and Thakor, 2011). Another set of theories emphasize the moral hazard angle, and focus on how greater capitalization would lead to the choice of less risky portfolios since risk-shifting incentives would be limited (Keeley, 1989; Keeley and Furlong, 1990; Calomiris and Kahn, 1991; Rochet, 1992; Freixas and Rochet, 2008; Acharya, Mehran, and Thakor, 2011).

However there are also other theories which argue that higher capital regulations may actually reduce bank stability. For example, Koehnan and Santomero (1980) argue higher capital may lead to higher portfolio risk, leading to greater fragility. Besanko and Kanatas (1996) argue reduced moral hazard benefits of higher capital may be offset by the cost of lower effort exerted by insiders whose ownership is diluted at higher levels of capital. Calem and Rob (1999) suggest a U-shaped relationship between bank capital and risk. Initially at low levels of capital, banks choose very risky portfolios to maximize the option value of deposit insurance. But as capitalization increases and future insolvency becomes unlikely, risk-taking incentives are curbed. Finally, at very high levels of capitalization, insolvency becomes so remote that additional capital leads to increased risk-taking because banks want to benefit from the upside.

Given the conflicting predictions of theoretical models and policy interest in this issue, there is also a growing empirical literature on the impact of bank capital on risk, again with mixed findings. Estrella, Park, and Peristiani (2000) examine the efficacy of different capital ratios in predicting U.S. bank failures in the early 1990s. They find that simple leverage measures outperform risk-adjusted measures of capital. Using a sample of European banks, Angora et al. (2009) find a positive association between bank risk and bank capital held in excess of capital regulations. Bichsel and Blum (2004) investigate the relationship between the changes in risk and changes in leverage for a panel of Swiss banks and again see a positive correlation between levels of capital and bank risk-taking. For US banks, Berger and Bouwman (2013) examine the impact of capital on individual bank fragility and market shares and find that while capital improves survival probability, higher capital helps medium and large banks primarily during crisis periods. Using an international sample of banks, Demirguc-Kunt, Detragiache and Merrouche (2013) investigate whether bank stock returns react differently to different types of capital ratios, and find that a stronger capital position was associated with stronger performance during the latest crisis, particularly for large banks, and that this relationship was stronger when capital is measured by leverage ratio rather than risk-based ratios, and when higher quality forms of capital are considered. Beltratti and Stulz (2010) also find that large banks with more capital had higher stock returns during the crisis, but these factors did not have a robust impact on bank risk, as measured by the bank's idiosyncratic volatility and distance-to default. Other papers investigate the usefulness of risk weighted assets concluding that either they do not predict market measures of risk (Das and Sy 2012), or predict bank failure only when the risk of a crisis is very low (Mariathasan and Merrouche, 2012). Acharya, Engle and Pierret (2014) examining the stress tests conducted by U.S. and European regulators find that when capital shortfalls are measured relative to risk-weighted assets, the ranking of financial institutions is very different from stress tests conducted using publicly available information. But, when capital shortfalls are measured relative to total assets, they find similar results.

We make a number of contributions to this literature. First, unlike the previous papers that examine the impact of capital on risk, stock market valuation or failure probabilities of individual banks, our paper focuses on systemic risk. Hence, we do not examine solely individual bank risk, but also the co-dependence of those risks, therefore addressing the macro-prudential regulation issues. This is consistent with the growing consensus to adjust capital requirements to better reflect an individual bank's contribution to the risk of the financial system as a whole, as opposed to absolute level of risk of any individual institution (Brunnermeier, Crockett, Goodhart, Persaud, and Shin 2009, Financial Stability Forum 2009a, 2009b). Second, we are able to examine the relationship between systemic risk and bank capital at the bank level, for different measures of regulatory capital while controlling for a variety of bank characteristics that may affect systemic risk. Third, the cross-country and panel nature of our data set allows us to investigate the impact of institutional and regulatory environment on the capital-systemic risk link, as well as the impact of latest regulatory changes on this relationship. Finally, we examine the extent to which regulatory risk weights reflect future asset volatility, and whether manipulation of risk weights contributes to systemic fragility.

The rest of the paper is organized as follows. Section 2 describes the data and the empirical methodology. Section 3 presents the empirical results and discusses the implications. Section 4 concludes.

2. Data and Empirical Methodology

2.1. Sample

We obtain bank level financial information from Bankscope. We use stock market information from Compustat Global for international banks and stock market information from CRSP for U.S. banks. The Bankscope database reports detailed balance sheet and income statement information for both public and private banks and covers over 90% of the total banking assets in a given country. The Compustat Global database provides daily stock price information for both active and delisted companies accounting for 98% of the global stock market capitalization. CRSP is the standard source for stock price information of U.S. companies

2.2. Measures of Systemic Fragility

As our focus is on systemic stability, instead of looking at the absolute level of risk in individual banks, we examine the *contribution* of each bank to the risk of the banking system as a whole. We measure systemic risk as a bank's contribution to the banking system within a given country.

Since bank regulation and supervision are conducted at the country level, from a policy perspective, systemic risk measured at the country level (as opposed to at the global level) is more relevant. In addition, Acharya (2011) suggests that banks will have incentives to take on correlated risks if there is an implicit guarantee provided by the state to cover losses stemming from a systemic crisis. Bertay, Demirguc-Kunt, and Huizinga (2012) also suggest that financial safety nets reduce bank internationalization because international banks are unlikely to be bailed out by local governments of the overseas countries where they operate.

In the aftermath of the financial crisis of 2007/08, there has been renewed interest quantifying systemic risk inherent in the global banking sector (Acharya et al 2010, Adrian and Brunnermeier 2012, Brownlees and Engle 2012, Huang, Zhou, and Zhu 2009). Instead of relying on a single measure of systemic risk contribution, we use three measures commonly used in the literature.

The first measure is the conditional value-at-risk (*Covar*) measure of Adrian and Brunnermeier (2011). It is the value-at-risk (*Var*) of the financial system conditional on institutions being under distress. A financial institution's contribution to systemic risk is the difference between *Covar* conditional on the institution being under distress and the *Covar* in the normal state of the institution. Following Adrian and Brunnermeier (2011), we compute a time-series of *Covar* measures for each bank using quantile regressions and a set of macro state variables. In particular, we run the following quantile regressions:

$$R_{i,t} = \propto_i + \gamma_i M_{t-1} + \varepsilon_{i,t}$$

$$R_{m,t} = \propto_{system|i} + \beta_{system|i} R_{i,t} + \gamma_{system|i} M_{t-1} + \varepsilon_{system|i,t} \quad (1)$$

Above, $R_{i,t}$ is the equity return for bank *i* in week *t*. $R_{m,t}$ is the weekly value-weighted return of all financial institutions in a given country. M_{t-1} are lagged state variables, and include change in the 3 month t-bill rate (*rate*), the change in the term spread (*term*), weekly country stock index return, volatility of the daily country stock index returns over the past 4 weeks. We use weekly stock returns from Compustat Global for international financial firms and weekly stock market information from CRSP for U.S. financial firms. For the aggregate market index, we use the country stock index in which the financial firm is incorporated.

Covar variable is computed as the change in the *Var* of the system when the institution is at the q^{th} percentile (or when the institution is in distress) minus the *Var* of the system when the institution is at the 50% percentile:

$$\Delta CovarSystem_t^q = \hat{\beta}_{system|i}^q \left(\widehat{R_{i,t}^q} - \widehat{R_{i,t}^{50\%}}\right) \quad (2)$$

We compute the ΔCovar measure at q=5% for each financial institution in our sample on a rolling three year time periods, in order to accommodate the time varying business conditions (Moore and Zhou 2011). Finally, we invert the *Covar* variable, so that higher values indicate greater systemic risk.

The second measure of systemic risk contribution is the Marginal Expected Shortfall (*MES*) measure described in Acharya et al (2010). The systemic expected shortfall of an institution describes the capital shortage a financial firm would experience in case of a systemic event. It is based on the notion that a shortage of capital is dangerous for the individual firm, but becomes dangerous for the whole economy if it occurs just when the rest of the banking sector is also undercapitalized. Marginal Expected Shortfall (*MES*) of a firm is the expected loss an equity investor in a financial firm would experience if the market declined substantially. *MES* measures the average firm return on days when the market as a whole is in the tail of its loss distribution:

$$MES_t^i = E\left(R_{i,t} \mid R_{m,t} < C\right) \quad (3)$$

Above, $R_{i,t}$ is the financial firm i's equity return and $R_{m,t}$ is the aggregate market index return. A systemic event is defined as a drop of the market index below a threshold, *C*, over a given time horizon. The systemic event is thus denoted by $R_t^m < C$. Acharya, Engle and Richardson (2012) show that *MES* can be used to set capital limits based on systemic risk contributions. Since the book value of debt will be relatively unchanged while equity values fall by *MES*, a regulator can require a bank to hold equity to satisfy a prudential capital ratio of *k*% to make sure that the systemic risk posed by the bank is zero: $Equity_{i,t} \geq \frac{k \times Debt_{i,t}}{(1-k) \times \left(1+MES_{i,t}\right)}$. We compute *MES* using a threshold that corresponds to the index at its lowest 5% level over the previous one year of return data.[2] For this computation we use daily stock returns from Compustat for international financial firms and daily stock market information from CRSP for U.S. financial firms. For the aggregate market index, we use the country stock index in which the financial firm is incorporated. We obtain the daily country stock indices data from Compustat Global.

The third measure, R-squared, is based on a commonly used measure in the study of convergence of asset prices (Bekaert and Wang 2009, Longin and Solnik 1995, Bekaert and Harvey 2000, and Bekaert, Hodrick and Zhang 2012). R-squared (*Rsq*) measures the total variation of returns of a given bank explained by returns of all other banks in a given country. Anginer, Demirguc-Kunt and Zhu (2014) use this measure in studying the relationship between competition and systemic risk in the banking sector. R-squared is obtained from regressing returns of an individual bank on average returns of all other banks in a given country. For each bank *i*, in country *j*, in year *t*, we run a time series regression of bank *i*'s weekly returns on the average return of other banks excluding bank *i* itself:

$$R_{i,j,t,w} = \alpha_{i,j,t} + \beta_{i,j,t} \frac{1}{n} \sum_{k=1,k\neq i}^{n} R_{k,j,t,w} + \varepsilon_{i,j,t,w} \tag{4}$$

We follow Morck, Yeung, and Yu (2000) and Karolyi, Lee, and Van Dijk (2011) and use the logistic transformation of R-squared from the above regression, which is equal to $log(rsq_{i,j,t}) / (1-rsq_{i,j,t}))$, to measure systemic risk posed by bank *i*. R-squared is only computed for banks with at least twenty-six weeks of non-zero volume returns data in a year. In terms of measuring co-dependence, using R-squared has advantages over alternative measures as described in Pukthuanthong and Roll (2009) and Bekaert and Wang (2009). Higher R-squared for a given bank suggests that a bank may be exposed to similar sources of risk as other banks in a given country, and also suggests that there may be channels of inter-dependency between the bank and others in a given country. Both interconnectedness and common exposure to risk makes the banking sector more vulnerable to economic, liquidity and information shocks.

2.3. Capital and Control variables

[2] We find similar results using changes in Merton (1970) distance-to-default measure instead of stock market returns in the calculation of MES.

Following Demirguc-Kunt, Detragiache and Merrouche (2013) we use a number of alternative definitions of capital. First set of capital ratios uses risk-adjusted assets computed according to Basel rules. We examine three ratios: Tier 1, Tier 2, and Tier 1 plus Tier 2 capital divided by risk-adjusted assets and off-balance sheet exposures (*tier 1 capital / rwa*, *tier 2 / rwa* and *total capital / rwa*). Tier 1 capital is computed as the sum of shareholder funds and perpetual, non-cumulative preference shares. Tier 2 capital is computed as the sum of hybrid capital, subordinated debt, loan loss reserves, and valuation reserves. The second set of ratios uses non-risk weighted assets. As before, we compute ratios with respect to Tier 1, Tier 2, and Tier 1 plus Tier 2 capital (*tier 1 capital / ta*, *tier 2 / ta* and *total capital / ta* respectively). Finally we examine common equity ratio (*common / ta*) computed as common equity divided by total assets, and tangible common equity ratio (*tangible / ta*), computed as tangible equity divided by tangible assets. Capital ratios are obtained from Bankscope.

In examining the relationship between capital and systemic stability, we control for a number of bank level variables. As with capital ratios, bank level controls come from Bankscope. For each bank, each year, we calculate relative bank size (*size*), which is the natural logarithm of total assets of a given bank divided by average total assets of other banks in a given country; bank liquidity (*liquid assets / ta*) which is liquid assets divided by total assets; reliance on deposits for funding (*deposits / ta*), which is deposits divided by total assets; asset quality (*loan loss provisions / ta*) which is loan loss provisions divided by total assets; business model (*net loans / ta*) which is net loans divided by assets. When we examine manipulation of risk weights, we control for earnings (*earnings / total loans*) which is net income divided by total gross loans. We winsorize all financial ratios at the 1^{st} and 99^{th} levels of their distributions to correct for potential data entry errors and reduce the influence of outliers.

As mentioned in the introduction we are interested in the impact of the larger regulatory and institutional framework on the capital and systemic stability relationship. In particular, capital may act as a substitute in reducing systemic risk for poor institutional environments that do not allow for efficient public and private monitoring of banks. We consider three groups of institutional variables. The first set of variables measure the strength of public and private monitoring in each country. The *supervisory power* is an index measuring supervisory authorities' power and authority to take specific preventive and corrective actions. The measure ranges from zero to fourteen, with fourteen indicating the highest power of the supervisory authorities. The *deposit insurance* variable indicates whether a country has explicit deposit insurance (Yes=1/No=0) and whether depositors were fully compensated the last time a bank failed (Yes=1/No=0). The variable ranges from 0 to 2. For both variables, data is obtained from the World Bank regulation and supervision surveys described in Barth, Caprio, and Levine (2008).

The second set of institutional variables capture information asymmetry in the lending market. Based on the notion that efficient private monitoring depends on information availability and sharing (Djankov, McLiesh, and Shleifer 2007), we use the depth of credit information sharing (*credit info depth*) from the World Bank Doing Business Survey as a measure of private monitoring.[3] This variable ranges from zero to six, with higher values indicating deeper credit information. From the same data source, we also create two dummy variables indicating whether a public credit registry (public registry) or a private credit bureau (private bureau) operates in a given country.

Finally, the third set of variables measure information transparency in the banking sector. The *rated* variable measures the fraction of ten biggest banks rated by international rating agencies. The *audit* variable indicates whether an external audit is required of the financial statements of a bank and, if so, by a licensed or certified auditor. The variable ranges from 0 to 2, with a higher value indicating more informative bank account. The *disclosure* variable indicates whether the income statement includes accrued or unpaid interest or principal on nonperforming loans, whether banks are required to produce consolidated financial statements, and whether bank directors are legally liable if information disclosed is erroneous or misleading. The variable ranges from 0 to 3, with a higher value indicating more informative bank account. Data for these three variables are obtained from the World Bank regulation and supervision surveys (Barth, Caprio, and Levine 2008).

Panel A of Table 1 provides summary statistics of all the bank level variables used in the empirical analyses. Panel B lists the number of unique banks and countries that have non-missing regulatory capital ratios and common equity ratios over time. Our sample with regulatory capital covers on average over 750 banks in over 40 countries. The coverage is greater for banks that have non-missing common equity ratios. We have over 1,300 banks in

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[3] Details on how these variables are constructed are available on World Bank's Doing Business Survey website at http://www.doingbusiness.org/methodology.

over 48 countries. For the full sample, the median risk-adjusted capital asset ratio is 13.1%, which is above the minimum Basel requirement of 8%. The median tangible and common ratios are 8.8% and 7.7% respectively.

3. Empirical results

3.1. Relationship between Capital and Systemic Risk

We begin the empirical analyses by examining the baseline relationship between capital and systemic risk. Figure 1 shows the evolution of the regulatory capital ratio and marginal expected shortfall (*MES*) over the sample period. As expected, we see a significant increase in *MES* during the financial crisis.[4] There is a negative overall correlation between systemic risk and capital ratios. To examine this relationship more formally, we run the following regression:

$$systemic\ risk_{ijt} = \beta_0 + \Omega \times bank\_controls_{ijt-1} + \beta_1 \times capital_{ijt-1} + \alpha_j \times \lambda_t + \varepsilon_{ij} \qquad (5)$$

The dependent variable is bank *i*'s systemic risk (in country *j* in year *t*), $systemic\ risk_{ijt}$, measured using *Covar*, *MES* and *Rsq* described in the previous section. The main explanatory variables of interest are the capital ratios, also described in the previous section. Bank level control variables include relative bank size, bank liquidity, reliance on deposit funding, asset quality and business model. All explanatory variables are lagged by one year. In the regression, we also include country-year fixed effects ($\alpha_j \times \lambda_t$) to control for all time varying country factors, such as, interest rates, inflation and other macroeconomic variables, differences in levels of economic development and quality of bank regulation and supervision, and differences in accounting and regulatory standards. Time varying fixed effects greatly reduce concerns about possible omitted variables.

Table 2 presents the results from the regression specification (5) above. Panel A reports the results using *Covar* as the measure of systemic risk. Panels B and C report the results using *MES* and *Rsq* as measures of systemic risk respectively. The control variables have the expected signs and are consistent with the results in Adrian and Brunnermeir (2011). Bank size is associated with higher systemic risk. Having greater liquid assets and greater reliance on deposit

[4] The time-series patterns for the other measures of systemic risk (*Rsq* and *Covar*) are similar.

funding is associated with lower levels of systemic risk. Asset quality proxied by loan loss provisions is associated with lower systemic risk, as is engagement in more traditional banking activities proxied by net loans over total assets. Across all measures, we find a significant negative relationship between total regulatory capital ratio and systemic risk (reported in column 1). That is, higher levels of capital ratios lead to lower systemic risk. Looking at the components of capital, we find that Tier 1 capital, which is of higher quality, has the greatest impact on reducing systemic fragility (colum 2). Tier 2 capital, on the other hand, has the opposite, destabilizing effect (column 3). This destabilizing effect may be due to components that make up Tier 2 capital. Subordinated debt, hybrid capital, loan loss reserves, and valuation reserves, can provide channels in which information shocks are propagated through the banking system.

The results are similar when we consider non-risk weighted assets. Capital ratios using un-weighted total assets are reported in columns 4 to 6. We find that Tier 1 capital reduces systemic risk, while Tier 2 capital has a destabilizing effect. Both tangible capital and common capital are associated with lower levels systemic risk (columns 7 and 8). In terms of economic significance, a one standard deviation increase in Tier 1 regulatory capital decreases *MES* by 25 basis points which is about 18% of its median value. During crisis years, the impact of Tier 1 regulatory capital goes up to 90 basis points or 65% of the median *MES* value.

3.2. Controlling for the Leverage Effect

Capital can reduce systemic risk by providing a buffer against economic shocks. Shocks would be absorbed by an individual bank and would not be propagated throughout the financial system. Capital acting as a cushion would provide a mechanical relationship between capital and systemic risk. At the extreme case of 100% capital ratios, for instance, there would be no defaults and hence no systemic risk. However, as discussed in the introduction capital can also affect systemic risk through other channels such as asymmetric information after controlling for this leverage effect. In this section, we examine the effect of capital through these other channels by explicitly controlling for the leverage effect. Instead of using equity returns which are affected by the level of leverage, we use asset returns in computing the three systemic risk measures.

Although equity values are observed through market prices, we do not observe market value of assets. We use the Merton (1974) structural model to infer market value of assets using equity values, leverage and equity return volatility. We use the approach outlined in Anginer, Demirguc-Kunt and Zhu (2013) to compute these asset values. Specifically, the market equity value of a company is modeled as a call option on the company's assets:

$$V_E = V_A e^{-dT} N(d_1) - X e^{-rT} N(d_2) + (1 - e^{-dT}) V_A$$
$$d_1 = \frac{\log\left(\frac{V_A}{X}\right) + \left(r - d + \frac{s_A^2}{2}\right)T}{s_A\sqrt{T}}; d_2 = d_1 - s_A\sqrt{T} \quad (6)$$

In equation (6), V_E is the market value of a bank. V_A is the value of the bank's assets. X is the face value of debt maturing at time T. r is the risk-free rate and d is the dividend rate expressed in terms of V_A. s_A is the volatility of the value of assets, which is related to equity volatility through the following equation: $s_E = \frac{V_A e^{-dT} N(d_1) s_A}{V_E}$. We simultaneously solve the above two equations to find the values of V_A and s_A. We use the market value of equity for V_E and total liabilities to proxy for the face value of debt X.[5] s_E is the standard deviation of daily equity returns over the past year. In calculating standard deviation, we require the bank to have at least 90 non-missing daily returns over the previous twelve months. T equals one year. r is the one year US treasury yield, which we take to be the risk free rate. We use the Newton method to simultaneously solve the two equations above. For starting values for the unknown variables, we use $V_A = V_E + X$ and $s_A = s_E V_E/(V_E+X)$. We winsorize s_E and $V_E/(V_E+X)$ at the 1st and 99th percentile levels to reduce the influence of outliers. After we determine asset values V_A, we compute asset returns as $V_{A,t}$-$V_{A,t-1}$ / $V_{A,t-1}$. We then compute the three systemic risk measures using these asset returns.

We run same regression specified in (5), but now using systemic risk measures computed from asset returns. The results from this regression are reported in Table 3. For brevity we only report the coefficients on the capital variables. Overall, the results are similar to those reported in Table 2. As before, we find that both regulatory and non-risk weighted capital ratios reduce

[5] Since the accounting information is on an annual basis, we linearly interpolate the values for all dates over the period, using beginning and end of year values for accounting items. The interpolation method has the advantage of producing a smooth implied asset value process and avoids jumps in the implied default probabilities at year end.

systemic risk. We also find that Tier 1 capital is more important in reducing systemic risk and Tier 2 capital has a destabilizing effect.

3.3. Bank and Country Factors Affecting the Impact of Capital

In this section, we examine cross-sectional heterogeneity in the relationship between capital and systemic risk. In particular, we examine whether the effect of capital on systemic risk is i) weaker for larger banks, ii) more important during crisis years, and iii) whether capital can substitute for weak regulatory supervision and an institutional environment that inhibits efficient public and private monitoring of banks.

If large banks are the beneficiaries of implicit too-big-to-fail guarantees (Acharya, Anginer and Warburton 2014), then we would expect capital have a less pronounced effect in reducing systemic fragility. On the other hand, larger banks are more interconnected, more likely to operate in a greater number of markets and countries, and engage in non-traditional banking activities, all of which make them more likely to benefit from having greater levels of capital. To examine the impact of size, we run the regression specified in (5). We include a new variable interacting relative bank size with the various capital ratios. To examine the impact of capital on the systemic risk of the very large banks, we interact the capital ratios with a dummy variable (*50bn_dum*) that takes on a value of one if a given bank's assets are greater than $50 billion. The results are reported Panels A and B of Table 4. The results suggest that capital is more effective in reducing systemic risk for larger banks. When we examine the largest banks, those with assets in excess of $50 billion, we also find that capital is more important in reducing systemic risk for these banks. These results are consistent with those in Demirguc-Kunt, Detragiache and Merrouche (2013) who find capital to have a greater impact on the returns of the largest banks during the financial crisis.

Next, we examine the effect of capital during crisis years. We run the regression specified in (5), but restrict the sample to the years between 2004 and 2010. In the regression, we also include a dummy variable, *crisis*, that takes on a value of one if a given country experienced a banking crisis as defined in Leaven and Valencio (2010). The reason we exclude the years prior to 2004 is the lack of crises during that time period, which makes identification biased towards a few smaller countries that experienced banking crisis during that time period.[6]

[6] Our sample captures only the end tail of the Asian financial crisis of the late 1990's.

As with bank size, we include interactions of the crisis dummy with the capital variables. The results are in Table 5. We find that the effect of capital is more pronounced during crisis. The economic significance triples in value with one standard deviation increase in Tier 1 regulatory capital reducing systemic risk (MES) by 90 basis points during crisis compared to 25 basis points in non-crisis years. We find Tier 1 capital (both risk weighted and non-risk weighted) to be most important. Tier 2 capital is even more destabilizing during crisis years.

Finally we examine the impact of institutional environment on the capital and systemic risk relationship. Anginer and Demiguc-Kunt (2013) show that strong supervision and strong institutional environments that allow for efficient public and private monitoring of financial institutions lead to lower systemic fragility in the banking sector. Anginer, Demiguc-Kunt and Zhu (2014) show that information availability and information asymmetry in the banking sectors are also an important drivers of systemic risk. We examine the impact of supervisory power, deposit insurance and information availability and symmetry in the banking sector. As before we run the regression specified in (5) and include institutional variables and their interaction with capital variables. Table 6 reports the results. We only report the interaction term in order to save space.

The first set of institutional variables measure the strength of supervision and private monitoring in each country. As bank failures can be very costly due to the crucial role banks play within the economic system, supervisors are naturally incentivized to monitor fragility in the banking system. But effective monitoring and supervision requires authorities to take timely corrective action. We use *supervisory power* which measures supervisory authorities' power and authority to take specific preventive and corrective actions, to proxy for public monitoring. We would expect capital to have a greater impact in countries with weak supervision and oversight where the regulators do not have the incentives or the power to take corrective action to reduce systemic risk. The results reported in Table 6 are consistent with this conjecture. Capital is less effective in reducing systemic risk in countries with greater supervisory power.

The *deposit insurance* variable indicates whether a country has explicit deposit insurance and whether depositors were fully compensated the last time there was a bank failure. Deposit insurance has two offsetting effects on systemic stability. While deposit insurance may prevent bank runs (Matutes and Vives 1996) and ensure systemic stability, it may also lead to moral hazard and excessive bank risk taking (Demirguc-Kunt and Kane 2002; Demirguc-Kunt and

Huizinga 2004).[7] Furthermore, generous safety nets tend to be correlated with other implicit state guarantees. As Demirguc-Kunt and Detragiache (2002) suggest, if funds are set aside to cover losses in the event of a crisis through a deposit insurance fund, then bank creditors and possibly bank shareholders may be able to put pressure on the policymakers to extend protection to their own claims.[8] If there is an implicit guarantee provided by the State to cover losses stemming from a systemic crisis, banks may also have incentives to take on correlated risks (Acharya 2011). Guaranteed banks will not have incentives to diversify their operations, since the guarantee takes effect only if other banks fail at the same time. The results in Table 6 are consistent with the notion that, with a potential implicit guarantee, capital may be less effective in reducing systemic fragility. The interaction term is positive and significant, suggesting the stabilizing effect of capital is less pronounced in countries with generous safety nets.

Next, we examine the impact of information availability and symmetry on the capital-systemic risk relationship. We consider the impact of information in the lending market, as well as, in the banking sector. We use three measures to proxy for information asymmetry. The first measure is credit information depth (*credit info depth*), which measures credit information availability and sharing. The other two measures indicate whether a public credit registry (public registry) or a private credit bureau (private bureau) operates in the country. Greater information availability and sharing allows for better monitoring of financial institutions (Djankov, McLiesh and Shleifer 2007). The second set of variables measure information transparency in the banking sector. The *rated* variable measures the fraction of ten biggest banks rated by international rating agencies. The *audit* variable indicates whether an external audit is required of the financial statements of a bank and, if so, by a licensed or certified auditor. The *disclosure* measures transparency and informativeness of bank financial statements. Information asymmetry provides a potential channel in which shocks can be propagated through the banking system. A number of papers have used constrained information asymmetry framework to explain risk contagion and crises (see for instance Genotte and Leland 1990; Kodres and Pritsker 2002; Hong and Stein 2003; Barlevy and Veronesi 2003, Yuan 2005). If capital provides a cushion against information shocks, then we would expect the impact of capital to be less pronounced in markets with greater

[7] Anginer, Demirguc-Kunt and Zhu (2012) show that the effect of deposit insurance on systemic risk is negative during the crisis period, although over the full sample period, the overall impact is still positive.
[8] Consistent with this view, Demirguc-Kunt and Huizinga (2004) find banks' cost of funds to be lower and less sensitive to risk in countries with explicit deposit insurance.

information availability and symmetry. The results in Table 6 using information measures for both the lending market and for the banking sector, suggest that capital is indeed more important in countries where information is scarce and market participants face greater information asymmetry.

3.4. Manipulation of Risk-Weights

Risk weights on banks assets are an important element of risk-based capital ratios. Banks can meet capital requirements by either increasing capital or decreasing risk-weighted assets. Since the current regulations provide substantial discretion to banks in determining risk-weights, a key concern has been that individual banks may try to minimize capital requirements by underestimating the risks of assets on their balance sheets. Jones (2000) discusses techniques that banks can use for regulatory capital arbitrage and provides evidence on the magnitude of these activities in the Unites States. LeLesle and Avramova (2012) provide evidence of heterogeneity with respect to the calculation of risk-weights. Recent growth in financial innovation and financial engineering may have also made it easier for financial institutions to manipulate regulatory risk measures. Acharya, Schnabl, and Suarez (2010) show that banks used certain forms of securitization to reduce bank capital requirements. These actions have led to greater concentration of risk. In this section, we examine whether regulatory risk-weights are associated with higher future asset volatility, and also examine if manipulation of risk weights are associated with greater systemic fragility.

Figure 2 shows an increase in average risk-weights for banks over time in the run up to the financial crisis. We examine whether changes in regulatory weights help predict future bank risk as measured by changes in future asset volatility. The specification we use is similar to those in the literature that have been used to examine discretionary loan provisioning practices (see for instance, Bushman and Williams 2012). In particular, we run the following regression:

$$\Delta rwa/ta_{ijt} = \beta_0 + \Omega \times bank\_controls_{ijt-1} + \beta_1 \times \Delta\sigma_{Aijt} + \beta_2 \times \Delta\sigma_{Aijt+1} + \beta_3 \times \Delta\sigma_{Aijt+1} \times size_{ijt-1} + \alpha_j \times \lambda_t + \varepsilon_{ijt} \quad (7)$$

Above $\Delta rwa/ta_{ijt}$ is the change in risk weighted assets divided by total assets for bank i in country j at year t. Our variable of interest is future changes in asset volatility, $\Delta\sigma_{Aijt+1}$, computed from the Merton model described in section 3.2. We control for contemporaneous changes in asset volatility ($\Delta\sigma_{Aijt}$), bank size (*size*), earnings (*earnings / total loans*) computed as net income over total assets, and un-weighted capital ratio (*total capital / ta*).

The results are reported in Table 7. We find a significant positive relationship between changes in risk weights and changes in future asset volatility (column 1). On average risk weights reflect banks future riskiness. There is, however, cross-bank heterogeneity in the relationship between asset risk and risk weights. In the regression specified in (7), we include an interaction of bank size with future asset volatility. The results reported in column 2, suggest that the relationship between risk weights and future asset volatility is weaker for larger banks. To examine the impact of potential manipulation of risk weights on systemic risk, we run the regressions specified in (5) above. We include a variable that measures risk-weights per unit of asset volatility. We divide the log value of risk weighted assets by asset volatility computed from the Merton model (*log(rwa)* /σ_A). We also include as additional controls total capital over total assets (*total capital* / *ta*), and risk weighted assets over total assets (*rwa* / *ta*). All the independent variables are lagged by one year. The results of this regression are reported in Table 8. We find a negative relationship between *log(rwa)* /σ_A and systemic risk. That is, a decline in risk weights without a corresponding decline in asset volatility leads to greater systemic fragility.

3.5. Impact of recent regulatory reforms

In the aftermath of the financial crisis of 2008, bank regulation and supervision has been the subject of much policy debate. A number of studies have pointed to weaknesses in regulation and supervision as one of the factors leading to the crisis (Dan, 2010, Lau, 2010, Levine, 2010 and Merrouche and Nier, 2010). In response, a number of countries have implemented macro-prudential reforms to focus on systemic risk and supervision of systemically important institutions. A number of countries have also implemented regulations to increase capital requirements on these systemically important institutions. We use World Bank's 2011–12 bank regulation and supervision survey to evaluate the effectiveness of recent reforms. In particular, we test to see if recent implementations of capital regulations targeting systemic risk after the crisis have been successful increasing the negative effect of capital on systemic risk. We run the following regression:

$$systemic\ risk_{ijt} = \beta_0 + \Omega \times bank\_controls_{ijt-1} + \beta_1 \times post + \beta_2 \times regulation_j + \beta_3 \times capital_{ijt-1} + \beta_4 \times capital_{ijt-1} \times post + \beta_5 \times capital_{ijt-1} \times regulation_j + \beta_6 \times capital_{ijt-1} \times regulation_j \times post + \alpha_j \times \lambda_t + \varepsilon_{ijt}. \quad (8)$$

As before, the dependent variable is bank *i*'s systemic risk (in country *j* in year *t*), $systemic\ risk_{ijt}$, measured using *Covar*, *MES* and *Rsq* described in the previous section. $regulation_j$ is a dummy variable that takes on a value of one for affirmative responses to the questions related systemic risk and capital in the bank regulation and supervision survey. We consider the following questions: Q1: Is there a specialized department in your agency dealing with financial stability and systemic supervision? Yes?/No?; Q2: If you perform stress tests at the system-wide level, using bank-by-bank data; Q3: Do you have any counter-cyclical regulations or tools to dampen boom/bust cycles in credit flows?; Q4: Is the counter-cyclical regulation capital requirements?; Q5: Do you supervise systemic institutions in a different way than non-systemic ones? Yes?/No?; Q6: Do you have any tools to oversee more closely and/or limit the activities of large/interconnected institutions? Yes?/No?. We also create a composite score (*rindex*) by adding up the affirmative answers to the six questions. For this analysis, we exclude the crisis years when the reforms have been enacted to reduce endogeneity concerns. The sample includes the years 2004-2006 and 2011-2013. The variable *post* is a dummy variable and takes on a value of one for the 2011-2013 time period.

The results are reported in Table 9. In Panel A, we report the results using regulatory capital as the capital measure, and in Panel B, we report the results using the non-risk weighted capital ratios. Although the post crisis time period is limited, the initial results support the notion that recent capital regulations targeting systemic risk after the crisis have been successful increasing the positive effect of capital on systemic risk.

4. Conclusion

The global financial crisis has demonstrated that the regulatory capital requirements in place were inadequate to prevent a system-wide banking crisis. As a result, there has been significant renewed interest in refinement of existing capital adequacy rules to increase capital cushions for financial intermediaries. Given that existing theories produce conflicting predictions regarding the effect of capital on bank risk, we examine this issue empirically using a bank-level database of 1,200 publicly traded banks in over 45 countries over the 1998 to 2012 period. Specifically, we distinguish among various types of capital and examine their effect on system-wide fragility. Hence, we examine not the absolute level of risk of individual banks, but the correlation in the risk taking behavior of banks to capture how they impact the risk of the system as a whole. We find that higher quality forms of capital reduce correlated risk taking behavior of banks, whereas lower quality forms may have a destabilizing impact, particularly during crisis periods. Our results suggest regulatory risk weights are correlated with higher future asset volatility, but less so for larger banks, not reflecting actual risk. Overall, we find the impact of capital on systemic risk to be less pronounced for smaller banks, and for banks located in countries with more generous safety nets and better public and private monitoring. Our results are consistent with the theoretical literature that emphasizes capital as a potential buffer in absorbing liquidity, information and economic shocks reducing contagious defaults.

The results from our study have important policy implications relevant for the current debate on strengthening capital regulations. Our empirical results suggest that higher capital does indeed provide a buffer to absorb losses, mitigating the effect of systemic risk factors (such as collective uncertainty, information asymmetry and counterparty risk) which can propagate shocks across institutions. Our results also suggest that the type of capital is important and greater emphasis should be given to higher quality capital (Tier 1 capital and tangible equity) as opposed to lower quality capital (Tier 2 capital) which may be destabilizing. The results further suggest risk adjusted assets may not reflect actual risk, particularly for large banks, supporting complementing these with basic leverage ratios. Finally, there is some suggestive evidence that the increased regulatory focus on macroprudential regulation after the crisis has strengthened the capital – systemic stability association.

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Figure 1: MES and regulatory capital over time

This figure shows the evolution of average *MES* and regulatory capital ratios over the sample time period from 1997 to 2012.

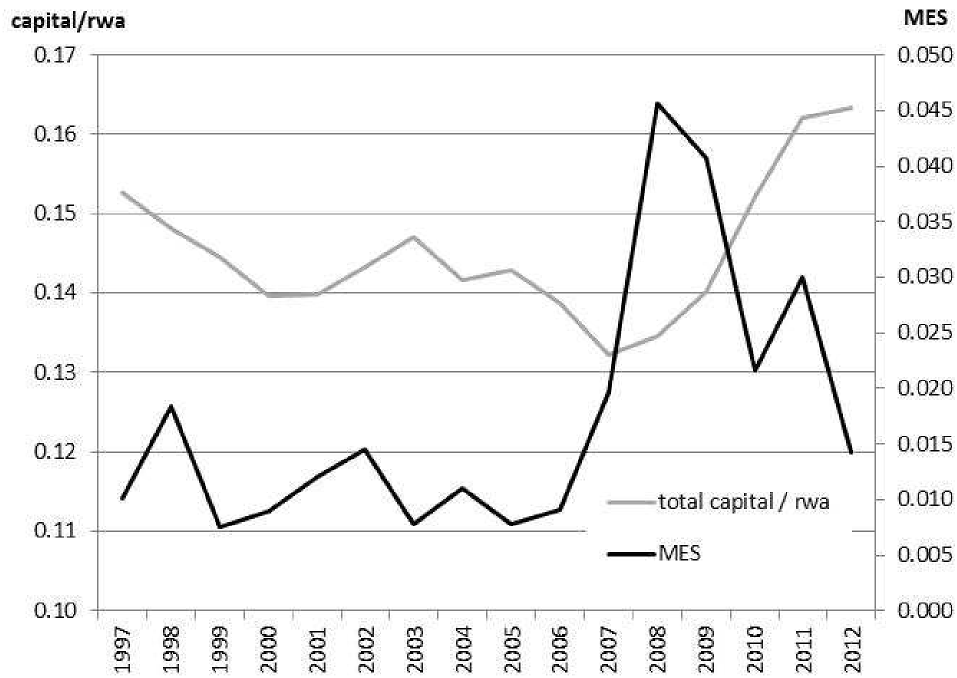

Figure 2: Risk weights over time

This figure shows the evolution of average ratio of risk weighted assets to total assets (*rwa*/*ta*) over the sample time period from 1998 to 2012. Averages for all banks and the banks incorporated in the USA are plotted separately.

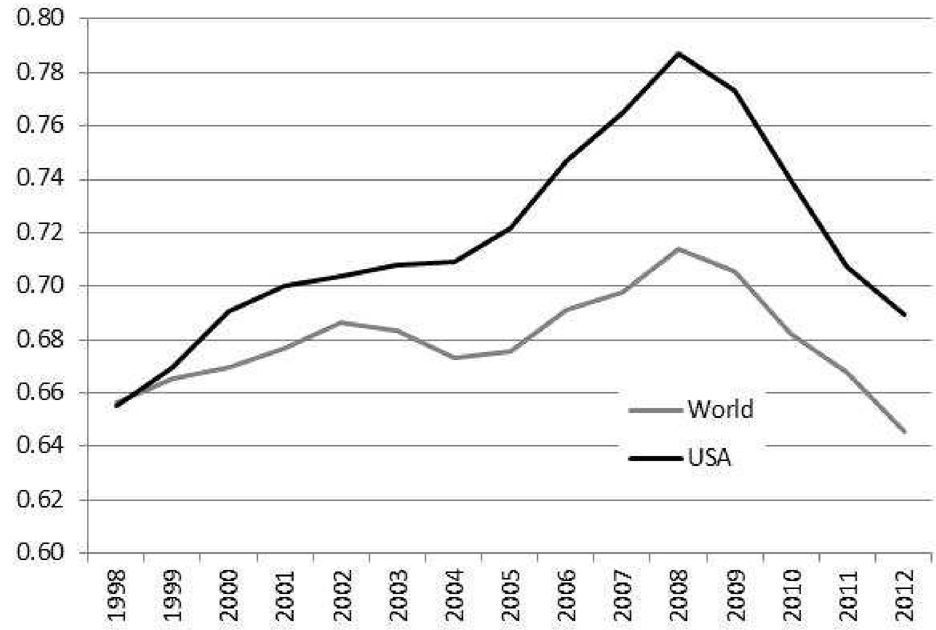

Table 1: Summary statistics

This table provides summary statistics of the variables used in the analyses. Definitions of variables are in Appendix I. Panel A presents the summary statistics of the variables used in this study. Panel B presents the number of banks and countries that have non-missing values for the regulatory capital and common equity capital variables.

Panel A: Summary statistics

Variable	N	Mean	Std Dev	Min	Max	P25	P50	P75
Covar	16700	0.039	0.040	-0.139	0.319	0.013	0.030	0.055
MES	19154	0.018	0.023	-0.711	0.318	0.004	0.014	0.028
Rsq	16942	-2.039	1.960	-17.862	5.232	-2.829	-1.495	-0.732
total capital / rwa	14019	0.156	0.130	0.052	1.197	0.112	0.131	0.158
tier 1 / rwa	13066	0.122	0.062	0.037	0.571	0.088	0.110	0.137
tier 2 / rwa	12944	0.021	0.016	-0.014	0.082	0.011	0.014	0.031
total capital / ta	11892	0.095	0.040	0.021	0.356	0.071	0.090	0.109
tier 1 / ta	13198	0.083	0.043	0.011	0.382	0.057	0.079	0.097
tier 2 / ta	11892	0.014	0.011	-0.008	0.059	0.007	0.010	0.019
tangible / ta	19154	0.099	0.096	-0.004	0.919	0.055	0.077	0.104
common / ta	19154	0.109	0.096	0.010	0.923	0.064	0.088	0.116
liquid assets / ta	19154	0.132	0.135	0.004	0.788	0.040	0.083	0.177
deposits / ta	19154	0.743	0.189	0.010	0.947	0.693	0.805	0.864
loan loss provisions / ta	19154	0.006	0.011	-0.006	0.079	0.001	0.003	0.007
net loans / ta	19154	0.608	0.187	0.004	0.916	0.527	0.643	0.733
size	19154	1.366	5.677	0.001	118.17	0.046	0.147	0.709

Panel B: Number of banks and countries covered in the analyses

	total capital / rwa		common / ta	
Year	# banks	# countries	# banks	# countries
1997	298	21	529	27
1998	379	24	713	32
1999	525	25	925	33
2000	566	24	998	35
2001	594	25	1029	36
2002	630	26	1184	38
2003	661	36	1353	51
2004	625	42	1384	54
2005	913	45	1424	55
2006	918	51	1405	57
2007	977	53	1462	58
2008	1022	55	1443	59
2009	1012	58	1379	61
2010	993	60	1371	63
2011	961	59	1331	63
2012	818	54	1224	58

Table 2: Capital and systemic risk: baseline results

Regression results of model $systemic\ risk_{ijt} = \beta_0 + \Omega \times bank\_controls_{ijt-1} + \beta_1 \times capital_{ijt-1} + \alpha_j \times \lambda_t + \varepsilon_{ijt}$. Panel A reports results using *Covar* as the dependent variable and Panels B and C report results using *MES* and *Rsq* as the dependent variables respectively. Definitions of all variables are listed in Appendix I. Standard errors are reported in parentheses below their coefficient estimates and adjusted for both heteroskedasticity and within correlation clustered at the bank level. *** (**) (*) indicates significance at 1% (5%) (10%) two tailed level, respectively.

Panel A: Covar

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	Covar	Covar	Covar	Covar	Covar	Covar	Covar	Covar
liquid assets / ta	-0.021***	-0.011	-0.022**	-0.028***	-0.022**	-0.029***	-0.013**	-0.014***
	(0.008)	(0.009)	(0.009)	(0.010)	(0.009)	(0.010)	(0.005)	(0.005)
deposits / ta	-0.024***	-0.034***	-0.019***	-0.028***	-0.027***	-0.020***	-0.021***	-0.017***
	(0.005)	(0.006)	(0.006)	(0.007)	(0.007)	(0.006)	(0.004)	(0.004)
loan loss provisions / ta	-0.162***	-0.229***	-0.239***	-0.211***	-0.221***	-0.304***	-0.068*	-0.069*
	(0.061)	(0.074)	(0.073)	(0.080)	(0.076)	(0.080)	(0.041)	(0.041)
net loans / ta	-0.026***	-0.032***	-0.026***	-0.025***	-0.022***	-0.033***	-0.022***	-0.022***
	(0.006)	(0.006)	(0.006)	(0.007)	(0.007)	(0.007)	(0.004)	(0.004)
size	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
total capital / rwa	-0.021***							
	(0.005)							
tier 1 / rwa		-0.080***						
		(0.012)						
tier 2 / rwa			0.309***					
			(0.049)					
total capital / ta				-0.046**				
				(0.021)				
tier 1 / ta					-0.081***			
					(0.019)			
tier 2 / ta						0.470***		
						(0.074)		
tangible / ta							-0.048***	
							(0.007)	
common / ta								-0.030***
								(0.007)
constant	0.325***	0.495***	0.488***	0.654***	0.408***	0.655***	0.245***	0.244***
	(0.089)	(0.112)	(0.129)	(0.130)	(0.132)	(0.129)	(0.042)	(0.043)
County × Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	11,622	10,897	10,802	9,854	11,014	9,854	16,022	16,022
R-squared	0.369	0.365	0.370	0.348	0.340	0.358	0.365	0.362

Panel B: MES

VARIABLES	(1) MES	(2) MES	(3) MES	(4) MES	(5) MES	(6) MES	(7) MES	(8) MES
liquid assets / ta	-0.004	-0.003	-0.006	-0.006	0.000	-0.006	0.001	0.001
	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.002)	(0.003)
deposits / ta	-0.011***	-0.014***	-0.008***	-0.014***	-0.015***	-0.010***	-0.015***	-0.012***
	(0.002)	(0.003)	(0.002)	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)
loan loss provisions / ta	0.223***	0.236***	0.243***	0.257***	0.224***	0.221***	0.143***	0.144***
	(0.040)	(0.042)	(0.043)	(0.046)	(0.043)	(0.046)	(0.025)	(0.025)
net loans / ta	-0.016***	-0.018***	-0.016***	-0.013***	-0.012***	-0.016***	-0.014***	-0.014***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)
size	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
total capital / rwa	-0.008***							
	(0.003)							
tier 1 / rwa		-0.033***						
		(0.004)						
tier 2 / rwa			0.108***					
			(0.020)					
total capital / ta				-0.023**				
				(0.009)				
tier 1 / ta					-0.038***			
					(0.007)			
tier 2 / ta						0.176***		
						(0.028)		
tangible / ta							-0.028***	
							(0.003)	
common / ta								-0.018***
								(0.004)
constant	0.153***	0.206***	0.198***	0.248***	0.188***	0.245***	0.099***	0.099***
	(0.035)	(0.038)	(0.042)	(0.044)	(0.046)	(0.044)	(0.022)	(0.023)
County × Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	12,876	12,005	11,899	10,818	12,046	10,818	17,693	17,693
R-squared	0.406	0.424	0.423	0.420	0.476	0.425	0.408	0.405

Panel C: Rsq

VARIABLES	(1) Rsq	(2) Rsq	(3) Rsq	(4) Rsq	(5) Rsq	(6) Rsq	(7) Rsq	(8) Rsq
liquid assets / ta	-0.926***	-0.741*	-1.193***	-1.439***	-1.241***	-1.554***	-0.340	-0.376
	(0.349)	(0.398)	(0.409)	(0.445)	(0.412)	(0.450)	(0.264)	(0.267)
deposits / ta	-0.666***	-1.055***	-0.357	-0.917***	-0.881***	-0.417	-0.721***	-0.517***
	(0.220)	(0.243)	(0.237)	(0.294)	(0.295)	(0.272)	(0.168)	(0.169)
loan loss provisions / ta	5.016**	5.309**	5.433*	8.121***	5.190**	3.973	2.189	2.182
	(2.425)	(2.641)	(2.840)	(2.884)	(2.641)	(3.012)	(1.477)	(1.484)
net loans / ta	-1.374***	-1.734***	-1.414***	-1.280***	-1.268***	-1.652***	-1.315***	-1.288***
	(0.269)	(0.290)	(0.292)	(0.318)	(0.318)	(0.316)	(0.203)	(0.205)
size	0.034***	0.028***	0.031***	0.031***	0.027***	0.028***	0.031***	0.033***
	(0.007)	(0.007)	(0.007)	(0.006)	(0.005)	(0.006)	(0.006)	(0.006)
total capital / rwa	-1.010***							
	(0.304)							
tier 1 / rwa		-3.786***						
		(0.507)						
tier 2 / rwa			12.024***					
			(2.316)					
total capital / ta				-3.271***				
				(0.907)				
tier 1 / ta					-4.361***			
					(0.849)			
tier 2 / ta						19.151***		
						(3.116)		
tangible / ta							-2.669***	
							(0.353)	
common / ta								-1.828***
								(0.358)
constant	11.546***	16.354***	15.614***	19.255***	15.549***	19.303***	8.371***	8.310***
	(3.569)	(4.715)	(4.831)	(6.575)	(5.059)	(6.512)	(2.045)	(2.045)
County × Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	12,081	11,282	11,180	10,175	11,345	10,175	16,725	16,725
R-squared	0.281	0.273	0.271	0.261	0.271	0.267	0.295	0.291

Table 3: Controlling for the leverage effect in the capital and systemic risk relationship

Regression results of model $systemic\ risk_{ijt} = \beta_0 + \Omega \times bank\_controls_{ijt-1} + \beta_1 \times capital_{ijt-1} + \alpha_j \times \lambda_t + \varepsilon_{ijt}$. *systemic risk* measures are computed using returns of implied asset values from the Merton model. We report results for the three systemic risk measures, *Covar*, *MES* and *Rsq* separately. We only report the coefficients on the *capital* variables to save space. Definitions of all variables are listed in Appendix I. Standard errors are reported in parentheses below their coefficient estimates and adjusted for both heteroskedasticity and within correlation clustered at the bank level. *** (**) (*) indicates significance at 1% (5%) (10%) two tailed level, respectively.

	Covar			MES			Rsq		
Variables	Coef	# obs	R^2	Coef	# obs	R^2	Coef	# obs	R^2
total capital / rwa	-0.002	12,215	0.238	-0.005**	12,122	0.223	-0.526***	11,966	0.360
	(0.004)			(0.002)			(0.171)		
tier 1/ rwa	-0.032***	11,439	0.401	-0.032***	11,375	0.234	-3.739***	11,173	0.354
	(0.004)			(0.005)			(0.426)		
tier 2 / rwa	0.106***	11,338	0.402	0.066***	11,273	0.234	10.276***	11,072	0.352
	(0.015)			(0.019)			(1.484)		
total capital / ta	-0.023***	10,371	0.403	-0.016*	10,298	0.225	-3.468***	10,131	0.344
	(0.007)			(0.009)			(0.753)		
tier 1/ ta	-0.030***	11,572	0.410	-0.024***	11,490	0.225	-4.345***	11,288	0.327
	(0.006)			(0.008)			(0.649)		
tier 2 / ta	0.157***	10,371	0.406	0.133***	10,298	0.225	17.310***	10,131	0.347
	(0.021)			(0.026)			(2.136)		
tangible / ta	-0.010***	16,959	0.240	-0.025***	16,795	0.180	-1.585***	16,663	0.317
	(0.003)			(0.003)			(0.228)		
common / ta	-0.008***	16,959	0.240	-0.014***	16,795	0.180	-1.029***	16,663	0.316
	(0.003)			(0.003)			(0.232)		

Table 4: Impact of size in the capital and systemic risk relationship

Regression results of model $systemic\ risk_{ijt} = \beta_0 + \Omega \times bank\_controls_{ijt-1} + \beta_1 \times capital_{ijt-1} + \beta_2 \times capital_{ijt-1} \times size_{ijt-1} + \alpha_j \times \lambda_t + \varepsilon_{ijt}$. We report results for the three systemic risk measures, *Covar*, *MES* and *Rsq* separately. We only report coefficients on the *size* interaction term to save space. Definitions of all variables are listed in Appendix I. Standard errors are reported in parentheses below their coefficient estimates and adjusted for both heteroskedasticity and within correlation clustered at the bank level. *** (**) (*) indicates significance at 1% (5%) (10%) two tailed level, respectively.

Panel A: Size interaction

	Covar			MES			Rsq		
Variables	Coef	# obs	R^2	Coef	# obs	R^2	Coef	# obs	R^2
total capital / rwa × size	0.001	12,154	0.343	-0.002**	13,369	0.389	0.069	12,598	0.276
	(0.002)			(0.001)			(0.129)		
tier 1 / rwa × size	0.005	11,378	0.346	-0.000	12,441	0.411	0.307	11,748	0.274
	(0.004)			(0.002)			(0.190)		
tier 2 / rwa × size	-0.131***	11,277	0.352	-0.043***	12,329	0.410	-3.596***	11,640	0.270
	(0.023)			(0.011)			(0.851)		
total capital / ta × size	-0.016**	10,317	0.328	-0.013***	11,235	0.408	-0.741***	10,622	0.262
	(0.007)			(0.003)			(0.286)		
tier 1 / ta × size	-0.004	11,518	0.326	-0.010***	12,506	0.463	-0.121	11,832	0.270
	(0.006)			(0.003)			(0.333)		
tier 2 / ta × size	-0.218***	10,317	0.345	-0.078***	11,235	0.414	-7.624***	10,622	0.269
	(0.033)			(0.015)			(1.270)		
tangible / ta × size	-0.005***	16,879	0.347	-0.004***	18,498	0.390	-0.349***	17,576	0.287
	(0.002)			(0.001)			(0.103)		
common / ta × size	-0.006***	16,879	0.342	-0.004***	18,498	0.387	-0.377***	17,576	0.283
	(0.002)			(0.001)			(0.095)		

Panel B: $50bn dummy interaction

	Covar			MES			Rsq		
Variables	Coef	# obs	R^2	Coef	# obs	R^2	Coef	# obs	R^2
total capital / rwa × 50bn_dum	-0.026***	11,726	0.381	-0.011***	12,965	0.420	-0.727***	12,187	0.293
	(0.006)			(0.003)			(0.248)		
tier 1 / rwa × 50bn_dum	-0.066***	10,972	0.376	-0.016*	12,065	0.439	-0.369	11,358	0.283
	(0.021)			(0.009)			(0.764)		
tier 2 / rwa × 50bn_dum	-0.082	10,874	0.380	-0.058	11,956	0.440	-9.123***	11,253	0.283
	(0.075)			(0.046)			(3.179)		
total capital / ta × 50bn_dum	-0.093**	9,926	0.360	-0.016	10,875	0.438	1.413	10,248	0.272
	(0.054)			(0.019)			(1.596)		
tier 1 / ta × 50bn_dum	-0.028	11,065	0.353	-0.017	12,083	0.492	-1.794	11,398	0.282
	(0.037)			(0.014)			(1.245)		
tier 2 / ta × 50bn_dum	0.163	9,926	0.367	-0.087*	10,875	0.442	-10.063**	10,248	0.277
	(0.127)			(0.049)			(4.589)		
tangible / ta × 50bn_dum	-0.040***	16,216	0.380	-0.023***	17,848	0.418	-1.557***	16,924	0.305
	(0.013)			(0.006)			(0.522)		
common / ta × 50bn_dum	-0.028**	16,216	0.378	-0.014**	17,848	0.416	-1.346**	16,924	0.303
	(0.014)			(0.006)			(0.524)		

Table 5: Impact of crisis in the capital and systemic risk relationship

Regression results of model $systemic\ risk_{ijt} = \beta_0 + \Omega \times bank\_controls_{ijt-1} + \beta_1 \times capital_{ijt-1} + \beta_2 \times capital_{ijt-1} \times crisis_{jt} + \alpha_j + \varepsilon_{ijt}$. Sample restricted to period from 2004 to 2012. We report results for the three systemic risk measures, *Covar*, *MES* and *Rsq* separately. We only report coefficients on the *crisis* interaction term to save space. Definitions of all variables are listed in Appendix I. Standard errors are reported in parentheses below their coefficient estimates and adjusted for both heteroskedasticity and within correlation clustered at the bank level. *** (**) (*) indicates significance at 1% (5%) (10%) two tailed level, respectively.

	Covar			MES			Rsq		
Variables	Coef	# obs	R^2	Coef	# obs	R^2	Coef	# obs	R^2
total capital / rwa × crisis	-0.025	6,461	0.310	-0.049**	7,034	0.222	-3.828**	6,588	0.214
	(0.033)			(0.024)			(1.578)		
tier 1 / rwa × crisis	-0.022	6,071	0.305	-0.083***	6,597	0.231	-3.502**	6,212	0.215
	(0.036)			(0.023)			(1.409)		
tier 2 / rwa × crisis	0.276*	6,042	0.308	0.187*	6,563	0.223	-0.812	6,183	0.209
	(0.150)			(0.100)			(4.699)		
total capital / ta × crisis	-0.033	5,484	0.297	-0.047	5,959	0.215	-2.700	5,621	0.206
	(0.053)			(0.029)			(1.824)		
tier 1 / ta × crisis	-0.056	6,026	0.304	-0.080***	6,536	0.236	-3.027*	6,166	0.223
	(0.051)			(0.030)			(1.595)		
tier 2 / ta × crisis	0.292	5,484	0.303	0.350***	5,959	0.220	0.617	5,621	0.207
	(0.201)			(0.102)			(6.131)		
tangible / ta × crisis	-0.023**	8,976	0.313	-0.039***	9,703	0.259	-1.371**	9,119	0.234
	(0.011)			(0.010)			(0.559)		
common / ta × crisis	-0.012	8,976	0.308	-0.015	9,703	0.252	-0.324	9,119	0.229
	(0.021)			(0.010)			(0.562)		

Table 6: Institutional environment

Regression results of model $systemic\ risk_{ijt} = \beta_0 + \Omega \times bank\_controls_{ijt-1} + \beta_1 \times capital_{ijt-1} + \beta_2 \times capital_{ijt-1} \times country\ regulation/information\ index_{jt} + \varepsilon_{ijt}$. We report results for the three systemic risk measures, *Covar*, *MES* and *Rsq* separately. We only report coefficients on the *country regulation/information index* interaction term to save space. Panel A reports results using *total capital / rwa* as the *capital* measure. Panel B reports results using *total capital / ta* as the *capital* measure. Definitions of all variables are listed in Appendix I. Standard errors are reported in parentheses below their coefficient estimates and adjusted for both heteroskedasticity and within correlation clustered at the bank level. *** (**) (*) indicates significance at 1% (5%) (10%) two tailed level, respectively.

Panel A: Risk weighted assets

	Covar			MES			Rsq		
Variables	Coef	# obs	R^2	Coef	# obs	R^2	Coef	# obs	R^2
total capital / rwa × supervisory power	0.005***	11,108	0.064	0.001	12,154	0.038	0.258***	11,522	0.143
	(0.001)			(0.001)			(0.056)		
total capital / rwa × deposit insurance	0.016***	11,108	0.065	0.019***	12,154	0.047	0.987***	11,522	0.145
	(0.003)			(0.002)			(0.164)		
total capital / rwa × credit info depth	0.012***	5,983	0.077	0.010***	6,623	0.053	0.238*	6,070	0.186
	(0.003)			(0.002)			(0.126)		
total capital / rwa × public registry	-0.005	11,185	0.062	0.012***	12,243	0.040	0.869***	11,609	0.144
	(0.006)			(0.004)			(0.330)		
total capital / rwa × private bureau	0.055***	11,185	0.067	0.038***	12,243	0.046	1.121***	11,609	0.143
	(0.008)			(0.005)			(0.370)		
total capital / rwa × disclosure	0.013***	11,108	0.063	0.005*	12,154	0.039	0.177	11,522	0.141
	(0.005)			(0.003)			(0.209)		
total capital / rwa × audit	0.037***	11,108	0.063	0.011	12,154	0.038	-0.788	11,522	0.141
	(0.012)			(0.008)			(0.534)		
total capital / rwa × rated	0.066***	10,728	0.065	0.028***	11,725	0.039	0.712	11,137	0.147
	(0.012)			(0.008)			(0.462)		

Panel B: Total assets

	Covar			MES			Rsq		
Variables	Coef	# obs	R^2	Coef	# obs	R^2	Coef	# obs	R^2
total capital / ta × supervisory power	0.018***	9,414	0.067	0.005***	10,182	0.056	0.455***	9,693	0.154
	(0.003)			(0.002)			(0.137)		
total capital / ta × deposit insurance	0.005	9,414	0.061	0.013**	10,182	0.055	0.504	9,693	0.152
	(0.009)			(0.006)			(0.379)		
total capital / ta × credit info depth	0.020***	5,264	0.079	0.013***	5,822	0.064	0.049	5,362	0.191
	(0.007)			(0.003)			(0.237)		
total capital / ta × public registry	-0.022	9,453	0.061	0.025***	10,229	0.056	1.342**	9,735	0.153
	(0.017)			(0.009)			(0.680)		
total capital / ta × private bureau	0.059***	9,453	0.062	0.027**	10,229	0.056	-1.229*	9,735	0.152
	(0.019)			(0.011)			(0.744)		
total capital / ta × disclosure	0.068***	9,414	0.064	0.010	10,182	0.054	0.075	9,693	0.152
	(0.016)			(0.008)			(0.568)		
total capital / ta × audit	0.087***	9,414	0.062	0.027	10,182	0.055	-1.805*	9,693	0.152
	(0.025)			(0.017)			(0.957)		
total capital / ta × rated	0.242***	9,213	0.070	0.062***	9,946	0.057	3.769**	9,489	0.155
	(0.032)			(0.018)			(1.510)		

Table 7: Risk weights and future asset volatility

Regression results of model $\Delta rwa/ta_{ijt} = \beta_0 + \Omega\times bank\_controls_{ijt-1} + \beta_1\times \Delta\sigma_{Aijt} + \beta_2\times \Delta\sigma_{Aijt+1} + \beta_3\times \Delta\sigma_{Aijt+1} \times size_{ijt-1} + \alpha_j\times \lambda_t + \varepsilon_{ijt}$. Definitions of all variables are listed in Appendix I. Standard errors are reported in parentheses below their coefficient estimates and adjusted for both heteroskedasticity and within correlation clustered at the bank level. *** (**) (*) indicates significance at 1% (5%) (10%) two tailed level, respectively.

VARIABLES	(1) Δrwa/ta	(2) Δrwa/ta
earnings / total loans	-0.002*	-0.002*
	(0.001)	(0.001)
Size	-0.002***	-0.002***
	(0.000)	(0.000)
total capital / ta	0.178***	0.167***
	(0.045)	(0.034)
$\Delta\sigma_{A,t}$	0.139***	0.156***
	(0.051)	(0.052)
$\Delta\sigma_{A,t+1}$	0.381***	1.028***
	(0.072)	(0.345)
$\Delta\sigma_{A,t+1}$ × size		-0.078**
		(0.037)
constant	-0.001	0.002
	(0.006)	(0.005)
Country × Year FE	Yes	Yes
Observations	9,080	9,080
R-squared	0.042	0.048

Table 8: Volatility adjusted risk weights and systemic risk

Regression results of model $systemic\ risk_{ijt} = \beta_0 + \Omega \times bank\_controls_{ijt-1} + \beta_1 \times capital_{ijt-1} + \beta_2 \times rwa_{t-1} / \sigma_{At-1} + \alpha_j \times \lambda_t + \varepsilon_{ijt}$. We report results for the three systemic risk measures, *Covar*, *MES* and *Rsq* separately. Definitions of all variables are listed in Appendix I. Standard errors are reported in parentheses below their coefficient estimates and adjusted for both heteroskedasticity and within correlation clustered at the bank level. *** (**) (*) indicates significance at 1% (5%) (10%) two tailed level, respectively.

VARIABLES	(1) Covar	(2) MES	(3) Rsq
liquid assets / ta	-0.031***	-0.007**	-1.322***
	(0.005)	(0.003)	(0.274)
deposits / ta	-0.033***	-0.016***	-1.061***
	(0.004)	(0.003)	(0.202)
loan loss provisions / ta	-0.300***	0.281***	3.415
	(0.057)	(0.042)	(2.286)
net loans / ta	-0.039***	-0.020***	-1.846***
	(0.004)	(0.003)	(0.201)
size	0.001***	0.000***	0.028***
	(0.000)	(0.000)	(0.003)
total capital / ta	-0.071***	-0.052***	-5.645***
	(0.013)	(0.007)	(0.824)
rwa / ta	0.027***	0.011***	1.391***
	(0.004)	(0.003)	(0.186)
log(rwa) / σ_A	-0.018	-0.030***	-0.500
	(0.013)	(0.007)	(0.602)
constant	0.086***	0.043***	-0.292
	(0.004)	(0.002)	(0.207)
Country × Year FE	Yes	Yes	Yes
Observations	9,818	9,960	9,964
R-squared	0.371	0.432	0.271

Table 9: Systemic risk regulation and supervision

Regression results of model $systemic\ risk_{ijt} = \beta_0 + \Omega \times bank\_controls_{ijt-1} + \beta_1 \times post + \beta_2 \times regulation_j + \beta_3 \times capital_{ijt-1}$ $\beta_4 \times capital_{ijt-1} \times post + \beta_5 \times capital_{ijt-1} \times regulation_j + \beta_6 \times capital_{ijt-1} \times regulation_j \times post + \alpha_j \times \lambda_t + \varepsilon_{ijt}$. The years 2004-2006 and 2011-2013 are included in the sample. The variable *post* is a dummy variable and takes on a value of one for the 2011-2013 time period. We report results for the three systemic risk measures, *Covar*, *MES* and *Rsq* separately. Columns 1 to 3 report results using the *total capital / rwa* as the *capital* measure and columns 4 to 6 use *total capital / ta*. Definitions of all variables are listed in Appendix I. Standard errors are reported in parentheses below their coefficient estimates and adjusted for both heteroskedasticity and within correlation clustered at the bank level. *** (**) (*) indicates significance at 1% (5%) (10%) two tailed level, respectively.

	Covar			MES			Rsq		
VARIABLES	Coef	# obs	R^2	Coef	# obs	R^2	Coef	# obs	R^2
Panel A: Risk-weighted assets									
Q1× total capital / rwa × post	-0.072***	3,568	0.198	-0.042***	3,979	0.112	-1.537*	3,641	0.164
	(0.023)			(0.015)			(0.883)		
Q2× total capital / rwa × post	-0.042	3,608	0.186	-0.012	4,031	0.088	-2.419*	3,681	0.160
	(0.027)			(0.022)			(1.393)		
Q3× total capital / rwa × post	0.024	1,756	0.160	-0.027	2,140	0.051	-0.994	1,827	0.040
	(0.037)			(0.021)			(0.812)		
Q4× total capital / rwa × post	-0.017	3,617	0.193	-0.027***	4,055	0.105	0.577	3,739	0.174
	(0.018)			(0.010)			(0.917)		
Q5× total capital / rwa × post	-0.061***	3,671	0.194	0.005	4,164	0.093	-2.488**	3,796	0.168
	(0.018)			(0.010)			(0.975)		
Q6× total capital / rwa × post	-0.009	3,671	0.196	-0.037***	4,164	0.118	0.656	3,796	0.171
	(0.020)			(0.011)			(1.039)		
rindex× total capital / rwa × post	-0.069***	3,555	0.202	-0.024***	3,959	0.117	-2.478***	3,628	0.165
	(0.018)			(0.009)			(0.808)		
Panel B: Total assets									
Q1× total capital / ta × post	-0.315***	3,010	0.213	-0.053	3,324	0.158	-4.630	3,081	0.160
	(0.069)			(0.043)			(4.256)		
Q2× total capital / ta × post	-0.048	3,029	0.200	-0.098**	3,357	0.140	-9.643***	3,100	0.160
	(0.075)			(0.040)			(3.591)		
Q3× total capital / ta × post	-0.113	1,236	0.245	-0.034	1,526	0.122	6.616	1,304	0.071
	(0.544)			(0.050)			(6.106)		
Q4× total capital / ta × post	0.034	3,032	0.208	-0.010	3,377	0.153	-1.707	3,153	0.168
	(0.079)			(0.050)			(4.582)		
Q5× total capital / ta × post	-0.194***	3,072	0.214	-0.017	3,466	0.147	-7.111*	3,194	0.166
	(0.069)			(0.038)			(4.048)		
Q6× total capital / ta × post	0.136*	3,072	0.209	0.040	3,466	0.152	-0.277	3,194	0.166
	(0.082)			(0.053)			(3.824)		
rindex× total capital / ta × post	-0.138***	3,004	0.215	-0.032**	3,313	0.167	-3.971*	3,075	0.163
	(0.038)			(0.016)			(2.377)		

Appendix I. Variable definitions

Variables	Definitions
Systemic risk variables	
Rsq	Logistic transformation of rsq (i.e.. log(rsq/(1-rsq))) , where rsq is r-squared from a regression of weekly change in distance to default on country average weekly change in distance to default (excluding the bank in question) by year.
Covar	Change in the VaR of the system when the institution is at the 1% percentile minus the VaR of the system when the institution is at the 50% percentile.
MES	The difference between the asset value of a firm and the face value of its debt scaled by the standard deviation of the firm's asset value, calculated from the Merton (1974) model.
Capital variables	
total capital / rwa	Tier 1 capital (sum of shareholder funds perpetual and non-cumulative preference shares) plus Tier 2 capital (subordinated debt, loan loss reserves, and valuation reserves) divided by risk-adjusted assets and off balance sheet exposures.
tier 1/ rwa	Tier 1 capital divided by risk-adjusted assets and off balance sheet exposures.
tier 2 / rwa	Tier 2 capital divided by risk-adjusted assets and off balance sheet exposures.
total capital / ta	Tier 1 capital plus Tier 2 capital divided by total assets.
tier 1/ ta	Tier 1 capital divided by total assets.
tier 2 / ta	Tier 2 capital divided by total assets.
tangible / ta	Tangible equity divided by tangible assets
common / ta	Common equity divided by total assets
Bank level variables	
size	Log value of total assets in millions of US dollars divided by the average assets of all other banks in a given country
50bn_dum	A dummy variable that takes on a value of 1if assets of a bank is greater than $50 billion USD.
liquid assets / ta	Liquid assets divided by total assets
deposits / ta	Total deposits divided by total assets.
loan loss provisions / ta	Loan loss provisions divided by total assets.
net loans / ta	Net loans divided by total assets.
earnings / total loans	Net income divided by total gross loans
Δrwa/ta	Annual change in risk-weighted assets divided by total assets
$\Delta\sigma_A$	Annual change in asset volatility computed from the Merton model using equity return volatility, leverage and equity values.
log(rwa)/σ_A	Log value of risk-weighted assets divided by asset volatility computed from the Merton model.
Country level variables	
crisis	A dummy variable that equals 1 if a country is experiencing a crisis defined as in Leaven and Valencio (2010) in a given year and 0 otherwise.
deposit insurance	A variable indicates whether a country has explicit deposit insurance (Yes=1/No=0) and whether depositors were fully compensated the last time a bank failed (Yes=1/No=0). The variable ranges from 0 to 2.
supervisory power	A variable that ranges from zero to fourteen, with fourteen indicating the highest power of the supervisory authorities. For each of the following fourteen questions, a value of 1 is added to the index if the answer is yes:

	1. Does the supervisory agency have the right to meet with external auditors to discuss their report without the approval of the bank? 2. Are auditors required by law to communicate directly to the supervisory agency any presumed involvement of bank directors or senior managers in illicit activities, fraud, or insider abuse? 3. Can supervisors take legal action against external auditors for negligence? 4. Can the supervisory authority force a bank to change its internal organizational structure? 5. Are off-balance sheet items disclosed to supervisors? 6. Can the supervisory agency order the bank's directors or management to constitute provisions to cover actual or potential losses? 7. Can the supervisory agency suspend the directors' decision to distribute: a) dividends? b) bonuses? c) management fees? 8. Can the supervisory agency legally declare-such that this declaration supersedes the rights of bank shareholders-that a bank is insolvent? 9. Does the banking Law give authority to the supervisory agency to intervene that is, suspend some or all ownership rights-a problem bank? 10. Regarding bank restructuring and reorganization, can the supervisory agency or any other government agency do the following: a) supersede shareholder rights? b) remove and replace management? c) remove and replace directors? Data comes from the World Bank regulation and supervision surveys described in Barth, Caprio, and Levine (2000, 2003, 2008).
credit info depth	A variable that ranges from zero to six, with higher values indicating deeper credit information. A value of 1 is added to the index when a country's reporting system has each of these characteristics: (1) both positive and negative information are distributed; (2) data on both firms and individuals are distributed; (3) besides data from financial institutions, data from retailers and utility companies are also distributed; (4) more than two years of historical data are distributed; (5) Data on loans below 1% of income per capita are distributed; and (6) laws guarantee borrowers the right to inspect their data in the largest registry in the economy. Data comes from the World Bank regulation and supervision surveys described in Barth, Caprio, and Levine (2000, 2003, 2008).
public registry	An indicator variable that is equal to 1 if a public registry operates in the country and 0 otherwise. Data comes from Djankov, McLiesh, and Shleifer (2007) and World Banking Doing Business Survey.
private bureau	An indicator variable that is equal to 1 if a private bureau operates in the country and 0 otherwise. Data comes from Djankov, McLiesh, and Shleifer (2007) and World Banking Doing Business Survey.
disclosure	A variable that indicates whether the income statement includes accrued or unpaid interest or principal on nonperforming loans, whether banks are required to produce consolidated financial statements, and whether bank directors are legally liable if information disclosed is erroneous or misleading. The variable ranges from 0 to 3, with a higher value indicating more informative bank account. Data comes from the World Bank regulation and supervision surveys described in Barth, Caprio, and Levine (2000, 2003, 2008).
audit	A variable that indicates whether an external audit is required of the financial statements of a bank and, if so, by a licensed or certified auditor. The variable ranges from 0 to 2, with a higher value indicating more informative bank account.
rated	The fraction of ten biggest banks rated by international rating agencies.
rindex	An index measuring systemic regulation and supervision based on answers to the questions in the 2011-2012 World Bank regulation and supervision survey covering the 2008-2010 time period. The index ranges from zero to six. For each of the following six questions, a value of 1 is added to the index if the answer is yes: Q1: Is there a specialized

	department in your agency dealing with financial stability and systemic supervision? Yes?/No?; Q2:If you perform stress tests at the system-wide level, using bank-by-bank data; Q3: Do you have any counter-cyclical regulations or tools to dampen boom/bust cycles in credit flows?; Q4: Is the counter-cyclical regulation capital requirements?; Q5: Do you supervise systemic institutions in a different way than non-systemic ones? Yes?/No?; Q6: Do you have any tools to oversee more closely and/or limit the activities of large/interconnected institutions? Yes?/No?