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Klomp, Jeroen; de Haan, Jakob

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Banking risk and regulation: Does one size fit all?

Jeroen Klomp [a], Jakob de Haan [b,c,*]

[a] Wageningen University, Social Sciences Group, PO Box 8130, 6700 EW Wageningen, The Netherlands
[b] De Nederlandsche Bank, PO Box 98, 1000 AB, Amsterdam, The Netherlands
[c] University of Groningen, The Netherlands

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ABSTRACT

Using data for more than 200 banks from 21 OECD countries for the period 2002–2008, we examine the impact of bank regulation and supervision on banking risk using quantile regressions. In contrast to most previous research, we find that banking regulation and supervision has an effect on the risks of high-risk banks. However, most measures for bank regulation and supervision do not have a significant effect on low-risk banks. As banking risk and bank regulation and supervision are multi-faceted concepts, our measures for both concepts are constructed using factor analysis.

1. Introduction

The world wide financial crisis following the failure of Lehman Brothers in September 2008 has highlighted the importance of adequate bank regulation and supervision. The G20 recently approved a package of proposals of the Basel Committee on Banking Supervision to strengthen global capital and liquidity regulations in order to promote a more resilient banking sector.[1]

In view of its importance, it is quite remarkable that only a limited number of studies have examined the impact of bank regulation and supervision on bank fragility. Several previous studies report that bank regulation and supervision have little, if any, effect on banking risk. A good example is the study by Demirgüç-Kunt and Detragiache (2011). Employing data for 3000 banks from 86 countries, they do not find support for the hypothesis that better regulation and supervision results in sounder banks. These authors use adherence to the Core Principles for Effective Bank Supervision as issued by the Basel Committee on Banking Supervision (BCPs) as indicators of bank regulation and supervision.[2]

Alternatively, a few studies – including the present one – employ the World Bank survey on supervision to construct measures of bank regulation and supervision. Barth et al. (2004) analyze the effect of different dimensions of bank regulation and supervision on bank stability using an earlier version of the survey dataset. Their findings suggest that policies that induce accurate information disclosure and (incentives for) private sector corporate control of banks work best to promote banking sector stability. Also Pasiouras et al. (2006) use this survey to construct indicators of bank regulation and supervision. Employing bank level data from 71 countries and 857 banks, they find that some dimensions of bank regulation and supervision have a significant impact on bank ratings.

As bank regulation and supervision is a multi-faceted concept, we apply principal component analysis to the data provided by Barth et al. (2004, 2008) to construct measures of bank regulation and supervision. Likewise, we use factor analysis on Bankscope data for more than 200 banks in 21 OECD countries for the period 2002–2008 to construct measures of banking risk. Our study is certainly not the first examining the impact of bank regulation and supervision using bank-level data (see, for instance, González, 2005; Demirgüç-Kunt et al., 2008; Fonseca and González, 2010). However, while most of these studies focus on one indicator of risk, we apply factor analysis to 25 indicators of banking risk to come up with our preferred measures of risk. The factor analysis suggests that two factors capture most of the variance of the various

* Corresponding author. Tel.: +31 205245657; fax: +31 205242506.
E-mail addresses: jeroen.klomp@wur.nl (J. Klomp), Jakob.de.Haan@dnb.nl (J.de Haan).

[1] See http://www.bis.org/press/p091217.htm.

[2] Other studies based on BCP compliance, which is classified information, include Das et al. (2005), Podpiera (2006), and Demirgüç-Kunt et al. (2008).

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indicators of banking risk, which we label 'capital and asset risk' and 'liquidity and market risk'.

Finally, most previous studies use panel models in which it is assumed that the effect of regulation and supervision on banking risk is homogenous. But in view of the heterogeneity of the banks and countries included, this assumption may be questioned.[3] We therefore use a multilevel quantile regression model to estimate the relationship between bank regulation and supervision and banking risk. This approach, proposed by Koenker and Bassett (1978), allows us to derive different parameter estimates for various conditional quantiles of the risk distribution. We find that bank regulation and supervision does not have a uniform impact on banking risk. While our measures for bank regulation and supervision do not have much effect on low-risk banks, they have a highly significant effect on high-risk banks.

The remainder of the paper is structured as follows. The next section describes the data and methodology used. Section 3 presents the results for the effect of bank regulation and supervision on banking risk, while Section 4 contains the sensitivity analysis. The final section discusses our results and concludes.

2. Data and methodology

2.1. Factor analysis: banking risk

Studies that examine bank behavior usually employ a one-dimensional risk indicator, like the share of non-performing loans, return on equity, the *Z*-factor, capital ratios, or credit ratings. However, it is questionable whether these indicators fully capture banking risk. Furthermore, most indicators based on balance sheet data contain some measurement error due to, for example, different calculation methods for on- and off balance issues (Zhao et al., 2009).

For all these reasons, we employ factor analysis on 25 indicators of banking risk. Factor analysis is a statistical data reduction technique used to explain variability among observed random variables in terms of fewer unobserved random variables called factors.[4] The observed variables are modeled as linear combinations of the factors plus an error term. The eigenvalue for a given factor measures the variance in all the variables that is accounted for by that particular factor. If a factor has a low eigenvalue it may be ignored, as other factors are more important in explaining variance.

We use proxies for the International Monetary Fund (IMF)'s core set of Financial Soundness Indicators or CAMEL indicators—i.e., capital adequacy, asset quality, earnings and profitability, and liquidity (IMF, 2000). There is broad agreement in the empirical literature that the CAMEL indicators are useful in assessing the financial vulnerability of banks. Supervisors often use (combinations of) these indicators to come up with an assessment of a bank's soundness. However, there is no clear agreement in the literature on how exactly to combine the various CAMEL indicators. We therefore apply Dynamic Factor Analysis (DFA) to 25 CAMEL indicators for 219 banks in 21 OECD countries for the period 2002–2008. Table 1 shows the indicators used. The data is taken from Bankscope of Bureau van Dijk and Thomson Datastream. Table A2 in Appendix A shows the correlation matrix of the indicators used. The correlations range between −0.6 and 0.6 illustrating that the indicators measure different forms of banking risk.

The commercial banks included in our sample are chosen on the basis of data availability: we only include banks for which we have more than 75% of the data on the risk indicators used. For some banks in our sample, some indicators are not available for all years. Overall, we have less than 15% missing observations. In order not to lose valuable information, we applied the EM algorithm of Dempster et al. (1977) to compute the missing observations.[5]

We divide the 25 indicators of banking risk in categories following the IMF (2000). The first group consists of indicators of capital adequacy. According to the IMF (2000), capital adequacy ultimately determines the robustness of financial institutions to shocks to their balance sheets. We measure capital adequacy using the ratio between total equity and total assets, and the total capital ratio.

The second group consists of risk variables related to asset quality. We proxy asset quality by (1) the ratio of loan loss provisions and total loans, (2) the ratio of non-performing loans and total loans, (3) the ratio of unreserved impaired loans and equity, and (4) the ratio of impaired loans and equity. An increasing non-performing loans ratio signals a deterioration of the quality of the credit portfolio, which may affect the financial soundness of the bank. It is often helpful to supplement this information with information on non-performing loans net of provisions, and the ratio of provisions plus interest suspension on impaired loans to total loans—particularly, if impaired loans have not yet been classified as non-performing.

The third group of variables consists of indicators referring to managerial qualities. A high ratio of expenses to total revenues may indicate that financial institutions are not operating efficiently due to management deficiencies. We proxy managerial quality by three indicators: the ratio of total costs and total income; the ratio of overhead costs and total assets; and profits per employee.

The fourth group consists of risk indicators related to the profitability of a bank. Declining trends in profit indicators may signal problems regarding the sustainability of financial institutions. On the other hand, unusually high profits may signal excessive risk-taking. Our first proxy is the ratio of profits and equity, which reflects the average return investors get from holding bank equity. The ratio has to be interpreted with caution, since a high (low) ratio may indicate both high (low) profitability as well as low (high) capitalization. As an alternative, we use the return on assets, which is commonly used to assess the risk of a financial institution. Next, we use the ratio between charge offs and total earnings as proxy for profitability. Finally, we include the *Z*-score, which is the number of standard deviations below the mean by which returns would have to fall to wipe out bank equity.

The fifth group of variables consists of indicators of liquidity and leverage. As the case of Northern Rock has shown, insufficient liquidity may threaten the survival of a bank, notably so in case of severe maturity mismatches. A high leverage ratio may also indicate riskiness. We proxy liquidity and leverage by the following indicators: liquid assets to total assets; total loans to deposits; fixed assets to total assets; subordinated debt to equity; liquid assets to short-term funds; debt due to the central bank; and debt due to other commercial banks.

Additional to the categories as distinguished by the IMF, we include a category related to market risk, i.e., the risk that the value

[3] Indeed, Delis et al. (2009) report that the effect of capital regulation on risk taking by banks is heterogeneous across countries, while Beatty and Gron (2001) find that capital regulation has a significant effect on low-capital banks but not on other banks. Likewise, Hanson et al. (2008) show that neglecting heterogeneity in banking risk may lead to inconsistent estimation results.

[4] Cf. Lattin et al. (2003), Wansbeek and Meijer (2000) and Stock and Watson (2002). An appendix to this paper that is available upon request contains an extensive description of the dynamic factor analysis methodology.

[5] There is a trade-off between including as many variables and banks on the one hand and the availability of all data on the other. We choose to use the 75% cut-off point as a reasonable compromise. If we increased the cut-off point to 80% our dataset would be reduced by more than 20%. On the other hand, increasing the number of observations by 10% would imply a cut-off point of 60% in which case about 30% of the data used in the analysis would be based on estimated data.

Table 1
Banking risk: dynamic factor analysis.

	(1) Lags	(2) Factor 1 Capital and asset risk	(3) Factor 2 Liquidity and market risk	(4) Variance explained
Capital adequacy				
Total equity/total assets	1	**−0.627**	−0.013	0.39
Total capital ratio	1	**−0.890**	−0.140	0.81
Asset quality				
Loan loss provision/total loans	−1	**−0.685**	−0.021	0.47
Nonperforming loans/total loans	−1	**0.853**	0.006	0.73
Unreserved impaired loans/equity	−1	**0.512**	0.159	0.29
Impaired loans/equity	0	**−0.880**	−0.292	0.86
Managerial qualities				
Total cost/total income	−1	−0.259	−0.278	0.14
Overhead cost/total assets	−1	0.078	0.270	0.08
Profit/number of employees	0	0.145	0.231	0.12
Earnings and profitability				
Return on equity	0	**−0.871**	−0.300	0.85
Return on assets	0	**−0.658**	−0.323	0.54
Charge offs/total equity	1	**0.734**	0.230	0.59
Log (Bank *Z*-score)	0	**−0.753**	0.002	0.57
Liquidity				
Liquid assets/total assets	0	−0.178	**−0.853**	0.76
Total loans/deposits	0	0.165	**0.782**	0.64
Fixed assets/total assets	0	0.020	**0.769**	0.59
Subordinated debt/equity	0	0.245	**0.860**	0.80
Liquid assets/customers and short-term funds	0	−0.233	**−0.883**	0.83
Due to central bank/total equity	1	0.112	**0.474**	0.35
Due to commercial banks/total equity	1	0.098	0.273	0.14
Market risk management				
Total interest expenses/total deposits	0	0.284	0.199	0.12
Off balance items/total assets	0	0.033	**0.676**	0.46
Government deposits/total deposits	0	−0.199	**−0.618**	0.42
Government securities/total assets	0	−0.302	**−0.599**	0.45
Stock return variability	−1	**0.552**	**0.542**	0.73
Correlation with the maximum		0.414	0.428	
Correlation with the minimum		0.427	0.374	
AR coefficient of the common part λ		0.438	0.397	
h-Squared	0.583			
Likelihood ratio test *p*-value	0.001			
Bai and Ng test *p*-value	0.000			
Kaiser–Meyer–Olkin test	0.641			

This table presents the outcomes of the factor analysis on 25 indicators of banking risk. The chosen lag lengths are shown in column (1). Columns (2) and (3) show the factor loadings on factor 1 and factor 2, respectively. The numbers in bold are above 0.4, indicating that these indicators are relevant in capturing this type of risk.

of a portfolio will decrease due to price changes. According to the IMF (2000), banks are increasingly involved in diversified operations, all of which involve one or more aspects of market risk. A high share of investments in volatile assets may signal a high vulnerability to fluctuations in the market value of those assets. Also some off-balance sheet items may have market risk. We proxy market risk by: total interest expenses to total deposits; off balance items to total assets; government deposits to total deposits; government securities to total assets; and the stock return variability.

One problem is that some indicators are of an *ex ante* nature (e.g., loan ratios) while others are *ex post* variables (e.g., capital and equity ratios). Whereas *ex ante* variables indicate a possible future risk, *ex post* variables indicate the presence of a risk. As a solution, we estimate various factor models with changing lags and leads (with a maximum of 2 years) and compare the models on the basis of different information criteria and the likelihood ratio statistics. The various factor models are highly correlated with a correlation coefficient ranging between 0.81 and 0.89.[6] The chosen lag lengths are shown in column (1) of Table 1.

The next step is to decide on the number of factors to represent banking risk. There is no 'optimal' criterion for deciding on the proper number of factors. According to the so-called Kaiser criterion, all factors with eigenvalues below one should be dropped. Alternatively, the Cattell scree test, which is a graphical method in which the eigenvalues are plotted on the vertical axis and the factors on the horizontal axis, can be used. This test suggests selecting the number of factors that corresponds to the point after which the remaining factors decline in approximately a linear fashion, and to retain only the factors above the elbow. Finally, information criteria, such as the information criterion proposed by Bai and Ng (2002), can be used.

According to both the Kaiser rule and the scree plot, banking risk can be represented as a two dimensional construct (see Fig. 1). The two-factor model is highly significant: the *p*-value of the likelihood ratio test is 0.001. Also the Bai and Ng information criterion suggests a two-factor model. We therefore decided that the two-factor model is appropriate to represent banking risk.

Columns (2) and (3) in Table 1 show the factor loadings on factor 1 and factor 2, respectively. About 60% of the variance is explained by the two factors (column 4), while about 40% of the total variance is unique, i.e., unexplained.

We use oblimin rotation, which minimizes the correlation between columns of the factor loadings matrix, to interpret the factors. In the first factor, variables on capital adequacy and asset

[6] The estimation results of the various models are available upon request.

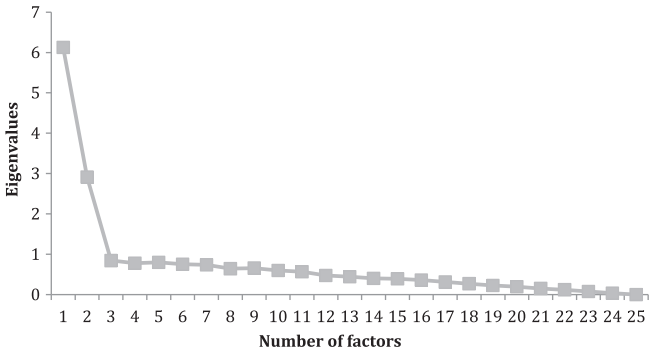

Fig. 1. Scree plot banking risk factors.

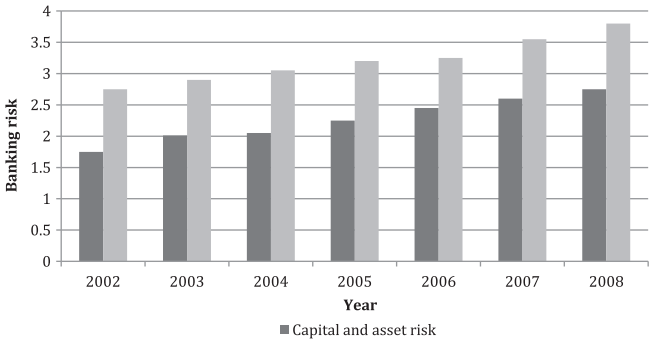

Fig. 2. Average measures of banking risk, 2002–2008.

quality score high so we call this factor 'capital and asset risk'. In the second factor, variables related to market risk and liquidity risk score high so we call this factor 'liquidity and market risk'. The correlation between the two factors is only 0.28, suggesting that both factors measure a different dimension of banking risk.

The risk factors are not very persistent as shown by the low correlation of the median score with the maximum or minimum score of the two factors (see Table 1). This is confirmed by the AR coefficient of the common part, which is significant but lower than 0.5. Fig. 2 presents a comparative analysis of the two dimensions of banking risk. We find that both types of risk are accumulating over time. On average, the 'capital and asset risk' indicator is about 3.17, while the 'liquidity and market risk' indicator is about 2.42. However, there are large differences between banks as illustrated by the standard deviation of the two risk measures (2.45 for 'asset and capital risk' and 2.12 for 'liquidity and market risk').

To check the validity of our indicators, we first compare them with the average credit default swap premium over the period 2002–2008. A credit default swap is an insurance contract against the default risk of bank. The premium of a credit default swap depends on the probability that the default risk materializes. The correlation between the credit default premium and 'capital and asset risk' is about 0.51 ($p = 0.000$), while the correlation between the credit default premium and 'liquidity and market risk' is about 0.36 ($p = 0.001$).[7]

As a second step, Fig. 3 shows the risks of banks, which drop from our sample (at $t = 4$) due to failure. The results show that, compared to Fig. 2, these banks accumulated more risk. On average, the level of risk of institutions that failed is about six times larger than the average risk in our sample. Fig. 3 also shows that 'liquidity and market risk' increases faster than 'capital and asset risk', suggesting that banks may first encounter liquidity problems which pass-through to capital and asset problems, for example, due to fire sales.

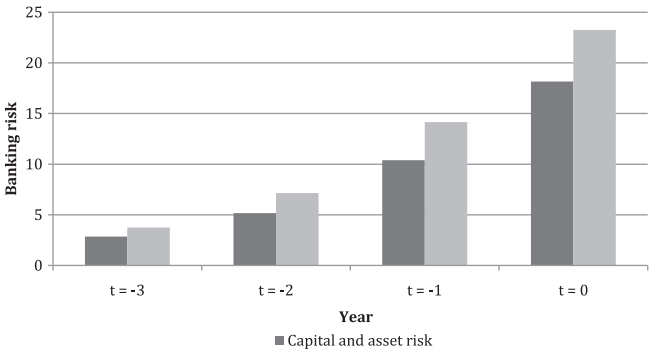

Fig. 3. Risk accumulation of failed banks.

As a robustness check, we re-estimate the factor analysis differentiating between banks for which we have data for the full sample period and banks that disappear over time due to a failure, a merger or acquisition. We find that the factor loadings on the risk indicators are somewhat higher in the latter sample. However, the results for the two samples do not show large differences compared to the results presented above (results are available upon request).[8]

2.2. Principal component analysis: bank regulation and supervision

Essentially two sources of information have been used to construct proxies for bank regulation and supervision. First, several studies (cf. Demirgüç-Kunt et al., 2008; Demirgüç-Kunt and Detragiache, 2011) use an index measuring the extent to which countries adhere to the Core Principles for Effective Bank Supervision as issued by the Basel Committee on Banking Supervision (BCPs). As compliance with the BCPs is mostly classified information, we use World Bank survey data to compute proxies for bank regulation and supervision. In several surveys, Barth et al. (2004, 2008) collected detailed and comprehensive information on bank regulation and supervision for more than 107 countries between 1999 and 2008. In our analysis we use the information provided by the World Bank for the 21 OECD countries in our sample.[9]

Following Pasiouras et al. (2006), we classify the survey questions used into seven groups: (1) capital regulations; (2) regulations on private monitoring; (3) regulations on activities restrictions; (4) supervisory control; (5) deposit insurer's power; (6) liquidity regulations, and (7) market entry regulations. In constructing our regulation and supervision variables, we use principle component analysis (PCA), which produces a factor score with mean zero and standard deviation one. An advantage of this method is that individual questions are not equally weighted.[10] Table A5 in Appendix A shows the (classification of the) questions of the survey included in our analysis, as well as their variation. The first principal component explains between 60% and 75% of the total variance of the questions included.

[7] We have also redone the factor analysis adding lagged credit ratings and the CDS premium to the list of indicators used in the factor analysis. Yet, due to the availability of the data the inclusion of these indicators would reduce our dataset by about 40%. Still, inclusion of these variables has little effect on the factor loadings of the other risk indicators (results are available on request).

[8] The analysis shown in Section 4 has also been done with these alternative factor models. The results (available upon request) are in line with those reported.

[9] We also did the principle component analysis for 107 countries. The results (available on request) are in line with those reported.

[10] We also simply sum the individual zero/one answers. This method gives equal weight to each of the questions in constructing the regulatory variables. However, the results are very similar to those reported and are available upon request.

The first measure refers to capital regulations and takes various issues into account, like: can regulatory capital include borrowed funds, are the sources verified by the regulatory or supervisory authorities, are risk elements and value losses considered in calculating regulatory capital? Fernandez and González (2005) find that stringent capital requirements reduce banking risk.

The second dimension refers to regulations on private monitoring. This variable measures the degree of information that is released to officials and the public, and requirements concerning auditing and credit ratings. Fernandez and González (2005) conclude that regulations that encourage and facilitate private monitoring of banks increase financial soundness, as they lower moral hazard created by information asymmetries.

The third measure captures regulations on activity restrictions. Due to moral hazard, banks may increase risk if they are allowed a broad range of activities (Boyd et al., 1993). However, the empirical results of Barth et al. (2004) indicate the opposite: restricting bank activities is negatively associated with bank stability and increases the probability of a banking crisis. In contrast, Demirgüç-Kunt and Huizinga (2009) find that banking strategies that rely prominently on generating non-interest income or attracting non-deposit funding create financial instability.

The fourth dimension represents the ability of supervisors to exercise power and to get involved in banking decisions. This variable is related to the supervisor's power in terms of prompt corrective action, declaring insolvency, and restructuring. Strong supervisory control can prevent managers from engaging in excessive risk-taking behavior. Barth et al. (2004) do not confirm the hypothesis that there is a significant relationship between banking risk and official supervisory power, but Fernandez and González (2005) report that in countries with low accounting and auditing requirements more supervisory control appears to reduce risk.

The fifth measure covers deposit insurance and the power of the deposit insurer. According to Demirgüç-Kunt and Detragiache (2002), a deposit insurance system influences bank soundness in two opposite ways. On the one hand, bank runs are less likely to occur when deposits are insured. On the other hand, a deposit insurance system provides banks incentives to engage in more risk-taking. Barth et al. (2004) and Demirgüç-Kunt and Detragiache (2002) provide evidence that an explicit deposit insurance scheme tends to increase the probability of banking crises.

The sixth regulatory dimension refers to liquidity regulations. Wagner (2008) finds that an increase in the homogeneity of banks' balance sheets decreases financial soundness due to the joint exposure to liquidity problems in other banks at the interbank market caused by, for example, fire sales.

The final regulatory dimension reflects the ease with which the domestic banking market can be entered. Beck et al. (2006) report that that banking systems where a large fraction of entry applications are denied and where regulations restrict banks from engaging in non-loan activities face a higher probability of a systemic crisis.

The correlation matrix in Table 2 shows that the correlation between the seven measures of bank regulation and supervision ranges between −0.12 and 0.37 indicating that the various measures capture different dimensions of the regulatory framework.

Table 3 categorizes the countries according to the difference between the maximum and minimum factor scores. In contrast to our measures for banking risk, Table 3 suggests that our measures for banking regulation and supervision are very persistent. In most cases more than 80% of the countries have a difference between the maximum and minimum score of less than 10%.[11] Due to the limited fluctuations over time of our measures for banking regulation and supervision, the probability that reverse causality (i.e. banking risk affects bank regulation and supervision) drives our findings seems limited.

2.3. Empirical model

In this section, we develop our model to examine the relationship between risk-taking by banks and bank regulation and supervision. As we include a large number of banks from different countries, our sample is very well suited to test whether our measures of banking regulation and supervision have a homogeneous impact on our proxies for banking risk. We use quantile regressions, as introduced by Koenker and Bassett (1978), which is a generalization of median regression analysis to other quantiles. The median regression fits a regression line through all observations by minimizing the sum of absolute errors, i.e., it estimates the median of the conditional distribution. The τth quantile of the conditional distribution is estimated by minimizing:

$$\phi_\tau(Y - X\beta) \tag{1}$$

with respect to β, where $\phi_\tau(u) = \phi(\tau - I(u < 0))$ where I is an indicator function and u equals $Y - X\beta$. This function can be interpreted as the inclination of bank riskiness (Y), which is dependent on observed variables (X) and a random error term (u). The conditional quantile function can be formally expressed as:

$$Q_{Y_i} = (\tau|x_i) = x_i'\beta(\tau) \tag{2}$$

Estimating a whole set of quantile functions provides a richer description of the heterogeneous relation between bank regulation and supervision and bank soundness. While standard regression estimators (like OLS) are not robust to modest departures from normality, quantile regression results are robust to outliers and distributions with heavy tails.[12] Furthermore, the quantile regression approach avoids the restrictive assumption that the error terms are identically distributed at all points of the conditional distribution. By allowing for parameter heterogeneity, the quantile regression approach is suitable to explore how bank risk is related to our proxies for bank regulation and supervision at different locations of the banking risk distribution.

As the risk of banks located in the same country may not be independent from one another, we use a multilevel model, which is a particular regression technique that is designed to take into account the hierarchical structure of data (Raudenbush and Bryk, 1987).[13] The baseline quantile regression is given by:

$$Q_{\tau ijt}(BR_{kijt}|RI_{jt}) = \alpha_{\tau ijt} + \theta_\tau BR_{kijt-1} + \beta_{\tau p} Z_{pijt-1} + \gamma_\tau RI_{jt-1} + \eta_t + \varepsilon_{i,t} + \varepsilon_{j,t} \tag{3}$$

where BR_{kijt} is the risk indicator of type k ('capital and asset risk and 'liquidity and market risk') for bank i in country j at time t. We include the lagged dependent variable to control for autoregressive tendencies. Z_{pijt-1} is a vector of (lagged) control variables containing p elements, while RI is a vector containing the measures of (lagged) bank regulation and supervision outlined above. The parameter η_t captures time fixed effects. The final two terms are error terms measured on bank level i and country level j, respectively. The regression is estimated for τ-quantiles, where τ is the 25th, 50th, 75th, and 95th quantile.[14] We estimated the models for 'capital

[11] Likewise, there is a high correlation of the median of our measures for bank regulation and supervision and their maximum and minimum score.

[12] The Jarque–Bera test for normality suggests that normality is rejected at the usual probability levels for both our proxies for banking risk. The p-value for 'capital and asset risk' is 0.08 and the p-value for 'liquidity and market risk' is 0.04. Furthermore, more than 30% of the observations are not in the range of 2 times the standard deviation from the mean.

[13] Alternatively, one can use time fixed effects, country fixed effects and bank fixed effects. However, this decreases the number of degrees of freedom drastically.

[14] We also estimate the regression for the 5th and 10th quantile. However, none of the measures of bank regulation and supervision are significant due to the small number of observations in these quantiles.

Table 2
Correlation matrix: bank regulation and supervision variables.

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Capital regulations	(1)	1.00	−0.12	−0.04	−0.05	−0.09	−0.12	0.01	0.19	0.23
Regulations on private monitoring	(2)		1.00	0.17	0.08	0.12	0.22	0.22	0.08	0.18
Regulations on activity restrictions	(3)			1.00	0.23	0.08	0.37	0.12	0.32	0.33
Supervisory control	(4)				1.00	−0.09	−0.12	0.18	0.10	0.30
Deposit insurer's power	(5)					1.00	−0.05	−0.04	0.08	0.30
Liquidity regulations	(6)						1.00	0.13	0.28	0.18
Market entry regulations	(7)							1.00	0.18	0.10
Financial liberalization	(8)								1.00	0.24
Institutional quality	(9)									1.00

This table shows the correlation between different measures of bank regulation and supervision. The explanation of the way these measures have been constructed is in the main text.

and asset risk' and 'liquidity and market risk' simultaneously using a system of two equations.

We include control variables suggested by previous studies. First, we control for macroeconomic factors: inflation, economic growth, depreciation of the exchange rate, external debt, current account balance, and shocks to the terms of trade (see also Beck et al., 2006). Adverse shocks affecting the economy will increase the instability of the financial system, for example, by affecting the solvency of borrowers, by increasing uncertainty, or by unexpected and excessive exposure to foreign exchange risk. We also include GDP per capita to control for differences in economic development.

According to Demirgüç-Kunt and Detragiache (1998), high short-term real interest rates affect bank balance sheets adversely if banks cannot increase their lending rates quickly enough and hence increase banking risk. Large capital inflows and capital flight may affect the stability of the financial sector. To test whether banking sector risk is related to sudden capital outflows or changes in the foreign exchange reserves, we include the interest rate differential,[15] net financial flows, and the ratio of M2 to foreign exchange reserves.

The government surplus as a percentage of GDP affects the financial room to manoeuvre of a government for intervening in a banking crisis through recapitalization and nationalization operations.

Keefer (1999) argues that not only the economic situation matters for financial soundness but also the political environment of a country. Countries lacking a sound legal system and good governance might have more financial system problems due to corruption or inefficient enforcement of law and government ineffectiveness (La Porta et al., 1998). To capture this, we include a measure based on the first principal component of indicators of the control of corruption, bureaucratic quality, rule of law, and democratic accountability of the International Country Risk Guide (2006).

Next, we include a measure to capture financial liberalization. Improperly implemented financial liberalization is likely to cause banking crises as financial institutions are allowed more opportunities for risk-taking in a liberalized financial market (Kaminsky and Reinhart, 1999). We proxy financial liberalization by including the first principal component of the indicators of credit controls, interest rate controls, capital account restrictions, and security market policy taken from Abiad et al. (2008).[16]

In addition, we add a variable to check whether globalization affects the risk taking behavior of a bank (*source*: Dreher, 2006). Finally, we control for concentration as De Nicolo et al. (2004) find that highly concentrated banking systems exhibit higher levels of systemic risk.

We also include bank-level control variables. First, Shehzad et al. (2010) find that ownership concentration significantly affects loan quality and bank capitalization. We include a dummy variable taking the value one if a bank has a shareholder who owns more than 25% of the bank concerned. We also include dummies reflecting government or foreign ownership. We use the natural logarithm of real total assets to control for the size of a bank. Next, we include the number of subsidiaries as a proxy for diversification and business franchise power. Finally, as Fig. 3 shows that there is a clear relationship between failure and the risk taken by a bank, we include two dummy variables to capture whether a bank failed or merged in a specific year.

Table A3 in Appendix A provides an overview of all variables, their definition as well as their source, while Table A4 presents a correlation matrix. All economic explanatory variables are lagged to avoid simultaneity and endogeneity problems. The lag structure is determined by the Akaike Information Criterion. We also include the lagged 'capital and asset risk' measure as an explanatory variable in the 'liquidity and market risk' regression and vice versa.

Before we proceed, we have to deal with the potential endogeneity of bank regulation and supervision. Barth et al. (2004) argue that bank regulation and supervision is affected by the general policy stance of the government and reflects national differences in legal and political systems. To check for potential endogeneity of bank regulation and supervision, we use a 2SLS instrumental regression model. We include a number of instrumental variables. First, we use the economic freedom index of the Fraser Institute and the ratio of total government spending to GDP, which both measure the involvement of the government in the economic process.[17] Second, we include a political ideology indicator, which measures the policy preferences of the government on a scale from −1 (full leftwing) to +1 (full rightwing); *source*: update of Beck et al. (2001). Third, we take up a measure of central bank independence, which measures differences in the independence of monetary policy makers across countries, following the method of Klomp and De Haan (2010). These variables do not directly impact risk-taking by banks. This is also reflected in the correlation between these variables and our measures of banking risking, which is about zero. We estimate the quantile regressions using the methodology proposed by Chernozhukov and Hansen (2006, 2008) and Galvao (2009) by including also the lagged regressors as instruments to reduce the bias associated with dynamic quantile regressions.

We check the validity of our instruments by the Sargan test under the null hypothesis that the used group of instruments is valid, i.e., they are uncorrelated with the error term in the equation. We cannot reject the null hypothesis, indicating that our set of instru-

[15] Defined as the difference of the real interest rate of a country and the world interest rate. The world interest rate is defined as the average interest rate in the United States, Germany and Japan.

[16] Liberalization, institutional quality and our measures of bank regulation and supervision may be related. However, as shown in Table 2, the correlation between liberalization and institutional quality is very low.

[17] See http://www.freetheworld.com.

Table 3
Changes in bank regulation and supervision.

Change in indicator	Capital regulations	Regulations on private monitoring	Regulations on activity restrictions	Supervisory control	Deposit insurer's power	Liquidity regulations	Market entry regulations
$\Delta I < \|10\|\%$	86.12	87.24	83.30	79.01	77.70	80.44	81.14
$\|10\|\% < \Delta I < \|15\|\%$	11.27	10.76	11.41	12.04	10.63	11.65	11.18
$\|15\|\% < \Delta I < \|20\|\%$	2.17	1.96	2.34	6.37	2.05	2.01	4.04
$\|20\|\% < \Delta I$	0.44	0.52	2.02	2.31	9.62	5.90	3.36

The table shows the share of countries in the individual categories. The categories are based on the *x*% absolute change between the maximum and minimum score of a country for the various measures of bank regulation and supervision.

ments is valid. Next, we apply the Wald test of exogeneity under the null hypothesis that the instrumented variables are exogenous. The results suggest that our bank regulation and supervision measures are not endogenous.

3. Empirical results

Unlike most previous, we consider a very long list of potential control variables. All these variables make sense from a theoretical perspective. In deciding which of these variables should be included in the base model, we apply the general-to-specific method. This method does not rely on economic theory, but is a widely used method in applied econometrics to decide on model specification (see Hendry, 1993). We first estimate a model including all control variables as outlined in the previous section, but without including our proxies for bank regulation and supervision. Next, we drop the least significant variable and estimate the model again. We repeat this procedure until only variables that are significant at a 10% level remain in at least one quantile. In view of the unequal distribution of the number of banks within a country (see Table A1), we cluster the Huber–White standard errors to obtain consistent standard errors. Because our measures for bank regulation and supervision are estimated, we use bootstrapping to obtain consistent standard errors.

About 40% of the total variance in banking risk can be attributed to the variance at the country level. This implies that there is risk dependence within a country and that it is appropriate to use a multilevel model. Table 4 reports the estimated marginal effects evaluated at the mean, which can be interpreted as elasticities, of the determinants of banking risk. Most control variables are significant and have the expected sign in the mean regression. Table 4 also shows that the marginal effect of the control variables differs significantly across quantiles. For instance, the results indicate that dispersed ownership increases the risk-taking behavior of banks with the highest risk. One explanation for this result is that it is caused by the free-riding behavior of small shareholders. No single shareholder has an incentive to monitor bank management, because his personal cost will exceed the benefits. Likewise, the relative size of a bank only significantly increases the riskiness of high-risk banks. Furthermore, financial liberalization has a positive effect on banking risk for banks in the right tail of the risk distribution. The dummies reflecting failure or a merger are only significant for banks in the most riskiest quantile. Finally, we find that for the more riskier quantiles, 'liquidity and market risk' has an effect on 'capital and asset risk' and vice versa.

Next, we include our proxies for bank regulation and supervision in our baseline model. In Table 5 we report the total effect of these measures. That is, we report the sum of the direct effect of a measure and its indirect effect through the effect on the other type of risk (recall that we include 'capital and asset risk' measure as an explanatory variable in the 'liquidity and market risk' regression and vice versa). The share of the indirect effect to the total effect ranges between zero and 20%.[18] This implies that our measures for regulation and supervision have the largest impact on banking risk through their direct effect. The extent to which bank regulation and supervision has a heterogeneous impact can be illustrated by the standard deviation of the coefficients which are reported in columns (6) and (12).

We first add our measure for capital regulations. The results show that, on average, this type of regulation significantly decreases 'capital and asset risk'. An increase of 1% in the level of capital regulation leads to a decrease of 'capital and asset risk' by 0.4%. However, the results also show that the impact is not uniform across quantiles. Capital regulations are most effective for banks with high levels of 'capital and asset risk'.

Next, we include our proxy for regulations on private monitoring. The results indicate that these regulations decrease 'liquidity and market risk', notably so for high-risk banks. In general, the elasticity of regulations on private monitoring is about 0.4. Regulations on private monitoring do not affect 'capital and asset risk'. This illustrates that regulation on private monitoring is not able to reduce 'capital and asset risk'. One explanation is that this type of regulation is quite heterogenous, as follows from the standard deviation of the individual survey questions and the variance explained in Table A5.

Regulations on activities restrictions on average reduce 'liquidity and market risk', but again the effect is only significant for high-risk banks. This dimension of bank regulation and supervision also affects 'capital and asset risk' of high-risk banks, contradicting the popular view that restrictions on bank activities do not influence financial fragility (cf. Barth et al., 2004). One possible explanation is that our results are corrected for heterogeneity, which decreases the likelihood of a spurious relation.

In contrast to other dimensions of bank regulation and supervision, supervisory control significantly affects both types of risk for all banks. However, the effect is larger for riskier banks. This supports the view that if governments want to increase financial soundness, they need to give more power to the authorities responsible for financial stability. Supervisory control has the second highest impact, after capital regulations.

We do not find any effect of regulations on deposit insurance on the level of banking risk. Apparently, the opposing effects of a deposit insurance scheme on banking risk cancel out.

The impact of liquidity regulations is also heterogeneous: although significant in the mean regression, they especially decrease 'liquidity and market risk' of high-risk banks.

Finally, market entry regulations reduce both types of risk, but again the effects are strongest for high-risk banks. One explanation is that market entry regulation is mostly targeted at new banks with riskier business models.

To sum up, we find that, on average, supervisory control, and regulations on capital and market entry have a significant impact on 'capital and asset risk', while supervisory control and regula-

[18] The division between direct and indirect effect is available upon request.

Table 4
Estimation results – baseline model (without bank regulation and supervision).

Quantile	Capital and asset risk					Liquidity and market risk				
	Mean (1)	0.25 (2)	0.5 (3)	0.75 (4)	0.95 (5)	Mean (6)	0.25 (7)	0.5 (8)	0.75 (9)	0.95 (10)
Lagged dependent	0.212 [1.92]**	0.016 [1.05]	0.115 [1.70]*	0.199 [2.15]**	0.341 [2.13]**	0.279 [1.83]*	0.024 [1.02]	0.129 [1.26]	0.253 [2.21]**	0.379 [2.25]**
Inflation	0.005 [0.55]	0.001 [0.04]	0.002 [0.30]	0.007 [0.54]	0.013 [0.80]	0.009 [1.30]	0.000 [0.36]	0.005 [0.86]	0.013 [1.63]	0.025 [2.46]**
GDP growth	−0.120 [−2.17]**	−0.008 [−1.78]*	−0.080 [−1.90]*	−0.193 [−2.62]**	−0.345 [−3.71]**	−0.198 [−2.60]**	−0.022 [−1.78]*	−0.072 [−1.96]**	−0.275 [−3.16]**	−0.511 [−4.49]**
Depreciation	−0.224 [−2.14]**	-0.018 [−0.41]	−0.107 [−0.77]	−0.315 [−2.36]**	−0.521 [−3.65]**	−0.122 [−1.05]	−0.023 [−0.37]	−0.063 [−0.60]	−0.204 [−1.43]	−0.353 [−1.69]*
Current account balance	−0.193 [−1.20]	−0.013 [−0.28]	−0.086 [−0.78]	−0.288 [−1.49]	−0.468 [−1.86]*	−0.269 [−2.44]**	−0.040 [−0.22]	−0.116 [−1.30]	−0.342 [−3.03]**	−0.774 [−4.09]*
Institutional quality	−0.303 [−2.96]**	−0.006 [−2.03]	−0.111 [−2.27]**	−0.410 [−4.05]**	−0.928 [−5.02]**	−0.257 [−2.97]**	−0.001 [−2.17]**	−0.193 [−2.57]**	−0.387 [−3.05]**	−0.779 [−5.23]*
Financial liberalization	0.094 [1.69]*	0.016 [0.05]	0.058 [1.25]	0.168 [2.38]**	0.280 [2.84]**	0.088 [1.93]*	0.002 [0.09]	0.034 [0.98]	0.144 [2.54]**	0.242 [3.45]*
Dispersed ownership	0.100 [1.98]**	0.001 [0.59]	0.039 [1.06]	0.139 [2.16]**	0.242 [3.68]**	0.051 [1.48]	0.008 [0.55]	0.035 [0.75]	0.076 [1.70]*	0.124 [2.94]*
Size	0.025 [1.09]	0.005 [0.80]	0.007 [1.49]	0.014 [1.93]*	0.046 [2.11]**	0.046 [1.26]	0.013 [1.33]	0.035 [1.65]*	0.051 [1.93]*	0.078 [2.05]*
Failure	0.025 [1.23]	0.003 [0.12]	0.015 [0.84]	0.041 [1.26]	0.068 [2.03]**	0.027 [1.14]	0.001 [0.08]	0.014 [0.80]	0.037 [1.44]	0.072 [1.94]*
Merger	0.017 [1.08]	0.002 [0.30]	0.007 [0.74]	0.023 [1.44]	0.046 [1.74]*	0.022 [1.11]	0.004 [0.15]	0.008 [0.52]	0.035 [1.31]	0.056 [1.84]*
Liquidity and market risk	0.154 [1.71]*	0.039 [1.36]	0.076 [1.80]*	0.149 [2.05]**	0.206 [2.07]**					
Capital and asset risk					0.100	0.024 [1.50]	0.103 [0.77]	0.149 [1.56]**	0.204 [2.02]**	[2.04]**
Variance on	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
% Bank level	0.366	0.363	0.376	0.355	0.379	0.398	0.371	0.383	0.401	0.365
% Country level	0.395	0.398	0.421	0.437	0.435	0.466	0.432	0.475	0.453	0.445
Log likelihood test *p*-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Implied *R*-squared	0.254	0.122	0.188	0.397	0.425	0.288	0.173	0.236	0.431	0.473
Sargan *p*-value	0.860	0.900	0.835	0.824	0.821	0.824	0.899	0.831	0.790	0.787
Wald test *p*-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Number of banks	219	219	219	219	219	219	219	219	219	219
Number of observations	1442	1442	1442	1442	1442	1442	1442	1442	1442	1442

The table shows the outcomes of the general to specific approach, using all the control variables discussed in the main text, but not including our measures for bank regulation and supervision.
t-Values are shown in parentheses.
* Significance level of 10%.
** Significance level of 5%.

tions on activities restrictions, private monitoring, market entry, and liquidity, have a significant effect on 'liquidity and market risk'. However, quantile regressions suggest that the effect of regulation and supervision differs across banks: most measures for bank regulation and supervision do not have a significant effect on low-risk banks, while they do affect high-risk banks.

Still, one caveat must be made concerning our measures for bank regulation and supervision. According to Demirgüç-Kunt et al. (2008) a limitation of survey information is that it reflects whether laws and regulations are in place (*de jure*), but not to what extent they are implemented in practice (*de facto*). This may explain why our results differ from previous studies using adherence to the Core Principles for Effective Bank Supervision as issued by the Basel Committee on Banking Supervision (BCPs) like Demirgüç-Kunt and Detragiache (2011). However, also the BCP compliance indicator has its weaknesses. For instance, Demirgüç-Kunt et al. (2008) find that it is only weakly associated with bank soundness, because it proxies for the overall quality of the institutional and macroeconomic environment. Unfortunately, we cannot check whether our results are different if we use a BCP compliance indicator, as this is not available for all countries in our sample due to its classified nature. The next section presents alternative robustness checks.

4. Sensitivity analysis

It is possible that the effect of bank regulation and supervision differs across various types of banks. For instance, Shehzad et al. (2010) argue that bank risk-taking behavior depends on the ownership structure of a bank. As a robustness check, we therefore split our sample as follows: listed vs. non-listed banks, and banks with public vs. banks with private ownership. Another possibility is that regulation has a different effect on banks that differ in terms of their size. Therefore, we also split our sample into small and large banks.

The first two columns of Table 6 show the results for listed vs. non-listed banks. We find that the effects of regulations on liquidity and activity restrictions are higher for listed banks, while the ef-

Table 5
Estimation results – impact of bank regulation and supervision.

Quantile	Capital and asset risk							Liquidity and market risk						
	Mean	0.25	0.50	0.75	0.95	Stand. Dev.	Direct	Mean	0.25	0.50	0.75	0.95	Stand. Dev.	Direct
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Capital regulations	−0.427 [−2.87]**	−0.066 [−0.70]	−0.283 [−2.08]**	−0.702 [−3.44]**	−1.194 [−5.16]**	0.941	0.92	−0.129 [−1.01]	−0.001 [−0.20]	−0.087 [−0.48]	−0.196 [−1.35]	−0.327 [−1.51]	0.312	0.75
Regulations on private monitoring	−0.179 [−1.12]	−0.016 [−0.22]	−0.088 [−0.64]	−0.224 [−1.13]	−0.476 [−1.56]	0.420	0.86	−0.374 [−2.23]**	−0.042 [−0.87]	−0.204 [−1.34]	−0.491 [−2.95]**	−0.970 [−4.20]**	0.877	0.87
Regulations on activities restrictions	−0.112 [−1.49]	−0.008 [−0.44]	−0.043 [−0.62]	−0.176 [−1.74]*	−0.306 [−2.62]**	0.249	0.78	−0.207 [−2.17]**	−0.015 [−0.68]	−0.135 [−1.37]	−0.337 [−2.25]**	−0.574 [−3.93]**	0.480	0.84
Supervisory control	−0.245 [−2.07]**	−0.037 [−1.69]*	−0.164 [−1.87]*	−0.387 [−2.66]**	−0.655 [−3.77]**	0.554	0.84	−0.298 [−2.37]**	−0.036 [−1.74]*	−0.220 [−1.83]**	−0.425 [−3.07]**	−0.757 [−4.08]**	0.700	0.78
Deposit insurer's power	−0.088 [−1.34]	0.004 [−0.01]	−0.066 [−0.58]	−0.142 [−1.06]	−0.236 [−1.59]	0.211	0.85	−0.099 [−1.46]	−0.017 [−0.46]	−0.068 [−0.83]	−0.145 [−1.34]	−0.272 [−1.48]	0.221	0.79
Liquidity regulations	−0.142 [−0.89]	−0.001 [−0.24]	−0.085 [−0.59]	−0.181 [−0.97]	−0.402 [−1.37]	0.307	0.88	−0.512 [−2.89]**	−0.015 [−0.45]	−0.353 [−1.74]*	−0.792 [−3.41]**	−1.477 [−5.16]**	1.255	0.89
Market entry regulations	−0.164 [−1.96]**	−0.017 [−0.69]	−0.066 [−1.24]	−0.233 [−2.56]**	−0.475 [−3.06]**	0.378	0.91	−0.158 [−2.01]**	−0.030 [−0.25]	−0.073 [−1.23]	−0.202 [−2.16]**	−0.441 [−3.75]**	0.366	0.72

Estimated with the control variables included in the model as shown in Table 4. Columns (6) and (13) show the standard deviation of the estimated coefficients. Columns (7) and (14) show the direct effect (as share of the total effect), i.e. the effect of the measure of bank regulation and supervision on capital and asset risk and liquidity and market risk, respectively. The remaining part is the indirect effect that is caused by the inclusion of liquidity and market risk in the model for capital and asset risk and vice versa. *t*-Values are shown in parentheses.
* Significance level of 10%.
** Significance level of 5%.

Table 6
Estimation results – sensitivity analysis.

Median effect	Capital and asset risk						Liquidity and funding risk					
	Listed	Non listed	Government	Private	Large	Small	Listed	Non listed	Government	Private	Large	Small
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Capital regulations	−0.474 [−2.94]**	−0.388 [−3.20]	−0.510 [−2.45]**	−0.493 [−3.06]**	−0.097 [−1.31]	−1.091 [−3.42]**	−0.129 [−1.04]	−0.119 [−0.90]	−0.125 [−0.91]	−0.135 [−0.89]	−0.035 [−0.27]	−0.440 [−2.61]**
Regulations on private monitoring	−0.047 [−0.26]	−0.587 [−3.80]	−0.167 [−1.05]	−0.199 [−1.15]	−0.186 [−1.07]	−0.153 [−1.16]	−0.105 [−0.48]	−1.288 [−2.57]**	−0.341 [−1.73]*	−0.389 [−1.93]**	−0.383 [−2.18]**	−0.365 [−2.41]**
Regulations on activities restrictions	−0.292 [−4.46]**	−0.031 [−0.34]	−0.026 [−0.44]	−0.284 [−5.08]	−0.351 [−4.80]**	−0.024 [−0.33]	−0.658 [−3.09]**	−0.058 [−0.49]	−0.050 [−0.56]	−0.699 [−2.64]**	−0.543 [−3.27]**	−0.055 [−0.59]
Supervisory control	−0.242 [−1.95]*	−0.258 [−1.80]*	−0.292 [−1.76]*	−0.211 [−1.87]*	−0.278 [−2.19]	−0.242 [−2.23]**	−0.340 [−2.59]**	−0.316 [−2.51]**	−0.264 [−2.32]**	−0.318 [−2.29]**	−0.277 [−2.69]**	−0.271 [−2.23]**
Deposit insurer's power	−0.092 [−1.52]	−0.085 [−1.36]	−0.093 [−1.10]	−0.085 [−1.57]	−0.092 [−1.50]	−0.094 [−1.34]	−0.093 [−1.58]	−0.111 [−1.52]	−0.087 [−1.52]	−0.105 [−1.26]	−0.098 [−1.65]	−0.095 [−1.25]
Liquidity regulations	−0.395 [−2.94]**	−0.035 [−0.23]	−0.035 [−0.24]	−0.401 [−2.24]**	−0.133 [−0.96]	−0.124 [−0.92]	−1.744 [−3.16]**	−0.131 [−0.75]	−0.135 [−0.74]	−1.504 [−3.47]**	−0.514 [−3.27]	−0.515 [−2.96]**
Market entry regulations	−0.182 [−2.25]**	−0.164 [−1.82]*	−0.155 [−2.09]**	−0.136 [−1.83]*	−0.156 [−1.95]*	−0.184 [−1.88]*	−0.171 [−1.82]*	−0.170 [−2.13]**	−0.160 [−1.87]*	−0.158 [−1.80]	−0.161 [−1.71]*	−0.136 [−2.07]**

Estimated with the control variables included in the model as shown in Table 4.
t-Values are shown in parentheses.
* Significance level of 10%.
** Significance level of 5%.

fect of regulations on private monitoring is significantly higher for non-listed banks.

In columns (3) and (4) of Table 6 we divide the sample into banks where the government owes more than 50% of the shares and banks that are privately held. The results indicate that restrictions on liquidity and activity have a stronger effect on risks of private banks.

In the final two columns of Table 6, we divide the total sample in banks with a total asset value of more 300 billion US dollar and banks with a total asset value below 300 billion US dollar.[19] The results indicate that regulations on activity restrictions have the largest impact on large banks, while capital regulations have the largest effect on small banks.

So our sensitivity results indicate that the effect of bank regulation and supervision on banking risk is not conditional only on the riskiness of a bank, but also on the ownership structure and the

[19] This is the average size of the banks in our sample over the entire sample period.

Table 7
Geographical split.

Median effect	Capital and asset risk		Liquidity and market risk	
	EMU (1)	North America (2)	EMU (3)	North America (4)
Capital regulations	−0.452 [−3.13]**	−0.386 [−2.73]**	−0.113 [−1.07]	−0.131 [−1.02]
Regulations on private monitoring	−0.179 [−1.21]	−0.147 [−1.03]	−0.312 [−2.27]**	−0.378 [−2.20]**
Regulations on activities restrictions	−0.122 [−1.62]	−0.099 [−1.55]	−0.219 [−2.03]**	−0.165 [−2.17]**
Supervisory control	−0.234 [−2.26]**	−0.227 [−2.02]**	−0.279 [−2.55]**	−0.309 [−2.33]**
Deposit insurer's power	−0.080 [−1.23]	−0.094 [−1.22]	−0.079 [−1.59]	−0.105 [−1.60]
Liquidity regulations	−0.136 [−0.82]	−0.122 [−0.90]	−0.509 [−2.67]**	−0.454 [−2.71]**
Market entry regulations	−0.166 [−2.01]**	−0.159 [−1.95]*	−0.143 [−1.88]*	−0.134 [−2.10]**

Estimated with the control variables included in the model as shown in Table 4.
t-Values are shown in parentheses.
* Significance level of 10%.
** Significance level of 5%.

Table 8
Reverse causality.

	Capital regulations	Regulations on private monitoring	Regulations on activities restrictions	Supervisory control	Deposit insurer's power	Liquidity regulations	Market entry regulations
Capital and asset risk	0.052 [1.48]	0.220 [1.42]	0.297 [1.36]	0.135 [1.17]	0.168 [1.06]	0.255 [1.49]	0.197 [1.04]
Liquidity and market risk	0.070 [0.86]	0.147 [1.47]	0.075 [1.35]	0.190 [0.98]	0.230 [1.46]	0.104 [0.74]	0.186 [0.99]

The model estimates the impact of our measures for banking risk on our measures for bank regulation and supervision. Control variables included are the lagged dependent variable, inflation, depreciation, current account balance, institutional quality, financial liberalization, the number of failures and the number of mergers.

size of the bank. However, the results for the quantiles of the various sample splits show a similar pattern as in Table 5. This implies that most regulatory proxies have the largest impact on high-risk banks (results are available upon request).

In addition, we re-estimate the model for two geographical locations: EMU countries and North America to examine whether geographical factors influence the impact of financial regulation on banking risk. The results as reported in Table 7 suggest that there are no large differences between the two subsamples. In general, the impact of bank regulation and supervision is slightly higher in the EMU sample.

Finally, we check whether results are driven by reverse causality. Arguably, after a period of financial instability governments implement more strict regulation and supervision. This implies that our banking risk indicators are a potential determinant of our bank regulation and supervision variables. The most straightforward way to test for this is to estimate models for our regulation and supervision variables and test for the impact of our banking risk proxies. We estimated the following quantile model:

$$RI_{jit} = \alpha_{\tau it} + \beta_{\tau p} X_{pit-1} + \gamma_{\tau} BR_{it-1} + \delta_i + \delta_t + \varepsilon_{it} \quad (4)$$

where RI_{kit} is a measure for bank regulation and supervision of type j in country i at time t, while BR_{it} is a measure of banking risk (either 'capital and asset risk' or 'liquidity and market risk') in country i at time t. We calculate BR_{it} by using the weighted average of bank specific BR weighted by the total asset size. The vector of control variables X_{pit} includes the lagged dependent variable, inflation rate, depreciation, current account balance, institutional quality, financial liberalization, the number of failures and the number of mergers. As the dependent regulation variable is measured at the country level, we do not include bank-level control variables. The

Table A1
Distribution of banks across countries.

Country	Number of banks	Coefficient of variation
Australia	4	4.457
Austria	3	5.127
Belgium	3	2.472
Canada	4	1.683
Czech republic	1	0.000
Denmark	3	2.676
France	8	2.750
Germany	17	2.353
Greece	3	1.151
Iceland	2	0.865
Ireland	4	1.430
Italy	12	4.003
Japan	9	3.760
Netherlands	3	2.554
Norway	2	3.215
Portugal	4	0.243
Spain	9	2.522
Sweden	5	5.223
Switzerland	2	11.969
United Kingdom	22	3.102
United states	55	2.718
Total	219	2.012

This table shows the number of banks in the countries in our sample and the coefficient of variation of the asset size of the banks in a particular country.

Table A2
Correlation matrix banking risk indicators.

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)
Total equity/total assets	(1)	1.00	0.60	0.58	−0.10	−0.22	−0.24	−0.46	−0.58	0.24	0.55	0.04	−0.23	−0.48	0.43	−0.36	−0.05	−0.47	0.26	−0.35	−0.22	−0.13	−0.03	0.12	0.09	−0.38
Total capital ratio	(2)		1.00	0.01	−0.41	−0.54	−0.53	−0.47	−0.52	0.11	0.39	0.37	−0.54	−0.37	0.05	−0.18	−0.53	−0.16	0.18	−0.04	−0.21	−0.60	−0.36	0.07	0.11	−0.08
Loan loss provision/total loans	(3)			1.00	−0.46	−0.01	−0.29	−0.25	−0.60	0.03	0.37	0.54	−0.31	−0.49	0.10	−0.45	−0.39	−0.55	0.31	−0.03	−0.09	−0.36	−0.28	0.59	0.46	−0.27
Nonperforming loans/total loans	(4)				1.00	0.07	0.48	0.40	0.04	−0.15	−0.24	−0.08	0.12	0.44	−0.13	0.07	0.43	0.15	−0.07	0.17	0.10	0.46	0.07	−0.29	−0.39	0.14
Unreserved impaired loans/equity	(5)					1.00	0.50	0.06	0.23	−0.21	−0.16	−0.48	0.32	0.01	−0.02	0.59	0.55	0.49	−0.09	0.05	0.15	0.17	0.08	−0.44	−0.10	0.20
Impaired loans/equity	(6)						1.00	0.54	0.06	−0.07	−0.17	−0.13	0.11	0.14	−0.53	0.49	0.60	0.33	−0.54	0.22	0.20	0.25	0.47	−0.19	−0.48	0.41
Total cost/total income	(7)							1.00	0.10	−0.06	−0.28	−0.08	0.44	0.57	−0.31	0.23	0.01	0.31	−0.31	0.35	0.24	0.45	0.24	−0.50	−0.50	0.18
Overhead cost/total assets	(8)								1.00	−0.10	−0.55	−0.17	0.31	0.48	−0.50	0.12	0.56	0.42	0.00	0.07	0.10	0.12	0.12	−0.59	−0.33	0.30
Profit/number of employees	(9)									1.00	0.02	0.18	−0.14	0.00	0.10	−0.17	−0.14	−0.14	0.25	−0.31	−0.05	−0.26	−0.12	0.06	0.29	−0.24
Return on equity	(10)										1.00	0.47	−0.15	−0.46	0.38	−0.27	−0.22	0.00	0.27	−0.10	−0.13	−0.26	−0.38	0.31	0.51	−0.12
Return on assets	(11)											1.00	−0.48	−0.20	0.09	−0.44	−0.53	−0.46	0.47	−0.14	−0.35	−0.35	−0.43	0.13	0.23	−0.28
Charge offs/total equity	(12)												1.00	0.22	−0.59	0.30	0.31	0.38	−0.31	0.31	0.28	0.11	0.23	−0.37	−0.33	0.28
Log (Bank *Z*-score)	(13)													1.00	−0.26	0.02	0.40	0.57	−0.19	0.34	0.19	0.60	0.00	−0.02	−0.37	0.45
Liquid assets/total assets	(14)														1.00	−0.50	−0.01	−0.46	0.23	−0.35	−0.08	−0.52	−0.05	0.05	0.25	−0.47
Total loans/deposits	(15)															1.00	0.08	0.43	−0.58	0.33	0.17	0.32	0.09	−0.39	−0.38	0.01
Fixed assets/total assets	(16)																1.00	0.53	−0.16	0.09	0.32	0.49	0.57	−0.51	−0.33	0.49
Subordinated debt/equity	(17)																	1.00	−0.56	0.19	0.09	0.52	0.14	−0.38	−0.09	0.20
Liquid assets/Short-term funds	(18)																		1.00	−0.16	−0.14	−0.18	−0.58	0.24	0.26	−0.54
Due to central bank/total equity	(19)																			1.00	0.07	0.23	0.05	−0.02	−0.30	0.18
Due to commercial banks/total equity	(20)																				1.00	0.01	0.14	−0.33	−0.07	0.14
Total interest expenses/total deposits	(21)																					1.00	0.55	−0.29	−0.57	0.59
Off balance items/total assets	(22)																						1.00	−0.13	−0.12	0.58
Government deposit/total deposit	(23)																							1.00	0.31	−0.45
Government securities/total assets	(24)																								1.00	−0.01
Stock return variability	(25)																									1.00

This table shows the correlation between the 25 indicators of bank risk that are used to construct our measures of bank risk used in the empirical analysis.

Table A3
Variables and sources used.

Variable	Description	Source
Current account balance	Value of export minus import as a share of GDP	World Bank (2008)
Inflation	Change in the consumer price index	World Bank (2008)
Economic growth	Annual percentage growth rate of GDP per capita at market prices based on constant 2000 US dollars	World Bank (2008)
Depreciation	Depreciation of the official exchange rate	World Bank (2008)
External debt	Total external debt is debt owed to non-residents repayable in foreign currency, goods, or services. Total external debt is the sum of public, publicly guaranteed, and private nonguaranteed long-term debt, use of IMF credit, and short-term debt	World Bank (2008)
Term of trade shocks	Standard deviation of the value of import divided by the value of export in constant prices of 2000	World Bank (2008)
Income per capita	The total output of goods and services for final use occurring within the domestic territory of a given country, regardless of the allocation to domestic and foreign claims. Data are in constant 2000 US dollars per capita	World Bank (2008)
Real interest rate	The deposit interest rate less the rate of inflation measured by the GDP deflator	World Bank (2008)
Interest rate differential	Difference between the rate interest rate in a country and the average real interest of Germany, United States and Japan	World Bank (2008)
Net financial flows	Total inflow of capital minus the outflow of capital. This including disbursements of loans and credits less repayments of principal	World Bank (2008)
M2 to foreign exchange reserves	The sum of currency outside banks, demand deposits other than those of the central government, and the time, savings, and foreign currency deposits of resident sectors other than the central government	World Bank (2008)
Government surplus	Government revenue minus government spending	World Bank (2008)
Institutional quality	Quality of institutions measured by a PCA of bureaucratic quality, corruption, rule of law and government stability	International Country Risk Guide (2006)
Financial liberalization	Principle component analysis on the level of credit controls, interest rate controls, capital account restrictions and security market policy in a particular country and year taken from Abiad et al. (2008)	Abiad et al. (2008)
Globalization	Measure on economic integration	Dreher (2006)
Dispersed ownership	A dummy variable taking the value 1 if a bank has a shareholder which has an ownership more than 25%	Bankscope (2009)
Government ownership	A dummy variable taking the value if a bank is owned for more than 50% by the government	Bankscope (2009)
Subsidiaries	Number of subsidiaries	Bankscope (2009)
Foreign activities	A dummy variable taking the value if a bank has foreign branches	Bankscope (2009) and Datastream (2009)
Size	Logarithm of total assets	Bankscope (2009)
Merger	A dummy variable taking the value 1 if a bank has merged in a specific year, otherwise zero	Financial Times (2010) and Wallstreet Journal
Failure	A dummy variable taking the value 1 if a bank has failed in a specific year, otherwise zero	Financial Times (2010) and Wallstreet Journal
Concentration	Herfindahl–Hirschmann index of bank assets within a country	Bankscope and Beck et al. (2006)

median results as reported in Table 8 indicate that our banking risk variables are not a significant determinant of our measures of bank regulation and supervision.

5. Conclusions

The world wide financial crisis has led to renewed attempts to enhance bank regulation and supervision. Previous research has come up with – at best – mixed results concerning the effectiveness of bank regulation and supervision in reducing banking risk. There are three major issues that have to be dealt with in examining the relationship between bank regulation and supervision and banking risk. First, there is no generally accepted definition of banking risk. As a solution, we apply factor analysis on 25 indicators of banking risk and examine whether risk is multidimensional. Using information for more than 200 banks in 21 OECD countries for the period 2002–2008, we conclude that two factors capture most of the variance of the various indicators of bank risk, which we label 'capital and asset risk' and 'liquidity and market risk'. Second, bank regulation and supervision is a multi-faceted concept as well. We have constructed seven measures of bank regulation and supervision, applying principal component analysis to the data of Barth et al. (2004, 2008). Finally, it is not clear whether the relationship between bank regulation and supervision and bank risk is homogeneous across banks. To deal with this issue, we have used quantile regressions; the quantiles are determined on the basis of the riskiness of the banks.

We find that supervisory control, capital regulations, and market entry regulations have a significant effect on 'capital and asset risk', while supervisory control and regulations on activity restrictions, private monitoring, market entry restrictions, and liquidity have a significant effect on 'liquidity and market risk'. Our most important finding, however, is that the impact of bank regulation and supervision on banking risk is not uniform. Our results suggest that regulation and supervision do not have much effect on low-risk banks, while most of our measures for the various dimensions of bank regulation and supervision do have a highly significant effect on high-risk banks. In addition, our sensitivity analysis suggests that the effect of bank regulation and supervision also depends on the ownership structure and the size of a bank.

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Appendix A

See Tables A1–A5.

Table A4
Correlation matrix control variables.

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)
Inflation	(2)	1.00	−0.06	0.05	0.09	−0.28	0.07	−0.07	0.01	0.15	0.01	−0.19	−0.05	−0.28	0.09	0.11	0.12	−0.06	−0.04	0.03	0.06	0.13	0.23	0.11
Economic growth	(3)		1.00	−0.04	−0.22	0.06	−0.19	0.27	−0.15	−0.13	−0.20	0.24	0.13	0.28	−0.08	−0.28	−0.10	0.07	0.26	−0.09	−0.21	−0.30	−0.17	−0.19
Depreciation	(4)			1.00	0.11	−0.16	0.20	−0.28	0.25	0.23	0.29	−0.19	−0.03	−0.25	0.24	0.29	0.26	−0.28	−0.30	0.24	0.02	0.09	0.13	0.29
External debt	(5)				1.00	−0.03	0.09	−0.29	0.15	0.03	0.27	−0.14	−0.22	−0.19	0.09	0.13	0.27	−0.04	−0.12	0.05	0.16	0.15	0.28	0.01
Current account balance	(1)					1.00	−0.06	0.07	−0.13	−0.14	−0.27	0.15	0.07	0.08	−0.19	−0.22	−0.01	0.19	0.02	−0.27	−0.07	−0.13	−0.24	−0.27
Terms of trade shocks	(6)						1.00	−0.05	0.30	0.26	0.01	−0.19	−0.21	−0.04	0.18	0.04	0.29	−0.08	−0.13	0.06	0.25	0.22	0.23	0.07
Income per capita	(7)							1.00	−0.04	−0.13	−0.26	0.06	0.30	0.00	−0.14	−0.08	−0.06	0.14	0.27	−0.16	−0.30	−0.22	−0.15	−0.15
Real interest rate	(8)								1.00	0.02	0.19	−0.21	−0.18	−0.14	0.17	0.26	0.03	−0.03	0.00	0.06	0.29	0.17	0.29	0.26
Interest rate differential	(9)									1.00	0.09	−0.23	−0.01	−0.17	0.29	0.04	0.02	−0.04	−0.06	0.13	0.28	0.14	0.06	0.02
Net financial flows	(10)										1.00	−0.13	−0.16	−0.26	0.19	0.18	0.26	−0.22	−0.27	0.14	0.15	0.00	0.10	0.23
M2 to foreign exchange reserves	(11)											1.00	0.14	0.11	−0.29	−0.20	−0.14	0.29	0.21	−0.11	−0.21	−0.04	−0.29	−0.02
Government surplus	(12)												1.00	0.23	−0.17	−0.11	−0.16	0.24	0.12	−0.15	−0.18	−0.08	−0.21	0.00
Institutional quality	(13)													1.00	−0.13	−0.09	−0.16	0.27	0.24	−0.30	−0.07	−0.14	−0.15	−0.02
Financial liberalization	(14)														1.00	0.01	0.05	−0.28	−0.13	0.13	0.22	0.19	0.03	0.20
Globalization	(15)															1.00	0.05	−0.11	−0.16	0.21	0.09	0.10	0.18	0.25
Concentration	(19)																1.00	−0.03	−0.25	0.11	0.24	0.29	0.29	0.15
Dispersed ownership	(16)																	1.00	0.20	−0.05	−0.18	−0.29	0.00	−0.28
Government ownership	(17)																		1.00	−0.17	−0.06	−0.21	−0.14	−0.22
Foreign activities	(18)																			1.00	0.04	0.23	0.00	0.06
Subsidiaries	(20)																				1.00	0.17	0.00	0.27
Size	(21)																					1.00	0.26	0.18
Failure	(22)																						1.00	0.11
Merger	(23)																							1.00

This table shows the correlation between the control variables used in the analysis.

Table A5
World Bank survey: classification of questions.

Question number	Question	Coding rule	Explained variance	Average	Standard deviation
Variables included in PCA of activities restrictions					
4.1	What are the conditions under which banks can engage in securities activities?	A score of 1 was assigned to unrestricted and 2, 3 and 4 to permitted, restricted, and prohibited, respectively	0.63	1.53	0.51
4.2	What are the conditions under which banks can engage in insurance activities?	A score of 1 was assigned to unrestricted and 2, 3 and 4 to permitted, restricted, and prohibited, respectively	0.64	2.71	0.65
4.3	What are the conditions under which banks can engage in real estate activities?	A score of 1 was assigned to unrestricted and 2, 3 and 4 to permitted, restricted and prohibited respectively	0.85	2.38	1.28
4.4	Can banks own voting shares in nonfinancial firms?	A score of 1 was assigned to unrestricted and 2, 3 and 4 to permitted, restricted, and prohibited, respectively	0.88	2.14	0.58
Variables included in PCA of capital regulations					
1.4	Is it legally required that applicants submit information on the source of funds to be used as capital?	A score of 0 was assigned for No and 1 for Yes	0.43	0.76	0.43
1.5	Are the sources of funds to be used as capital verified by the regulatory/supervisory authorities?	A score of 0 was assigned for No and 1 for Yes	0.32	0.71	0.46
1.6	Can the initial disbursement or subsequent injections of capital be done with assets other than cash or government securities?	A score of 0 was assigned for No and 1 for Yes	0.43	0.66	0.48
3.1.1	Is this ratio risk weighted in line with the 1988 Basle guidelines?	A score of 0 was assigned for No and 1 for Yes	0.51	0.97	0.12
3.3	Does the minimum ratio vary as a function of market risk?	A score of 0 was assigned for No and 1 for Yes	0.71	0.52	0.51
	Is subordinated debt allowable as part of regulatory capital?	A score of 0 was assigned for No and 1 for Yes	0.41	0.98	0.11
3.6	Is subordinated debt required as part of regulatory capital?	A score of 0 was assigned for No and 1 for Yes	0.31	0.01	0.1
3.9.1	Before minimum capital adequacy is determined, is market value of loan losses not realized in accounting books deducted from the book value of capital?	A score of 0 was assigned for No and 1 for Yes	0.61	0.47	0.51
3.9.2	Before minimum capital adequacy is determined, are unrealized losses in securities portfolios deducted from the book value of capital?	A score of 0 was assigned for No and 1 for Yes	0.31	0.81	0.4
3.9.3	Before minimum capital adequacy is determined, are unrealized foreign exchange losses deducted from the book value of capital?	A score of 0 was assigned for No and 1 for Yes	0.88	0.62	0.5
Variables included in PCA of supervisory control					
5.5	Does the supervisory agency have the right to meet with external auditors to discuss their report without the approval of the bank?	A score of 0 was assigned for No and 1 for Yes	0.64	0.94	0.3
5.6	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?	A score of 0 was assigned for No and 1 for Yes	0.43	0.86	0.36
5.6.1	Are external auditors legally required to report to the supervisory agency any other information discovered in an audit that could jeopardize the health of a bank?	A score of 0 was assigned for No and 1 for Yes	0.44	0.9	0.3
5.7	Can supervisors take legal action against external auditors for negligence?	A score of 0 was assigned for No and 1 for Yes	0.84	0.65	0.4
6.1	Can the supervisory authority force a bank to change its internal organizational structure?	A score of 0 was assigned for No and 1 for Yes	0.71	0.81	0.4
11.2	Can the supervisory agency order the bank's directors or management to constitute provisions to cover actual or potential losses?	A score of 0 was assigned for No and 1 for Yes	0.47	0.75	0.44
11.3.1	Can the supervisory agency suspend the directors' decision to distribute dividends?	A score of 0 was assigned for No and 1 for Yes	0.43	0.7	0.47
11.3.2	Can the supervisory agency suspend the directors' decision to distribute bonuses?	A score of 0 was assigned for No and 1 for Yes	0.62	0.37	0.5
11.3.3	Can the supervisory agency suspend the directors' decision to distribute management fees?	A score of 0 was assigned for No and 1 for Yes	0.51	0.37	0.5
11.6.1	Can the bank supervisor legally declare, such that this declaration supersedes some of the rights of shareholders, that a bank is insolvent?	A score of 0 was assigned for No and 1 for Yes	0.77	0.38	0.5
11.7.1	According to the Banking Law, has the bank supervisor authority to intervene, that is, suspend some or all ownership rights of a problem bank?	A score of 0 was assigned for No and 1 for Yes	0.31	0.76	0.43
11.9.1.1	Regarding bank restructuring and reorganization, can the supervisory agency supersede shareholder rights?	A score of 0 was assigned for No and 1 for Yes	0.32	0.62	0.5
11.9.2.1	Regarding bank restructuring and reorganization, can the supervisory agency remove and replace management?	A score of 0 was assigned for No and 1 for Yes	0.26	0.8	0.41
11.9.3.1	Regarding bank restructuring and reorganization, can the supervisory agency remove and replace directors?	A score of 0 was assigned for No and 1 for Yes	0.22	0.95	0.22
11.9.5.1	Regarding bank restructuring and reorganization, can the supervisory agency insure liabilities beyond any explicit deposit insurance scheme?	A score of 0 was assigned for No and 1 for Yes	0.31	0.04	0.2
Variables included in PCA of power of deposit Insurer					
8.1.10	Does the deposit insurance authority make the decision to intervene a bank?	A score of 0 was assigned for No and 1 for Yes	0.45	0.22	0.42
8.1.11	Does the deposit insurance authority have the legal power to cancel or revoke deposit insurance for any participating bank?	A score of 0 was assigned for No and 1 for Yes	0.54	0.21	0.41
8.6	Can the deposit insurance agency/fund take legal action for violations	A score of 0 was assigned for No and 1 for Yes	0.69	0.5	0.51

Table A5 (*continued*)

Question number	Question	Coding rule	Explained variance	Average	Standard deviation
	against laws, regulations, and bylaws (of the deposit insurance agency) against bank directors or other bank officials?				
8.7	Has the deposit insurance agency/fund ever taken legal action for violations against laws, regulations, and bylaws (of the deposit insurance agency) against bank directors or other bank officials?	A score of 0 was assigned for No and 1 for Yes	0.75	0.33	0.48
8.1.4	If deposit insurance is prefunded, what is the ratio of accumulated funds to total bank assets?	A score of 0 was assigned for No and 1 for Yes	0.32	0.07	0.02
Variables included in PCA of private sector monitoring					
5.1.2	Is it required by the regulators that bank audits be publicly disclosed?	A score of 0 was assigned for No and 1 for Yes	0.71	0.73	0.45
5.3	Are auditors licensed or certified?	A score of 0 was assigned for No and 1 for Yes	0.51	0.94	0.21
10.4.1	Are off-balance sheet items disclosed to the public?	A score of 0 was assigned for No and 1 for Yes	0.32	0.95	0.24
10.5	Must banks disclose their risk management procedures to the public?	A score of 0 was assigned for No and 1 for Yes	0.55	0.81	0.4
10.7	Do regulations require credit ratings for commercial banks?	A score of 0 was assigned for No and 1 for Yes	0.65	0.02	0.02
10.7.1	How many of the top ten banks (in terms of total domestic assets) are rated by international credit rating agencies (e.g., Moody's, Standard and Poor)?	In percentage	0.52	8.21	2.67
10.7.2	How many of the top ten banks (in terms of total domestic assets) are rated by domestic credit rating agencies?	In percentage	0.53	3.53	4.92
10.7.3.1	Are bank activities about bond issuances rated?	A score of 0 was assigned for No and 1 for Yes	0.72	0.97	0.12
10.7.3.2	Are bank activities about commercial paper issuance rated?	A score of 0 was assigned for No and 1 for Yes	0.65	0.95	0.21
10.7.3.3	Are other bank activities (e.g., issuance of bank certificates of deposit, pension and mutual funds, insurance companies, financial guarantees, etc.) rated?	A score of 0 was assigned for No and 1 for Yes	0.38	0.72	0.46
Variables included in PCA of liquidity regulations					
7.1	Are there explicit, verifiable, and quantifiable guidelines regarding asset diversification? (for example, are banks required to have some minimum diversification of loans among sectors, or are their sectoral concentration limits)?	A score of 0 was assigned for No and 1 for Yes	0.81	0.47	0.51
7.3	Are banks required to hold either liquidity reserves or any deposits at the Central Bank?	A score of 0 was assigned for No and 1 for Yes	0.71	0.81	0.4
7.6	Are banks required to hold reserves in foreign denominated currencies or other foreign denominated instruments?	A score of 0 was assigned for No and 1 for Yes	0.49	0.05	0.21
7.9	What percent of the commercial banking system's assets is in central government bonds or other government or central bank securities?	In percentage	0.35	0.05	0.05
7.10	What percent of the commercial banking system's assets is funded with deposits?	In percentage	0.51	0.46	0.18
7.10.1	What percent of the commercial banking system's assets is funded with insured deposits?	In percentage	0.43	0.21	0.15
Variables included in PCA entry regulation					
1.9	In the past five years, how many applications for commercial banking licenses have been denied from domestic entities (e.g., those 50%or more domestically owned)?	As a share of received applications	0.89	0.19	0.33
1.10	How many applications for commercial banking licenses have been denied from foreign entities in the past 5 years?	As a share of received applications	0.71	0.36	0.58
1.12.1	Are foreign entities prohibited from entering?	A score of 0 was assigned for No and 1 for Yes	0.41	0.38	0.5

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