Bank regulation, the quality of institutions and banking risk in emerging and developing countries: An empirical analysis

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Abstract

Using data for more than 400 banks from about 70 non-industrial countries from 2002 to 2008, we examine the impact of bank regulation and supervision on banking risk. Our main findings suggest that stricter regulation and supervision reduces banking risk. Notably, capital regulations and supervisory control reduce bank riskiness. Liquidity regulation and activities restrictions also restrain banking risk but only in case of a high level of institutional quality. Finally, we find that the effect of regulation and supervision also depends on the structure of a bank (such as ownership, size, being listed, and riskiness) and the level of development.

Keywords: Banking risk; Bank regulation and supervision; Institutional quality; Bank structure

JEL Codes: E44; G2; O16

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1. Introduction

During the past two decades, many developing and emerging countries have liberalized their financial systems by ceasing credit controls, privatizing state banks, removing interest rate ceilings, and allowing free entry. Several authors claim that this financial reform increases the financial system's efficiency, thereby enhancing economic growth (King and Levine, 1993; Rajan and Zingales, 1998; Levine et al., 2000).[2] Ağca et al. (2013) report that banking sector reforms are associated with lower corporate debt in emerging countries. This finding is consistent with the notion that these reforms improve banks' risk management and result in tighter lending standards, leading firms to use less bank debt in their capital structure. However, financial liberalization may also lead to financial crises as financial institutions have more opportunities for excessive risk-taking in a liberalized financial system (Kaminsky and Reinhart, 1999). Strong bank regulation and supervision may reduce the risks of financial fragility due to financial liberalization (Barth et al., 2004a; Podpiera, 2004; Das et al., 2005; Demirgüç-Kunt et al. 2008; Delis and Staikouras, 2011; Klomp and de Haan, 2012).

Most previous research on the relationship between bank regulation and supervision and banking risk employed samples that include industrial, emerging and developing countries.[3] In this paper we use a sample of developing and emerging economies as these countries differ in a number of respects from industrial countries (Claessens and Yurtoglu, 2013) which may affect the extent to which bank regulation and supervision affect banking risk.

First, developing and emerging countries generally have a lower level of institutional development than industrial countries. Notably with respect to law and order, contract enforcement and corruption the countries in our sample lack behind advanced countries. Demirgüç-Kunt and Detragiache (1998) find that the probability of financial fragility is positively associated with weaker institutions. Similarly, Delis (2012) reports

[2] See Bumann et al. (2013) for an extensive survey of the literature on the relationship between financial liberalization and economic growth. Since the Asian crises of 1997-98, the conventional wisdom has changed. The new consensus holds that, while capital account and domestic financial liberalization are the best policies in the long run, financial reforms should be accompanied by efforts to improve the incentives of financial agents, including adequate financial regulation (Pesenti and Tille, 2000).

[3] See section 2 for a discussion of previous research.

that financial liberalization policies reduce the market power of banks in countries with advanced institutions, while banking competition does not improve at the same pace in countries with weaker institutions. Likewise, institutional development may affect the effectiveness of bank regulation and supervision. Therefore, we examine whether the impact of regulation and supervision on banking risk is conditioned by the quality of institutions.

Second, the countries in our sample are (far) behind advanced countries with respect to their level of economic development. Even though our analysis does not include advanced countries, the level of economic development of the countries in our sample differs considerably. Therefore, we examine whether the level of development affects the impact of regulation and supervision on banking risk. Earlier studies (Demirgüç-Kunt et al., 2008 and Barth et al., 2004a) report that the impact of regulation and supervision increases with the level of development. Likewise, we analyze whether the extent of financial liberalization matters. Even though most countries in our sample liberalized their financial system, there is much variability in our sample with respect to the level of financial liberalization. Kaminsky and Reinhart (1999) argue that the impact of regulation and supervision may be stronger in more liberalized countries.

Finally, we analyze whether the structure of the supervised bank affects the impact of regulation and supervision on banking risk. For instance: do ownership (private vs. government ownership; domestic vs. foreign ownership), riskiness and size of the bank matter? Likewise, are listed and unlisted banks affected in the same way by bank regulation and supervision? As will be explained in more detail in section 6, previous literature suggests that these dimensions of bank structure may influence the effectiveness of bank regulation and supervision in reducing banking risk.

Our analysis is based on a five-stage approach. In the first stage of our analysis, we use the survey data of Barth et al. (2004a,b; 2008) to compute our proxies for bank regulation and supervision. Following Pasiouras et al. (2006), we construct seven measures: 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, respectively.

In the second stage of our analysis, we apply factor analysis on 14 indicators of banking risk. We use data provided by Bankscope for more than 400 banks located in about 70 developing and emerging countries for the 2002-2008 period to construct measures of banking risk. For this period sufficient data are available, while relationships are not affected by the recent financial crisis. The results of the factor analysis suggest that a one-factor model captures most of the variance of the various indicators of banking risk.

In the third stage of our analysis, we use a dynamic panel model to estimate the relationship between banking risk and bank regulation and supervision, taking institutional quality into account. We address the potential endogeneity problems of bank regulation and supervision by presenting system-GMM and instrumental variable models.

In the fourth stage of our analysis, we split our sample in different subsamples according to particular bank structure characteristics, such as ownership, size and riskiness. This allows us to draw inferences about the importance of these bank characteristics. In the final stage of our analysis, we split the sample according to levels of economic development, and financial liberalization.

Our main finding suggests that some measures of bank regulation and supervision have a significant negative impact on banking risk in developing and emerging countries. In particular, we find that stricter capital regulation and supervisory control reduce the level of banking risk. In addition, restrictions on liquidity and activities are effective in restraining banking risk but only when the institutional environment is sufficiently strong. Finally, we find that the impact of most regulation and supervision measures in a country depends on the structure of a bank. The impact of regulation and supervision on banking risk, for instance, is higher for high-risk banks than for low-risk banks, while capital and liquidity regulations have a larger impact on small banks than on large banks. Also the country's level of development matters: the impact of regulation and supervision on banking risk is stronger in emerging countries than in developing countries.

The remainder of the paper is structured as follows. The next section gives a short overview of the existing studies on banking risk and regulation. Section 3 intro-

duces our proxies for bank regulation and supervision and banking risk, while section 4 describes the methodology and other data used. Section 5 presents the estimation results for the effect of bank regulation and supervision on banking risk and the role of institutional quality therein, while section 6 examines the impact of bank structure. Section 7 zooms in on sample splits according to the levels of development and financial liberalization. The final section concludes.

2 Literature review

There is a small but growing literature on the impact of bank regulation and supervision on bank behavior. A major issue in this line of research is how to construct proxies for bank regulation and supervision. A few studies 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). A good example is the study by Demirgüç-Kunt et al. (2008) who find a positive relationship between financial soundness and the overall index of BCP compliance, but this result is sensitive to controlling for the institutional quality of the country and to the exclusion of outliers. More recently, Demirgüç-Kunt and Detragiache (2011) have explored whether BCP compliance affects bank soundness (proxied by the Z-score, defined as the number of standard deviations by which bank returns have to fall to exhaust bank equity). Using data for 3,000 banks from 86 countries, they do not find support for the hypothesis that better compliance with BCPs results in sounder banks.

Three earlier papers have also used information on BCP compliance to study bank performance. Sundararajan et al. (2001) use a sample of 25 countries to examine the relationship between an overall index of BCP compliance and non-performing loans (NPLs) and loan spreads. They found BCP compliance not to be a significant determinant of financial soundness. Podpiera (2004) extends the set of countries and finds that better BCP compliance lowers NPLs. Das et al. (2005) relate bank soundness to a broader concept of regulatory governance, which encompasses both compliance with the BCPs and with standards and codes for monetary and financial policies. Better regu-

latory governance is found to be associated with sounder banks, particularly in countries with better institutions.

Compliance with the BCPs is mostly classified information. Most studies therefore employ the World Bank survey on supervision to construct measures of 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. Barth et al. (2004) report 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 various dimensions of bank regulation and supervision have a significant impact on bank credit ratings.

Fonseca and González (2010) examine capital buffers. Using panel data of 1337 banks in 70 countries between 1992 and 2002, they find that the net effect of regulation and supervision on capital buffers is positive. Delis et al. (2011) examine the relationship between capital regulation and banking risk (proxied by NPLs, the Z-score and volatility of ROA). Using data for OECD countries for the 1998-2008 period they find that that capital regulation can have a positive or negative effect on banking risk depending on certain bank characteristics, other regulations and the state of the macroeconomic environment. Agoraki et al. (2011) consider the impact of capital requirements, restrictions on bank activities and official supervisory power, using data from the Central and Eastern European banking sectors over the 1998–2005 period. Their results suggest that these regulations reduce banking risk (proxied by NPLs and the Z-score), but the effect of capital regulations and of regulations on activities restrictions depends on banks' market power.

Also Klomp and de Haan (2012) employ the World Bank data to construct proxies for bank regulation and supervision. In addition, they use factor analysis on Bankscope data for more than 200 banks in 21 OECD countries for the period 2002 to 2008 to construct measures of banking risk. Using quantile regressions, Klomp and de

Haan find that bank regulation and supervision do not have much effect on low-risk banks, but they have a highly significant effect on high-risk banks.

Barth et al. (2013) employ panel analysis of 4050 banks observations in 72 countries over the period 1999–2007 and find that tighter restrictions on bank activities are negatively associated with bank efficiency, while greater capital regulation stringency is marginally and positively associated with bank efficiency. They also find that official supervisory power is positively increases bank efficiency, but only in countries with independent supervisory authorities.

Some papers use an alternative to the BCP compliance indicators or the World Bank survey data. For instance, González (2005) uses a panel of 251 banks in 36 countries from 1995 to 1999 to analyze the impact of bank regulation on bank charter value and risk-taking. To measure the level of regulatory restrictions on bank activities, Gonzáles (2005) employs the banking and finance index published annually for each country by the Heritage Foundation, which measures the relative openness of a country's banking and financial system. Gonzáles concludes that banks in countries with stricter regulation have a lower charter value, which increases their incentives to follow risky policies.

Another example is the study by Ben Naceur and Omran (2011) who use a sample of 173 banks from ten countries (Tunisia, Bahrain, Egypt, Jordan, Kuwait, Lebanon, Morocco, Oman, Saudi Arabia, and United Arab Emirates) over the period 1989–2005 to assess the impact of bank regulations and institutional factors on bank performance. Their proxy for reserve requirements is the ratio of non-interest earning assets divided by total assets, while they include the coverage-to-deposit per capita ratio to control for the protection provided by authorities for depositors. These authors find that both proxies increase bank cost efficiency.

3. Measuring bank regulation and supervision and banking risk[4]

3.1 Bank regulation and supervision

Barth et al. (2004a,b; 2008) collected detailed and comprehensive information on bank regulation and supervision for more than 107 countries between 1999 and 2008. We use this survey data to compute proxies for bank regulation and supervision. The survey consists of 175 questions on regulation and supervision of commercial banks. 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. An appendix, which is available on request, shows the (classification of the) questions of the survey included in our analysis, as well as their variation. In constructing our regulation and supervision variables, we use principle components analysis (PCA) to the questions used to construct the measures of bank regulation and supervision. PCA produces a factor score with mean zero and standard deviation one. An advantage of this method is that individual questions used in constructing each measure are not equally weighted. The correlation matrix in Table 1 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 2 categorizes the countries according to the difference between the maximum and minimum factor scores. Table 2 suggests that our measures for bank regulation and supervision are very persistent. In most cases more than 75 percent of the countries have a difference between the maximum and minimum score of less than 10 percent.[5] Due to the limited fluctuations over time of our measures for bank regulation and supervision, the probability that reverse causality (i.e. banking risk affects bank regulation and supervision) drives our findings seems limited.

[4] This section draws on Klomp and de Haan (2012).

[5] Likewise, there is a high correlation of the medians of our measures for bank regulation and supervision and their maximum and minimum scores.

[Insert Tables 1 and 2 here]

3.2 Banking risk

Studies on banking risk 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 (see section 2 for details). However, it is questionable whether these indicators fully capture banking risk. According to Gaganis et al. (2006) and Agoraki et al. (2011), indicators of asset quality, capitalization and market structure are more informative as an indicator of banking risk compared to indicators of profitability, efficiency and management qualities. This suggests that banking risk is multidimensional. Furthermore, most indicators based on balance sheet data contain some measurement error due to, for example, different calculation methods or on- and off balance issues (Zhao et al., 2009).

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, management, earnings and profitability, and liquidity (IMF, 2000).[6] There is a 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 assess banks' soundness. However, there is no clear agreement in the literature on how exactly to combine the various CAMEL indicators. For this reason, we follow Klomp and de Haan (2012) and employ factor analysis on 14 CAMEL indicators for about 400 banks in about 70 developing and emerging market countries for the period 2002 to 2008.[7] 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.[8] 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 eigen-

[6] In addition, we also include a set of indicators related to market risk management. According to the IMF (2000), banks are increasingly involved in diversified operations, all of which involve one or more aspects of market risk.

[7] In comparison to Klomp and de Haan (2012) our set of indicators is limited to 14 indicators due to data availability in developing countries and emerging markets. Table A1 in the Appendix lists the countries.

[8] Cf. Lattin et al. (2003), Wansbeek and Meijer (2000) and Stock and Watson (2002).

value it may be ignored, as other factors are more important in explaining variance (an appendix which is available on request provides a more detailed description of the use of factor analysis).

The commercial banks included in our sample are chosen on the basis of data availability: we only include banks for which Bankscope of Bureau van Dijk provides more than 70 percent of the data on the risk indicators used.[9] For some banks in our sample, some indicators are not available for all years. Overall, we have about 20 percent missing observations. In order not to lose valuable information, we applied the EM algorithm of Dempster et al. (1977) to compute missing observations. Table 3 shows the indicators used, while Table A2 in the Appendix presents their correlations. The correlations range between -0.6 and 0.7 illustrating that the indicators measure different forms of banking risk.[10]

As pointed out by Klomp and de Haan (2009; 2012), one problem is that some indicators of banking risk 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 have estimated various factor models with changing lags and leads (with a maximum of two 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 0.79 and 0.91.[11] The chosen lag lengths are shown in column (1) of Table 3.

[Insert Table 3 here]

[9] There is a trade-off between including as many risk indicators and banks on the one hand and the availability of data on the other. We choose to use the 70 percent cut-off point as a reasonable compromise. If we increased the cut-off point to 80 percent our dataset would be reduced by more than 40 percent. On the other hand, increasing the number of observations by 10 percent would imply a cut-off point of 60 percent in which case about 40 percent of the data used in the analysis would be based on imputed data.

[10] We also estimated our models presented in this paper using only the banks for which we have complete data. The main results do not differ, but our dataset is reduced by more than 60 percent (results are available upon request).

[11] The estimation results of the various models are available upon request. When we re-estimate the empirical models shown in section 4 using different lag structures, the main conclusions do not change although the coefficients of the regulation and supervision variable differ somewhat across models.

The next step is to decide on the number of factors to represent banking risk. There is no 'optimal' criterion for deciding on the appropriate 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 the Kaiser rule, banking risk can be represented as a four-dimensional construct. However, this is a so-called Heywood case where some solutions of the unique variances of the indicators are smaller than zero.[12] In general, a Heywood case is an indication of a poorly specified model. If instead the elbow criterion is used, banking risk can be represented as a one-dimensional construct. The Likelihood Ratio test statistic of the one-factor model is highly significant at the five percent level. The test rejects the null hypothesis that the estimate of a satured model is equal in favor of the restricted one-factor model. This is confirmed by the Bai and Ng information test. We therefore decided that the one-factor model is appropriate to represent banking risk.

Column (2) of Table 3 shows that capital and asset risk indicators have high factor loadings. This partly confirms the conclusion of the IMF (2000) study according to which banking systems in OECD countries mainly exhibit liquidity risk, while in less advanced countries asset quality risk is more pronounced. Column (3) of Table 3 reports the variance explained of each banking risk indicator. About 50 percent of the variance is explained by the one-factor model, while the remaining variance is unique, i.e., unex-

[12] See Heywood (1931).

plained.[13] That is, about half of the total banking risk is common for all banks included, while the remaining part is bank-specific.[14]

The risk factor is not very persistent as shown by the low correlation of the median score with the maximum or minimum score of the factor (available on request). This is confirmed by the autoregressive coefficient of the common part, which is significant but lower than 0.5.

Figure 1 presents a comparative analysis of banking risk in developing and emerging countries.[15] We find that in both country samples banking risk is accumulating over time. On average, our banking risk indicator is about 1.5 times higher for developing countries than for emerging countries. However, there are large differences between individual banks as illustrated by the standard deviation of the two samples (3.45 for developing countries and 2.92 for emerging countries).

[Insert Figure 1 here]

4. Data and methodology

4.1 Empirical model[16]

In this section we develop the model to estimate the relationship between bank regulation and supervision and banking risk. There may be an endogeneity problem, which we address by using use system-GMM and instrumental variables.

We estimate a dynamic model based on an unbalanced panel including about 400 banks from 70 developing and emerging countries between 2002 and 2008:

[13] As a robustness check, we re-estimated 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, but our general findings are not sensitive to this (results available on request).

[14] Compared to Klomp and de Haan (2012) our one-factor model explains less of the total variance. One reason is that common risk is lower in developing and emerging market economies due to, for instance, lower connectivity. However, idiosyncratic risk may be higher due to, for example, inefficient risk management of individual banks. In addition, banks in developing and emerging countries are more heterogeneous, which reduces the common factor.

[15] See Table A1 in the Appendix for the classification of the countries in our sample.

[16] This section draws on Klomp and de Haan (2012).

$$risk_{ijt} = \alpha_{ij} + \sum_{j=1}^{m} \mu_i risk_{ijt-l} + \sum_{j=1}^{m} \beta_k X_{kijt-l} + \gamma_{qi} regulation_{qit-l} + \varepsilon_{ijt} \quad (1)$$

where $risk_{ijt}$ is the risk indicator based on the factor scores for bank *i* in country *j* at time *t*. We include the lagged dependent variable to control for autoregressive tendencies. X_{kijt-1} is a vector of (lagged) control variables containing *k* elements (discussed in section 4.2), while *regulation* is a vector containing *q* dimensions of (lagged) bank regulation and supervision outlined above. Our hypothesis is that banking risk decreases due to stricter bank regulation and supervision ($\gamma_q < 0$). The parameter α_{ij} is a bank-specific intercept. The final term is the error term, whereas *l* indicates the number of lags.

Equation (1) poses a dynamic error-components model. Substantial complications may arise if this model is estimated by OLS. In both the fixed and random effects settings, the lagged dependent variable is correlated with the error term, even if the disturbances are not autocorrelated. Arellano and Bond (1991) develop a generalized method of moments (GMM) estimator that solves the problems using the first difference of the equation.

$$\Delta risk_{ijt} = \sum_{j=1}^{m} \mu_i \Delta risk_{ijt-l} + \sum_{j=1}^{m} \beta_k \Delta X_{kijt-l} + \gamma_{qi} \Delta regulation_{qit-l} + (\varepsilon_{ijt} - \varepsilon_{ijt-1}) \quad (2)$$

Estimation of (2) requires an instrumental variable procedure to correct for the endogeneity as well as the correlation between the lagged difference of the dependent variable and ε_{it-1}. We can use the second and higher-order lags of the endogenous and dependent variable and the first difference of the exogenous variables as instruments in the estimation of (2) if ε_{it} is serially uncorrelated.

This approach, however, has drawbacks. First, differencing the equation removes the long-run cross-country information present in the levels of the variables. Second, if the independent variables display persistence over time, their lagged levels will

be poor instruments for their differences. Under additional assumptions, it is possible to construct an alternative GMM estimator that overcomes these problems. Specifically, more moment conditions are available if we assume that the explanatory variables are uncorrelated with the individual effects (see Arellano and Bover, 1995). In this case, lagged differences of these variables and of the dependent variable may also be valid instruments for the levels equation. The estimation then combines the set of moment conditions available for the first-differenced equations with the additional moment conditions implied for the levels equation. Blundell and Bond (1998) show that this system GMM estimator is preferable to that of Arellano and Bond (1991) when the independent variables are persistent, like our proxies for bank regulation and supervision. Finally, as long as the model is over-identified, validity of the assumptions underlying both the difference and the system estimators can be tested through Sargan tests of orthogonality between the instruments and the residuals and through tests of second- or higher order residual autocorrelation.

To assess the robustness and validity of the system-GMM estimation results we also use an instrumental variable technique suggested by Newey (1987), including a number of instrumental variables. Barth et al. (2004a) argue that cross-country differences in bank regulation and supervision reflect national differences in legal and political systems (see also Demirgüç-Kunt and Detragiache, 2011). We therefore use the following instruments: First the length of time a country has been independent. Second, its legal tradition based on whether the country has a British, French German, or Scandinavian legal origin (cf. La Porta et al., 1998; Beck et al., 2003). La Porta et al. (1998) argue that civil law and socialist law countries tend to support stronger governments to a greater degree than common law countries. Thus, legal origin may also influence a country's approach to bank regulation and supervision. Third, we include the shares of Catholics, Protestants and Muslims in each country. Stulz and Williamson (2003) argue that Protestant countries have stronger creditor right protection and stricter regulation, while Landes (1998) points out that Catholic and Muslim religions tend to generate hierarchical bonds of authority that shape the structure of government institutions. Fourth, as discussed in Beck et al. (2003) and Easterly and Levine (2003), countries in tropical

climates tend to have exploitative political regimes that gear governmental institutions toward protecting a small elite. Thus, endowments may influence the type of institutions in place, including bank regulatory and supervisory institutions. To take this latter issue into account, we use distance from the equator as an instrument. Finally, we include ethnic fractionalization, since Easterly and Levine (1997) show that ethnic diversity tends to reduce the provision of public goods, including supervisory institutions.

The idea behind these instruments is that these historical country characteristics affect a country's institutions and thus have a bearing on bank regulation and supervision. Clearly, 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 risk, which is about zero.

4.2 Control variables

We include control variables suggested by previous studies on banking risk (cf. Demirgüç-Kunt and Detragiache, 1998; Kaminsky and Reinhart, 1999; Klomp and de Haan, 2012; Delis and Staikouras, 2011). 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 macroeconomic 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. In addition, we include *GDP per capita* to control for differences in economic development. Furthermore, we include two dummy variables taking the value one in case of a *debt crisis* or *currency crisis* in a particular country-year as banking risk arguably increases during financial crises (source: Laeven and Valencia, 2008).

According to Demirgüç-Kunt and Detragiache (1998), high real *short-term interest rates* affect bank balance sheets adversely if banks cannot increase their lending rates quickly enough and hence increase banking risk. In addition, large capital inflows and capital flight may affect the stability of the financial sector. We therefore control for

the *interest rate differential*[17], *net financial flows*, and the *ratio of M2 to foreign exchange reserves*.

The *fiscal balance* (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.

Not only the economic situation matters for financial soundness but also the institutional environment within a country. Countries lacking a sound legal system and good governance might have weaker banks due to corruption or inefficient enforcement of law and government ineffectiveness (La Porta et al., 1998; Levine, 1998; Barth et al., 2004a; Fernandez and González, 2005). To capture *institutional quality* within a country, we include a measure based on the first principal component of the six governance indicators of Kaufmann et al. (2009): voice and accountability, political instability and violence, government effectiveness, regulatory quality, rule of law, and control of corruption.

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 system (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 policies taken from Abiad et al. (2008).[18]

Furthermore, we control for bank market concentration as De Nicoló et al. (2004) find that highly concentrated banking systems exhibit higher levels of systemic risk. In addition, based on Dreher (2006), we include a dummy variable taking the value one if in a particular year a country received *financial assistance* from the IMF. Improving the health of the financial sector is frequently part of the adjustment program that comes with IMF support.

[17] Calculated 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.

[18] Our measures for liberalization, institutional quality and our dimensions of bank regulation and supervision may be related, but the correlation coefficients do not suggest multicollinearity problems.

Moreover, we include a number of bank-level control variables. First, Shezhad et al. (2010) find that *ownership concentration* significantly affects loan quality and bank capitalization. We therefore include a dummy variable taking the value one if a bank has a shareholder who owns more than 25 percent of the bank concerned. We also include dummies reflecting *government* or *foreign ownership*. Moreover, we use the natural logarithm of real total assets to control for the *size of a bank*. Next, we add the number of subsidiaries as a proxy for *diversification* and business franchise power. Finally, we include two dummy variables to capture whether a bank *failed* or *merged* in a specific year. Table A3 in the appendix provides an overview of all variables, their definitions as well as their sources.

5. Empirical results

This section presents the estimation results for the effect of bank regulation and supervision on banking risk, starting with the outcomes of the system-GMM estimator. The optimal number of lags for each variable is selected using the Schwarz Bayesian Information Criterion (SBC).

Unlike most previous studies, we consider a very long list of potential control variables. All these variables make sense from a theoretical perspective. However, due to data availability, using all control variables in one specification would reduce our dataset dramatically. To overcome this problem we apply the general-to-specific method to decide which of these variables should be included in the base model (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 the 10 percent level remain. In view of the unequal distribution of the number of banks within a country (see Table A1), we cluster the standard errors at the bank level to obtain consistent standard errors. For example, our sample contains 25 banks from Russia, while it only contains 1 bank from Gabon or Cameroon. We use bootstrapping with 1,000 replications to obtain consistent standard errors.

The consistency of the GMM estimator depends on the validity of the instruments. To address this issue we consider two specification tests. The first is a Sargan test of over-identifying restrictions, which tests the overall validity of the instruments by analyzing the sample analog of the moment conditions used in the estimation process. The second test examines the hypothesis that the error term ε_{it} is not serially correlated. The Sargan test provides no evidence of misspecification, while the serial correlation tests point to first- but no second-order autocorrelation of the residuals, which is in accordance with the assumptions underlying the selection of instruments.

The general-to-specific procedure (excluding our measures of bank regulation and supervision) yields a number of significant variables that we select for our X_{kij} vector. Our sample is reduced to a total of 371 banks in about 50 countries due to data availability of the control variables. Column (1) in Table 4 reports the estimated marginal effects evaluated at the mean of the determinants of banking risk. The coefficients of the control variables have the expected sign in the baseline regression. The results suggest that economic growth decreases banking risk, while inflation has a significant positive impact on the riskiness of banks. Moreover, a currency crisis and a current account deficit increase banking risk, although the coefficients of these variables are only significant at the ten percent level. Furthermore, we find that countries with better institutions have lower banking risk. This is in line with the results of Demirgüç-Kunt and Detragiache (1998) and Fernandez and González (2005). These studies report that the probability of a banking crisis is positively associated with weaker institutions, especially those related to the rule of law, the level of corruption and contract enforcement. We also find that financial liberalization increases risk-taking of banks. Finally, our results suggest that bigger banks are more risky.

[Insert Table 4 here]

Next, we add our proxies for bank regulation and supervision to the baseline model.[19] Column (2) in Table 4 includes our aggregate measure of regulation and supervision, which is the average of the (standardized) seven measures of bank regulation and supervision as described in section 3.1.[20] The results show that stricter regulation and supervision significantly decreases banking risk. An increase of one percent of our aggregate measure of bank regulation and supervision decreases banking risk by 0.3 percent.

However, the effect of each of the seven dimensions of bank regulation and supervision may be different. In columns (3) to (9) we therefore add these measures subsequently to the baseline specification. We first add the measure on capital regulation. The results suggest that this type of regulation significantly decreases banking risk. A one percent increase in the level of capital regulation decreases banking risk by 0.6 percent at the five percent significance level. This result is in line with the results reported by Agoraki et al. (2011) and Barth et al. (2004a) who find a significant negative impact of capital regulation on the share of non-performing loans and the onset of a banking crisis. Likewise, Leaven and Levine (2009) conclude that stricter capital requirements increase the distance-to-default, while Klomp and de Haan (2012) demonstrate that adequate capital regulation is one of the most effective ways to restrain banking risk. In contrast, Beck et al. (2006) and Delis and Staikouras (2011) do not find evidence that capital regulations reduce the fragility of the banking system, measured by the occurrence of a banking crisis or the distance-to default.

Next, we include our proxy for regulations on private monitoring. The results indicate that this type of regulation has no significant effect on banking risk. This result is in line with the findings of Klomp and de Haan (2012), but Barth et al. (2004a; 2001) and Agoraki et al. (2011) find that the share of non-performing loans decreases when there is more private monitoring present. One explanation for our result is that asymmetric information may be more pronounced in our sample of non-industrialized economies. This information problem makes private monitoring less effective.

[19] If we take up the regulation and supervision variables directly into the general-to-specific approach, the results (available on request) are very similar.

[20] Using the first principal component of the seven indicators of bank regulation and supervision instead of the average gives similar results (available on request).

Also regulations on restricting bank activities do not reduce banking risk. This result confirms the view that restrictions on bank activities do not necessarily reduce financial fragility (cf. Barth et al., 2004a; Agoraki et al., 2011). Beck et al. (2006) even report that activity restrictions increase the likelihood of a banking crisis due to limiting the opportunities to diversify risk. In contrast, Delis and Staikouras (2011) find that the distance-to-default is reduced by regulation limiting bank activities. One potential explanation for our result is that banks in emerging and developing countries may be less involved in more complex banking activities.

Our results suggest that supervisory control significantly reduces banking risk. If the level of supervisory control increases by one percent, banking risk decreases by 0.4 percent. In contrast, Barth et al. (2001) find a significant positive impact on financial fragility of supervisory power using a panel including industrialized and transition countries. However, when transition countries are excluded, Barth et al. (2001) do no longer find a significant effect of supervisory power.

We do not find a significant effect of regulations on deposit insurance on the level of banking risk. One explanation is that a deposit insurance system influences bank soundness in two opposite ways (Demirgüç-Kunt and Detragiache, 2002). 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.[21] Apparently, the opposing effects of a deposit insurance scheme on banking risk cancel out.

Finally, we do not find a significant effect of liquidity restrictions or market entry regulations on banking risk. The latter result contradicts the conclusion of Barth et al. (2004a) who argue that a higher score on the ‘entry into bank requirements index‘ increases the likelihood of a banking crisis.

[21] Anginer et al. (2013) examine the relation between deposit insurance and banking risk in the years leading up to and during the recent financial crisis. They find that generous financial safety nets increase banking risk in the years leading up to the global financial crisis, but during the crisis banking risk is lower.

To sum up, we find that stricter regulation and supervision has a significant impact on banking risk. In particular, we find that capital regulation and supervisory control have a negative effect on banking risk.

To assess the robustness and validity of the system-GMM results, we use an instrumental variable approach (using the specifications of Table 4). We first 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 instruments 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. The results as shown in Table 5 are similar to the GMM outcomes. Again, we find a significant effect of bank regulation and supervision on banking risk, which is mainly driven by the impact of capital regulation and supervisory control.

[Insert Table 5 here]

An important question to which we turn now is whether the impact of regulation and supervision on banking risk depends on institutional quality. There is evidence that institutional quality affect banking risk. For instance, Demirgüç-Kunt and Detragiache (1998) report that financial fragility is positively associated with weaker institutions, especially those related to the rule of law, the level of corruption and contract enforcement. In contrast to previous studies, we examine whether institutional quality has a direct as well as an indirect effect, i.e. we test whether the impact of regulation and supervision is conditional on our proxy for institutional quality by including an interaction term of both variables in our model:

$$\begin{aligned} risk_{ijt} = \alpha_{ij} + \mu_i risk_{ijt-1} + \gamma_1 regulation_{qit-l} + \gamma_2 institutions_{it-l} \\ + \gamma_3 (regulation_{qit-l} \times institutions_{it-l}) + \beta_k X_{kijt-l} + \varepsilon_{ijt} \end{aligned} \quad (3)$$

where $institutions_{it}$ refers to our proxy for institutional quality. Table 6 shows the system-GMM estimation results.[22] The conditional effect of bank regulation and supervision on banking risk can be calculated as follows:

$$\frac{\partial risk}{\partial regulation} = \gamma_1 + \gamma_3 institutions \tag{4}$$

The statistical significance of the interaction effects cannot be tested with a simple *t*-test on the coefficient of the interaction terms but must be based on the estimated cross-partial derivative. The standard error of interest is

$$\hat{\sigma}_{\frac{\partial risk}{\partial regulation}} = \sqrt{\mathrm{var}(\gamma_1) + institutions^2 \times \mathrm{var}(\gamma_3) + 2 \times institutions \times \mathrm{cov}(\gamma_1, \gamma_3)} \tag{5}$$

The standard errors are used to calculate the confidence bands around the marginal effect. We use the methodology suggested by Brambor et al. (2006) and Ai and Norton (2003), i.e., we plot the marginal effect of our measures for bank regulation and supervision on banking risk conditional on institutional quality. The 95 percent confidence intervals around the marginal effect line allow us to determine when regulation and supervision has a statistically significant effect on banking risk. There is a statistically significant effect when the upper and lower bounds of the confidence interval are both above (or below) zero.

Figure 2 shows the marginal impact of regulation and supervision on banking risk (vertical axis), conditional on institutional quality (horizontal axis) based on the regressions shown in Table 6. The following conclusions stand out. First, the negative impact of capital regulations and supervisory control on banking risk is stronger in

[22] Given space constraints, we do not report the results of the interaction between bank regulation and supervision and institutions for our instrumental variable model, which are similar to the system-GMM results and available upon request.

countries with strong institutions. Second, regulations on bank activities and liquidity also reduce banking risk but only if our measure for institutional quality is above a threshold of about 5 (which is the case for about sixty percent of the observations). Finally, the impact of the remaining measures of bank regulation and supervision (i.e. deposit insurance power, private monitoring and market entry) does not depend on the level of institutional quality.

[Insert Table 6 here]

[Insert Figure 2 here]

6. Bank structure

In this section we examine whether bank structure characteristics affect the impact of bank regulation and supervision on banking risk. Our approach is to split the total sample into subsamples based on relevant bank system characteristics.

First, Klomp and de Haan (2012) argue that the impact of financial regulation and supervision on banking risk is conditional on the level of banking risk. That is, the impact of stricter regulation and supervision is larger for banks with a high level of risk than for banks with a low level of risk. In columns (1) and (2) in Table 7 we therefore divide the sample into two subsamples based on the median level of banking risk in the period 2002 to 2008. The estimation results confirm the findings of Klomp and de Haan (2012). The impact of regulation and supervision on banking risk is on average about 1.5 times higher for high-risk banks than for low-risk banks.

In addition, the effect of bank regulation and supervision on banking risk may differ across various types of banks. For instance, Shezhad et al. (2010) and Laeven and Levine (2009) argue that bank risk-taking behavior depends on the ownership structure of a bank. We therefore split our sample as follows: listed vs. non-listed banks, banks with public ownership vs. banks with private ownership, and banks with foreign vs.

domestic ownership.[23] Another possibility is that large banks may be affected differently by regulation and supervision than small banks. Therefore, we also split our sample into small and large banks.

Columns (3) and (4) in Table 7 show the results for listed and non-listed banks. Our results suggest that regulation and supervision has a stronger impact on non-listed banks. This effect is mainly determined by the stronger impact of capital regulation and supervisory control.

Columns (5) and (6) in Table 7 present the results for banks where the government owns more than fifty percent of the shares and banks that are privately held, respectively. The results indicate that regulation and supervision has a similar impact on both types of banks. This is in contrast to Barth et al. (2004a) who find that regulation of government banks is less effective.

In columns (7) and (8) the sample is split into foreign and domestic owned banks. The results suggest that the impact of regulation and supervision on banking risk is not very different across foreign and domestic owned banks. Only liquidity regulation has a significant impact on foreign owned banks, while it has no impact on domestic owned banks.

In the final two columns in Table 7, we split the sample in banks with a total asset value of more 90 billion US dollar and banks with a total asset value below 90 billion US dollar.[24] The results indicate that regulations on activity restrictions have the strongest impact on large banks, while capital and liquidity regulations have the largest effect on small banks.[25]

[Insert Table 7 here]

[23] For a discussion about ownership, see Andrianova et al. (2008).

[24] This is the median size of the banks in our sample over the entire sample period. As a robustness test we also performed this sample split using the 10 percent largest banks measured by their asset size as our 'large banks' subsample and the remaining banks as our 'small banks' subsample. The qualitative results (available on request) do not differ from the ones presented in the main text.

[25] In addition, we performed a sample split using two equal-sized samples based on the number of banks present within a country. However, we do not find any systematic differences between both samples of the impact of bank regulation and supervision.

7. Levels of development and liberalization

This section presents the outcomes of several sensitivity tests in which we divide our sample according to level of development, geographical position, and level of financial liberalization. We also use an alternative indicator of banking risk and finally discuss the issue of reverse causality.

Even though we focus on emerging and developing countries, there is still quite some variation in our sample in terms of the countries' economic and institutional development. To examine whether our results also hold for subsamples, we estimate the system-GMM model for different groups of countries.[26] First, we split our sample in developing countries and emerging countries.[27] The results show that, on average, regulation and supervision have a stronger impact on banking risk in emerging countries. Our proxies for liquidity regulation and activities regulation are significant in emerging economies although only at the ten percent level. This confirms the conclusion of Demirgüç-Kunt et al. (2008) and Barth et al. (2004a) that the impact of regulation and supervision increases with the level of development.

The next three columns in Table 8 show the estimates for subsamples based on geographical location of the bank: Asia, Africa and Latin America. The results indicate that our measure for overall regulation and supervision is insignificant in Africa, while it has a significant impact in Asia and Latin America. The results confirm our previous finding that regulation is most effective in emerging economies, which are mostly located in Asia and Latin America.

In columns (6) and (7) in Table 8 we split the sample on the basis of the median level of financial liberalization. Arguably, the impact of regulation and supervision may be stronger in more liberalized countries (Kaminsky and Reinhart, 1999). Our results lend support to this hypothesis. In general, we find that the impact of supervision and regulation is strongest in countries which are more liberalized.

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[26] The results using the instrument variable approach are similar to the system-GMM results (available upon request).

[27] We classify countries in accordance with the criteria suggested by the World Bank. A country as developing when it has an annual GDP per capita lower than $2.000 and as an emerging market country when its GDP per capita ranges between $2.000 and $10.0000.

[Insert Table 8 here]

In the results reported so far we used our indicator of banking risk, which is derived from factor analysis on several risk indicators. To assess whether our results depend on this choice, we instead employ a commonly used indicator of risk, the so-called Z-score, which is computed as follows:

$$zscore = \frac{ROA + \frac{E}{A}}{\sigma^2_{ROA}}$$

where *ROA* is the return on assets, *E* is the total equity, *A* are the total assets and σ^2_{ROA} is the standard deviation of *ROA* over the last 5 years. The Z-score can be interpreted as the number of standard deviations by which returns would have to fall from the mean to wipe out all equity in the bank. Unfortunately, using this risk indicator causes a reduction of our dataset by more than 60 percent due to the calculation of the standard deviation over the last 5 years.[28] The correlation between our aggregate banking risk indicator and the Z-score is about 0.54, so they are not perfect substitutes. Column (8) in Table 8 shows the estimates using the Z-score as dependent variable. Following Demirgüç-Kunt et al. (2008) we use the logarithm of 1 + *Zscore* to smooth out higher values of the Z-score and avoid losing observations with a dependent variable of zero. Again, the results suggest that capital regulation and supervisory control significantly reduce banking risk. So our main results are not driven by the choice of our banking risk variable.

Finally, we check whether our results are driven by reverse causality. Arguably, after a period of financial instability governments implement stricter regulation and supervision. This implies that our banking risk indicators are a potential determinant of

[28] We also used a 3-year standard deviation but this gives similar results.

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 dynamic models:

$$regulation_{qit} = \alpha_{it} + \beta_p X_{pit-1} + \gamma_i risk_{it-1} + \varepsilon_{it} \tag{6}$$

Where $regulation_{qit}$ is a measure for bank regulation and supervision of type q in country i at time t, while $risk_{it}$ is our measure of banking risk in country i at time t. We calculate $risk_{it}$ by using the country average of our banking risk measure $risk_{ijt}$. We weighted the risk within a country by the total asset size of an individual bank. The vector of control variables X_{pit} includes the lagged dependent variable, inflation, depreciation, current account balance, institutional quality, financial liberalization and the number of bank failures and the number of bank mergers. The results as reported in Table 9 indicate that our banking risk variable is not a significant determinant of our measures of bank regulation and supervision, suggesting that our results are not driven by reverse causality.

[Insert Table 9 here]

8. Conclusions

The aim of this paper is to examine the relationship between regulation and supervision and banking risk in developing and emerging market economies. We examine whether the impact of bank regulation and supervision on banking risk is conditioned by institutional quality. In addition, we analyze whether the impact of bank regulation and supervision is affected by bank characteristics and by the countries' levels of economic development and financial liberalization.

We use the data provided by Barth et al. (2004a,b; 2008) to construct seven measures of bank regulation and supervision. In addition, we use factor analysis on Bankscope data for more than 400 banks in about 70 countries in the 2002-2008 period

to construct measures of banking risk. The factor analysis suggests that one factor captures most of the variance of the various indicators of banking risk.

Our findings suggest that bank regulation and supervision reduce banking risk. In particular, we find that stricter capital regulation and supervisory control decrease banking risk. Liquidity regulation and activities restrictions also restrain banking risk but only in case of a high level of institutional quality.

In addition, we find that the impact of most regulation and supervision measures on banking risk depend on the level of development of a country and on the structure of a bank. In emerging economies, bank regulation and supervision has a stronger effect on banking risk than in developing countries. The impact of regulation and supervision on banking risk is bigger for high-risk banks than for low-risk banks. Our results also suggest that regulation and supervision have a stronger impact on non-listed than on non-listed banks. In addition, we find that regulations on activity restrictions have the strongest impact on large banks, while capital and liquidity regulations have the largest effect on small banks.

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Table 1. Correlation matrix: bank regulation and supervision variables

		(1)	(2)	(3)	(4)	(5)	(6)	(7)
Capital regulations	(1)	1.00	-0.11	-0.04	-0.05	-0.09	-0.11	0.01
Regulations on private monitoring	(2)		1.00	0.17	0.09	0.11	0.20	0.23
Regulations on activity restrictions	(3)			1.00	0.24	0.08	0.39	0.12
Supervisory control	(4)				1.00	-0.09	-0.13	0.16
Deposit insurer's power	(5)					1.00	-0.05	-0.04
Liquidity regulations	(6)						1.00	0.13
Market entry regulations	(7)							1.00

The table shows the correlation of the seven measures of bank regulation and supervision used in the analysis.

Table 2. 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
$\Delta I < \lvert 10 \rvert\%$	79.19	73.76	80.80	70.46	75.54	73.16	75.18
$\lvert 10 \rvert\% < \Delta I < \lvert 15 \rvert\%$	9.89	9.31	10.62	11.77	9.22	11.61	9.65
$\lvert 15 \rvert\% < \Delta I < \lvert 20 \rvert\%$	2.04	1.72	1.98	5.97	1.75	1.91	3.26
$\lvert 20 \rvert\% < \Delta I$	8.87	15.21	6.61	11.80	13.49	13.32	11.92

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.

Table 3. Banking risk: Dynamic factor analysis

	Lags	Factor loading	Variance explained
	(1)	(2)	(3)
Capital adequacy			
Total equity / total assets	1	-0.860	0.74
Total capital ratio	1	-0.868	0.75
Asset quality			
Loan loss provision / total loans	-1	0.936	0.88
Non-performing loans / total loans	-1	0.741	0.55
Managerial qualities			
Total cost / total income	-1	0.484	0.23
Overhead cost/total assets	-1	0.480	0.23
Earnings and profitability			
Return on equity	0	-0.838	0.70
Return on assets	0	-0.709	0.50
Liquidity			
Liquid assets / total assets	0	-0.592	0.35
Total loans / deposits	0	0.566	0.32
Liquid assets/short-term funds	0	-0.520	0.27
Due to central bank / total equity	1	0.307	0.09
Market risk management			
Total interest expenses / total deposits	0	0.501	0.25
Government securities / total assets	0	-0.524	0.28
Correlation with the maximum		0.212	
Correlation with the minimum		0.310	
AR coefficient of the common part λ		0.244	
h-squared	0.531		
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 14 indicators of banking risk. The chosen lag lengths are shown in column (1). Column (2) shows the factor loadings, while column (3) reports the variance explained of the individual risk indicators.

Table 4. Estimation results - Baseline model System GMM

	Dependent variable: banking risk								
Regulation and supervision measure:		Overall	Capital regulations	Private monitoring	Activities restrictions	Supervisory control	Deposit insurer's power	Liquidity regulations	Market entry
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Lagged dependent	0.312**	0.316**	0.296**	0.279**	0.262**	0.266*	0.277**	0.272*	0.274**
	[2.01]	[2.10]	[2.02]	[2.05]	[1.99]	[1.90]	[1.97]	[1.92]	[1.99]
Inflation	0.007**	0.007*	0.007**	0.007**	0.007**	0.007**	0.007**	0.007**	0.007**
	[1.97]	[1.93]	[2.00]	[2.08]	[2.15]	[2.13]	[2.05]	[2.07]	[2.08]
GDP growth	-0.341**	-0.330**	-0.321**	-0.323**	-0.314**	-0.322*	-0.336*	-0.326*	-0.335*
	[-2.08]	[-2.01]	[-2.02]	[-2.07]	[-1.99]	[-1.90]	[-1.82]	[-1.82]	[-1.85]
Currency crisis	1.457**	1.423**	1.459**	1.399**	1.426**	1.437**	1.503**	1.451**	1.492**
	[2.37]	[2.30]	[2.40]	[2.52]	[2.62]	[2.71]	[2.68]	[2.74]	[2.71]
Current account balance	-0.298*	-0.294*	-0.295*	-0.301*	-0.306**	-0.296*	-0.282*	-0.285**	-0.295*
	[1.88]	[1.94]	[1.96]	[1.93]	[1.96]	[1.94]	[1.92]	[1.97]	[1.89]
Institutional quality	-0.712**	-0.703**	-0.696**	-0.673**	-0.692**	-0.718**	-0.738**	-0.737**	-0.717**
	[-2.84]	[-2.81]	[-2.69]	[-2.62]	[-2.62]	[-2.64]	[-2.55]	[-2.53]	[-2.62]
Financial liberalization	0.120*	0.119*	0.125*	0.125*	0.124*	0.120*	0.125*	0.126*	0.122*
	[1.85]	[1.84]	[1.88]	[1.82]	[1.86]	[1.83]	[1.92]	[1.87]	[1.81]
Size	0.159**	0.158**	0.158**	0.157**	0.157**	0.159**	0.159**	0.162**	0.165**
	[2.22]	[2.27]	[2.27]	[2.38]	[2.43]	[2.48]	[2.55]	[2.66]	[2.67]
Regulation and supervision		-0.342*	-0.612**	-0.089	-0.387	-0.498**	-0.079	-0.348	-0.195
		[-1.87]	[-2.32]	[-1.34]	[-1.54]	[-2.04]	[-1.24]	[-1.62]	[-1.27]
Variance on									
% Bank level	0.266	0.276	0.267	0.254	0.261	0.248	0.232	0.232	0.240
% Country level	0.295	0.278	0.274	0.278	0.261	0.270	0.236	0.225	0.228
Log likelihood test p-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Implied R-squared	0.254	0.256	0.247	0.235	0.229	0.233	0.242	0.242	0.249
Arellano–Bond test AR(1)	0.001	0.001	0.002	0.002	0.001	0.002	0.002	0.002	0.002
Arellano–Bond test AR(2)	0.652	0.694	0.648	0.649	0.648	0.600	0.677	0.667	0.620
Sargan test (p-value)	0.580	0.527	0.520	0.567	0.562	0.576	0.521	0.571	0.532
Number of banks	371	371	371	371	371	371	371	371	371
Number of observations	1379	1379	1379	1379	1379	1379	1379	1379	1379

The first column of this 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, which are added in subsequent columns. **/* indicates significance levels of 5 and 10 percent, respectively. t-values are shown in parentheses.

Table 5. Estimation results – Instrumental variables

	Dependent variable: banking risk		
	Coefficient	Sargan test (p-value)	Wald test (p-value)
	(1)	(2)	(3)
Overall	-0.327	0.729	0.000
	[-1.91]*		
Capital regulations	-0.513	0.732	0.000
	[-2.16]**		
Regulations on private monitoring	-0.086	0.723	0.000
	[-1.27]		
Regulations on activities restrictions	-0.435	0.767	0.000
	[-1.57]		
Supervisory control	-0.594	0.764	0.000
	[-2.23]**		
Deposit insurer's power	-0.082	0.715	0.000
	[-1.35]		
Liquidity regulations	-0.347	0.763	0.000
	[-1.55]		
Market entry regulations	-0.213	0.720	0.000
	[-1.28]		

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. **/* indicates significance levels of 5 and 10 percent, respectively. t-values are shown in parentheses. Using number of years of independence, legal origin, share of several religions, ethnic fractionalization and latitude as instruments.

Table 6. Estimation results – Conditional effect of institutions

	Dependent variable: banking risk							
Regulation and supervision measure:	Overall	Capital regulations	Private monitoring	Activities restrictions	Supervisory control	Deposit insurer's power	Liquidity regulations	Market entry
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Lagged dependent variable	0.318**	0.303**	0.301**	0.311**	0.317**	0.296**	0.288**	0.287**
	[2.08]	[2.09]	[2.04]	[2.00]	[2.08]	[2.11]	[2.08]	[2.03]
Inflation	0.007*	0.007*	0.007*	0.006*	0.007*	0.007*	0.006*	0.006*
	[1.88]	[1.90]	[1.89]	[1.90]	[1.81]	[1.76]	[1.82]	[1.90]
GDP growth	-0.320**	-0.330**	-0.314**	-0.316**	-0.310**	-0.305**	-0.318**	-0.317**
	[-2.23]	[-2.23]	[-2.15]	[-2.18]	[-2.07]	[-2.08]	[-2.11]	[-2.02]
Currency crisis	1.435**	1.397**	1.375**	1.392**	1.423**	1.394**	1.344**	1.358**
	[2.26]	[2.24]	[2.33]	[2.43]	[2.31]	[2.39]	[2.31]	[2.23]
Current account balance	-0.310**	-0.316*	-0.327*	-0.339*	-0.326*	-0.314**	-0.323*	-0.325*
	[2.01]	[1.93]	[1.89]	[1.81]	[1.90]	[1.96]	[1.95]	[1.87]
Institutional quality	-0.667**	-0.691**	-0.696**	-0.713**	-0.742**	-0.767**	-0.770**	-0.736**
	[-3.11]	[-3.01]	[-3.01]	[-3.11]	[-3.08]	[-2.94]	[-3.02]	[-3.13]
Financial liberalization	0.124*	0.128*	0.130*	0.124*	0.129*	0.131*	0.130*	0.136*
	[1.95]	[1.88]	[1.73]	[1.92]	[1.87]	[1.82]	[1.77]	[1.76]
Size	0.157**	0.158**	0.156**	0.157**	0.156**	0.154**	0.156**	0.156**
	[2.20]	[2.25]	[2.27]	[2.22]	[2.12]	[2.19]	[2.26]	[2.33]
Regulation and supervision	-0.385*	-0.595**	-0.089	-0.398**	-0.493**	-0.076	-0.349*	-0.189
	[-1.95]	[-2.34]	[-1.31]	[-1.67]	[-2.08]	[-1.22]	[-1.73]	[-1.21]
Regulation and supervision x institutional quality	-0.017**	-0.020**	-0.019	-0.019*	-0.017**	-0.017	-0.020*	-0.017
	[-2.08]	[-2.17]	[-0.87]	[-1.91]	[-2.06]	[-0.32]	[-1.95]	[-1.13]
Variance on								
% Bank level	0.276	0.261	0.271	0.259	0.245	0.238	0.244	0.236
% Country level	0.301	0.292	0.256	0.269	0.246	0.238	0.239	0.228
Log likelihood test p-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Implied R-squared	0.258	0.259	0.253	0.257	0.259	0.257	0.265	0.245
Arellano–Bond test AR(1)	0.003	0.001	0.003	0.001	0.002	0.002	0.002	0.000
Arellano–Bond test AR(2)	0.690	0.623	0.695	0.662	0.700	0.642	0.614	0.671
Sargan test (p-value)	0.537	0.531	0.507	0.573	0.582	0.550	0.558	0.562
Number of banks	371	371	371	371	371	371	371	371
Number of observations	1379	1379	1379	1379	1379	1379	1379	1379

This table tests whether the impact of the different measures for regulation and supervision are conditional on the institutional quality by including interaction terms for these variables. The control variables are derived using 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. The latter are added to the base model subsequently. **/* indicates significance levels of 5 and 10 percent, respectively. t-values are shown in parentheses.

Table 7. Estimation results –bank structure

	Dependent variable: banking risk									
	High risk	Low risk	Listed	Unlisted	Government owned	Private owned	Foreign owned	Domestic owned	Small bank	Large bank
Measure of regulation and supervision:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Overall	-0.590**	-0.302*	-0.267*	-0.482**	-0.395**	-0.529**	-0.321**	-0.299**	-0.363*	-0.453*
	[-2.76]	[-1.76]	[-1.89]	[-2.03]	[-2.18]	[-1.97]	[-2.21]	[-1.97]	[-1.89]	[-1.95]
Capital regulations	-0.874**	-0.484*	-0.321*	-0.870**	-0.520**	-0.654**	-0.531**	-0.607**	-0.726**	-0.401*
	[-2.39]	[-1.83]	[-1.70]	[-2.68]	[-2.12]	[-2.10]	[-2.27]	[-2.08]	[-2.49]	[-1.68]
Regulations on private monitoring	-0.131	-0.060	-0.095	-0.131	-0.188	-0.280	-0.085	-0.065	-0.045	-0.090
	[-1.48]	[-1.04]	[-0.95]	[-1.35]	[-1.37]	[-1.44]	[-1.26]	[-1.11]	[-0.70]	[-1.70]
Regulations on activities restrictions	-0.416*	-0.342	-0.299*	-0.370*	-0.315	-0.461	-0.354	-0.295	-0.300	-0.415*
	[-1.83]	[-1.12]	[-1.66]	[-1.95]	[-1.46]	[-1.40]	[-1.50]	[-0.82]	[-1.13]	[-1.91]
Supervisory control	-0.690**	-0.365**	-0.258*	-0.780**	-0.493**	-0.539*	-0.472*	-0.359**	-0.474**	-0.419**
	[-2.22]	[-1.99]	[-1.71]	[-2.91]	[-1.98]	[-2.04]	[-1.88]	[-2.01]	[-1.99]	[-2.49]
Deposit insurer's power	-0.118	-0.073	-0.041	-0.082	-0.078	-0.124	-0.072	-0.076	-0.058	-0.080
	[-1.44]	[-0.84]	[-0.69]	[-1.58]	[-1.29]	[-1.14]	[-1.13]	[-0.89]	[-1.23]	[-1.30]
Liquidity regulations	-0.428*	-0.342	-0.246	-0.301**	-0.329	-0.318	-0.354*	-0.311	-0.628*	-0.245
	[-1.78]	[-1.68]	[-1.70]	[-2.21]	[-1.55]	[-1.48]	[-1.74]	[-1.58]	[-1.75]	[-1.41]
Market entry regulations	-0.285	-0.164	-0.155	-0.170	-0.278	-0.379	-0.179	-0.169	-0.153	-0.282
	[-1.41]	[-0.81]	[-0.75]	[-1.49]	[-1.20]	[-1.21]	[-1.37]	[-0.94]	[-0.74]	[-1.75]

The table shows the results for different subsamples, which are determined using certain bank characteristics, such as riskiness (columns 1-2), listed vs. unlisted banks (columns 3-4), ownership (private vs. government ownership (columns 5-6) and foreign vs. domestic ownership (columns 7-8)) and size (columns 9-10). The model is estimated including the control variables as shown in Table 4. **/* indicates significance levels of 5 and 10 percent, respectively. t-values are shown in parentheses.

Table 8. Estimation results – Development, geography, liberalization and alternative risk indicator

	Dependent variable: banking risk							Z-score
	Developing	Emerging markets	Africa	Latin America	Asia	High liberalization	Low liberalization	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Overall	-0.243*	-0.575**	-0.231	-0.475	-0.357	-0.409	-0.298	-0.206
	[-1.74]	[-2.72]	[-1.61]	[-2.23]**	[-2.55]**	[-3.34]**	[-2.41]**	[-1.92]*
Capital regulations	-0.487*	-0.668**	-0.342	-0.904	-0.655	-0.779	-0.548	-0.791
	[-1.81]	[-2.46]	[-1.70]*	[-2.81]*	[-2.19]*	[-2.91]**	[-2.32]**	[-2.40]**
Regulations on private monitoring	-0.068	-0.118	-0.058	-0.125	-0.099	-0.159	-0.107	-0.080
	[-0.82]	[-1.85]	[-0.61]	[-1.20]	[-1.34]	[-1.45]	[-1.10]	[-1.22]
Regulations on activities restrictions	-0.220	-0.489*	-0.203	-0.551	-0.222	-0.457	-0.367	-0.277
	[-1.39]	[-1.69]	[-0.91]	[-1.84]*	[-1.78]*	[-1.78]**	[-1.52]	[-1.31]
Supervisory control	-0.264*	-0.687**	-0.226	-0.807	-0.608	-0.551	-0.327	-0.824
	[-1.96]	[-2.08]	[-1.66]*	[-2.33]**	[-1.88]*	[-2.33]**	[-2.00]**	[-2.11]**
Deposit insurer's power	-0.055	-0.111	-0.063	-0.112	-0.101	-0.115	-0.070	-0.081
	[-0.84]	[-1.55]	[-0.75]	[-1.47]	[-1.31]	[-1.13]	[-1.58]	[-1.14]
Liquidity regulations	-0.236	-0.434*	-0.239	-0.488	-0.321	-0.308	-0.189	-0.342
	[-1.34]	[-1.71]	[-1.11]	[-1.92]*	[-1.89]*	[-1.88]*	[-1.36]	[-1.68]*
Market entry regulations	-0.135	-0.249	-0.117	-0.239	-0.196	-0.226	-0.187	-0.198
	[-1.08]	[-1.55]	[-0.94]	[-1.43]	[-1.10]	[-1.30]	[-1.45]	[-1.15]

This table shows results if the sample is split based on income level (columns 1-2), geographical location of banks (columns 3-5), and the degree of financial liberalization (columns 6-7). Column 8 shows the estimation results using the so-called Z-score as alternative risk indicator; see the main text for details. The model is estimated including the control variables as shown in Table 4. **/* indicates significance levels of 5 and 10 percent, respectively. t-values are shown in parentheses.

Table 9. Estimation results – Reverse causality (dependent variable: regulation and supervision)

Measures of regulation and supervision:	Banking risk
Capital regulations	0.098
	[1.41]
Regulations on private monitoring	0.201
	[1.54]
Regulations on activities restrictions	0.201
	[1.32]
Supervisory control	0.100
	[1.23]
Deposit insurer's power	0.145
	[1.05]
Liquidity regulations	0.251
	[1.08]
Market entry regulations	0.201
	[1.35]

This table examines reverse causality by estimating 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.

Figure 1. Banking risk in emerging and developing countries, 2002-2008

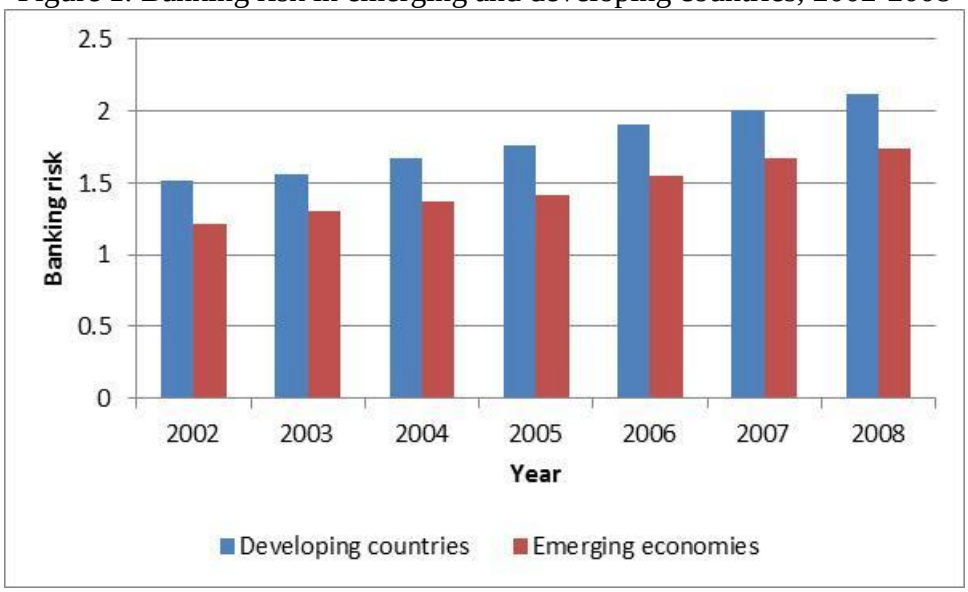
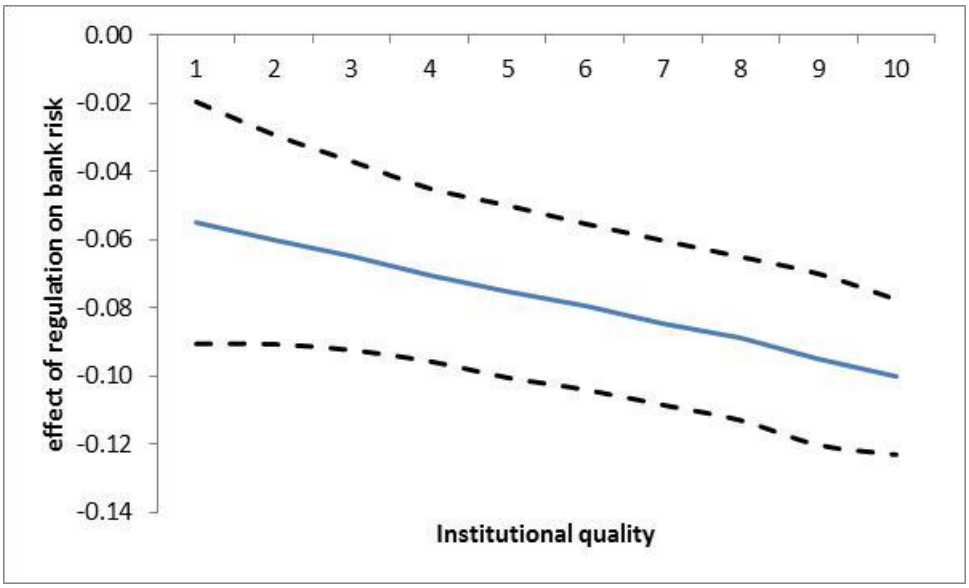
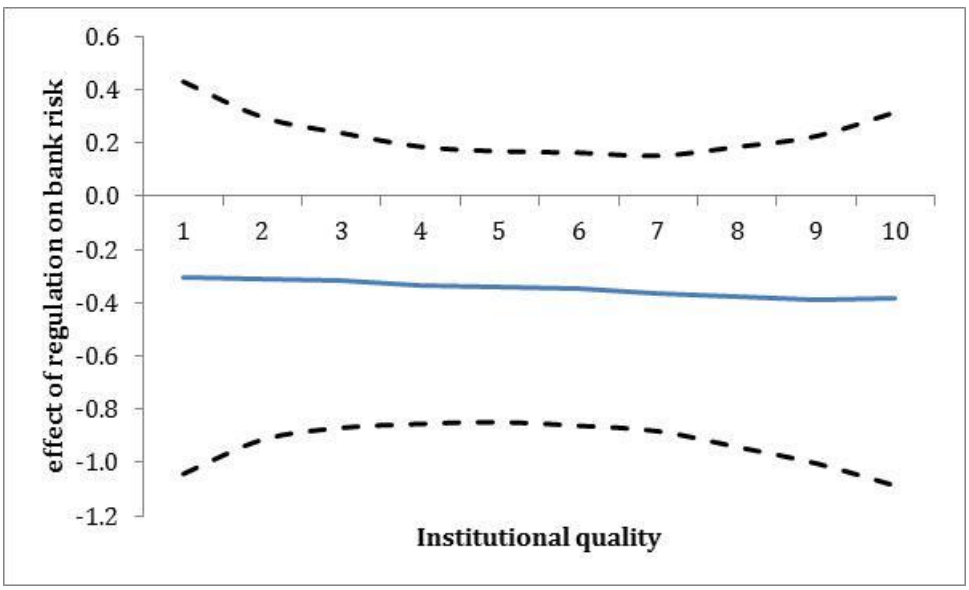


Figure 2. Marginal effect of regulation and supervision on banking risk, conditional on institutional quality

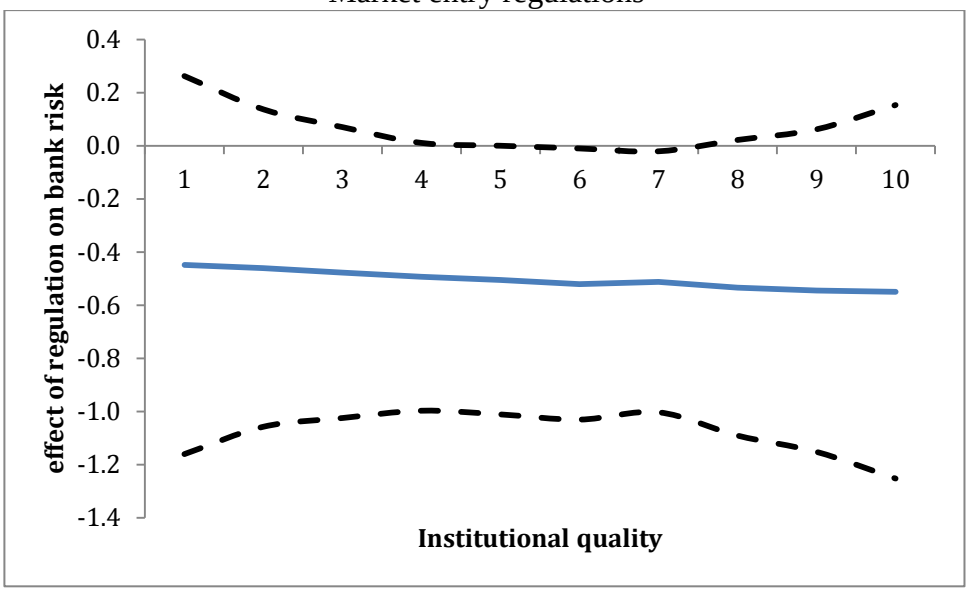
Overall index



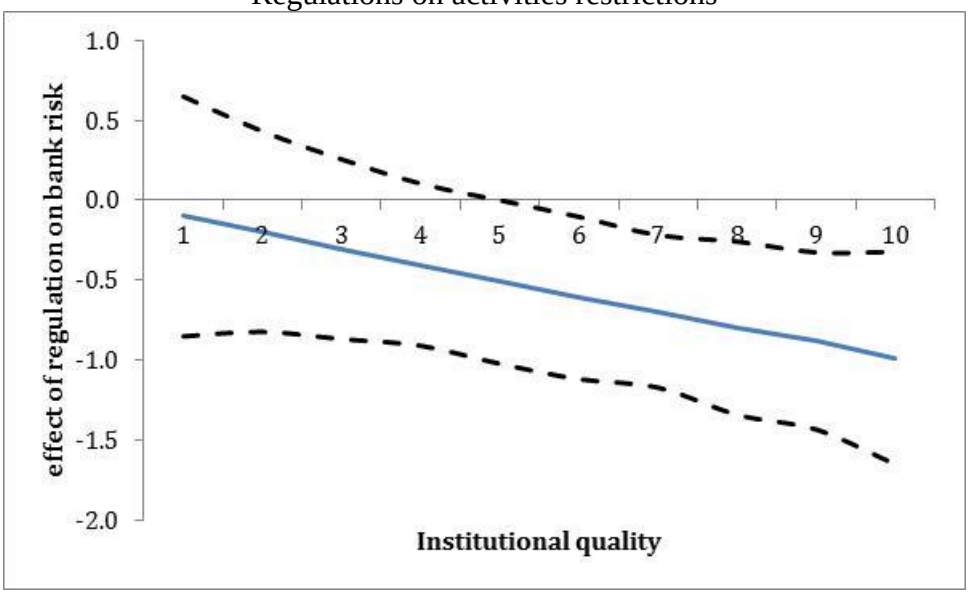
Capital regulations



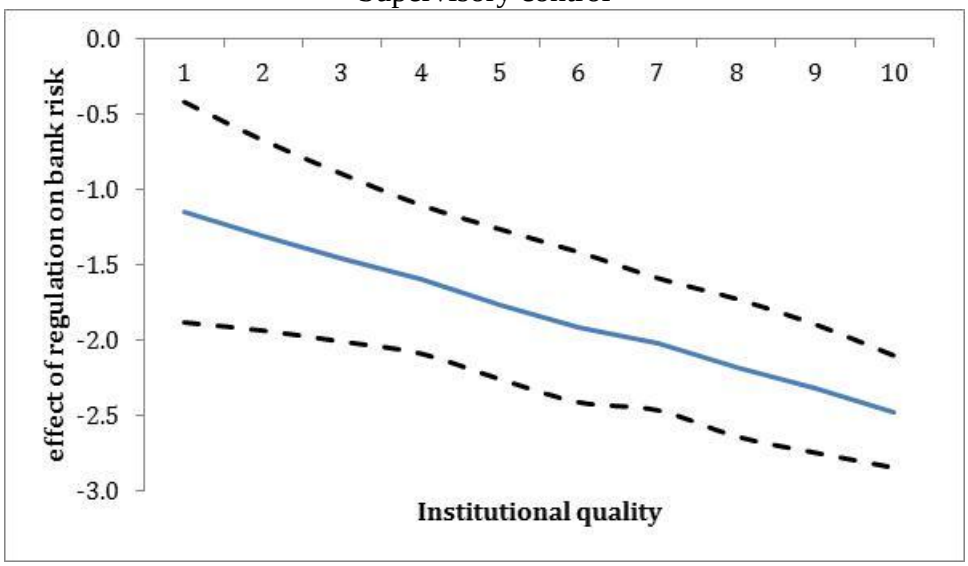
Market entry regulations



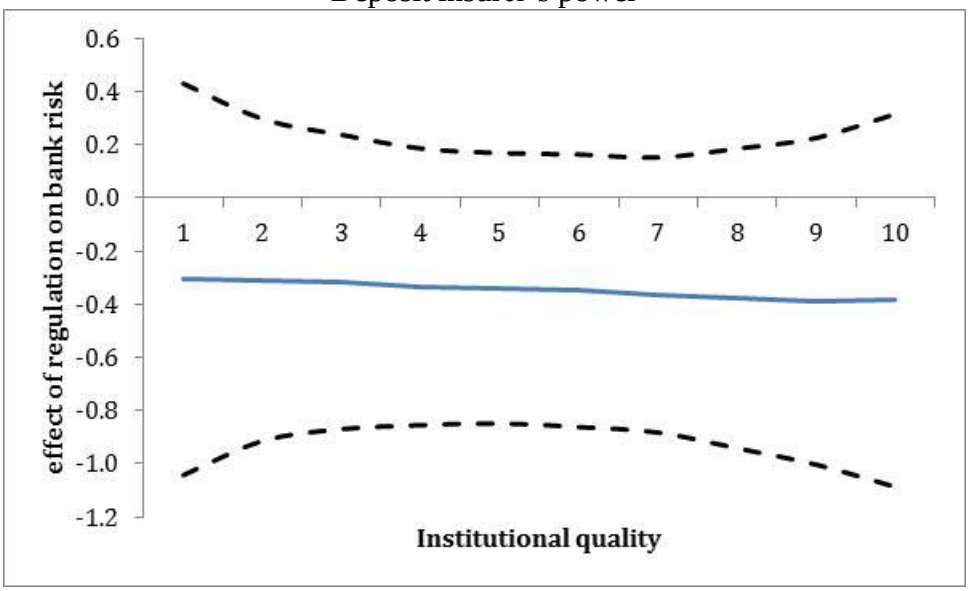
Regulations on activities restrictions



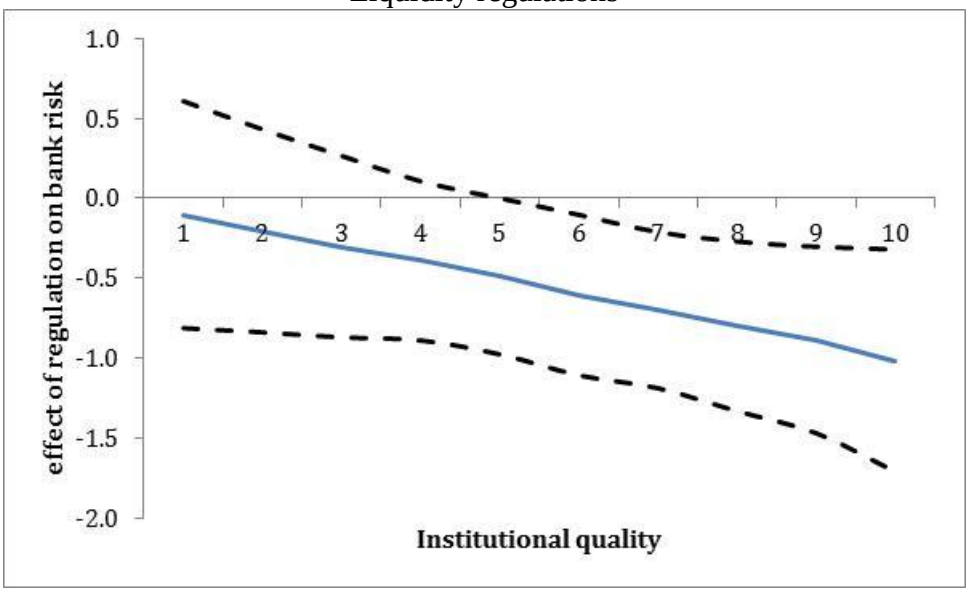
Supervisory control



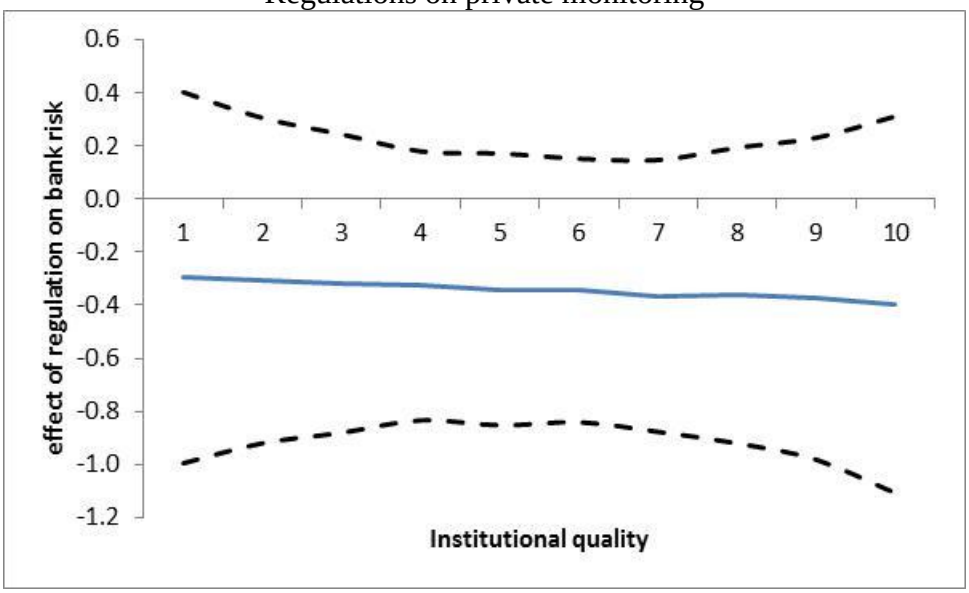
Deposit insurer's power



Liquidity regulations



Regulations on private monitoring



Appendix Table A1. Distribution of banks across countries

Country	Number of banks	Country	Number of banks
ALBANIA#	3	LITHUANIA#	2
ALGERIA	5	MACEDONIA#	2
ARGENTINA#	12	MADAGASCAR	1
ARMENIA*	2	MALAYSIA#	5
AZERBAIJAN	6	MAURITIUS*	7
BAHRAIN*	2	MEXICO#	4
BELARUS#	6	MOLDOVA REP. OF	3
BELIZE*	1	MONTENEGRO#	5
BENIN*	2	NAMIBIA*	2
BOSNIA-HERZEGOVINA#	6	NIGER*	2
BOTSWANA*	1	NIGERIA	4
BRAZIL#	21	PAKISTAN	8
BULGARIA#	6	PANAMA*	15
CAMBODIA*	7	PERU	2
CAMEROON	1	PHILIPPINES	11
CHILE#	3	POLAND#	13
COLOMBIA#	3	QATAR*	1
CONGO, DR*	1	ROMANIA#	9
COSTA RICA	8	RUSSIAN FEDERATION#	85
CROATIA#	6	RWANDA*	2
ECUADOR	13	SENEGAL	2
EL SALVADOR	4	SERBIA#	16
ESTONIA#	1	SLOVAKIA#	5
GABON*	1	SOUTH AFRICA	3
GAMBIA*	1	SRI LANKA	2
GHANA	4	SUDAN*	4
GUATEMALA	1	SWAZILAND*	2
GUINEA*	1	THAILAND	3
HONDURAS*	5	TONGA*	1
INDIA#	18	TRINIDAD AND TOBAGO*	2
KAZAKHSTAN	6	TUNISIA*	9
KENYA	4	TURKEY#	9
KYRGYZSTAN	4	UKRAINE#	16
LATVIA#	7	VENEZUELA	10
LEBANON*	3	ZIMBABWE	3
LESOTHO*	1		
Total	446		
Average number of banks per country	6.28		

* Countries excluded from the estimation in Tables 4 and 5 due to missing data on control variables.
# Emerging market country.

Table A2. Correlation matrix banking risk indicators

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Total equity / total assets	(1)	1.00	0.67	-0.20	0.16	0.20	0.11	0.00	0.01	-0.08	-0.02	-0.14	-0.05	0.12	-0.10	0.02
Total capital ratio	(2)		1.00	-0.55	0.02	-0.10	0.15	0.20	-0.04	0.08	0.08	-0.05	-0.13	-0.17	0.19	-0.04
Loan loss provision / total loans	(3)			1.00	0.44	-0.04	-0.14	0.06	0.16	-0.18	0.16	-0.06	0.02	-0.18	-0.15	0.14
Non-performing loans / total loans	(4)				1.00	0.19	-0.13	0.04	0.00	-0.02	-0.17	-0.19	0.10	0.06	-0.15	-0.02
Total cost / total income	(5)					1.00	0.39	0.13	0.06	0.12	0.01	-0.17	-0.16	-0.06	0.06	-0.13
Overhead cost/total assets	(6)						1.00	0.31	-0.06	0.07	-0.08	0.10	0.18	0.20	-0.05	0.09
Return on equity	(7)							1.00	0.71	0.43	-0.13	-0.10	0.07	-0.10	0.19	-0.19
Return on assets	(8)								1.00	0.52	-0.13	0.02	-0.07	0.14	-0.14	-0.02
Log (Bank Z-Score)	(9)									1.00	0.21	0.01	-0.03	0.09	0.04	-0.17
Liquid assets / total assets	(10)										1.00	0.25	0.10	0.05	-0.05	0.02
Total loans / deposits	(11)											1.00	0.10	-0.08	-0.08	0.17
Liquid assets/short-term funds	(12)												1.00	0.50	-0.06	0.10
Due to central bank / total equity	(13)													1.00	0.08	-0.19
Total interest expenses / total deposits	(14)														1.00	0.54
Government securities / total assets	(15)															1.00

Table A3. Variables and sources used

Variable	Description	Source
Current account balance	Value of export minus import as a share of GDP	World Bank (2010)
Inflation	Change in the consumer price index	World Bank (2010)
Economic growth	Annual percentage growth rate of GDP per capita at market prices based on constant 2000 U.S. dollars	World Bank (2010)
Current account balance	Ratio between export plus import to GDP	World Bank (2010)
Currency crises	Dummy variable if in a country-year there is a currency crises, otherwise 0.	Laeven and Valencia (2008)
Debt crisis	Dummy variable if in a country-year there is a debt crises, otherwise 0.	Laeven and Valencia (2008)
Depreciation	Depreciation of the official exchange rate	World Bank (2010)
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 (2010)
Term of trade shocks	Standard deviation of the value of import divided by the value of export in constant prices of 2000.	World Bank (2010)
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 U.S. dollars per capita.	World Bank (2010)
Real interest rate	The deposit interest rate minus inflation measured by the GDP deflator.	World Bank (2010)
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 (2010)
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 (2010)
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 (2010)
Government surplus	Government revenues minus government spending	World Bank (2010)
IMF program	Dummy variable if in a country-year there is a IMF program is running, otherwise 0.	Dreher (2006) and www.imf.org.
Institutional quality	Quality of institutions measured by a PCA of bureaucratic quality, corruption, rule of law and government stability	International Country Risk Guide (2008)
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)
Dispersed ownership	A dummy variable taking the value 1 if a bank has a shareholder which has an ownership more than 25 percent	Bankscope (2009)
Government ownership	A dummy variable taking the value if a bank is owned for more than 50 percent 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	Financial Times and Wallstreet

	year, otherwise zero.	Journal
Failure	A dummy variable taking the value 1 if a bank has failed in a specific year, otherwise zero.	LexusNexus and various bank statements and country reports
Concentration	Herfindahl-Hirschmann index of bank assets within a country	Bankscope and Beck et al. (2006)

Appendix: World Bank survey questions used (not intended for publication)

World Bank Survey 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.	0.54	1.48	0.44
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.	0.58	2.70	0.57
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.	0.75	1.91	1.14
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.	0.78	2.02	0.48
		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.	0.36	0.74	0.42
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.	0.27	0.62	0.40
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.	0.35	0.61	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.	0.23	0.95	0.10
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.	0.58	0.50	0.49
	Is subordinated debt allowable as part of regulatory capital?	A score of 0 was assigned for No and 1 for Yes.	0.37	0.80	0.10
3.6	Is subordinated debt required as part of regulatory capital?	A score of 0 was assigned for No and 1 for Yes.	0.27	0.01	0.08
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.	0.49	0.43	0.41
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.	0.26	0.72	0.35
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.	0.75	0.50	0.43

	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.	0.62	0.90	0.28
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.	0.41	0.81	0.29
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.	0.39	0.76	0.28
5.7	Can supervisors take legal action against external auditors for negligence?	A score of 0 was assigned for No and 1 for Yes.	0.80	0.55	0.35
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.	0.58	0.78	0.33
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.	0.28	0.62	0.41
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.	0.38	0.68	0.46
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.	0.56	0.31	0.47
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.	0.49	0.33	0.49
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.	0.72	0.36	0.49
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.	0.30	0.65	0.35
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.	0.27	0.52	0.46
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.	0.23	0.77	0.35
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.	0.18	0.82	0.21
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.	0.25	0.04	0.20
	Variables Included in PCA of Deposit's Insurer Power				
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.	0.44	0.22	0.41

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.	0.45	0.20	0.40
8.6	Can the deposit insurance agency/fund take 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.	0.64	0.49	0.45
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.	0.68	0.30	0.44
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.	0.26	0.06	0.02
	Variables Included in PCA of Regulations on 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.	0.61	0.61	0.44
5.3	Are auditors licensed or certified?	A score of 0 was assigned for No and 1 for Yes.	0.44	0.89	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.	0.30	0.76	0.21
10.5	Must banks disclose their risk management procedures to the public?	A score of 0 was assigned for No and 1 for Yes.	0.44	0.77	0.33
10.7	Do regulations require credit ratings for commercial banks?	A score of 0 was assigned for No and 1 for Yes.	0.63	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	0.43	8.12	2.22
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	0.43	3.09	4.91
10.7.3.1	Are bank activities about bond issuances rated?	A score of 0 was assigned for No and 1 for Yes.	0.61	0.78	0.11
10.7.3.2	Are bank activities about commercial paper issuance rated?	A score of 0 was assigned for No and 1 for Yes.	0.59	0.92	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.	0.37	0.67	0.40
	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.	0.79	0.40	0.50

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.	0.69	0.81	0.35
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.	0.46	0.04	0.20
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	0.29	0.05	0.04
7.10	What percent of the commercial banking system's assets is funded with deposits?	In percentage	0.41	0.39	0.18
7.10.1	What percent of the commercial banking system's assets is funded with insured deposits?	In percentage	0.37	0.18	0.12
	Variables Included in PCA of Market Entry Regulations				
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	0.79	0.19	0.28
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	0.65	0.32	0.49
1.12.1	1.12 Are foreign entities prohibited from entering through	A score of 0 was assigned for No and 1 for Yes.	0.41	0.37	0.48

Factor analysis on banking risk indicators (not for publication)

To determine whether indicators of banking risk have a multidimensional character, a so-called Dynamic Factor Analysis (DFA) is employed. The objective of DFA is to identify what different indicators of a latent variable (like bank risk) have in common and to separate common factors from specific factors. Following Lattin *et al.* (2003), Wansbeek and Meijer (2000) and Stock and Watson (2002) the factor analysis model can be written as:

$$\begin{aligned} x_{it} &= \Delta\xi_{it} + \varepsilon_{it} \\ \xi_{it} &= \lambda\xi_{it-1} + v_{it} \\ \varepsilon_{it} &= \rho\varepsilon_{it-1} + w_{it} \end{aligned} \tag{A1}$$

Where x_{it} is a vector containing M (demeaned) indicators (in our case the various indicators of different dimensions of the risk taking behavior of an individual bank) for country i, where $i = 1\ldots k$, Δ is a vector of factor loadings of order $M \times k$, and ξ is a vector of latent variables with mean zero and positive definite covariance. The parameters λ and ρ are the autoregressive coefficients and the error terms w_{it} and v_{it} are independent of each other. This model incorporates lagged effects of factors on variables by allowing the factor scores ζ_{it} to manifest time-related dependence in the form of autocorrelation. The current factor scores are influenced by the factor scores in the previous period. The strength of the influence is determined by the value of λ. The random error term ε_{it} is assumed to be uncorrelated with the latent variables[29]. Under these assumptions, the covariance matrix of x_i is:

$$\Xi = \Delta\Phi\Delta' + \Omega \tag{A2}$$

[29] E(ε) = 0 and E($\zeta\varepsilon'$) = 0.

Where Ξ is the parameterized covariance matrix that can be decomposed in the covariance matrix of the factors Φ and the diagonal covariance matrix of error terms Ω. The model is estimated by the Maximum Likelihood (ML). The log-likelihood function can be written as:

$$ln\,L = ln|\Xi| + tr\left[S\Xi^{-1}\right] \tag{A3}$$

Where S represents the sample covariance matrix. Minimizing this fit function means choosing the values for the unknown parameters that lead to the implied covariance matrix as close as possible to the sample covariance matrix.

The next step is to decide on the number of factors to represent banking risk. In general, there are three ways of interpreting this graph. First, one can use information criteria such as the Bai and Ng (2002) information criteria. An alternative is to look for an 'elbow' in the scree plot, i.e., the point after which the remaining factors decline in approximately a linear fashion, and to retain only the factors above the elbow. The scree plot graphs the number of factors against the eigenvalues of the covariance matrix of the indicators. Finally, the Kaiser criterion can be used according to which all factors with eigenvalues below one should be dropped.

Having optimized the likelihood function, it is possible that the factors of the (standardized) solution of the model are difficult to interpret. In that case, we can make use of the fact that the distribution of the indicators depends on the factor loadings Δ, only through $\Delta\Phi\Delta'$ and hence the matrix of factor loadings is not identified. That is, it can be multiplied with any orthonormal matrix without affecting the distribution of the indicators. Meaning, the factor loadings can be rotated so that a solution results that may be easier to interpret because the matrix has a simpler structure. We use the Oblimin rotation, which allows for correlation among the factors and minimizes the correlation of the columns of the factor loadings matrix. We used oblique rotation (instead of e.g. varimax rotation), because it does not arbitrarily constrain the factor rotation to an orthogonal solution. The oblimin rotation identifies the extent to which each of the fac-

tors is correlated to each other. As a result, a typical indicator will have high factor loadings on one factor, while it has low loadings on the other factors.

All indicators receive factor scores for the various dimensions (factors) identified. These factor scores are used to come up with the so-called Bartlett predictor, i.e., the best linear unbiased predictor of the factor scores:

$$\hat{\xi}_i = (\Delta'\Omega^{-1}\Delta)^{-1}\Delta'\Omega^{-1}x_i \tag{A4}$$

These factor scores can then be used as our indicator of bank risk.