Systemic risk, bank capital, and deposit insurance around the world*

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15th September 2014

Abstract

We analyze the effect of bank capital, regulation and deposit insurance on the global systemic risk of international banks during the period of 1999-2012. Using a comprehensive panel of large global banks, we find that higher Tier 1 capital decreases both the exposure and contribution of individual banks to global systemic risk. We also show that deposit insurance schemes that require banks and depositors to bear more financial risk are associated with a more pronounced vulnerability and contribution of individual banks to a crisis of the financial sector. Further results show that bank size and interconnectedness are positively related to global financial fragility. In contrast, we find no convincing evidence that a bank's supervisory environment or non-interest income significantly influence a bank's exposure or contribution to systemic risk.

Keywords: Financial crises, systemic risk, bank regulation, regulatory capital, deposit insurance.
JEL Classification: G01, G21.

*We received very useful comments from Santiago Carbo-Valverde, the participants of the 7th International Risk Management Conference 2014 in Warsaw, and two anonymous referees.

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"Stronger regulation and supervision [...] would have been a more effective and surgical approach to constraining the housing bubble than a general increase in interest rates."
Ben Bernanke, January 3, 2010

1 Introduction

To what extent can bank regulation and supervision limit the build-up of systemic risks in a financial sector?[1] Many commentators of the recent financial crisis of 2007-2009 have blamed (at least in part) the lax regulation of U.S. banks prior to the crisis as a significant contributor to the build-up of systemic risk (see, e.g., Stiglitz, 2010).[2] Since then, central bankers and regulators around the world have been concerned with the question how national and international capital requirements and supervision standards for banks should be overhauled and improved upon to prevent the next crisis. These initiatives by regulators are flanked by an overwhelmingly unanimous opinion in financial economics that banks should be obligated to operate with more capital (see, e.g., Kashyap et al., 2008; Admati et al., 2011; Hart and Zingales, 2011; BIS, 2012). Moreover, the available empirical evidence finds that more stringent regulation and supervision attenuates bank risk-taking (see Barth et al., 2004; Buch and DeLong, 2008; Laeven and Levine, 2008). At the same time, public outcries for tougher capital regulation and more powerful supervisory agencies have received considerable criticism by bank managers who argue that higher capital requirements will negatively affect bank performance which could in turn deteriorate financial stability. The empirical evidence on the effects of higher bank capital, however, questions both views. On the one hand, several studies (see, e.g., Jiménez et al., 2012; Berger and Bouwman, 2013) find no evidence supporting a value-destroying effect of higher capital requirements. On the other hand, more stringent capital regulations also do not necessarily improve financial stability as, e.g., Barth et al. (2004) find that a country's capital stringency has only little power for explaining banking crises.

[1] Throughout this paper, we follow the Group of Ten (2001) and define systemic risk as the risk that an "exogenous shock will trigger a loss of economic value in a substantial portion of a financial system causing significant adverse effects on the real economy". More precisely, we follow Adrian and Brunnermeier (2011) and Acharya et al. (2010) and define an individual bank's contribution to such a systemic risk as the degree to which the bank contributes to the financial sector as a whole being undercapitalized.

[2] Insightful discussions of the causes and lessons from the recent financial crisis are given by (e.g.) Brunnermeier (2009) and Gorton (2010a).

However, Cihák et al. (2013) find that crisis countries had less stringent definitions of capital and exhibited lower capital ratios. As both the academic literature and public opinion appear to be divergent on the issue of how bank capital, regulation and supervision affect financial stability and the optimal design of a regulatory system, we address this empirical question in our paper. To be precise, we analyze the question how bank capital, regulation and supervision around the world influence systemic risk at the firm-level based on a comprehensive panel of international banks.

The nexus between bank regulation and supervision on the one hand and financial stability on the other hand has been discussed extensively in the financial intermediation literature as it is directly linked to the benefits and drawbacks of government interventions (see, e.g., Shleifer and Vishny, 1998, for a critical view on the role of governments). These interventions regularly include (see Barth et al., 2004) the introduction of regulations on capital adequacy, restrictions on domestic and foreign bank entry and bank activities, tougher supervision, regulations on private-sector monitoring of banks and the introduction of an explicit deposit insurance scheme. The first measure, more stringent capital requirements, has been widely advocated both before and after the financial crisis as a regulator's weapon of choice to prevent bank crises. Higher capital functions as a buffer against losses making bank failures less likely and aligns the incentives of a bank's shareholders, creditors and depositors (see Keeley and Furlong, 1990; Dewatripont and Tirole, 1994; Berger et al., 1995; Acharya et al., 2011; Herring and Calomiris, 2011). Economic theory, however, is divided on the question whether capital adequacy requirements are purely beneficial to financial stability. For example, Diamond and Rajan (2001) show that a bank requires a fragile capital structure that is subject to bank runs to enable depositors to withdraw capital at low cost and buffer firms from the liquidity needs of their investors. Furthermore, sufficiently high capital could incentivize banks to increase their risk-taking (see Koehn and Santomero, 1980; Kim and Santomero, 1988; Besanko and Kanatas, 1996; Calem and Rob, 1999) which in turn could destabilize the financial system. Nonetheless, the empirical evidence of, e.g., Calomiris and Mason (2003), Calomiris and Wilson (2004), Berger et al. (2012) and Berger and Bouwman (2013) clearly supports the beneficial effects of higher bank capital on bank performance.

Financial stability, however, could also be influenced by the extent to which national regulators restrict banks from engaging in certain business activities. As theoretical justification for such bank activity restrictions, it is often argued that diversification of banks into trading, underwriting and investment banking causes conflicts of interest (see John et al., 1994), increased risk-taking (see Boyd et al., 1998; Brunnermeier et al., 2012) and helps the creation of financial conglomerates that are too complex to monitor.[3] On the other hand, restrictions on bank activities ultimately limit a bank's ability to diversify and to exploit economies of scale and scope. In line with this argument, the empirical evidence by Ang and Richardson (1994); Puri (1996) and Barth et al. (2004) finds bank activity restrictions to solely have detrimental effects on financial stability. In fact, rather than limiting excessive risk-taking, tighter restrictions on bank activities appear to incentivize banks to simply increase risk-taking outside their home countries (see Ongena et al., 2013).

In addition to activity restrictions, financial stability could also be affected (positively and negatively) by tougher supervision and better private monitoring of banks (see Barth et al., 2004; Hoque et al., 2014). More powerful supervisors could for instance improve the insufficient or inefficient monitoring of banks, in turn improving financial stability. Similarly, a regulator could force banks to disclose comprehensive information on their trading activities and risk management to improve private monitoring. Second, tougher supervision could help mitigate the probability of a bank run or at least mitigate its real economic consequences. In case a deposit insurance scheme is in place, tougher supervision could additionally stabilize the financial sector by tackling the moral hazard problem induced by deposit insurance as supervisors limit the excessive risk-taking of banks. Despite the positive effects of supervision on financial stability, supervisors could be tempted to exploit their powers with the ensuing corruption leading to greater financial fragility (see, e.g., Djankov et al., 2002).[4]

Finally, governments often hope to limit systemic risk by introducing explicit deposit insurance

3 Additionally, activity restrictions could thus also lead to less competition and subsequent to the "concentration-fragility" hypothesis (see, e.g., Kane, 2000) to more systemic risk.

4 Even without corruption, self-interested supervisors could still act in a socially sub-optimal way due to insufficient monitoring by taxpayers (see Boot and Thakor, 1993).

schemes. Diamond and Dybvig (1983) show in their classic model that deposit insurance can help prevent self-fulfilling runs by depositors while Bhattacharya et al. (1998) show that deposit insurance systems are superior to suspensions.[5] Yet, explicit deposit insurance schemes are also known to create a moral hazard problem as they tempt bank managers to take on excessive risks leading to more bank failures and possibly systemic risk (see Kane, 1989; Demirgüç-Kunt and Detragiache, 2002). The empirical literature is also inconclusive on the question whether the benefits of deposit insurance outweigh its drawbacks. While earlier work by Demirgüç-Kunt and Detragiache (2002) stresses the detrimental effect of deposit insurance on financial stability, Anginer et al. (2014b) find that moral hazard seems to be dominating during calm periods while the stabilizing effect of deposit insurance dominates during times of financial crisis.

Consequently, as economic theory and empirical work in banking provide interesting yet conflicting results, our paper addresses this need for a comprehensive analysis of the relation between bank regulation and global financial stability. We study the determinants of several measures of global systemic risk for a sample of large international banks from 1999 to 2012 concentrating on the banks' regulatory and supervisory environment. More precisely, we compute the banks' SRISK (see Acharya et al., 2012), Marginal Expected Shortfall (MES) (see Acharya et al., 2010) and ΔCoVaR (see Adrian and Brunnermeier, 2011) and estimate panel regressions of the annual values of these three measures of global systemic risk on variables on a country's regulatory system and deposit insurance schemes taken from the databases of Barth et al. (2013) while controlling for several idiosyncractic factors (e.g., bank size, interconnectedness, leverage, and debt maturity). The novel aspect of our paper is the focus on global systemic risk instead of systemic risk at the country level. We argue that due to the effects of increasing globalisation large international banks are part of a global banking network. Hence, financial fragility within this global banking network does not only affect markets on a country level but is likely to affect markets of overseas countries as well. The most prominent example for our line of argumentation is the recent global financial

[5] Bank runs are of course not the only source of systemic risk as runs by creditors can also destabilize the financial sector (see, e.g., Gorton and Metrick, 2012, for an analysis of the "run on repo" during the recent financial crisis).

crisis that took its origin in the United States but damaged financial institutions globally.[6]

We empirically test various hypotheses from the financial intermediation literature on the beneficial (or possibly detrimental) effects of bank capital, bank regulation and deposit insurance using a sample of 1,536 bank-year observations from 211 publicly listed international banks. We concentrate on large banks with total assets in excess of $ 50 billion[7] and find evidence that strongly supports the view that higher bank capital decreases systemic risk. In contrast, a bank's size and interconnectedness with the global financial sector are found to be positively related to its contribution to financial fragility. Additionally, we also show that the moral hazard created by the generosity and design of an explicit deposit insurance scheme is a main driver of global systemic risk. Interestingly, while we do find that higher Tier 1 capital decreases and bank size increases systemic risk, we find no convincing evidence that a country's regulatory capital requirements of a bank's supervisory environment significantly affect a bank's contribution or exposure to systemic risk. Moreover, our analysis of an international sample of large banks yields several insights that contradict previous findings in the literature. For example, contrasting the findings of Brunnermeier et al. (2012) for U.S. banks, a bank's non-interest income to interest income ratio is not a significant driver of systemic risk. Additionally, although of high importance during the recent financial crisis (see, e.g., Gorton, 2010b; Diamond and Rajan, 2009), the debt maturity of banks did not play such a significant role during our full sample period.

The empirical work in this study is related to several recent papers on the factors that cause banks to become systemically relevant. Our paper is most closely related to the recent work by Brunnermeier et al. (2012) on the drivers of the MES and ΔCoVaR of U.S. banks. However, their study does not analyze a sample of international banks while our study exploits the variation in na-

[6] Contrasting this line of argumentation researchers argue that regulation takes place at the country level and hence systemic risk at the country level is more relevant. However, the Basel Accords are a global regulatory standard, even though a voluntary one. Nonetheless, the standards suggested by the Basel Accords are transfered into national regulation in most countries. Additionally, Bertray et al. (2012) suggest that financial safety nets reduce bank internationalization because international banks are unlikely to be bailed out by governments of the overseas countries where they operate. However, we argue that financial fragility of a large bank in overseas countries is likely to affect the home banking sector as well and consequently the home government would ensure a bailout.

[7] Our motivation follows the Dodd-Frank Act of 2010 which defines banks to be systemically important if they have total assets in excess of $ 50 billion.

tional bank regulation and supervision to explore the determinants of global systemic stability. Our work is also related to the studies by Hovakimian et al. (2012) and Anginer et al. (2014b). While the former focuses on systemic risk in the U.S., the latter is only concerned with the correlation between deposit insurance and systemic risk during the financial crisis. In contrast, our paper studies not only the influence of deposit insurance but also national bank regulation and supervision based on an international panel of banks. Besides, our study is related to Anginer et al. (2014a). Using a panel approach of international banks with time-fixed and bank-fixed effects the authors study the relation between bank competition and systemic risk as well as the influence of the institutional and regulatory environment on bank systemic risk. They find that enhanced competition, supervision and private monitoring fosters systemic stability. In contrast to their study, we focus on global systemic risk and control for the influence of several aspects of regulation and supervision simultaneously. Similarly, Beck et al. (2013) also study the effect of bank competition and bank stability while controlling for cross-country variation in the regulatory environment. The authors find that the effect that an increase in competition has on banks' risk depends on country-specific characteristics, e.g., activity restrictions or the deposit insurance scheme. Laeven et al. (2014) focus on the relationship between size and systemic importance. The authors find evidence that large banks have a distinct, possibly more fragile, business model and large banks that have lower capital and less stable funding create more systemic risk. However, their study is limited to the crisis period of 2007-2008 while our study covers the period from 1999-2012. Additionally, our study is related to Anginer and Demirgüç-Kunt (2014). The authors analyze the effect of various types of capital on system-wide fragility. However, we additionally study the influence of national bank regulation and supervision on global systemic risk. The recent study by Hoque et al. (2014) also considers the influence of the regulatory and supervisory environment, but their study is limited to the credit and sovereign debt crises while our study considers both, crises as well as non-crisis periods. Furthermore, our analysis is related to the work by Drehmann and Tarashev (2013). The authors propose two different measures to quantify the systemic importance of banks that focus on the interconnectedness between financial institutions: the participation approach and the generalized contribution approach. The measures capture the extent to which a bank propagates shocks across the system and is vulnerable to propagated shocks. The main feature of their study is to verify the intuition that a banks' interconnectedness is a main driver of its systemic importance. Moreover, Houston et al. (2012) analyze whether cross-country differences in the regulatory environment influence international bank flows and find strong evidence that banks transfer capital to markets with fewer regulations. However, while the authors observe a race to the bottom in global regulations, in order for massive capital flows a strong institutional environment (e.g. creditor rights, property rights) for the receiving market is necessary. Finally, our paper is also related to the recent studies by Berger and Bouwman (2013); Beltratti and Stulz (2012); Fahlenbrach and Stulz (2011); Pelster et al. (2014); Demirgüç-Kunt et al. (2013) and Fahlenbrach et al. (2012). Their studies, however, are all concerned with the determinants of bank performance during the crisis in contrast to a bank's exposure and contribution to systemic risk.

The paper proceeds as follows. In Section 2, we describe our data and discuss the expected influence of various idiosyncratic and regulatory variables on financial stability. In Section 3, we document our main findings on the drivers of systemic risk. Section 4 concludes.

2 Data

This section describes the construction of our sample, defines the different systemic risk measures and presents the choice of our main independent variables as well as descriptive statistics of our data.

2.1 Sample construction

We construct our initial sample using all publicly traded banks included in the country and dead firm list of *Thomson Reuters Financial Datastream* from 1999 through 2012. [8] While daily share price data are retrieved from *Thomson Reuters Financial Datastream*, financial accounting

[8] We include banks that went bankrupt during our sample period to minimize an otherwise possible survivorship bias.

data are taken from the *Worldscope* database. From our initial sample, we drop banks with missing *Worldscope* data and exclude all secondary and non-primary issues as we consider a bank's country to be the country of its primary listing. Furthermore, we drop both all banks with "Pink Sheet" and OTC Bulletin Board stocks as well as banks with missing Datastream Codes. Stock prices from *Datastream* are known to suffer from data errors that require several filter screens to minimize a potentially biasing effect on our results. We follow the screening procedures proposed by Ince and Porter (2006) who analyze the effect of daily bank stock returns retrieved from *Datastream*. In particular, banks with an average share price below $1 within one year are excluded to avoid distorting effects in returns due to *Datastream*'s practice of rounding stock prices. In addition, we require for each bank available share price data for the full observation year to estimate a bank's systemic risk measures on a daily basis. Next, we exclude bank-years if the number of zero-return days exceeds 80% in a given month of a year. Excluding bank-years from our analysis as a result of missing or incomplete data might induce a selection bias which could be attributed to the banks' opaqueness. We address these concerns and confirm for most banks excluded from our sample that data taken from the *Datastream* or *Worldscope* databases are only partially missing with at least one key data item (like, e.g., total assets) being available. Moreover, we manually check if we can find at least one annual report from a respective bank if *Worldscope* does not provide any data on a given bank.

As our study is concerned with the influence of bank regulation on systemic risk, we want to focus on those banks that are large enough to destabilize the financial system at the global level. The Dodd-Frank Act of 2010 defines banks to be systemically important if they have total assets in excess of $ 50 billion. We follow its line of argumentation and only include those banks in our sample with total assets of $ 50 billion or more. We allow banks to merge during our sample period as banks are likely to have used mergers and acquisitions to become larger and possibly more systemically relevant or as exit channels in times of financial stress. While the banks in our sample took part in several M&A transactions as acquirers, only one bank was acquired. Our final sample consists of 1,536 bank-year observations of 211 banks in 40 countries over the period of

1999 to 2012. For increased transparency, we list all banks in our final sample together with the respective number of bank-year observations in Appendix I.

Figure 1 shows the total number of bank-year observations of all banks in our sample sorted by country. An overview of the number of banks included in our sample sorted by country is given in Figure 2.

[Place Figures 1 and 2 about here]

Japan has the largest number of bank-year observations (255) in our sample, followed by the United States and Italy with 177 and 151 bank-year observations, respectively. For several smaller countries, however, we only have few bank-year observations. Therefore, we do not winsorize bank-specific variables in our main analysis, to avoid distorting effects in our panel regression analyses. The total number of banks at the start of our sample period is 86 (1999), and the number of banks increases up to 150 banks through 2012.

2.2 Systemic risk measures

To capture different aspects of the systemic importance of international banks in each year, we compute several measures based on daily stock market data.[9] We choose these systemic risk measures based on three aspects. On the one hand, we are interested in measures that are used by regulators and central bankers for monitoring financial stability. At the same time, we are looking for measures that constitute the current state-of-the-art and that have been extensively discussed in the recent literature (see Benoit et al., 2013). Finally, we are interested in measures that can be estimated for a large number of financial institutions.[10]

[9] The need to consider several distinct measures of systemic risk is also stressed by the findings of Giglio et al. (2013) and Allen et al. (2012).

[10] Aside from the measures we use, several other measures of systemic risk have been proposed in the literature as a consequence to the recent financial crisis. One example are the CDS spread-based measures introduced by Oh and Patton (2013). However, including these measures would limit the number of banks in our sample significantly, as data on CDS spreads is not available for a large number of banks. Further examples for systemic risk measures are due to De Jonghe (2010); Huang et al. (2011); Schwaab et al. (2011); Hautsch et al. (2012); Hovakimian et al. (2012) and White et al. (2012). The systemic risk measures we employ, however, share the property that they are all based on economic theories of bank regulation. For a recent survey see Bisias et al. (2012), an earlier survey is given by De Bandt and Hartmann (2002).

First, we compute daily Marginal Expected Shortfall (MES) estimates in all years using the dynamic model of Brownlees and Engle (2012). The MES captures the marginal *exposure* of an institution to a system-wide collapse and is defined as the negative mean net equity return of a bank conditional on the global (financial) market experiencing extreme downward movements.[11] As a proxy for the financial sector, we use the *World Datastream Bank Index* (DS code BANKSWD).[12] The dynamic approach we use is econometrically more challenging than the original static version of the MES due to the fact that the proposed model by Brownlees and Engle (2012) accounts for time-varying volatility and correlation as well as nonlinear tail dependence in the banks' and market's returns. We employ the TARCH (see Rabemananjara and Zakoïan, 1993) and Dynamic Conditional Correlation (DCC) (see Engle, 2002) specifications for computing daily MES estimates for all trading days within one year.[13] In our panel regressions, we use the annual maximum of the daily MES estimates as a dependent variable.[14]

In addition, we use the SRISK measure proposed by Acharya et al. (2012). The SRISK is the capital that a firm is expected to need conditional on a crisis, i.e., $SRISK = \mathrm{E}_{i,t}[CapitalShortfall_i \mid Crisis]$. Acharya et al. (2012) argue that the expected capital shortfall captures several important characteristics for systemic risk and thus merges size, leverage, interconnectedness and the co-movement of the firm's assets with the total financial sector in a single measure. The SRISK for bank i at time t is given by $SRISK_{i,t} = \min\{0, CS_{i,t}\}$, where the Capital Shortfall for bank i at time t $CS_{i,t}$ is given by $CS_{i,t} = k(Debt_{i,t}) - (1-k)(1-LRMES_{i,t})Equity_{i,t}$. k is a regulatory variable which is set to 8%, $Debt_{i,t}$ denotes the bank's book value of debt, $Equity_{i,t}$ is the daily market value of the

[11] To define extreme downward shocks of the financial sector index, we follow Acharya et al. (2010) and use the 5% quantile of a respective sector index.

[12] In additional regressions we use the *Datastream MSCI World Index* to proxy for the global economy. As the focus of our paper lies on the role of bank regulation and thus the systemic risk of banks (and not other financial institutions like, e.g., insurers) we opted for the use of a global bank sector index for calculating our measures of systemic risk in our baseline analysis. Unreported robustness analyses confirm that out main results are robust to such a change in the index used for measuring a bank's systemic risk.

[13] Annual estimates of systemic risk as measured by the MES are also analyzed by Brunnermeier et al. (2012) while quarterly estimates are studied by Hovakimian et al. (2012). However, both studies exclusively focus on U.S. banks.

[14] Another approach to annualize the daily MES estimates could be to average the daily estimates for each bank-year. However, we argue that the average of the daily estimates neglects the worst realizations during the considered time period as they are leveled by less extreme values.

bank's equity and $LRMES_{i,t}$ is the daily estimated long run Marginal Expected Shortfall defined as $1 - exp(-18 \cdot MES)$, where MES is the dynamically estimated Marginal Expected Shortfall. For each bank-year, we then take the maximum of the daily SRISK estimates to proxy for this bank-year's annual SRISK estimate.

To additionally capture the *contribution* of a bank to systemic risk, we employ the ΔCoVaR method proposed by Adrian and Brunnermeier (2011), which is based on the tail covariation between a financial institution and the financial system. Adrian and Brunnermeier (2011) criticize the MES measure as not being able to adequately address the procyclicality that arises from contemporaneous risk measurement while ΔCoVaR measures the externalities a bank causes on the system.[15] For each bank-year observation in our sample, we compute the conditional ΔCoVaR which is time-varying and estimated using a set of state variables that capture the evolution of tail risk dependence over time. Following the estimation procedure outlined in Adrian and Brunnermeier (2011), we use the change in the three-month Treasury bill rate, the difference between the ten-year Treasury Bond and the three-month Treasury bill rate, the change in the credit spread between BAA-rated bonds and the Treasury Bond, the MSCI World Index as a proxy for the market return, the return on the Case-Shiller Home Price Index, and implied equity market volatility from VIX as state variables in the estimation of the conditional ΔCoVaR.[16]

2.3 Bank characteristics

We investigate the hypothesis that the differences in global systemic risk can be explained with idiosyncratic bank characteristics and (regulatory) country-specific factors. To this end, we collect a set of variables that covers bank characteristics, the banks' macroeconomic and regulatory environment as well as the individual bank's risk culture. The Bank for International Settlements (2013) recognizes five important dimensions of systemic risk: The size of the banking

[15] Conversely, Acharya et al. (2010) criticize the ΔCoVaR measure as being based on a non-coherent risk measure. Finally, both measures can be criticized for not taking a bank's size and leverage into account (see Acharya et al., 2012).

[16] We take the data from the U.S. Federal Reserve Board's H.15 as we believe the U.S. to have the biggest influence on the world's economy.

firms, their interconnectedness, the lack of available substitutes, their cross-jurisdictional activity and their complexity. We choose different variables to incorporate each of the factors in our panel regressions. While we explicitly consider all five categories proposed by the Bank for International Settlements (2013), our variables within the categories differ. To some degree we choose different indicators as we believe our choice to be more fitting, whereas in some cases we have to choose different indicators of systemic importance due to data availability. All variables used in our study as well as their respective data sources are defined in Appendix II.

The first set of variables we use includes standard idiosyncratic bank characteristics. To proxy for bank size we use the natural logarithm of a bank's total assets.[17] The bank's market-to-book ratio defined as the book value of common equity divided by the market value of common equity serves as a proxy for the bank's valuation. We would expect bank size to be an economically significant driver of systemic risk. For a larger bank it is more difficult for its activities to be quickly replaced by other banks. Additionally, with increasing size a failure is more likely to damage confidence in the financial system as a whole. In accordance with the too-big-to-fail hypothesis (see O'Hara and Shaw, 1990; Acharya and Yorulmazer, 2008), an increased probability of a government bailout in case of default could cause managers to engage in excessively risky projects (see Gandhi and Lustig, forthcoming). However, the trend to ever larger banks might be limited as Demirgüç-Kunt and Huizinga (2013) show that for large banks downsizing or splitting up might increase their value. Conversely, banks with greater charter value could provide managers with incentives to have higher capital ratios and to limit their risk-taking to insure against losses in charter value in case the bank defaults (see also Keeley, 1990). A bank's valuation and its systemic risk contribution could thus be negatively correlated. We include both variables as controls in our study and expect both variables to be highly significant drivers of systemic risk. In line with the too-big-to-fail hypothesis, we limit our sample to larger banks. Our fundamental hypothesis, however, is that the relationship between banking firms and global systemic risk is subject to reasons that go beyond sheer size or valuation.

[17] Note that we only include banks with more than $50 billion in total consolidated assets in our sample.

As a further explanatory variable, we employ a bank's leverage which is defined as the quasi-market value of assets divided by the market value of equity in which the quasi-market value of assets is given by the book value of assets minus the book value of equity plus the market value of equity (see Acharya et al., 2010). Earlier studies confirm hypotheses that highly levered banks contribute more to systemic risk and performed worse than less levered banks during the recent financial crisis (see Brunnermeier et al. (2012) as well as Beltratti and Stulz (2012)). Shleifer and Vishny (2010) affirm that highly levered banks contribute more to systemic risk as well as economic volatility while Acharya and Thakor (2011) argue that liquidity creation through the threat of premature liquidation can give rise to contagion. On the contrary, Berger and Bonaccorsi di Patti (2006) find that managers at banks with low leverage are inclined to commit free cash flows to risky projects thus increasing the likelihood of the bank's default, and consequently, its contribution to systemic risk. As a result, we expect the sign of leverage to be unrestricted in our regressions.

Next, we proxy for a bank's dependence on non-interest income by using the ratio of a bank's non-interest income to total income as an explanatory variable. Brunnermeier et al. (2012) show in their empirical study that banks with higher non-interest income have a higher contribution to systemic risk. The authors argue that non-core banking activities like, e.g., investment banking, are fundamentally different from the traditional deposit taking and lending functions of banks leading to more risk-taking by banks. These findings are also underlined by the evidence of DeYoung and Torna (in press) who find that a bank's default probability is significantly driven by higher stakeholder income from non-traditional activities that require banks to make asset investments. Additionally, Mercieca et al. (2007) and Baele et al. (2007) both show that non-interest income banking activities increase systemic risk. Based on the unanimous empirical evidence in the literature, we expect our variable Non-interest Income to be highly significant and positively correlated with global systemic risk.

We also use the variables Loans, Foreign Loans and Cash & Due From Banks defined as the ratio of a bank's total loans, a banking firm's foreign loans and a bank's cash & due from banks to total assets, respectively. A forecast of these variables on systemic risk is not clear-cut. A higher loans-to-assets ratio could be an indicator of a more traditional business model. Therefore, in line with the argumentation on the effects of non-interest income, the degree to which a bank relies on granting loans could be negatively correlated with its systemic importance. Contrasting these arguments, banks that grant more loans could as well be less selective and hence have riskier loans in their portfolio. Consequently, the default probability of loans increases and likewise the bank's likelihood of becoming insolvent (see Bartram et al., 2007). This line of argumentation is also supported by Foos et al. (2010) who show that loan growth leads to a peak in loan loss provisions and lower capital ratios. Additionally, banks that grant more loans could have a higher exposure to credit contagion (see Jorion and Zhang, 2007).

To proxy for the quality of a bank's loan portfolio, we consider the variable Loan Loss Provisions. A bank's loan loss provisions is defined as the natural logarithm of expenses set aside as an allowance for uncollectable or troubled loans in our regressions. Consequently, we expect a positive relation between loan loss provisions and systemic risk. Beltratti and Stulz (2012) argue that banks with fewer loans could be holding either more credit-risky securities which could make them more susceptible to increases in credit spreads or more government securities which would make them less risky. The variable Foreign Loans could be an indicator of greater diversification and higher cross-jurisdictional activity. While diversification in loans would decrease the bank's likelihood of becoming insolvent and likewise its exposure to systemic risk, the latter could result in a higher contribution to global systemic risk. The effects of Cash & Due From Banks could be ambiguous as well. On the one hand knock-on effects become possible which could increase systemic risk exposure, on the other hand the stabilizing role of interbank lending remains thereby decreasing systemic risk contribution (see Iori et al., 2006). Thus, we expect our variables on a bank's lending to have a differential influence on global systemic risk.

To proxy for the funding of a bank, we include in our regressions the variables Tier 1 Capital and Debt Maturity which are defined as the ratio of Tier 1 Capital to total risk-weighted assets and the ratio of total long term debt to total debt, respectively. Tier 1 capital is the highest quality component of a banking firm's capital. It is capable of fully absorbing losses without interrupting the bank's business in any way. However, it is the most costly form of capital for a bank to raise. Cihák et al. (2013) find that crisis countries had lower actual capital ratios. Hence, we would expect systemic risk to be negatively correlated with Tier 1 capital. Allen et al. (2013) argue that the use of short-term debt might lead to inefficiently liquidated banks if creditors receive negative information about banks' overall solvency. This line of argumentation is also supported by Shleifer and Vishny (2010) who advocate that the cyclicality of credit risk-taking and the use of short-term debt contributed to the financial crisis. More precisely, the dependence of certain banks on short-term funding exposed these institutions to liquidity risks during the financial crisis and ultimately led to significant systemic risks (see Brunnermeier and Pedersen, 2009). Based on these findings, the authors argue that direct regulation of short-term borrowing by banks is needed, amongst others, to dampen cyclical credit fluctuations and to control for systemic risk. Similarly, Fahlenbrach et al. (2012) find empirical evidence that banks that performed poorly during the recent crisis were more reliant on short-term funding than other banks (see also Adrian and Shin, 2010). Consequently, we expect Debt Maturity to be negatively correlated with systemic risk.

As a final balance-sheet variable we consider Deposits in our main regressions. Deposits is defined as total deposits to total liabilities. Banks that have less deposits have to rely on high overnight money market funding. Thus, we anticipate banks with a higher portion of deposit taking and therefore a less fragile funding to contribute less to systemic risk and to have a smaller exposure to systemic risk than banks engaging more strongly in non-core banking activities (see also Brunnermeier et al., 2012).[18]

In addition to the balance-sheet information, we also calculate several bank-specific variables that are related to a bank's performance and its stock liquidity. Following Fahlenbrach et al. (2012), we calculate and employ the variable Performance which we define as a bank's annual buy-and-hold return on its stock lagged by one year as a proxy for persistence in a bank's risk culture. Our

[18] Many countries in our sample have an explicit deposit insurance scheme. In these cases, in contrast to money market funding, deposit funding is thus not subject to runs (see Gorton, 2010a) and higher values of Deposits should clearly have a stabilizing effect on the financial system. As we will discuss later, however, the presence of an deposit insurance scheme on the other hand could induce a moral hazard problem.

prediction is that banks that performed well in the past stick to their (successful) culture of taking risks and contribute less to systemic risk. To include a measure of a bank's exposure to illiquid assets, we calculate the variable Liquidity Beta. If a bank invests in illiquid assets, its exposure to liquidity beta could impede the bank's ability to reduce its balance sheet and to avoid financial distress. Hence, we expect the liquidity beta to be positively correlated to systemic risk. Liquidity betas are estimated as the regression liquidity beta of a bank's excess return on the market-wide liquidity innovations of Pástor and Stambaugh (2003) which are computed from data for the 14 months preceding a respective bank-year.

A financial institution in financial distress can raise the likelihood of distress at other institutions due to the contractual obligations between these banks.[19] Thus, together with size we expect interconnectivity to be a main driver of global systemic risk (see Memmel and Sachs, 2013; Drehmann and Tarashev, 2013).[20] Unfortunately, data on interconnectedness is not readily available from public sources. Information on interbank loans is included in the annual financial statement, but annual information on such a crucial variable is nowhere near enough. Unlike Memmel and Sachs (2013), our international sample is much larger and thus we do not have access to detailed supervisory data but have to rely on market-based indicators of interconnectedness. Thus, to include more information on the interconnectedness of a bank with the global financial system in our regressions, we employ the variable Interconnectedness as defined by Billio et al. (2012). The authors define the number of connections as the sum of all in- and out-connections of a bank where one out-connection of bank *A* is given by financial institution *A* statistically significantly Granger-causing the stock returns of a second financial institution *B*. Simultaneously, this connection is an in-connection for banking firm *B*. Our variable Interconnectedness then measures the number of connections of each bank to other banks in our sample.

19 On the crucial role that existing linkages among banks and financial institutions play in channeling and amplifying shocks hitting the system, see Chinazzi and Fagiolo (2013). The authors survey the recent literature on contagion and conclude that the regulatory framework should rather follow a macroprudential instead of a microprudential approach (see for example Huang et al., 2011; Hanson et al., 2011).

20 We expect size and interconnectivity to be positively correlated as well. As a banking firm becomes larger it will naturally enter into more contractual obligations with other banks. However, a bank is also likely to increase in size when entering into more contractual obligations with other financial institutions.

2.4 Regulatory environment

To analyze the relation between bank regulation and financial stability, we include in our regressions several regulatory variables and additionally control for macroeconomic and other country-specific characteristics. To investigate whether these variables can explain the differences in the systemic risk exposure and contribution of banks, we take advantage of the database by Barth et al. (2013) on bank regulation and supervision in 180 countries over the past 12 years. The authors supply several variables and indices as a result of four surveys. These variables are not available for every year of our full sample period. However, Barth et al. (2004) find that most of their variables only adapt slowly in time. Therefore, we update missing data points with the most recent data that is available to us (see also Anginer et al., 2014a, for a similar approach).

Empirical evidence suggests that the risk taking of banks is sensitive to domestic regulation and in particular, restrictions on bank activities and market entry (see for example Barth et al., 2004; Laeven and Levine, 2008; Buch and DeLong, 2008). Ongena et al. (2013) find lower barriers to entry and tighter restrictions on bank activities in domestic markets to be associated with lower bank lending standards not only in domestic markets, but also in foreign markets. Hence, differences in the exposure and contribution to global systemic risk could be driven by differences in the way regulators prohibit banks from engaging in certain business activities or shield markets from (foreign) competitors. We employ several variables that capture these differences in banking regulation. We start with the variable Activity Restrictions taken from the database of Barth et al. (2013). The variable is an index of the overall restrictions on banking activities and measures to which extent a bank is allowed to engage in securities, insurance or real estate activities. Cihák et al. (2013) find that in crisis countries banking firms faced fewer restrictions on non-bank activities. Thus, we expect activity restrictions and global systemic risk to be negatively correlated.

Additionally, we consider the power and independence of a country's banking supervisory authority as further regressors in our empirical study. Again, we rely on the database of Barth et al. (2013). First, we include the variable Independence of Supervisory Authority which measures the degree to which the supervisory authority is independent of the executive branch of government. Higher values stand for greater independence. To proxy for the power of the supervisory authority, we use the Official Supervisory Power Index which measures the extent to which supervisory authorities have the authority to discipline banks by taking specific actions to prevent and correct problems. Again, higher values denote greater power. For all these variables, we expect stricter supervision and regulation to have a limiting influence on systemic risk. This is consistent with the argumentation that lax regulation facilitated the recent crises and in line with the results of Hoque et al. (2014). The authors show that bank risk can be explained by lack of official supervisory power and private monitoring.[21]

The stringency of capital regulations in a given banking system is proxied by the Capital Regulatory Index. This index measures whether the capital requirements reflect certain risk elements and deduct certain market value losses from capital before the minimum capital adequacy is determined. The index ranges from zero to ten with higher values denoting greater stringency. Barth et al. (2012) show that many countries made capital regulations more stringent over the last twelve years. We expect stricter capital regulations to lead to more systemic stability.

Next, we also employ the Private Monitoring Index of Barth et al. (2013) that captures the incentives and capabilities provided by regulatory and supervisory authorities to encourage the private monitoring of banks. Higher monitoring of banks by private investors should be linked to less systemic risk. Cihák et al. (2013) verify that the private sector in crisis countries had weaker incentives to monitor banking firms' risks. Barth et al. (2012) highlight that most countries have not enhanced the incentives or ability of the private sector to monitor banks and several have weakened private monitoring incentives over the last twelve years. The incentives of private monitoring are also connected with the deposit insurance schemes in the respective country.

To proxy for the design of a country's deposit insurance scheme, we use the Moral Hazard Index of Barth et al. (2013) that summarizes various factors concerning the design of the deposit insurance into one index. To be specific, the index captures the degree to which banking firms

[21] However, Beltratti and Stulz (2012) show that stricter regulation does not yield better bank performance.

have to contribute financial resources to the deposit insurance scheme as well as the degree to which depositors are insured for less than 100% of their deposits. Higher index values on a scale from 0 to 3 indicate less moral hazard. Anginer et al. (2014b) find that deposit insurance reduces the incentives of depositors to monitor banks and thus increases bank risk in good times. During a crisis, however, deposit insurance coverage increases systemic stability as it limits bank runs. This line of argumentation is also supported by Yorulmazer (2012) who argues that bank managers could be inclined to engage in more risk-taking thereby increasing the individual bank's contribution to systemic risk. Conversely, following the classic result of the Diamond and Dybvig (1983) model, the pure existence of deposit insurance should prevent bank runs and thus reduce systemic risk. However, not only the existence but also the design of an explicit deposit insurance scheme could be a key determinant of systemic fragility. Consequently, as the index included in our regressions measures factors mitigating moral hazard in the context of increased risk-taking and less incentives to monitor banks, we expect the variable to have an ambiguous influence on systemic risk.

2.5 Further control variables

Complementing the variables on the banks' regulatory environment from Barth et al. (2013), we additionally use several standard country controls from various data sources. From the World Bank's World Development Indicator (WDI) Database, we include the variable GDP growth as a standard macroeconomic control variable. To address the concern that our systemic risk estimates are simply driven by differences in the relative importance of local stock markets relative to the global market portfolio, we compute each country's relative stock market importance in the world defined as a country's stock market turnover relative to the total worldwide stock market turnover. Finally, to capture the market structure in a respective country, we include the Herfindahl-Hirschman Index (HHI) computed as the sum of the squared market shares of a country's domestic and foreign banks from the WDI database. High values of the index suggest that one or few banks control the market. Thus, a substitute of a given bank is not readily available and its systemic importance increases. This line of argumentation is also supported by Anginer et al. (2014a) who find a robust positive relation between bank competition and systemic stability. Furthermore, the authors show that the negative effect of lack of competition can be compensated by more efficient private and public monitoring of banks. However, increased competition erodes profits and thus lowers the charter value of banks which coupled with the existence of limited liability leads to increased risk taking. Hence, Marques-Ibanez et al. (2014) argue that competition increases bank risk and this effect is not compensated by higher capital levels for banks that face fiercer competition. Furthermore, Beck et al. (2006) show that systemic crises are less likely in economies with more concentrated banking systems. Finally, we control for the existence of a financial crisis using the crisis index proposed by Laeven and Valencia (2012). The dummy variable takes the value one if a crisis is identified in a given country for a given year, and zero otherwise.

2.6 Descriptive statistics

Summary statistics for all dependent and independent variables used in our study are reported in Tables I and II. For variables describing the regulatory environment of our sample banks, the median value is reported. While Table I provides descriptive statistics of our international bank sample averaged for each country across years, Table II presents descriptive statistics averaged for each year across countries. In addition, correlations between our explanatory variables are reported in Table IA.I in the Internet Appendix.

[Place Tables I and II about here]

Panel A of Tables I and II present mean estimates of our systemic risk measures. Our measure of dynamic MES varies widely across all countries and across time. The average mean dynamic MES across all countries is 7.3%. The average dynamic MES estimate is highest for banks in Hungary and lowest for banks in Jordan. Interestingly, while most bank in our sample are predominantly located in Japan, these banks show a below average mean dynamic MES of 4.76%. U.S. banks, on the other hand, have a mean dynamic MES of 10.5%, which means that U.S. banks lose 5.74% points more during times of financial market turmoil than Japanese banks. This difference is economically significant and large.

Our results on SRISK support this view. SRISK combines both a bank's liabilities as well as the bank's exposure to shocks in equity prices, which is the lowest for Saudi Arabia and the highest for the Netherlands and the United Kingdom. Turning to our yearly analysis, we can see that the dynamic MES across all years is 7.3%. While the average dynamic MES increased for the year 2000 as a result of the Dotcom crash to 15.1%, the estimate reached its peak level with 17.4% in the year 2008 during the Subprime crisis. Similar results can be found for SRISK as well as the static MES. Analyzing the results on the mean ΔCoVaR, the estimate is highest for Qatar and lowest for Turkey. For instance, while banks in emerging countries like India and Brazil have a mean ΔCoVaR of minus 1.32% and minus 1.25%, respectively, banks in developed countries like the United Kingdom and the Finland contribute less to overall systemic risk, i.e., 1.06% and accordingly 0.65%.

The time variation of our systemic risk measures is illustrated in Figures 3, 4, and 5.

[Place Figures 3 to 5 about here]

The three individual systemic risk measures take a similar course when averaged over all countries and sorted by year. The Dynamic MES, SRISK and ΔCoVaR measures all show an upward slope in the buildup to the Financial crisis and peak in 2008.[22]

The average exposure and contribution of banks to systemic risk sorted by countries is shown in figures 6, 7 and 8, respectively.

[Place Figures 6 to 8 about here]

All plots show that the average exposure and contribution to systemic risk differed significantly from country to country. As we would expect, banks from the EU and the United States had the highest average SRISK estimates in our sample. In contrast, banks from the United Kingdom and

[22] Note that while banks were severely exposed to the market crash during the Dotcom crisis in 2000, they did not contribute to the downturn of the market.

the United States had the highest average exposure to systemic risk while banks in South Korea, Turkey, and Austria had the highest average contribution to downturns of the financial sector.

The summary statistics on our bank-specific variables in Table I show the average size of our sample bank varies widely across all countries. More precisely, on average all banks have total assets of approximately $ 345 billion, with highest total assets for banks in France and at the same time the lowest value for banks in Jordan. Moreover, our comparison of summary statistics over time given in Table II shows that average bank size has more than doubled over the past 14 years to a value of $ 425 billion in 2012. At the same time, we can observe that larger banks, on average, have a higher leverage that ranges from 3.71 for banks in Qatar to 701 for Swiss banks.

Table I also reveals that banks from Qatar have the lowest non-interest to total interest ratio of 18.37%, while Spanish banks, on average, have a four times higher NII ratio. U.S. banks, however, show an above-average non-interest income to total income ratio of approximately 49% and at the same time a total loans to total assets ratio of 60% which is below-average. Interestingly, Swiss banks have the lowest total loans to total assets ratio of nearly 17%. Further, Tier 1 capital ranges from 7.45% for India to 18.65% for the UK. We also observe significant differences for the Interconnectedness variable across countries. Perhaps not surprisingly, the United States report one of the highest values, but banks from Cyprus, South Korea, and Australia report even higher average values for Interconnectedness. Next, the summary statistics on our bank-specific variables show that the average funding structure of banks in our sample differs quite substantially from country to country. For example, values for the banks' deposits to liabilities ratio differ from 19.88% (Switzerland) to 91.05% (Cyprus). Similarly, banks in Saudia Arabia and Cyprus have the lowest average debt maturity, while banks in South Korea and India had average debt maturities of 79.15% and 82%, respectively.

Finally, the summary statistics for our regulatory and macroeconomic variables given in Table I show that the countries in our sample are characterized by a diverse set of regulatory systems. In particular, the main regulatory indices on capital requirements and supervision show without exceptions a high variation across countries, thus underlining the motivation of our study. Beginning with the Activity Restrictions Index of the overall restrictions on banking activities, we see differences in the restrictiveness across countries. While Hong Kong and most European Countries have a score of 3 to 5, the United States and Japan have a higher value of 8. Also, the values for the Capital Regulatory Index range widely across all countries, underlining the findings from the variable Tier 1 capital. For example, Poland and Sweden have the lowest stringency of capital regulations in the banking system, while countries like, e.g., Hungary and Turkey have the highest values in our sample. Values for the indices for the independence and power of the supervisory agency also differ substantially from country to country. As do the restrictions on the activity of banks and the entry barriers to banks from foreign countries.

We now turn to the time variation in our explanatory variables presented in Table II. Starting with the bank-specific variables and their annual changes, we can observe that our sample banks' performance increased, on average, in the pre-crisis period and not surprisingly, suffered drastic decreases of 45% during the financial crisis in 2009. The interconnectedness of each sample bank with other banks experienced an immense increase both during the financial crisis and also in the aftermath of the Subprime crisis. Most likely due to the experiences from the crisis, our proxy for interconnectednes decreased to pre-crisis levels again after the crisis in 2012. Other bank-specific factors showing high volatility during the crisis period include non-interest income and the market-to-book ratio. Non-interest income decreases after the crisis period but has reached pre-crisis levels again by 2012. The differences in the banks' market-to-book ratios are rather drastic and highlight the turbulences in the financial market during the crisis. In fact, most bank-specific variables show at least some variation over time. One notable exception is our variable Loans that has been constant at 61% for eleven years in 2012.[23] The banks' average Tier 1 capital shows a steady increase since 1999 illustrating the efforts undertaken by regulators during that time span to improve financial stability.

Panel B and C of Table II present median and mean estimates of our regulatory and country-specific variables and their variation over time, respectively. The statistics on our variables de-

[23] This finding is consistent with Kashyap and Stein (2000) who find that the aggregate declines on loan supply during financial crises are mostly driven by smaller banks.

scribing the regulatory environment in our study highlight that regulation is adapting over time. Especially the External Governance Index and the Activity Restrictions Index show a steady increase since 1999. Not surprisingly, the median Capital Regulatory Index exhibits a jump from 2011 to 2012, increasing from 5 to 8. Foreign Bank Limitations is the only regulatory variable that is constant over time. However, some regulatory variables like the Diversification Index, Entry Requirements as well as Foreign Bank Limitations also do not vary significantly across all countries or across time.

To conclude our presentation of the summary statistics on our sample, we address the frequently stated concern (see, e.g., Benoit et al., 2013; Giglio et al., 2013) that the systemic risk measures we employ in our empirical study are simply substitutes for a bank's equity beta. As shown by Benoit et al. (2013), the MES corresponds to the product of the market's tail risk and the institution's beta while ΔCoVaR corresponds to the product of the institution's VaR and the linear projection coefficient of the market return on the individual institution's return. In addition to our measures of systemic risk, we also estimate our sample banks' equity betas and compare them to the systemic risk estimates. Table III shows the correlations between our systemic risk measures and the banks' betas.

[Place Table III about here]

Two major findings can be seen in Table III. First, concerns that our systemic risk measures only capture a bank's equity beta are unjustified as correlations between beta and our systemic risk measured do not exceed 36%. Second, the moderate correlations ($|\rho| < 0.54$) among our three systemic risk measures emphasize the notion that each measures captures a different aspect of systemic risk.

3 Systemic risk around the world: The role of bank regulation

In this section, we present the results of our panel regression in which we analyze the determinants of both the banks' exposure and contribution to global systemic risk. We begin by presenting the results of our main regressions in the first part of this section. In the second part of this section, we discuss the robustness of our main findings.

3.1 Regression analysis

For the analysis of the determinants of our systemic risk measures, we estimate panel regressions with time-fixed and bank-fixed effects of the following form using at the bank level clustered robust standard errors.[24]

$$\text{Systemic risk measures}_{i,t} = \beta_1 \cdot \text{Tier-1-capital}_{i,t-1} + \beta_{\text{Regulatory}} \cdot X_{i,t-1} + \beta_{\text{Bank controls}} \cdot Y_{i,t-1} + \beta_{\text{Country controls}} \cdot Z_{i,t-1} + u_i + v_t + \epsilon_{i,t}$$

We run separate regressions for each of our three systemic risk measures, the dynamic MES, SRISK and ΔCoVaR. We regress each variable on a set of bank-specific, regulatory and country-specific variables to determine which factors drive the exposure and contribution of banks to systemic fragility. To mitigate the problem that our dependent variables and some of our independent variables could be determined simultaneously, we lag all our explanatory variables by one year. The results of our baseline panel regressions are shown in Table IV.

[Place Table IV about here]

Models (1) to (3) in Table IV use the banks' MES as dependent variable. The results of our panel estimation show that in all three model specifications, the Tier 1 capital ratio is negatively related to the banks' exposure to overall systemic risk. This result is intuitive as Tier 1 capital represents the highest quality of a bank's capital. A higher Tier 1 capital ratio coincides with a higher

[24] This procedure is valid due to the fact that the residuals are not correlated across both time and bank. For further analyses see, e.g., Thompson (2011) and Beck and De Jonghe (2013). In contrast, Anginer and Demirgüç-Kunt (2014) use country x year fixed effect regression specifications. However, this approach is inapplicable for our purposes as this specification would eliminate the influence of our regulatory variables.

probability of absorbing losses and therefore decreases the banks' exposure to systemic risk.[25] Interestingly, and in contrast to the results of Brunnermeier et al. (2012), the ratio of a bank's non-interest income to total income enters our most comprehensive regression (3) with a statistically significant negative sign.[26] This result indicates that banks engaging more in non-traditional activities decrease their exposure to systemic risk. In our most comprehensive model (3), a bank's leverage is positively related with its exposure to systemic risk. Furthermore, and in line with intuition, we find Interconnectedness to be positively related to dynamic MES in regression (1). In other words, banks that are highly interconnected with the rest of the financial system also have a higher exposure to adverse spillover effects from the financial sector. This result is in line with the findings of Drehmann and Tarashev (2013). The authors argue that interconnectedness is an essential driver of the systemic risk of a banking firm. However, the significance of this effect vanishes as soon as our control variables on the banks' regulatory environment are included in the regression. Similarly, several of our idiosyncratic variables do not possess any explanatory power in the regressions of the banks' exposure to systemic risk. Most notably, both the banks' deposits to liabilities and loans to assets ratios are not statistically significant in regressions (1) to (3).

Turning to the variables on the banks' regulatory environment, we see that the Private Monitoring Index is negatively related to the dynamic MES. This variable captures the supervisory authorities' incentives for a better private monitoring of banks. Therefore, more private monitoring reduces an individual bank's exposure to systemic risk. Additionally, we find that the design of an explicit deposit insurance scheme is significantly related to the exposure of an individual bank to global systemic risk. In fact, banks in a country in which a scheme is in place that requires banks to contribute more resources to deposit insurance possess a higher MES on average.

[25] However, Ellul and Yerramilli (2013) analyze the relation between a bank holding company's risk management index and its tail risk for a sample of 72 publicly listed U.S. bank holding companies over the 1995 to 2010 period and find that higher tier 1 capital to assets ratios correspond to higher tail risk. The authors argue that the result is based on the fact that riskier banks have higher tier 1 capital.

[26] Our coefficient estimates for control variables are different from other studies as we are the first to focus on global systemic risk and consider an international sample at the same time. For example, the sample of Brunnermeier et al. (2012) is limited to U.S. banks.

Finally, the analysis of our macroeconomic control variables shows that, as expected, banks located in countries with a high GDP growth tend to have a lower exposure to systemic risk, though this effect is only weakly significant in models (1) and (2). The importance of a bank's respective home country's stock market in the world is negatively related to MES. Even more interestingly, concentration in the banking sector is significantly positively related to the average bank's systemic risk exposure. This finding is in line with recent results of Anginer et al. (2014a) who find that more competition incentivizes bank managers to take on more diversified risks.

In models (4) to (6) of Table IV, we repeat our regressions using SRISK as our dependent variable. In contrast to our previous regressions on dynamic MES, a bank's total assets now enters all regressions with a significant and positive coefficient. However, this result is not too surprising as SRISK is designed as a measure of the sensitivity of a bank's equity and its total debt to market stress. In addition, the quality of a bank's loan as proxied by its loan loss provisions is positively related to a bank's contribution to systemic risk. Banks that hold more non-performing loans also have a significantly higher contribution to systemic risk. Moreover, in regression (6) we find a bank's SRISK to be increasing in the bank's interconnectedness and decreasing in the loans to total assets ratio. More interconnected bank that grant less loans thus appear to be more systemically important than others.

Again, in our most comprehensive regression model (6), we find the concentration of a bank's home country's financial sector to be a highly statistically and economically significant determinant of a bank's contribution to systemic risk. Turning to the regulatory environment, again, we do not find any clear-cut results. Most strikingly, we do not find clear evidence that higher capital requirements or deposit insurance significantly affect the Capital Shortfall of international banks.

Finally, in columns 7 to 9 of Table IV, we present the results of our panel regression of ΔCoVaR, which captures a bank's contribution to global systemic risk. Again, we consider the same set of independent variables as in our previous regressions. Similar to our regressions of the banks' MES, bank size does not enter any of our regressions with a significant sign. More interestingly, and in line with our findings for the banks' exposure to systemic risk, an increase in a bank's Tier 1 capital has a negative impact on the systemic risk contribution of a bank. This effect is highly statistically and economically significant and shows that more regulatory capital, on average, significantly decreases an individual bank's contribution to the fragility of the financial system. Corroborating our findings for MES, a higher non-interest income to interest income ratio is positively related to the ΔCoVaR of banks. Again, our results for a bank's non-interest income are thus in contradiction to the findings of Brunnermeier et al. (2012). Further, we find that a bank's interconnectedness with the rest of the banking sector significantly increases its contribution to global systemic risk. Banks that are highly interconnected can thus more easily facilitate shocks across financial systems.

Complementing our previous findings, we also find a bank's contribution to systemic risk to be increasing in the extent to which banks have to contribute financially to deposit insurance. Taken together with our results on the banks' MES, we thus find evidence that the design of an explicit deposit insurance scheme significantly impacts financial stability. Furthermore, the index of a regulatory system's restrictions on bank activities is significantly positively related to a bank's ΔCoVaR. Preventing banks from engaging in too risky activities outside the classical lending and deposit-taking business thus limits the build-up of systemic risk.

3.2 Additional analyses

In addition to our multivariate analyses, we perform several regressions in which we employ the same set of systemic risk measures as in Table IV but in addition to our control variables additionally include different interaction terms. Again, we estimate panel regressions of MES, ΔCoVaR, and SRISK with robust standard errors as well as time-fixed and bank-fixed effects. The results are presented in Table V.

[Place Table V about here]

In the regressions in Table V, we also employ a dummy variable proposed by Laeven and Valencia (2012) that takes on the value one if a country experienced a financial crisis in a given year, and zero otherwise. To investigate the effect of times of financial crisis on our systemic risk measures, we interact this dummy variable with a selection of our bank-specific variables. The results show that during crisis periods, a higher Tier 1 capital ratio significantly decreased a bank's systemic risk exposure. This result supports our previous finding that Tier 1 capital shields banks from adverse effects spilling over from the financial sector to individual institutions. Even more importantly, a higher ratio of Tier 1 capital enables banks to absorb losses especially during times of financial crisis hence reducing a bank's exposure to systemic risk. Moreover, we find that banks that are highly interconnected during crisis periods on average, possess a lower dynamic MES. Interestingly, while the variable interconnectedness is positively related to a bank's systemic risk exposure in our previous panel estimations, this effect is reversed during crisis periods.

Turning to SRISK as our main dependent variable, we find that bank size significantly exacerbates the positive relation between a bank's interconnectedness and its SRISK. In line with common economic intuition, banks become highly systemically important if they are of critical size and if they are highly interconnected with the rest of the financial system. Also, a higher portion of cash and due from banks increases banks' SRISK in crisis periods. Most probably driven by the bank-year observations in the Subprime crisis, this result is in line with the notion that more interconnections with the banking sector increases a bank's systemic importance, especially during times of crisis. A similar argument applies to the interaction term of a bank's debt maturity with the proxy for a bank's interconnectedness. In regression model (8), the interaction term is weakly statistically significant and negative. Banks that are highly interconnected thus contribute more to systemic risk if their funding structure is more fragile. Again, this result is in line with experiences from the recent financial crisis.

In Panel C of Table V, we repeat our regressions including interaction terms with the banks' ΔCoVaR as the dependent variable. In model (1), we again find that Tier 1 capital exerts a positive effect on systemic risk. The adverse effect of a deposit insurance scheme that requires more financial resources from banks on systemic risk is attenuated if the bank holds more Tier 1 capital. Underlining our result from the corresponding regression of SRISK, we again find that the negative impact of interconnectedness on an institution's contribution to systemic risk is worsened by a higher value for cash and due from banks. This result is not surprising as a higher interconnectedness through the interbank market can thus more easily faciliate shocks through the interbank market. On the other hand, a higher interconnectedness in crisis periods significantly decreases banks' contribution to systemic risk. Finally, in line with the result of Anginer et al. (2014b) we find the negative effect of deposit insurance on systemic risk to be less severe in times of financial crisis.

Next, in untabulated regressions, we compare U.S. banks with European banks in our sample. The Financial Stability Board (FSB) recently identified 28 systemically important banks. Out of these 28 banks, 8 are from the U.S., 16 from Europe and only 4 from countries outside these two regions. Hence, we assume that U.S. and European banks help us find some additional insight into global systemic risk. The most interesting fact that we find, is the increased influence of size for European banks. While size is still the main driver of Capital Shortfall for U.S. banks, for European banks, size is the main driver for all our systemic risk measures.

In addition, we perform several robustness checks in order to complement the main regressions in the previous sections. For this purpose, we consider additional data and variables and examine if the results of our analysis change. First, we check the robustness of our results using the MSCI World Index as a proxy for the global market portfolio. Our main conclusions remain qualitatively and quantitatively unchanged.

Additionally, our main results could be biased by the market structure in some countries. Many foreign- or government-owned banks could have significant influence on global systemic risk. Hence, to control for the market structure, we include the variables Capital account openness, Foreign-Owned Banks and Government-Owned Banks in our regression. In unreported results, we find that the additional variables do not influence our conclusions.

Furthermore, we run regressions to additionally check for the influence of supervision on global systemic risk. Consequently, we include all variables that are concerned with the supervisory environment (Multiple Supervisor, Official Supervisory Power and Independence of Supervisory

Authority) in an additional regression. Again, we find the influence of the variable Multiple Supervisor to be statistically insignificant. Thus, our main conclusions remain unchanged.[27]

4 Conclusion

In this paper, we investigate whether regulation and supervision can limit the build-up of global systemic risk in the banking sector. To this end, we study a comprehensive panel of international banks over the period of 1999-2012 with 1,536 bank-year observations from 211 banks with total assets in excess of $ 50 billion in 40 countries. We use panel regressions to analyze the determinants of each bank's average annual exposure as well as contribution to systemic risk using bank-specific, country-specific as well as regulatory explanatory variables. We study three measures of systemic risk, ΔCoVaR, Dynamic MES and SRISK. We find that all three measures exhibit a similar temporal distribution as all three measures increase over time and peak before and during the financial crisis.

The key result of our empirical study is that higher regulatory capital in the form of Tier 1 capital is negatively related to the banks' exposure and contribution of banks to global systemic risk. This result implicates that more capital on average does indeed support financial stability with banks with higher Tier 1 capital being less exposed and at the same time contributing less to systemic crises. In addition, we find that a deposit insurance scheme that requires banks to provide more financial resources is associated with a higher average exposure and contribution of individual banks to systemic fragility.

Moreover, a bank's size and interconnectedness with the global banking sector all exert an increasing effect on systemic risk. Larger banks that are more interconnected with other large banks contribute more to global systemic risk. At the same time, we find no compelling evidence

[27] We also test the influence of the variable in Djankov et al. (2007) OLS regressions. For each period during which Barth et al. (2013) perform a separate survey, we run OLS regressions like suggested by Djankov et al. (2007). Doing so, we can invalidate the objection that the regulatory variables show little variation and thus the measurement of their influence is intercepted by time-fixed effects. Once again, we find no statistically significant influence.

that supervision influences systemic fragility in the banking sector.

The policy implications of our results are twofold. First, regulators appear to be going in the right direction with regulatory capital requirements being toughened around the world since the financial crisis. Our results support this view as banks with higher Tier 1 capital clearly contribute less to systemic risk as measured by distinct measures of financial fragility. Second, proposals to monitor bank size and interconnectedness more closely or even split up banks that are too-big-to-fail are backed by our results. Moreover, the detrimental effect of business activities that are not related to lending appear to be of lesser concern to regulators outside the United States.

Appendix

Appendix I: Sample banks.

The appendix lists all sample banks (in alphabetical order). Bank names are retrieved from the *Thomson Reuters Worldscope* Database (data item WC060033). Together with the bank name, the number of bank-year observations in our sample for that particular bank is shown.

Bank name	Bank-year obs.	Bank name	Bank-year obs.	Bank name	Bank-year obs.
77 Bank	6	Chugoku Bank	7	Mitsubishi UFJ Financial Group	11
Abbey National	6	CIC Union Europeenne CIP	14	Mizuho Financial Group	9
ABN Amro Holding	11	Cimb Group Holdings	3	Nanto Bank	2
Absa Group	8	Citigroup	14	National Australia Bank	14
Akbank	5	Comerica	11	National Bank of Abu Dhabi	3
Al Rajhi Bank	1	Comit	3	National Bank of Canada	10
Alliance and Leicester	8	Commerzbank	14	National Bank of Greece	10
Allied Irish Banks	10	Commerzbank	14	National Westminster Bank	2
Almanij	6	Commonwealth Bank of Australia	14	Natixis	13
Alpha Bank	5	Credit Agricole	11	Nedbank Group	8
Anglo Irish Bank	2	Credit Lyonnais	4	Nippon Credit Bank	1
Aozora Bank	4	Credit Suisse Group N	14	Nishi-Nippon City Bank	7
Arab Bank	2	Dai-Ichi Kangyo Bank (AMS)	4	Nordea Bank	14
Argentaria	2	Daishi Bank	2	North Pacific Bank	9
Asahi Bank	2	Danske Bank	14	Northern Rock	7
Australia and New Zealand Banking Group	14	DBS Group Holdings	14	Ogaki Kyoritsu Bank	1
Banca Antonveneta	4	Deutsche Bank	14	sterreichische Volksbanken	7
Banca Carige	2	Deutsche Pfandbrief Bank	6	OTP Bank	1
Banca Civica	1	Deutsche Postbank	8	Oversea-Chinese Banking	8
Banca Lombarda	1	Dexia	12	PKO Bank	3
Banca Monte dei Paschi	9	Discount	1	PNC Financial Services Group	14
Banca Nazionale Lavoro	7	DNB	10	Pohjola Pankki	2
Banca Popolare di Milano	4	Dresdner Bank	4	Public Bank	5
Banca Popolare Emilia Romagna	8	Erste Group Bank	14	Punjab National Bank	3
Banca Popolare Italiana	4	Espirito Santo Financial Group	9	Qatar National Bank	2
Banco Bilbao Vizcaya Argentaria	14	Eurobank Ergasias	5	Raiffeisen Bank International	6
Banco BPI	3	Eurohypo	10	Realdanmark	2
Banco Brasil	9	Fifth Third Bancorp	11	Regions Financial New	8
Banco de Sabadell	8	Firstrand	6	Resona Holdings	10
Banco Españ ol de Credito	10	Fuji Bank	4	Rheinische Hypothekenbank	4
Banco Espirito Santo	7	Fukuoka Financial Group	4	Royal Bank of Canada	14
Banco Popolare	9	Gunma Bank	9	Royal Bank of Scotland Group	14
Banco Popular Españ ol	8	Hachijuni Bank	9	Saint George Bank	5
Banco Santander	14	Hana Bank	3	Samba Financial Group	1
Bangkok Bank	3	Hana Financial Group	7	San Paolo IMI	9
Bank Austria Creditanstalt	5	Hang Seng Bank	14	San-in Godo Bank	1
Bank Hapoalim B M Limited	12	HBOS	7	Santander Bearer Units	3
Bank of America	14	HDFC Bank	1	Sanwa Bank	4
Bank of Athens Property	7	Higo Bank	1	Sberbank of Russia	5
Bank of Baroda	2	Hiroshima Bank	11	Schweizerische National Bank	12
Bank of Cyprus	2	Hokuhoku Financial Group	8	Senshu Ikeda Holdings	2
Bank of East Asia	5	HSBC Holdings	14	Shiga Bank	2
Bank of Greece	5	Hudson City Bancorp	3	Shinhan Financial Group	10
Bank of India	2	Huntington Bancshares	5	Shinsei Bank	4
Bank of Ireland	9	Hyakugo Bank	2	Shizuoka Bank	14
Bank of Kyoto	5	Hyakujushi Bank	1	Siam Commercial Bank	1
Bank of Montreal	14	Icici Bank	6	Société Générale	14
Bank of Nova Scotia	14	Idbi Bank	1	Standard Bank Group	9
Bank of Piraeus	3	IKB Deutsche Industriebank	3	Standard Chartered	14
Bank of Scotland	4	Industrial Bank of Korea	10	State Bank of India	13
Bank of Tokyo-Mitsubishi	4	Intesa Sanpaolo	14	Sumitomo Mitsui Financial Group	9
Bank of Yokohama	14	Itauunibanco	7	Sumitomo Mitsui Trust Holdings	10
Bank Polska Kasa Opieki	1	IYO Bank	4	Sumitomo Trust and Banking	13
Bankia	1	Joyo Bank	14	Suntrust Banks	14
Banque Nationale de Belgique	9	JP Morgan Chase and Company	14	Toronto-Dominion Bank	14
Banque Nationale de Paris Paribas	14	Julius Br Gruppe	1	Turkiye Garanti Bankasi	5
Barclays	13	Juroku Bank	2	UFJ Holdings	4
Bayerische Hypo-und-Vereinsbanken	11	Kansai Urban Banking	2	Unibanco Holding	2
BB&T	12	Kasikornbank	2	Unicredit	14
Bendigo and Adelaide Bank	2	Kaupthing Bank	2	Unidanmark	2
BOC Hong Kong	7	KB Financial Group	12	Unione di Banche Italian	9
Bradesco	9	KBC Bancassurance	14	United Overseas Bank	11
Bradford and Bingley	4	KBC Group	14	United States Bancorp	14
Caixabank	5	Keycorp	14	Wells Fargo and Company	14
Caja de Ahorros del Mediterraneo	3	Kookmin Bank	3	Westpac Banking	14
Canadian Imperial Bank Commerce	14	Korea Exchange Bank	10	Woori Bank	1
Canara Bank	2	Leumi Limited	11	Woorifinance Holdings	10
Capitalia	8	Lloyds Banking Group	9	Yamaguchi Financial Group	5
CCF	2	M&T Bank	8	Yapi VE Kredi Bankasi	2
Chiba Bank	14	Malayan Banking	6	Zions Bancorporation	5
CHO Hung Bank	2	Mediobanca Banca di Credito Financial	7		

Appendix II: Variable definitions and data sources.

The appendix presents both, definitions and data sources for all dependent and independent variables that are used in the empirical study. The bank characteristics were retrieved from the *Thomson Reuters Financial Datastream* and *Thomson Worldscope* databases. The country control variables are taken from the World Bank's World Development Indicator (WDI) database. Data on the banks' regulatory environment and deposit insurance schemes are taken from Barth et al. (2006), Barth et al. (2013) and Demirgüç-Kunt et al. (2008), respectively.

Variable name	*Definition*	*Data source*
Dependent variables		
Dynamic MES	Dynamic Marginal Expected Shortfall as defined by Acharya et al. (2010) and calculated following the procedure laid out by Brownlees and Engle (2012).	Datastream, own. calc.
SRISK	SRISK estimate as defined by Acharya et al. (2012). The SRISK for bank i at time t is given by $SRISK_{i,t} = \min\{0, CS_{i,t}\}$, where the Capital Shortfall for bank i at time t $CS_{i,t}$ is given by $CS_{i,t} = k(Debt_{i,t}) - (1-k)(1-LRMES_{i,t})Equity_{i,t}$. k is a regulatory variable which is set to 8%, $Debt_{i,k}$ denotes the bank's book value of debt, $Equity_{i,t}$ is the market value of the bank's equity and $LRMES_{i,t}$ is the long run Marginal Expected Shortfall defined as $1 - exp(-18 \cdot MES)$, where MES is the dynamically estimated Marginal Expected Shortfall.	Datastream, own. calc.
ΔCoVaR	Conditional ΔCoVaR as defined by Adrian and Brunnermeier (2011), measured as the difference between the Value-at-Risk (VaR) of a World financial sector index conditional on the distress of a particular bank and the VaR of the sector index conditional on the median state of the bank. As state variables for the computation of conditional ΔCoVaR, we employ the change in the three-month Treasury bill rate, the delta of the difference between the ten-year Treasury Bond and the three-month Treasury bill rate, the change in the credit spread between BAA-rated bonds and the Treasury Bond, the MSCI World Index as the market return, the return on the Case-Shiller Home Price Index, and implied equity market volatility from VIX.	Datastream, Chicago Board Options Exchange Market, Federal Reserve Board's H.15, S&P, own. calc.
Bank characteristics		
Total assets	Natural logarithm of a bank's total assets at fiscal year end.	Worldscope (WC02999).
Market-to-book	Market value of common equity divided by book value of common equity.	Worldscope (WC07210 and WC03501).
Leverage	Book value of assets minus book value of equity plus market value of equity, divided by market value of equity (see Acharya et al., 2010).	Worldscope (WC02999, WC03501, WC08001), own calc.
Non-interest income	Non-interest income divided by total interest income.	Worldscope (WC01021 and WC01016).
Loans	Ratio of total loans to total assets	Worldscope (WC02271 and WC02999).
Loan Loss Provisions	Ratio of expenses set aside as an allowance for uncollectable or troubled loans to total loans.	Worldscope (WC01271 and WC02271).
Foreign Loans	Ratio of foreign loans to total assets	Worldscope (WC02268 and WC02999).
Cash & Due from Banks	Ratio of cash & due from banks to total assets	Worldscope (WC02004 and WC02999).
Tier 1 Capital	Ratio of Tier 1 Capital to total risk-weighted assets	Worldscope (WC18157).

Appendix II: Variable definitions and data sources. (continued)

Variable name	*Definition*	*Data source*
Debt Maturity	Total long-term debt (due in more than one year) divided by total debt.	Worldscope (WC03251 and WC03255).
Deposits	Total deposits divided by total liabilities.	Worldscope (WC03019 and WC03351).
Performance	Buy-and-hold returns of a bank lagged by one year.	Datastream, own calc.
Liquidity Beta	The beta factor of a bank in year t with respect to liquidity innovations as defined by Pástor and Stambaugh (2003) using a regression of monthly stock returns in excess of the three-month Treasury bill rate during the years $t-3$ to $t-1$ on the excess returns of country-specific market indexes and liquidity innovations.	Datastream, own calc.
Liquidity	Amihud measure of an individual stock's illiquidity adjusted following the procedure proposed by Karolyi et al. (2012). The adjusted Amihud measure is defined as $-\ln\left(1+\frac{\lvert R_{i,t}\rvert}{P_{i,t}VO_{i,t}}\right)$ where $R_{i,t}$ is the return, $P_{i,t}$ is the price and $VO_{i,t}$ is the trading volume of stock i on day t.	Datastream, own calc.
Interconnectedness	The number of connections of each banking firm to other banks (sum of in and out connections) as defined by Billio et al. (2012).	Datastream, own calc.
Regulatory environment		
Activity Restrictions	Index of the overall restrictions on banking activities that measures the extent to which a bank can engage in securities, insurance, and real estate activities. Index ranges from 3 to 12. Higher scores denote greater restrictiveness.	Barth et al. (2013).
Capital Regulatory Index	Index of the stringency of capital regulations in the banking system, capturing whether the capital requirement reflects certain risk elements and deducts certain market value losses from capital before minimum capital adequacy is determined. Index ranges from 0 to 10. Higher values denote greater stringency.	Barth et al. (2013).
External Governance Index	Index of external governance variables. Includes but is not limited to the effectiveness of external audits of banks, the transparency of bank financial statement practices, the type of accounting practice used and assessment of external rating agencies. Index ranges from 0 to 18. Higher scores denote better corporate governance.	Barth et al. (2013).
Independence of Supervisory Authority	Index of the degree to which the supervisory authority is independent of the executive branch of government. Index ranges from 0 to 3. Higher scores denote greater independence.	Barth et al. (2013).
Official Supervisory Power	Index of the extent to which supervisory authorities have the authority to discipline banks by taking specific actions to prevent and correct problems. Index ranges from 0 to 14. Higher scores denote greater power.	Barth et al. (2013).

Appendix II: Variable definitions and data sources. (continued)

Variable name	*Definition*	*Data source*
Moral Hazard Index	Captures the degree to which moral hazard exists. Index ranges from 0 to 3. Higher values indicate a greater mitigation of moral hazard.	Barth et al. (2013).
Private Monitoring Index	Index of the incentives and capabilities provided by regulatory and supervisory authorities to encourage the private monitoring of banks. Index ranges from 0 to 12. Higher scores indicate greater regulatory empowerment of the monitoring of banks by private investors.	Barth et al. (2013).
Deposit Insurer Power	Index of the ability of the deposit insurance authority to intervene in a banking firm and to take legal action against bank directors or officials. Index ranges from 0 to 4. Higher scores indicate greater insurer power.	Barth et al. (2013).
Deposit Insurance Ratio	Ratio of the size of the deposit insurance fund to total bank assets.	Barth et al. (2013).
Funding with Insured Deposits	Ratio of total deposits covered by insurance scheme to total assets (as of end of 2010).	Barth et al. (2013).
Country characteristics		
GDP growth	Annual real GDP growth rate (in %).	WDI database.
Stock market importance	Ratio of the stock market turnover of country i to the worldwide stock market turnover (computed as the sum over all countries in the WDI database).	WDI database.
HHI	Herfindahl-Hirschman Index computed as the sum of the squared market shares of a country's domestic and foreign banks.	WDI database.
Crisis dummy	Dummy variable that equals one if a financial crisis is identified by Laeven and Valencia (2012) in a country for a given year, and zero otherwise.	Laeven and Valencia (2012).
Market coverage	Percentage of all locally listed firms in a country that are covered in the *Worldscope/Datastream* databases.	Datastream, World Federation of Exchanges, national stock exchange websites, own calc.

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Figures and Tables

Figure 1: Bank-years in sample sorted by country, 1999-2012

This figure shows the total number of bank-years of all banks in our sample sorted by country.

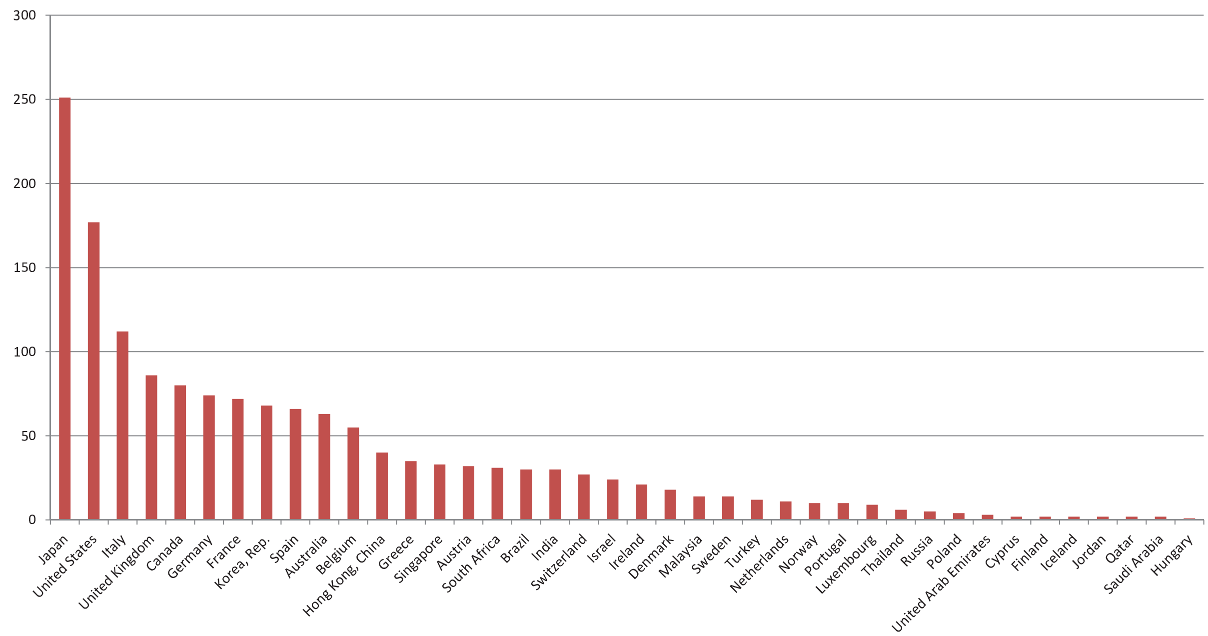

Figure 2: Banks in sample sorted by country, 1999-2012

This figure shows the total number of banks included in our sample sorted by country.

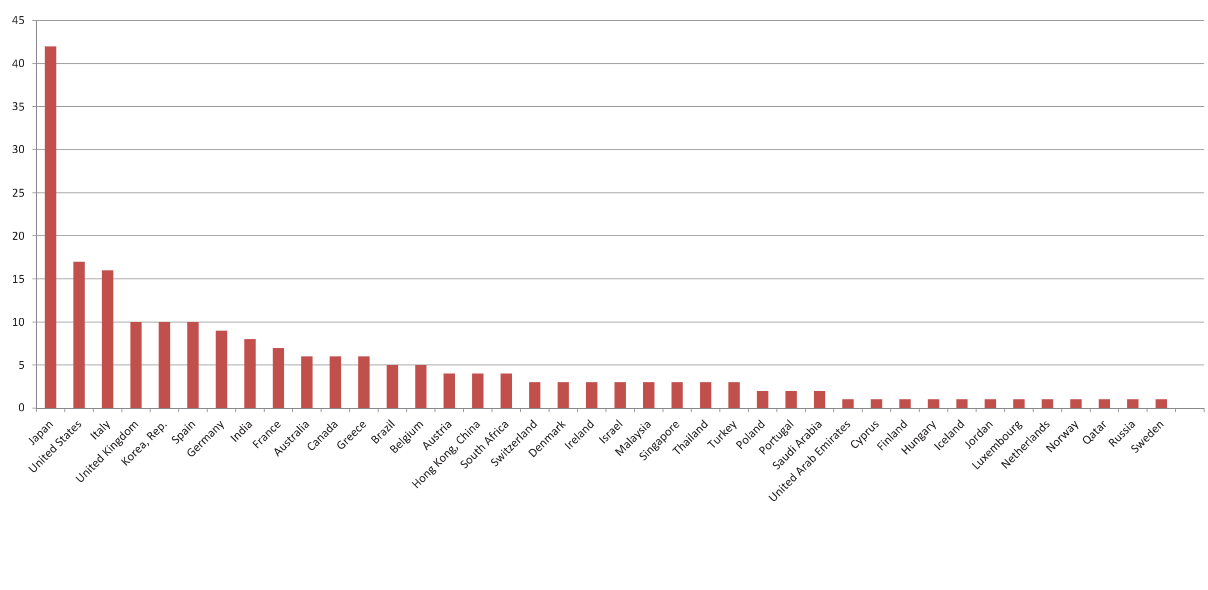

Figure 3: Development of the contribution to global systemic risk of banks from 1999-2012

This figure shows the development of the ΔCoVaR of all banks included in our sample averaged per year. The conditional ΔCoVaR is calculated as proposed by Adrian and Brunnermeier (2011). The extreme value of the daily estimates for each bank in each year is taken as the value for the bank in the resp. year. These values are then averaged by year.

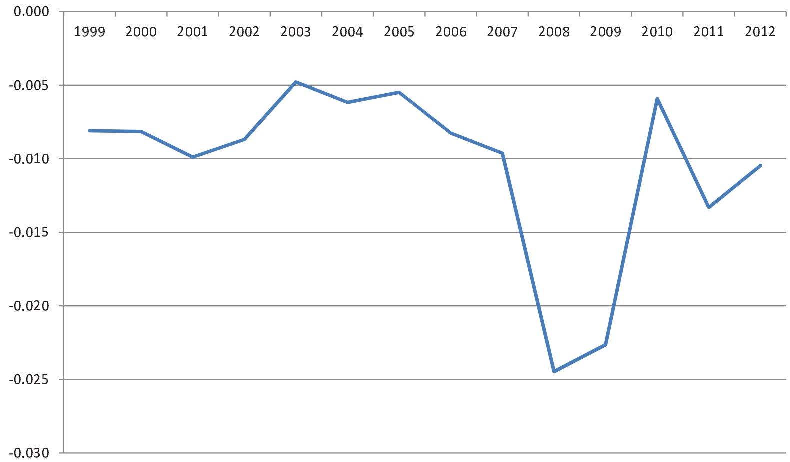

Figure 4: Development of the systemic risk exposure of banks from 1999-2012

This figure plots the development of the Marginal Expected Shortfall (MES) of banks in our sample averaged per year. The yearly MES estimates are the extreme value from daily MES estimates computed by the use of the dynamic model proposed by Brownlees and Engle (2012). These values are then averaged by year.

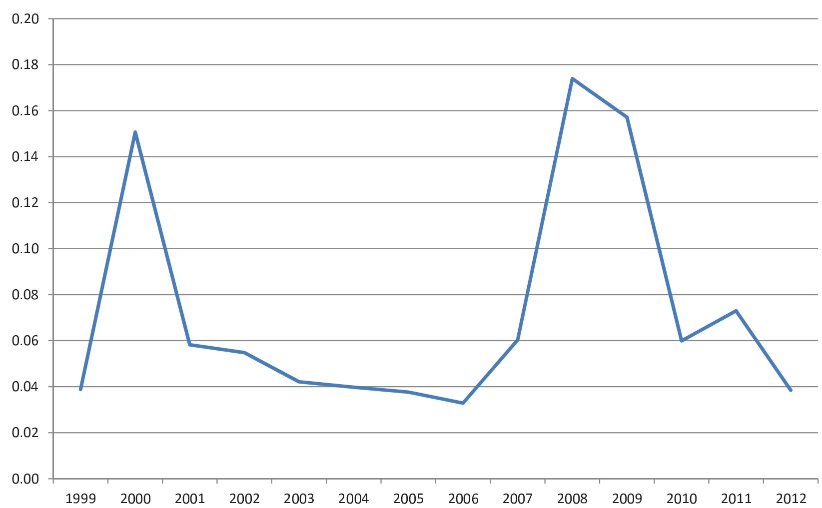

Figure 5: Development of the Capital Shortfall of banks from 1999-2012

This figure shows the development of the Capital Shortfall (SRISK) of banks in our sample averaged per year. The yearly SRISK estimates are the extreme value from daily SRISK estimates computed as proposed by Acharya et al. (2012). These values are then averaged by year.

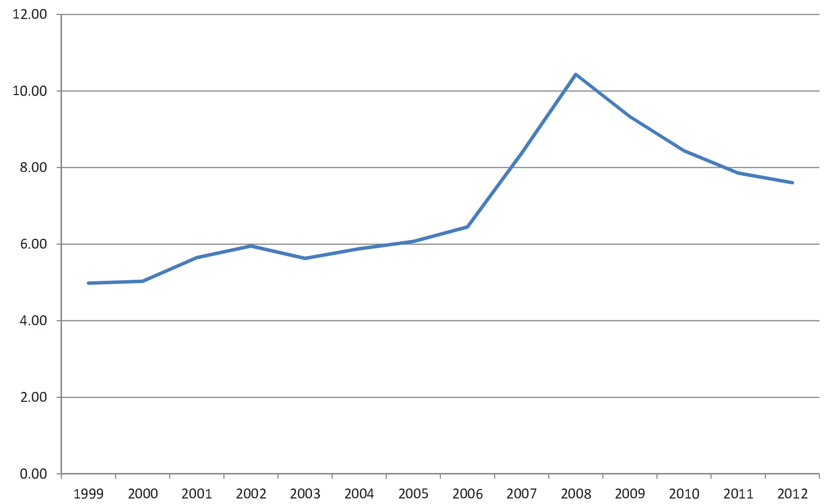

Figure 6: Contribution to global systemic risk of banks sorted by country, 1999-2012

This figure plots the average ΔCoVaR of all banks included in our sample sorted by country. The conditional ΔCoVaR is calculated as proposed by Adrian and Brunnermeier (2011). The extreme value of the daily estimates for each bank in each year is taken as the value for the bank in the resp. year. These values are then averaged by country.

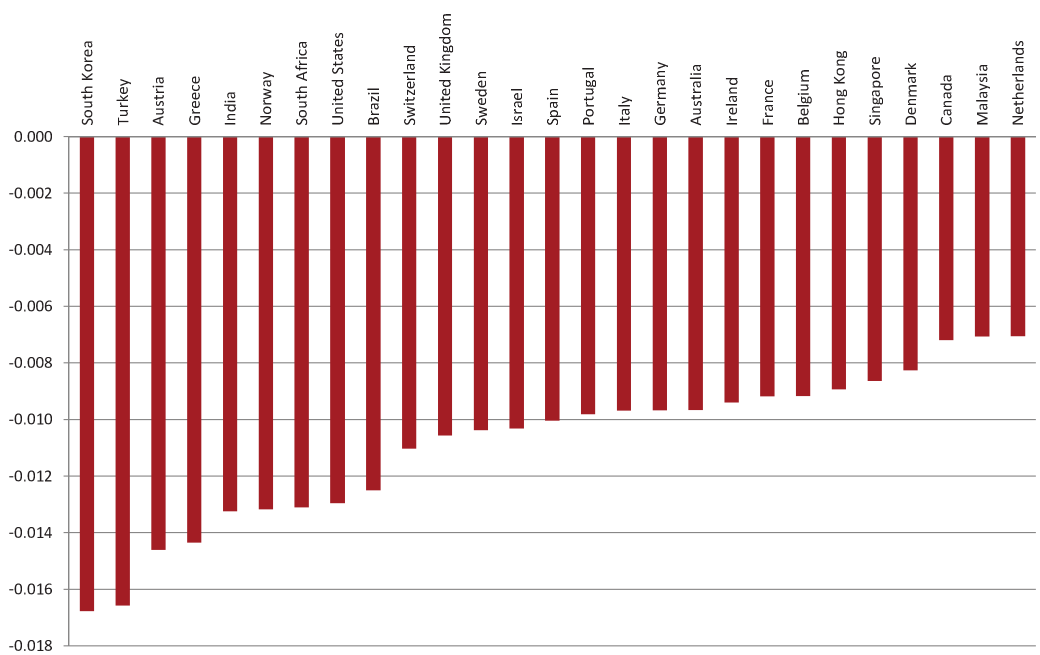

Figure 7: Systemic risk exposure of banks sorted by country, 1999-2012

This figure shows the average Marginal Expected Shortfall (MES) of banks in our sample sorted by country. The yearly MES estimates are the extreme value from daily MES estimates computed by the use of the dynamic model proposed by Brownlees and Engle (2012). These values are then averaged by country.

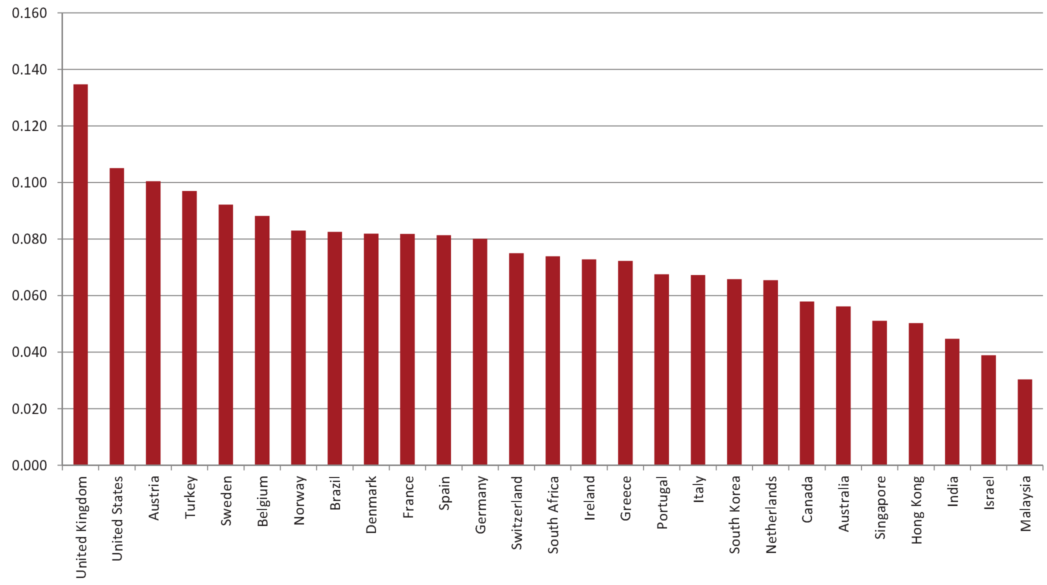

Figure 8: Capital Shortfall of banks sorted by country, 1999-2012

This figure shows the average Capital Shortfall (SRISK) of banks in our sample sorted by country. The yearly SRISK estimates are the extreme value from daily SRISK estimates computed as proposed by Acharya et al. (2012). These values are then averaged by country.

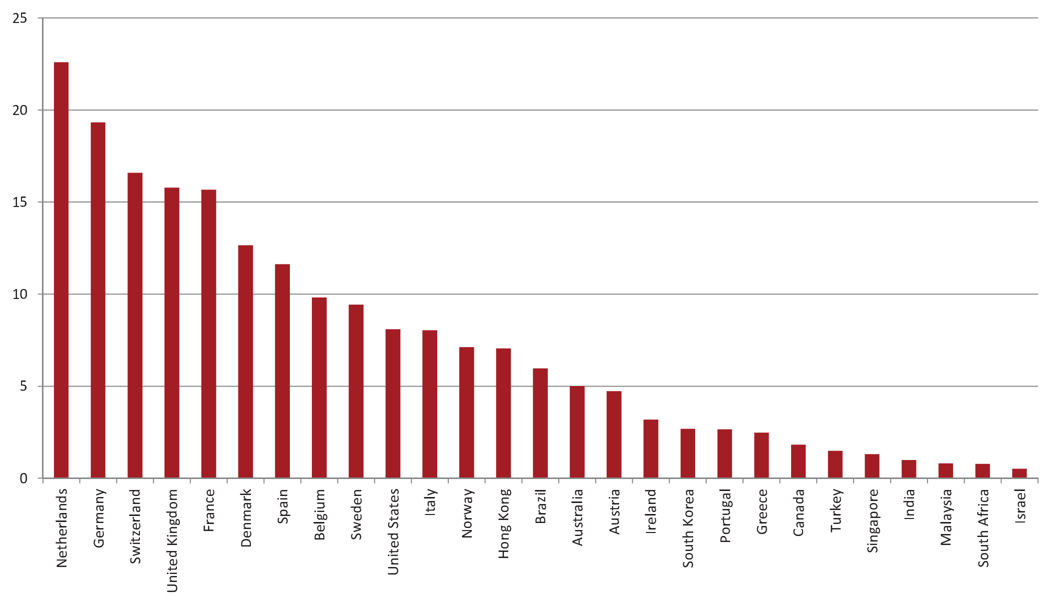

Table I: Descriptive statistics by country.

This table presents mean values of all firm-level and mean/median values for all country-specific variables for bank-year observations we use in our empirical study. The sample consists of 211 publicly traded international banks from 40 countries with assets in excess of $ 50 billion over the period 1999-2012. Stock market data are retrieved from *Thomson Reuters Financial Datastream* while financial accounting data are taken from the *Worldscope* database. Regulation variables come from Barth et al. (2013) and country characteristics are retrieved from World Bank's World Development Indicator (WDI) Database. Definitions of variables as well as descriptions of the data sources are given in Table II in the Appendix. Panel A shows mean values for firm-level characteristics while Panel B and C report mean/median values for country-level characteristics. The mean/median values of the variables are computed from data covering the time period from 1999 to 2012. All variables are created using U.S. dollar denominated data. SRISK and Total assets are given in billion U.S. dollars, Liquidity Beta is reported in trillions and Liquidity in thousands.

Panel A: Bank-level characteristics

Country	Dynamic MES	ΔCoVaR	SRISK	MES	Total assets	Market-to-book	Leverage	Non-interest income	Loans	Loan loss provisions	Foreign Loans	Cash & Due	Tier 1 capital	Debt Maturity
Abu Dhabi	0.0156	-0.0063	1.33	0.0020	60.24	1.47	8.05	0.2832	0.7608	0.0076	NA	0.0351	15.94	0.3636
Australia	0.0563	-0.0097	5.01	0.0163	272.59	2.22	9.11	0.2624	0.7098	0.0031	0.1149	0.0237	7.75	0.6111
Austria	0.1005	-0.0146	4.73	0.0317	153.82	1.49	32.38	0.2973	0.6898	0.0077	0.2033	0.0349	8.96	0.5048
Belgium	0.0883	-0.0092	9.83	0.0230	327.91	1.41	35.05	0.3931	0.5475	0.0028	NA	0.0081	9.96	0.3604
Brazil	0.0826	-0.0125	5.97	0.0372	217.74	2.41	6.53	0.5772	0.4328	0.0431	0.0242	0.0966	13.58	0.3192
Canada	0.0580	-0.0072	1.83	0.0224	286.39	2.07	12.67	0.4783	0.5202	0.0043	0.1719	0.0094	10.79	0.1934
Cyprus	0.1115	-0.0143	0.20	0.0357	53.37	0.99	18.08	0.2139	0.6726	0.0094	NA	0.0273	8.00	0.0000
Denmark	0.0819	-0.0083	12.65	0.0209	313.04	1.32	26.43	0.2226	0.6491	0.0036	0.1680	0.0137	9.29	0.4324
Finland	0.1182	-0.0065	2.50	0.0392	52.11	1.05	15.96	0.6126	0.5151	0.0049	NA	0.0954	11.20	0.4875
France	0.0819	-0.0092	15.67	0.0306	862.99	1.19	36.44	0.6868	0.4208	0.0046	NA	0.0192	8.88	0.2291
Germany	0.0801	-0.0097	19.33	0.0269	620.13	1.33	41.07	0.2290	0.5834	0.0037	0.1439	0.0091	8.52	0.4999
Greece	0.0723	-0.0143	2.47	0.0286	100.76	1.75	55.03	0.2101	0.6845	0.0109	NA	0.0445	10.13	0.2304
Hong Kong	0.0504	-0.0089	7.05	0.0112	588.14	2.71	7.27	0.4801	0.6125	0.0042	0.1040	0.0427	10.64	0.2625
Hungary	0.1642	-0.0123	1.05	0.0589	51.79	1.20	7.01	0.1937	0.7532	0.0339	NA	0.0518	15.00	0.5282
Iceland	0.0401	-0.0186	3.56	0.0254	71.07	1.89	7.87	0.2686	0.7296	0.0016	NA	0.0224	10.05	0.6272
India	0.0448	-0.0132	0.99	0.0190	112.92	1.62	15.15	0.3180	0.5816	0.0096	0.0675	0.0628	9.31	0.8200
Ireland	0.0728	-0.0094	3.19	0.0217	112.03	2.77	8.71	0.2846	0.7206	0.0017	NA	0.0202	7.50	0.2374
Israel	0.0390	-0.0103	0.51	0.0191	69.43	1.06	17.15	0.3759	0.7535	0.0064	0.0008	0.0680	8.16	0.7726
Italy	0.0673	-0.0097	8.04	0.0265	243.69	1.44	16.05	0.4487	0.7092	0.0070	NA	0.0165	7.48	0.5407
Japan	0.0476	-0.0109	3.11	0.0075	292.22	1.13	25.58	0.5291	0.6306	NA	0.0222	0.0440	9.62	0.4563
Jordan	-0.0019	-0.0061	0.37	0.0002	50.78	1.10	6.23	0.2824	0.6529	0.0101	NA	0.0694	15.65	0.3046
Luxembourg	0.0354	-0.0100	3.70	0.0104	92.84	3.05	73.53	0.5013	0.6693	0.0064	0.1369	0.0220	7.62	0.5487
Malaysia	0.0304	-0.0071	0.81	0.0076	79.16	2.63	6.19	0.3597	0.7088	0.0049	0.1450	0.0759	11.30	0.3397
Netherlands	0.0655	-0.0071	22.60	0.0212	805.84	2.49	18.90	0.3160	0.6234	0.0034	NA	0.0176	8.80	0.3148
Norway	0.0830	-0.0132	7.12	0.0374	217.54	1.26	17.78	0.5298	0.7159	0.0019	NA	0.0269	7.99	0.4764
Poland	0.0961	-0.0143	0.30	0.0493	54.36	2.66	3.90	0.4988	0.7762	0.0100	NA	0.0395	NA	0.6685
Portugal	0.0676	-0.0098	2.67	0.0269	76.24	1.48	15.59	0.4507	0.7312	0.0069	0.0822	0.0307	7.55	0.6596
Qatar	0.0137	-0.0055	0.28	0.0005	72.14	2.64	3.72	0.1837	0.7430	0.0039	NA	0.0929	18.65	0.2852
Russian Federation	0.0903	-0.0136	1.83	0.0376	214.59	2.96	4.51	0.2283	0.7656	0.0220	NA	0.0757	11.04	0.6432
Saudi Arabia	0.0123	-0.0056	0.17	0.0054	55.14	2.33	3.86	0.4328	0.6709	0.0059	NA	0.0693	16.41	0.0160
Singapore	0.0512	-0.0086	1.31	0.0169	122.04	1.54	8.11	0.3219	0.6167	0.0033	NA	0.0653	12.43	0.2663
South Africa	0.0739	-0.0131	0.78	0.0294	100.95	1.97	9.52	0.6584	0.6052	0.0086	0.0140	0.0345	11.06	0.4138
South Korea	0.0659	-0.0168	2.69	0.0219	138.54	1.11	19.75	0.3706	0.6997	0.0099	0.0711	0.0503	9.16	0.7915
Spain	0.0814	-0.0100	11.62	0.0311	356.14	1.90	23.48	0.8403	0.6934	0.0071	NA	0.0233	8.52	0.4408
Sweden	0.0922	-0.0104	9.43	0.0333	436.12	1.67	16.50	0.4362	0.6593	0.0013	NA	0.0127	7.85	0.4887
Switzerland	0.0750	-0.0110	16.59	0.0217	515.41	1.03	700.96	0.6746	0.1957	0.0011	0.0571	0.0468	14.25	0.1626
Thailand	0.0297	-0.0112	0.49	0.0133	58.31	1.63	6.65	0.6238	0.7852	0.0055	NA	0.0221	11.25	0.3426
Turkey	0.0971	-0.0166	1.49	0.0377	70.23	1.77	5.70	0.2938	0.6115	0.0097	0.0139	0.0613	16.48	0.3045
United Kingdom	0.1347	-0.0106	15.78	0.0262	643.26	2.24	20.62	0.3798	0.6501	0.0048	0.1060	0.0176	8.51	0.3455
United States	0.1051	-0.0130	8.10	0.0371	444.15	1.77	9.35	0.4923	0.6045	0.0126	0.0219	0.0278	9.65	0.5065
Sample	0.0737	-0.0109	7.27	0.0233	344.75	1.65	32.79	0.4557	0.6188	0.0071	0.0607	0.0322	9.48	0.4421

Table I: Descriptive statistics by country (continued)

Panel B: Bank-level characteristics and regulatory variables

Country	Deposits	Perfor-mance	Liquidity Beta	Liquidity	Inter-connected-ness	Activ. Restr.	Cap. Reg. Index	Conglo-merate Restr.	Div. Index	Entry Require-ments	Ext. Govern. Index	Foreign Bank Limit.	Ind. Superv. Auth.	Off. Superv. Power	Moral Hazard
Abu Dhabi	0.6553	0.2333	NA	-2.2472	0.1510	5	6	4	2	8	NA	4	2	14	NA
Australia	0.5829	0.1213	-115.39	-0.0087	0.2546	8	7	7	1	8	15	4	3	11	0
Austria	0.4320	0.1333	-6.57	-0.0238	0.1673	9	10	6	1	8	NA	4	3	14.5	3
Belgium	0.4036	0.0508	178.90	-0.2007	0.1449	3	6	7	2	6	14.5	4	2	9	2
Brazil	0.4078	0.3687	NA	-1.1287	0.2292	5	6	5	1	8	11.25	4	2	8	1
Canada	0.6863	0.1500	20.80	-0.0022	0.1860	7	4	6	1	8	16	4	2	14	1
Cyprus	0.9105	0.0117	NA	-0.0721	0.2713	7	4	8	1	8	18	4	1	11	0
Denmark	0.2757	0.0744	-31.04	-0.0186	0.1630	5	6	6	1	4	16	4	1	8	3
Finland	0.1658	-0.1002	NA	-0.0386	0.2053	9	10	6	1	8	16	4	2	12	2
France	0.3544	0.0828	39.12	-0.0506	0.1709	8	8	7	1	3	14	4	3	12	1
Germany	0.2889	0.0609	NA	-0.4994	0.1563	6	5	4	1.5	7.5	13	4	2.5	9	2
Greece	0.5211	-0.0077	NA	-0.1672	0.1551	8	5	9	2	8	17	3	3	15.5	2
Hong Kong	0.7631	0.1025	80.66	-0.0025	0.2501	7.5	7	5.5	1	8	15	4	0	6.5	2
Hungary	0.6643	0.9275	NA	-0.0050	0.2447	9	7.5	9	1.5	8	NA	1.5	2	12	1
Iceland	0.2396	0.1109	NA	-0.0070	0.1660	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
India	0.7894	0.2072	NA	-0.0566	0.1184	8	5	7	2	7	14	4	2	12	NA
Ireland	0.5606	0.1600	NA	-0.0805	0.1453	9	8	10	2	0	NA	0	3	9	NA
Israel	0.8431	0.1403	NA	-0.0139	0.1351	8	7	7	1	8	NA	4	1	NA	NA
Italy	0.4101	0.0860	80.20	-0.0462	0.1579	9	7	9	2	6	17	4	3	10	0
Japan	0.8404	0.0808	16.60	-0.3245	0.2138	5	4	8	2	8	12	4	2	6	NA
Jordan	0.8282	-0.1930	NA	-0.0542	0.0436	5	9	6	2	8	NA	4	1	NA	NA
Luxembourg	0.3733	-0.0166	NA	-3.0476	0.1324	7	3	5	1	8	15	4	2	9	2
Malaysia	0.7919	0.2460	NA	-0.0113	0.2474	8	9	NA	2	8	16.5	NA	2	9	NA
Netherlands	0.4769	0.1194	NA	-0.0018	0.1687	10	6	9	2	3	14	4	1	9	NA
Norway	0.4170	0.2644	NA	-0.0053	0.2055	7	7	8	2	8	14	4	2	13	1
Poland	0.8746	0.0310	NA	-0.0060	0.2131	6	6	6	2	7	16	3	1	6	NA
Portugal	0.4729	0.0010	NA	-0.0423	0.1927	5	7	9	1	8	15	4	3	9	2
Qatar	0.8025	0.3613	NA	-0.0364	0.0707	4	7	NA	1	8	13	NA	1	11	NA
Russian Federation	0.8719	1.1822	NA	-0.3715	0.1876	6	7	6	1	8	NA	3	1	8	1
Saudi Arabia	0.8784	-0.2060	NA	-0.0364	0.1661	NA	NA	NA	NA	NA	NA	NA	2	NA	NA
Singapore	0.6955	0.1424	98.34	-0.0265	0.2172	6	4	6	0	7	14	4	1	10	1
South Africa	0.6130	0.2172	NA	-0.0111	0.1830	9	9	7	2	8	13	4	3	14	NA
South Korea	0.6355	0.2033	NA	-0.1712	0.2659	8	4.4	7	1	8	15	4	0	7	2
Spain	0.4584	0.0369	141.93	-0.1359	0.1837	5	7	6	2	8	14	4	2.5	12.5	1
Sweden	0.5112	0.1122	24.03	-0.0027	0.1795	5	4.6	6	2	7	13.25	4	3	9	2
Switzerland	0.1988	0.0525	-110.26	-0.0008	0.1468	4	6	5	2	6	11	4	2	7.5	2
Thailand	0.8026	0.2992	NA	-0.0047	0.1773	7	3	5	1	8	13	4	2	6	1
Turkey	0.6353	0.2493	NA	-0.0027	0.1506	6	7	7	2	8	17	4	3	13.5	3
United Kingdom	0.4753	0.0510	60.83	-0.0029	0.1485	6	7	7	1	8	13.25	4	2	8.5	1
United States	0.6809	-0.0282	-2.57	-0.0041	0.2522	7	7.5	6	2	8	14	4	2	11	2
Sample	0.5872	0.0943	17.49	-0.1466	0.1948	7	6	7	2	8	15	4	2	11	2

Table I: Descriptive statistics by country (continued)

Panel C: Regulatory variables and country-specific characteristics

Country	Private Mon. Index	Deposit Insurer Power	Deposit Insur. Ratio	Funding Insur. Deposits	GDP Growth	ADRI	Anti-Self-Dealing	Creditor Rights Index	Stock market import.	Stock market turnover	Capital account openness	HHI	Foreign-Owned Banks	Govnm.-Owned Banks	Market Coverage
Abu Dhabi	NA	NA	NA	NA	4.23	3	NA	1	NA	NA	2.4557	NA	NA	NA	NA
Australia	10	2	NA	7.30	3.65	4	0.7903	3	NA	NA	1.1827	0.0821	16.20	0	NA
Austria	9	2	0.3470	18.97	2.57	NA	0.2094	1	0.0192	48.94	2.4557	0.1181	15.75	1.79	99.91
Belgium	8	1	0.0007	39.47	1.92	5	0.5403	4	0.0156	40.25	2.2247	0.0987	27.42	0	100.00
Brazil	8	0	0.0848	5.00	4.74	3	0.2913	3	NA	NA	0.2554	0.0587	22.94	40.58	NA
Canada	9	0	0.0078	15.25	2.42	5	0.6510	1	0.0286	73.41	2.4557	0.6811	6.00	0	NA
Cyprus	NA	2	0.0011	34.00	3.57	3.5	NA	NA	0.0051	13.38	2.4557	NA	37.00	3.0000	96.61
Denmark	8	1	0.0387	42.00	1.42	2.5	0.4656	3	0.0296	76.41	2.4557	0.0672	11.62	0.0333	97.38
Finland	8	NA	0.0017	14.00	6.30	2	0.4601	2	0.0449	103.89	2.4557	0.0470	65.60	0	NA
France	NA	0	0.0015	7.69	2.88	NA	0.3823	NA	0.0366	92.91	2.4557	0.0632	14.86	0.56	91.83
Germany	7.5	0	0.0050	NA	2.01	3.5	0.2788	1	0.0495	126.74	2.4557	0.0474	5.04	41.21	100.00
Greece	9	2	0.0048	37.66	1.46	5	0.2250	3	0.0207	53.35	2.4557	0.0490	12.55	19.53	92.98
Hong Kong	7	0.5	0.0001	10.99	3.34	NA	0.9635	NA	NA	NA	2.4557	NA	NA	0	NA
Hungary	9.5	1	0.0050	43.62	2.16	4	0.2036	2	NA	110.69	2.4557	NA	96.06	0	NA
Iceland	NA	NA	0.0100	22.50	2.50	NA	0.2372	NA	0.0371	112.58	1.1323	NA	0.00	0	NA
India	9	0	0.0076	34.33	5.94	3.5	0.5490	2	NA	NA	-1.1593	0.0505	6.06	74.94	NA
Ireland	0	NA	0.0020	NA	6.67	NA	0.7868	2	0.0212	53.82	2.4557	0.1072	NA	NA	91.65
Israel	7	NA	NA	NA	4.22	1	0.7135	1	0.0240	58.51	2.1138	0.1493	1.48	36.88	NA
Italy	8	1	NA	95.41	0.73	5	0.3854	2	0.0519	130.87	2.4557	0.0561	7.49	11.37	99.17
Japan	9	4	0.0000	NA	0.24	4	0.4830	1	NA	NA	2.4273	0.0950	6.23	0.52	NA
Jordan	9	2	NA	NA	7.61	5	0.1568	2	NA	NA	2.4557	NA	9.30	0	NA
Luxembourg	8	0	NA	12.85	2.62	NA	0.2490	0	0.0002	0.53	NA	0.1265	94.53	5.09	100.00
Malaysia	9	NA	0.0008	17.89	5.09	NA	0.9479	NA	NA	NA	-0.4692	NA	21.09	0	NA
Netherlands	10	NA	0.0000	44.83	2.56	4	0.2090	3	0.0521	136.27	2.4557	0.0932	4.43	4.92	68.84
Norway	7.5	1	0.0150	21.88	2.14	NA	0.4354	NA	0.0461	115.87	2.4557	0.1037	22.03	0	100.00
Poland	10	NA	0.0113	48.20	5.45	5	0.3000	3	0.0210	50.73	0.0793	0.0930	67.93	20.73	79.76
Portugal	7.5	1	0.0036	44.40	0.75	3.5	0.4861	2	0.0274	76.24	2.4557	0.1145	16.68	24.12	NA
Qatar	10	NA	NA	NA	25.48	5	NA	NA	NA	NA	2.4557	NA	0.00	NA	NA
Russian Federation	7	2	0.0027	27.20	6.05	NA	0.4757	2	NA	NA	0.1583	0.0340	10.44	37.76	100.00
Saudi Arabia	NA	NA	NA	NA	4.23	3	NA	1	NA	NA	1.1323	NA	NA	NA	NA
Singapore	9	1	0.0030	35.09	5.09	2	1.0000	1	NA	NA	2.4238	NA	52.86	0	NA
South Africa	7	NA	NA	0.00	4.40	2.5	0.8135	1	NA	NA	-1.1593	0.0476	20.15	0.016	NA
South Korea	8	2	0.0013	31.30	3.75	2.5	0.4609	2	NA	NA	0.0574	0.0822	37.27	28.98	NA
Spain	6	1	0.0038	29.60	2.51	2.5	0.3705	3	0.0632	160.96	2.4557	0.0806	9.63	0	5.33
Sweden	10	2	0.0130	1.10	2.34	4	0.3396	1	0.0439	112.31	2.4557	0.0542	1.00	0	NA
Switzerland	6	2	NA	9.09	2.07	3	0.2667	0	0.0376	96.24	2.4557	0.0787	9.56	13.84	100.00
Thailand	7	0.5	0.0057	31.35	2.46	3.5	0.8490	1	NA	NA	-0.5797	NA	5.55	16	NA
Turkey	9	NA	0.0080	15.32	1.33	5	0.4260	3	0.0604	146.10	-0.1271	0.0366	16.56	31.60	100.00
United Kingdom	9	1	NA	49.01	2.54	4	0.9271	3	0.0452	115.24	2.4557	0.0652	46.62	1.083	89.51
United States	7	2	-0.0095	38.85	1.87	2	0.6510	2	0.0808	206.19	2.4557	0.0811	10.59	0	100.00
Sample	9	2	0.0085	34.26	2.34	3.5	0.5423	2	0.0465	118.52	2.0134	0.1130	15.03	9.95	90.03

Table II: Descriptive statistics by year.

This table presents mean values of all firm-level and mean/median values for all country-specific variables for every year from our empirical study. The sample consists of 211 publicly traded international banks from 40 countries with assets in excess of $ 50 billion over the period 1999-2012. Stock market data are retrieved from *Thomson Reuters Financial Datastream* while financial accounting data are taken from the *Worldscope* database. Regulation variables come from Barth et al. (2013) and country characteristics are retrieved from World Bank's World Development Indicator (WDI) Database. Definitions of variables as well as descriptions of the data sources are given in Table II in the Appendix. Panel A shows mean values for firm-level characteristics while Panel B and C report mean/median values for country-level characteristics. The mean/median values of the variables are computed from data covering all banks in a given year. All variables are created using U.S. dollar denominated data. SRISK and Total assets are given in billion U.S. dollars, Liquidity Beta is reported in trillions and Liquidity in thousands.

Panel A: Bank-level characteristics

Year	Dynamic MES	ΔCoVaR	SRISK	MES	Total assets	Market-to-book	Leverage	Non-interest income	Loans	Loan loss provisions	Foreign Loans	Cash & Due	Tier 1 capital	Debt Maturity
1999	0.0388	-0.0081	4.98	0.0128	210.35	2.33	14.64	0.3028	0.6597	0.00699	0.1161	0.0297	7.6818	0.3670
2000	0.1506	-0.0082	5.03	0.0104	214.57	2.35	14.09	0.3564	0.6524	0.00626	0.1008	0.0266	7.5883	0.3854
2001	0.0582	-0.0099	5.65	0.0198	243.52	2.16	36.74	0.3656	0.6319	0.00430	0.1051	0.0259	8.1268	0.3889
2002	0.0548	-0.0087	5.95	0.0214	262.30	1.91	30.46	0.3500	0.6064	0.00581	0.0832	0.0260	8.3126	0.3935
2003	0.0421	-0.0048	5.63	0.0147	254.08	1.53	38.17	0.4152	0.6131	0.00833	0.0664	0.0269	8.2327	0.3779
2004	0.0398	-0.0062	5.88	0.0141	278.63	1.65	33.39	0.4834	0.6139	0.00843	0.0527	0.0273	8.6051	0.4063
2005	0.0376	-0.0055	6.07	0.0086	295.55	2.12	23.08	0.4984	0.6129	0.00540	0.0478	0.0270	8.8334	0.4315
2006	0.0328	-0.0083	6.45	0.0144	315.50	1.94	20.75	0.5458	0.6082	0.00430	0.0454	0.0300	8.4953	0.4637
2007	0.0603	-0.0096	8.37	0.0190	364.03	2.11	17.48	0.5074	0.6139	0.00421	0.0492	0.0286	8.7687	0.4710
2008	0.1739	-0.0245	10.44	0.0551	429.86	1.68	21.90	0.4334	0.6146	0.00475	0.0623	0.0309	8.3455	0.4430
2009	0.1571	-0.0226	9.33	0.0422	445.16	0.91	48.74	0.3855	0.6168	0.00872	0.0500	0.0324	9.1194	0.4633
2010	0.0599	-0.0059	8.44	0.0279	420.75	1.11	37.45	0.5359	0.6193	0.01458	0.0558	0.0374	10.8452	0.4779
2011	0.0729	-0.0133	7.86	0.0318	418.13	1.23	43.34	0.5222	0.6141	0.00884	0.0551	0.0419	11.2590	0.5056
2012	0.0385	-0.0105	7.60	0.0155	425.75	1.02	61.10	0.4796	0.6129	0.00642	0.0516	0.0464	11.6340	0.4820

Table II: Descriptive statistics by year (continued)

Panel B: Bank-level characteristics and regulatory variables

Year	Deposits	Performance	Liquidity Beta	Liquidity	Interconnectedness	Activ. Restr.	Cap. Reg. Index	Conglomerate Restr.	Div. Index	Entry Requirements	Ext. Govern. Index	Foreign Bank Limit.	Ind. Superv. Auth.	Off. Superv. Power	Moral Hazard
1999	0.5517	0.2237	NA	-0.2317	0.1354	7	6	7	1	8	13	4	2	11	2
2000	0.5624	0.1128	-84.81	-0.2062	0.1253	6	6	7	1	7	12	4	2	11	2
2001	0.5496	0.0383	-157.36	-0.0408	0.2042	6	6	6	1	8	12	4	2	11	2
2002	0.5594	-0.1056	134.39	-0.0562	0.1674	6	6	6	1	7	13	4	2	11	2
2003	0.5765	-0.0586	282.53	-0.1731	0.1547	6	6	6	1	7	12.4	4	2	10	2
2004	0.5804	0.5521	49.36	-0.0978	0.1204	7	5	7	2	8	15	4	1	11	2
2005	0.5847	0.2556	131.15	-0.0318	0.1048	7.5	5	7	2	8	15	4	1	11	2
2006	0.5544	0.1699	-120.31	-0.1246	0.1962	7	5	7	2	8	15	4	1	11	2
2007	0.5387	0.2739	-220.51	-0.1875	0.2505	7	5	7	2	8	15	4	1	11	2
2008	0.5598	0.0256	68.4	-0.0348	0.2814	7	5	7	1	8	15	4	2	11	2
2009	0.5798	-0.4505	105.87	-0.1434	0.2312	8	5	7	2	8	15	4	2	11	2
2010	0.6183	0.4153	-454.95	-0.0921	0.2659	8	5	7	2	8	15	4	2	11	2
2011	0.6594	0.0844	119.36	-0.3597	0.2202	8	5	7	2	8	15	4	2	11	2
2012	0.6691	-0.2070	59.56	-0.2168	0.1730	7	8	7	2	8	16	4	2	11	1

Table II: Descriptive statistics by year (continued)

Panel C: Regulatory variables and country-specific characteristics

Year	Private Mon. Index	Deposit Insurer Power	Deposit Insur. Ratio	Funding Insur. Deposits	GDP Growth	ADRI	Anti-Self-Dealing	Creditor Rights Index	Stock market import.	Stock market turnover	Capital account openness	HHI	Foreign-Owned Banks	Govnm.-Owned Banks	Market Coverage
1999	8.5	2	0.0121	NA	2.33	3.5	0.5507	3	0.0269	83.64	2.2115	0.1271	7.26	7.31	96.18
2000	8	2	0.0117	NA	3.42	3.5	0.5445	2.5	0.0340	77.65	2.2205	0.1302	7.18	8.15	95.50
2001	8	2	0.0136	NA	4.51	3.5	0.5662	2	0.0244	96.23	2.2014	0.1398	7.11	9.19	94.43
2002	8	2	0.0135	NA	1.63	3.5	0.5741	2	0.0472	103.16	2.2518	0.1307	8.14	8.58	96.89
2003	8	2	0.0117	NA	2.22	3.5	0.5557	2	0.0511	113.98	2.1220	0.1230	7.20	9.96	89.38
2004	9	2	0.0014	41.19	1.95	3.5	0.5484	2	0.0440	95.94	2.0983	0.1216	16.27	10.28	91.04
2005	9	2	0.0013	40.92	3.43	3.5	0.5493	2	0.0458	103.18	2.0604	0.1130	14.70	9.99	97.88
2006	9	2	0.0015	38.87	2.99	3.5	0.5462	2	0.0434	107.93	2.0173	0.1104	15.16	10.64	96.16
2007	9	2	0.0016	39.50	3.48	3.5	0.5373	2	0.0452	124.36	2.0095	0.1059	14.66	11.24	88.62
2008	9	1	0.0051	31.38	3.44	3.5	0.5208	2	0.0464	153.16	1.9577	0.1008	17.66	9.26	87.60
2009	9	2	0.0050	30.38	0.86	3.5	0.5198	2	0.0584	176.66	2.0274	NA	16.82	8.47	85.82
2010	9	2	0.0047	30.68	1.12	3.5	0.5277	2	0.0609	145.66	1.9210	0.1000	18.15	8.84	81.59
2011	9	2	0.0046	28.64	1.31	3.5	0.5418	2	0.0571	117.25	1.7715	0.0990	15.98	11.49	79.94
2012	9	1	0.0306	31.54	1.33	3.5	0.5431	2	0.0548	124.42	1.7664	0.0987	24.84	13.11	72.85

Table III: Correlations of systemic risk measures.

This table shows correlations between the ΔCoVaR, Dynamic MES, SRISK, and equity beta of banks in our sample. The sample consists of 211 publicly traded international banks from 40 countries with assets in excess of $ 50 billion over the period 1999-2012. Stock market data are retrieved from *Thomson Reuters Financial Datastream* while financial accounting data are taken from the *Worldscope* database. Regulation variables come from Barth et al. (2013) and country characteristics are retrieved from World Bank's World Development Indicator (WDI) Database. Definitions of variables as well as descriptions of the data sources are given in Table II in the Appendix.

	max(dynMES)	mean(dynMES)	max(SRISK)	mean(SRISK)	min(ΔCoVaR)	mean(ΔCoVaR)	Beta
max(DynMES)	1						
mean(DynMES)	0.7612	1					
max(SRISK)	0.2651	0.1777	1				
mean(SRISK)	0.2659	0.184	0.9947	1			
min(ΔCoVaR)	-0.526	-0.407	-0.1391	-0.141	1		
mean(ΔCoVaR)	-0.5388	-0.4496	-0.1043	-0.106	0.8938	1	
Beta	0.1895	0.2209	0.3586	0.3531	-0.1105	-0.0406	1

Table IV: Regressions of a bank's systemic risk measures.

The regressions estimate the relation between ΔCoVaR, Dynamic MES, and SRISK and bank characteristics, country-characteristics and regulatory variables over the period 1999-2012. The sample consists of 211 publicly traded international banks from 40 countries with assets in excess of $ 50 billion. Stock market data are retrieved from *Thomson Reuters Financial Datastream* while financial accounting data are taken from the *Worldscope* database. Regulation variables come from Barth et al. (2013) and country characteristics are retrieved from World Bank's World Development Indicator (WDI) Database. Definitions of variables as well as descriptions of the data sources are given in Table II in the Appendix. The regressions include all banks from our sample. We apply a panel regression with time-fixed and bank-fixed effects using heteroskedasticity-robust standard errors. P-values are in parentheses, *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. Adj. R^2 is adjusted R-squared.

Dependent variable	Model (1) dynMES	Model (2) dynMES	Model (3) dynMES	Model (4) SRISK	Model (5) SRISK	Model (6) SRISK	Model (7) ΔCoVaR	Model (8) ΔCoVaR	Model (9) ΔCoVaR
Bank-level characteristics									
Total Assets	0.079	0.024	0.011	31300000.000 ***	32000000.000 ***	32300000.000 ***	0.003	0.002	0.005
	(0.138)	(0.668)	(0.866)	(0.000)	(0.000)	(0.000)	(0.600)	(0.651)	(0.440)
Market-to-book	0.028	0.017	0.020	-1156282.000	-62193.120	167304.400	-0.002	-0.003	-0.004
	(0.106)	(0.427)	(0.414)	(0.174)	(0.952)	(0.881)	(0.386)	(0.395)	(0.352)
Leverage	0.000	0.001	0.001 **	7853.740	5179.602	17828.980	0.000	0.000	0.000
	(0.920)	(0.102)	(0.031)	(0.650)	(0.846)	(0.527)	(0.934)	(0.173)	(0.103)
Non-interest income	-0.032 *	-0.034	-0.044 *	-328575.200	-1579848.000	957892.100	0.002 *	0.002	0.003 **
	(0.083)	(0.101)	(0.090)	(0.882)	(0.586)	(0.749)	(0.088)	(0.116)	(0.049)
Cash and Due from Banks	-0.299	-0.731	-0.998 *	15300000.000	34900000.000	55700000.000 *	0.055	0.072	0.098
	(0.301)	(0.209)	(0.088)	(0.583)	(0.294)	(0.096)	(0.221)	(0.391)	(0.228)
Loans	0.014	0.020	-0.032	-12000000.000	-8641442.000	-13100000.000 *	0.003	0.009	0.014
	(0.799)	(0.800)	(0.680)	(0.126)	(0.204)	(0.090)	(0.624)	(0.338)	(0.179)
Loan Loss Provisions	0.945	0.789	0.824	176000000.000	184000000.000 **	186000000.000 **	-0.020	0.020	0.037
	(0.178)	(0.142)	(0.178)	(0.123)	(0.030)	(0.023)	(0.723)	(0.734)	(0.579)
Tier 1 Capital	-0.006 *	-0.006 *	-0.007 *	310870.100	36193.750	64883.280	0.001 ***	0.001 ***	0.001 ***
	(0.056)	(0.079)	(0.062)	(0.276)	(0.861)	(0.779)	(0.001)	(0.008)	(0.007)
Debt Maturity	0.047	0.042	0.067	-2125289.000	454961.400	1522273.000	-0.003	-0.003	-0.004
	(0.162)	(0.368)	(0.238)	(0.412)	(0.867)	(0.605)	(0.280)	(0.432)	(0.420)
Deposits	-0.033	-0.108	-0.175	-14600000.000 *	-18600000.000 *	-11700000.000	0.019 *	0.018	0.022 *
	(0.735)	(0.390)	(0.217)	(0.086)	(0.055)	(0.193)	(0.079)	(0.138)	(0.098)
Performance	-0.013	-0.005	-0.012	21413.270	6746.547	183299.200	0.003 **	0.003 ***	0.004 ***
	(0.237)	(0.631)	(0.284)	(0.977)	(0.993)	(0.803)	(0.011)	(0.006)	(0.003)
Interconnectedness	0.127 **	0.056	0.035	464831.600	3323095.000	8360315.000 *	-0.017 ***	-0.014 **	-0.015 **
	(0.028)	(0.394)	(0.672)	(0.916)	(0.444)	(0.088)	(0.001)	(0.013)	(0.041)
Country characteristics									
GDP Growth	-0.010 *	-0.009 *	-0.008	-629974.800	-1075259.000 **	-790584.800	0.000	0.000	0.000
	(0.075)	(0.091)	(0.128)	(0.312)	(0.037)	(0.127)	(0.839)	(0.556)	(0.686)
HHI	0.355 ***	0.563 ***	0.548 *	48700000.000 ***	31800000.000	44700000.000 **	-0.043 **	-0.020	0.003
	(0.003)	(0.002)	(0.067)	(0.000)	(0.135)	(0.037)	(0.013)	(0.320)	(0.924)
Stock market importance	-0.693 **	-0.872 ***	-1.321 ***	7487482.000	-24300000.000	-11000000.000	-0.011	-0.010	0.018
	(0.011)	(0.001)	(0.000)	(0.814)	(0.211)	(0.559)	(0.604)	(0.692)	(0.552)
Regulatory environment									
Activity Restrictions		0.005	-0.015		-2400312.000 ***	-684436.600		0.001	0.003 **
		(0.533)	(0.272)		(0.007)	(0.407)		(0.139)	(0.034)
Capital Regulatory Index		-0.004	-0.007		1405214.000 **	831316.300		0.000	0.001
		(0.507)	(0.352)		(0.011)	(0.132)		(0.574)	(0.241)
Independence of Supervisory Authority		-0.003	-0.003		369760.100	-435784.900		-0.001	-0.001
		(0.787)	(0.827)		(0.723)	(0.690)		(0.474)	(0.426)
Official Supervisory Power		0.005 *	0.000		-557849.200 *	-313999.600		0.000	0.000
		(0.063)	(0.936)		(0.090)	(0.366)		(0.924)	(0.248)
Private Monitoring Index		-0.015 **	-0.022 **		913393.500	578291.000		-0.001	0.000
		(0.035)	(0.021)		(0.279)	(0.410)		(0.392)	(0.696)
Moral Hazard Index			0.038 **			307696.400			-0.004 ***
			(0.015)			(0.866)			(0.006)
Bank-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	662	521	464	662	521	464	662	521	464
R^2	0.426	0.493	0.508	0.581	0.557	0.566	0.574	0.579	0.601
Adj. R^2	0.402	0.46	0.471	0.563	0.528	0.533	0.555	0.551	0.57

Table V: Bank-specific and regulatory interactions.

Panel A, B and C report the results of our baseline regression from Table IV over the period 1999-2012 using Dynamic MES, SRISK and ΔCoVaR respectively as our main dependent variables. In addition to our multivariate analyses, we include several interaction terms. The sample consists of 211 publicly traded international banks from 40 countries with assets in excess of $ 50 billion over the period 1999-2012. Stock market data are retrieved from *Thomson Reuters Financial Datastream* while financial accounting data are taken from the *Worldscope* database. Regulation variables come from Barth et al. (2013) and country characteristics are retrieved from World Bank's World Development Indicator (WDI) Database. Definitions of variables as well as descriptions of the data sources are given in Table II in the Appendix. Again, we apply a panel regression with time-fixed and bank-fixed effects using heteroskedasticity-robust standard errors. P-values are in parentheses, *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. Adj. R^2 is adjusted R-squared. We suppress the coefficients of our control variables for brevity.

Panel A: Regressions of banks' dynamic MES	(1) MES	(2) MES	(3) MES	(4) MES	(5) MES	(6) MES	(7) MES	(8) MES
Moral Hazard Index × Tier 1 Capital	-0.002 (0.728)							
Crisis × Tier 1 Capital		-0.008* (0.090)						
Total Assets × Interconnectedness			-0.070 (0.612)					
Cash and Due from Banks × Interconnectedness				2.286 (0.669)				
Crisis × Cash and Due from Banks					-0.051 (0.943)			
Crisis × Moral Hazard Index						-0.032 (0.229)		
Interconnectedness × Crisis							-0.192* (0.085)	
Interconnectedness × Debt Maturity								0.220 (0.252)
N	464	416	464	464	416	416	416	464
R^2	0.509	0.493	0.509	0.509	0.490	0.494	0.493	0.510
adj. R^2	0.470	0.446	0.470	0.470	0.443	0.447	0.446	0.471

Panel B: Regressions of banks' SRSIK	(1) SRISK	(2) SRISK	(3) SRISK	(4) SRISK	(5) SRISK	(6) SRISK	(7) SRISK	(8) SRISK
Moral Hazard Index × Tier 1 Capital	-255349.0 (0.380)							
Crisis × Tier 1 Capital		222850.3 (0.544)						
Total Assets × Interconnectedness			57100000.0*** (0.000)					
Cash and Due from Banks × Interconnectedness				-601094.7 (0.998)				
Crisis × Cash and Due from Banks					37400000.0*** (0.000)			
Crisis × Moral Hazard Index						-71482.0 (0.958)		
Interconnectedness × Crisis							1184517.0 (0.897)	
Interconnectedness × Debt Maturity								-21300000.0* (0.095)
N	464	416	464	464	416	416	416	464
R^2	0.567	0.581	0.645	0.566	0.581	0.580	0.580	0.568
adj. R^2	0.532	0.542	0.617	0.532	0.542	0.542	0.542	0.534

Panel C: Regressions of banks' ΔCoVaR	(1) ΔCoVaR	(2) ΔCoVaR	(3) ΔCoVaR	(4) ΔCoVaR	(5) ΔCoVaR	(6) ΔCoVaR	(7) ΔCoVaR	(8) ΔCoVaR
Moral Hazard Index × Tier 1 Capital	0.001** (0.011)							
Crisis × Tier 1 Capital		0.000 (0.687)						
Total Assets × Interconnectedness			0.008 (0.418)					
Cash and Due from Banks × Interconnectedness				-1.576** (0.020)				
Crisis × Cash and Due from Banks					-0.007 (0.921)			
Crisis × Moral Hazard Index						0.007* (0.055)		
Interconnectedness × Crisis							0.013 (0.411)	
Interconnectedness × Debt Maturity								-0.034 (0.146)
N	464	416	464	464	416	416	416	416
R^2	0.611	0.638	0.602	0.627	0.637	0.653	0.638	0.64
adj. R^2	0.58	0.604	0.57	0.598	0.604	0.621	0.605	0.606
Time fixed effetcs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank characteristics control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country characteristics control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Internet Appendix to
“Systemic risk, bank capital, and deposit insurance around the world”

This Internet Appendix contains several additional Figures and Tables that present the results of further analyses and robustness checks.

Table IA.I: Correlations of independent variables.

This table shows the correlations between the independent variables used in our main regressions. The sample consists of 211 publicly traded international banks from 40 countries with assets in excess of $ 50 billion over the period 1999-2012. Stock market data are retrieved from *Thomson Reuters Financial Datastream* while financial accounting data are taken from the *Worldscope* database. Regulation variables come from Barth et al. (2013) and country characteristics are retrieved from World Bank's World Development Indicator (WDI) Database. Definitions of variables as well as descriptions of the data sources are given in Table II in the Appendix.

	Total Assets	Market-to-book	Leverage	Non-interest income	Cash & Due	Loans	Loan Loss Prov.	Tier 1 Capital	Debt Maturity	Deposits	Perfor-mance	Inter-connected-ness	GDP Growth	HHI	Act. Restri-ctions	Capital Reg. Index	Inde. of Superv.	Offic. Superv. Power	Private Moni. Index
Total Assets																			
Market-to-book	-0.1187																		
Leverage	0.1864	-0.4672																	
Non-interest income	0.2196	0.0296	-0.0956																
Cash & Due	-0.1543	0.1083	-0.0648	0.0372															
Loans	-0.6029	0.0255	-0.1332	-0.3644	-0.0172														
Loan Loss Prov.	-0.0384	-0.1459	-0.0059	0.0617	0.3447	-0.0473													
Tier 1 Capital	0.0833	-0.1366	0.1208	0.1754	0.2346	-0.3469	0.2576												
Debt Maturity	-0.2978	-0.3028	0.0047	-0.1443	0.1093	0.3616	0.1339	-0.1354											
Deposits	-0.2889	0.1222	-0.4259	-0.0136	0.2282	0.2236	0.1517	0.1443	0.071										
Performance	-0.0609	0.2200	-0.1636	0.0069	0.0197	0.0006	0.0862	-0.029	-0.0569	-0.0391									
Interconnectedness	0.2075	-0.0582	-0.0689	0.1096	0.0843	-0.1934	0.1781	0.0376	-0.0357	0.1147	-0.1456								
GDP Growth	-0.0750	0.4297	-0.1830	-0.1140	0.3447	-0.0513	-0.1185	-0.2086	-0.0100	0.1081	0.1256	-0.0480							
HHI	0.0506	0.2802	-0.1232	0.0871	-0.2345	-0.2101	-0.1597	0.1999	-0.4451	0.2722	0.0873	0.0080	-0.0111						
Act. Restr.	-0.1832	-0.2614	-0.1746	0.0864	0.1966	0.0517	0.2346	-0.0356	0.3532	0.2779	-0.1373	0.2163	-0.1715	-0.2701					
Capital Regulatory Index	0.0646	-0.0437	0.0131	-0.0147	0.1003	0.0064	0.0355	0.0128	0.1668	-0.0276	-0.0681	-0.0535	0.1712	-0.3735	-0.0372				
Independence Superv. Authority	0.0953	-0.1161	0.0969	0.0624	0.1573	-0.1901	0.0444	0.3724	-0.0433	0.2428	-0.1105	0.1818	0.0533	0.3467	-0.0126	0.2027			
Off. Superv. Power	-0.0427	0.0555	-0.1600	0.0892	0.2169	-0.0729	0.2675	0.2085	0.0466	0.3713	-0.2084	0.2897	0.0485	-0.1051	0.1521	0.2444	0.1737		
Private Monitoring Index	-0.0002	0.0516	-0.1385	0.0551	-0.1006	-0.0205	0.121	0.0611	-0.0367	0.3417	-0.2134	0.1319	-0.0545	0.1349	0.1077	-0.0599	-0.2029	0.4668	
Moral Hazard Index	0.1648	-0.1237	0.0414	0.0262	-0.5466	-0.1202	-0.1502	-0.0532	-0.211	-0.1984	0.061	-0.0485	-0.3932	0.3384	-0.1195	-0.1227	-0.0846	-0.1446	0.0347