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Do we need big banks?
Evidence on performance, strategy and market discipline

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Abstract: For an international sample of banks, we construct measures of a bank's absolute size and its systemic size defined as size relative to the national economy. We then examine how a bank's risk and return, its activity mix and funding strategy, and the extent to which it faces market discipline depend on both size measures. While absolute size presents banks with a trade-off between risk and return, systemic size is an unmitigated bad, reducing return without a reduction in risk. Despite too-big-to-fail subsidies, we find that systemically large banks are subject to greater market discipline as evidenced by a higher sensitivity of their funding costs to risk proxies, suggesting that they are often too big to save. The finding that a bank's interest cost tends to rise with its systemic size can also in part explain why a bank's rate of return on assets tends to decline with systemic size. Overall, our results cast doubt on the need to have systemically large banks. Bank growth has not been in the interest of bank shareholders in small countries, and it is not clear whether those in larger countries have benefited. While market discipline through increasing funding costs should keep systemic size in check, clearly it has not been effective in preventing the emergence of such banks in the first place. Inadequate corporate governance structures at banks seem to have enabled managers to pursue high-growth strategies at the expense of shareholders, providing support for greater government regulation.

Key words: Bank size, systemic risk, market discipline
JEL classifications: G21,G28

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1. Introduction

In the last several decades, banks have relentlessly increased in size. Many institutions have become very large in absolute terms and relative to their national economies. During the recent financial crisis, it has become apparent that large bank size can imply large risks to a country's public finances. Large bank failures in Iceland in 2008 triggered a national bankruptcy, and large-bank distress forced Ireland to seek EU and IMF financial assistance in 2010. An obvious solution to the public-finance risks posed by large banks it to force them to downsize and split up. In the aftermath of the EU bail-out, Ireland will probably be required to considerably downsize its banks, reflecting its rather small national economy. In the UK, the Bank of England has been active in a debate on whether major UK banks need to be split up to reduce risks to the British treasury.[2] In the US, the Wall Street Reform and Consumer Protection Act (or Dodd-Frank Act) passed in July 2010 prohibits bank mergers that result in a bank with total liabilities exceeding 10 percent of the aggregate consolidated liabilities of all financial companies to prevent the emergence of an oversized bank. [3]

While the public finance risks of large banks are obvious, it is less clear whether there are other costs or benefits associated with systemic size that need to be taken into account. To fill this gap, this paper provides empirical evidence on whether systemically important banks are different in three key areas. First, we examine whether large banks have different performance in terms of risk and return outcomes. Second, we consider whether large banks have different

[2] See, for instance, a speech by Mervyn King, Governor of the Bank of England, on June 17, 2009 at http://www.bankofengland.co.uk/publications/speeches/2009/speech394.pdf.

[3] A previous proposal of the Obama administration to impose a tax on the non-deposit liabilities of banks with assets in excess of $50 billion failed to be enacted. In the UK, an Independent Commission on Banking chaired by Sir John Vickers is considering options for dealing with systemically important banks, with a final report due by the end of September 2011. See Goldstein and Véron (2011) for a discussion of the policy debate in the US and in Europe regarding systemically important banks.

business models as to their activity mixes and funding strategies. Third, we investigate whether large banks are subject to market discipline to a different degree compared to smaller banks. We consider these issues for a large international sample of banks over the years 1991-2009. This international setting enables us to make a distinction between a bank's absolute size as measured by the logarithm of its total assets, and its systemic size as measured by its liabilities-to-GDP ratio.

Our main results are as follows. A bank's rate of return on assets is shown to increase with its absolute size, but to decline with its systemic size. Bank risk in turn increases with absolute size, and appears to be largely unaffected by systemic size. A bank's absolute size thus represents a trade-off between bank risk and return. Systemic size, on the other hand, is an unmitigated bad, as it reduces return without a clear impact on risk. In practice, a bank determines its absolute and systemic size jointly, if it remains established in the same country. This implies that banks located in larger countries may have a larger optimal size as determined by a risk and return trade-off, as such banks can increase their absolute size with a relatively small nefarious impact on systemic size.

Regarding bank business models, we find that larger banks obtain a larger share of their income in the form of non-interest income such as trading income and fees. Systemically larger banks, in contrast, earn a relatively small share of income as non-interest income. Large banks are further shown to hold a relatively small share of their assets in the form of loans rather than, for instance, securities, and they attract a relatively large share of their short-term funding in the form of non-deposit or wholesale funding. Thus, large banks appear to be relatively active on the capital markets on both assets and liabilities sides of the balance sheet. These tendencies are not found however, for banks that are just systemically large.

A major issue is how size affects market discipline. Large size may render a bank too big to fail, reducing its funding cost. On the other hand, given tight public finances, systemic size may make a bank too big to save, increasing its funding cost. At the same time, a bank's too-big-to-fail status may render its interest cost less sensitive to a proxy for bank riskiness such as its capitalization rate, while a bank's too-big-to-save status can make its interest cost more sensitive to bank risk. Empirically, we find that the sensitivity of a bank's interest cost to proxies for bank risk rises with the bank's systemic size, while this sensitivity is not significantly related to absolute size. Thus, we find evidence of market discipline on the basis of systemic size consistent with the view that systemically large banks may become too big to save, while we do not find international evidence of reduced market discipline on the basis of a too-big-to-fail status due to larger absolute size. Our finding that a bank's interest cost tends to rise with its systemic size can in part explain why a bank's rate of return on assets tends to decline with systemic size.

Our results shed light on whether large bank size is desirable. In practice, bank managers have taken the decisions that have led to the considerable growth of banks around the world in the last two decades or so. This is prima facie evidence that such growth was in the interest of bank managers. Bank managers can benefit from size, as their status and pay may be positively affected by bank size.

It is less clear that large bank size is in the interest of bank shareholders. Our results suggest that bank growth may increase a bank's rate of return in relatively large economies, but even then at a cost of more bank risk. In smaller countries, bank growth may have reduced bank return on assets, and increased bank risk. These findings suggest that bank growth has not been in the interest of bank shareholders in smaller countries, while there are doubts whether

shareholders in larger countries have benefited. Inadequate corporate governance structures at banks may have enabled managers to pursue high-growth strategies at the expense of shareholders.

This paper builds on the literature dealing with bank size, business models and market discipline. Berger and Mester (1997) estimate banking returns to scale using US bank data for the 1990s to find an optimal banking size of around $25 billion in assets. In line with this, Amel, Barnes, Panetta and Salleo (2004, Table 2) report that commercial banks in North America with assets in excess of $50 billion have higher operating costs than banks in smaller size classes. This suggests that today's large banks, with assets in some instances exceeding $ 1 trillion, are far beyond the technologically optimal point. Demsets and Strahan (1997) further find that large bank holding companies have a diversification advantage, as evidenced by lower idiosyncratic risk. Large bank holding companies, however, are not less risky as they tend to have lower capital ratios. These contributions on the scale and risk effects of bank size cannot distinguish between absolute and systemic size as they use data for only the US.

Several studies consider the risk and return implications of combining traditional banking with other financial activities. Among these, Stiroh (2004) considers how the impact of the activity mix of US banks, proxied by the share of interest income in total income, affects bank risk, finding that risk is lowest for a share of interest income in total income close to one.[4] Demirgüç-Kunt and Huizinga (2010a) extend this analysis to an international sample of banks, again finding that banks with a substantial noninterest income share are riskier. Banks with a large share of nondeposit wholesale funding in total short-term funding area are also shown to be riskier. Demirgüç-Kunt and Huizinga (2010a) further demonstrate that the noninterest income

[4] See also DeYoung and Roland (2001), Kwast (1989), Rosen, Lloyd-Davies, Kwast, and Humphrey (1989), and Templeton and Severiens (1992).

share and the nondeposit funding share are both positively related to bank size, but they do not consider systemic size as a potential determinant of bank activity and funding patterns.

An extensive literature examines whether depositors exert market discipline on banks. Park and Peristiani (1998), for instance, find evidence that riskier thrifts in the US pay higher interest rates, and attract smaller amounts of uninsured deposits. Goldberg and Hudgins (2002) similarly find that failed banks exhibit declining proportions of uninsured deposits to total deposits prior to failure. Billet, Garfinkel, and O'Neal (1998), however, conclude that market discipline by uninsured depositors may be ineffective, as riskier banks are able to increase their use of insured deposits. Flannery and Sorescu (1996) find that spreads on bank subordinated debentures reflect bank risk relatively more during the last three years of the 1983-1991 period, following policy changes that increased the default risk on subordinated bank debentures. For European data over the 1991-2001 period, Sironi (2003) instead finds that spreads on bank subordinated notes and debentures are relatively insensitive to bank risk in the second part of the 1990s, which is attributed to a disappearing perception of safety net guarantees on the part of investors.

A major issue regarding market discipline is whether a bank's size reduces market discipline, as a large bank may be deemed too big to fail. Kane (2000) considers US bank mergers over the 1991-1998 period, finding that stockholders of large-bank acquirers have gained value when a deposit institution target is large and even more value when a deposit institution target was previously headquartered in the same state. Benston, Hunter and Wall (1995) similarly find that bank mergers and acquisitions are in part motivated by enhancing the deposit insurance put option. Penas and Unal (2004) consider the returns to bond holders around US bank mergers in the 1991-1997 period, yielding that adjusted returns on merging banks'

bonds are positive across pre-merger and announcement months. These studies, however, do not distinguish between absolute and systemic size as potential determinants of market discipline on a bank.

Demirgüç-Kunt and Huizinga (2010b) consider absolute and systemic size as separate determinants of the market-to-book value of a bank's equity for a sample of international sample of banks over the 1991-2008 period. Bank market-to-book value is found to be negatively related to either size measure, while it is more negatively related to systemic size in countries with large public deficits, as evidence that systemically large banks can be too large to save. The present paper's finding that the sensitivity of bank interest expenses to bank risk is greater for systemically large banks also suggests that these banks can be too large to save, and thus it is consistent with the evidence from bank stock pricing in our earlier paper.

The remainder of this paper is organized as follows. Section 2 discusses the data. Section 3 presents the empirical results. Section 4 concludes.

2. The data

In this study, we examine an international sample of banks over the 1991-2009 period. Income statement and balance sheet information on individual banks is taken from Bankscope. A full list of variable definitions and data sources is given in the Appendix. Our sample is restricted to publicly-listed banks to ensure relatively high data quality. With data from many countries, we can distinguish between a bank's absolute size and its systemic size, i.e. its size relative to the national economy. To measure a bank's absolute size, we define the assets variable as the log of total assets in constant dollars. To gauge systemic size, we take a bank's liabilities-to-GDP ratio, denoted

liabilities over GDP. This ratio corresponds is to a country's maximum expenditure in a bank bail-out relative to its GDP, if all of a bank's assets go completely sour.

In Table 1 with summary statistics, we see that liabilities over GDP has a sample mean of 0.046. Figure 1 provides additional information about the overall distribution of liabilities over GDP. Specifically, this figure plots the percentages of banks with liabilities over GDP in consecutive intervals of size 0.05 up to a value of 1, and also in a remainder category of banks with liabilities over GDP exceeding 1. Most banks are shown to be rather small relative to GDP, as 87 percent of banks have liabilities over GDP of less than 0.05. However, a considerable number of banks is sizeable relative to GDP, as 8.0 percent of banks liabilities exceed 10 percent of GDP, and 0.9 percent of banks have total liabilities exceeding GDP.

In addition to liabilities over GDP, we alternatively consider several indicator variables to represent a bank's systemic size. These variables take on a value of 1 if liabilities over GDP exceed a certain threshold, while they are zero otherwise. Thus, the Big0.1 variable equals 1 if liabilities over GDP exceed 0.1, and it is zero otherwise. Analogously, the Big0.25, Big0.5 and Big1 variables are constructed with thresholds for the liabilities over GDP ratio of 0.25, 0.5 and 1, respectively. In Table 1, we see that the Big0.5 variable has a mean of 0.019, indicating that 1.9 percent of banks have liabilities exceeding half of GDP.

In the empirical work below, we examine how bank size affects bank performance as proxied by four variables. First, a bank's profitability is proxied by the return on assets, computed as pre-tax profits divided by assets, with a mean of 0.013 in the sample. Second, as a measure of bank solvency we use the Z-score which is constructed as the sum of the mean return on assets and the mean ratio of equity to assets, divided by the standard deviation of the return on assets (see Roy, 1952). The Z-score measures the number of standard deviations that a bank's rate of return on assets

can fall in a single period before it becomes insolvent. A higher Z-score signals a lower probability of bank insolvency. A Z-score is calculated only if we have accounting information for at least four years. The mean Z-score is 23.522.

We consider a bank's business model, as proxied by five variables. First, fee income is the share of noninterest income, comprising fees, commissions and trading income, in total operating income. Fee income measures the overall importance of a bank's noninterest income generating activities, relative to more traditional interest generating activities. On average, banks are seen to obtain 30.6 percent of their income in the form of noninterest fees. As related variables, we also consider a bank's net interest income relative to assets and its noninterest income relative to assets. The interest income and other operating income variables have sample means of 0.031 and 0.024, respectively.

As an alternative indicator of traditional customer focus, we define loans as the ratio of loans to total earning assets. This variable indicates to what extent banks originate loans rather than hold other assets such as securities. As an indicator of customer focus on a bank's liability side, we consider its non-deposit funding variable, constructed as the share of non-deposit funding in total customer and short-term funding. A higher non-deposit funding share means that a bank relies relatively more on non-deposit, wholesale funding, and that it deals relatively little with traditional bank depositors. The mean non-deposit funding share is 0.083.

We also consider how bank size affects market discipline. Market discipline of a distressed bank by depositors and other bank liability holders can result in a higher interest rate on bank liabilities. Also, it can engender a lower growth rate of deposits that becomes negative in case of net withdrawals. Accordingly, we consider a price and a quantity variable as possibly affected by market discipline. In particular, a bank's interest expense stands for its interest expense relative to

total interest-bearing liabilities, with a sample mean value of 0.034. Further, deposit growth is computed as the annual rate of real growth of deposits in percent, with a mean value of 0.079.

Stronger market discipline should be applied to banks that are at greater risk of failure. To represent bank risk, we consider three variables. First, the equity variable, computed as the ratio of bank equity to assets, represents a bank's capitalization rate. The average equity ratio in the sample is 0.109. Second, liquidity is constructed as the ratio of liquid assets to total assets, with a mean of 0.096. Third, the return on assets, as a measure of bank profitability, is also used as an indicator of bank risk. Higher values for the equity, liquidity and return on assets variables are all taken to imply a lower risk of bank failure, and thus to lessen the rationale for market discipline.

The empirical work includes several bank-level and also country-level control variables. Among the bank-level controls, overhead is the ratio of personnel and other non-interest expenses to total assets, with a mean value of 0.031. Further, short term debt is short term debt divided by total liabilities, with a mean of 0.841. Next, banks tend to have different charters that affect their activity mix and overall performance. To signal bank type, we construct three categorical variables for banks other than commercial banks. First, investment bank is a dummy that equals one for investment banks and securities houses and zero otherwise. In the sample, 5.0 percent of banks fit this category. Second, non-banking credit institution is a dummy signaling a non-banking credit institution, which applies to 2.1 percent of all banks. Third, other bank is a dummy for other banking categories (these are cooperative banks, Islamic banks, medium and long term credit banks, real estate and mortgage banks, and savings banks), representing 3.1 percent of all banks. The remainder category of commercial banks comprises the lion's share, or 89.8 percent, of all banks in the sample.

Finally, we use three macroeconomic control variables. There are the rate of inflation of consumer prices, the growth rate of real GDP per capita, and GDP per capita in thousands of 2000 constant US dollars.

To conclude this section, Table 2 provides pairwise correlations between our absolute and systemic bank size variables and the main performance, business model and market discipline variables. Importantly, the correlation between assets and liabilities over GDP is rather low at 0.105. In an international context, this suggests that it is meaningful to distinguish between absolute and systemic bank size. Further, the table shows that the correlation between the assets and interest expense variables is negative at -0.040, while the correlation between liabilities over GDP and interest expense is positive at 0.028. This suggest that the economic impact of absolute and systemic bank size on banking outcomes may be opposite, which makes distinguishing between absolute and systemic bank size important.

3. The empirical evidence

This section presents empirical results on the impact of absolute and systemic bank size on bank performance, bank activity and funding strategies, and market discipline of banks by bank liability holders. In addition, it considers whether some of the relationships between bank size and bank performance and strategies were different during the economic and financial crisis of 2008 and 2009.

3.1. Bank performance

Table 3 presents results of regression of proxies for bank performance on absolute and systemic bank size and controls. The rate of return on assets is the dependent variable in regressions

1-5, and the Z-score is the dependent variable in regressions 6-10. Return on assets regressions include country and year fixed effects, while errors are clustered at the bank level. Z-score regressions include a time fixed effect for the last year of the time series for a specific bank, and clustering at the country level. In the return on assets regressions, the assets variable obtains a positive coefficient of 0.001 that is significant at the 1 percent level, indicating that a bank's rate of return on assets rises with its absolute size, perhaps reflecting increasing returns to scale for the average bank.[5]

In contrast, the liabilities over GDP variable obtains a negative coefficient of -0.006 that is significant at the 1 percent level in regression 1, suggesting that a bank's return declines with its systemic size. This may reflect that systemically large banks have run out of profitable business opportunities in their domestic markets. Alternatively, as we consider further below, systemically important banks may face higher funding costs, reflecting doubts whether they can be bailed out by their national governments. In the return on assets regressions 2-5, we replace the liabilities over GDP variable by one of the categorical systemic size variable Big0.1, Big0.25, Big0.5 and Big1. The estimated coefficients for these Big variables are increasingly negative at -0.004, -0.005,- 0.008 and -0.010, and they are significant at 5 percent in case of the first coefficient, and 1 percent in case of the other three. This confirms that systemically large banks, and especially the very largest banks, tend to achieve relatively low rates of return on assets.

The Z-score regressions 6-10 in Table 3 are analogous to the return on assets regressions 1-5. In regression 6, the assets variable is seen to obtain a negatively coefficient of -1.344 that is significant at the 1 percent level. Thus, banks with large absolute size tend to be riskier, perhaps because they undertake riskier activities. In regression 6, the liabilities over GDP variable obtains a

[5] Demirgüç-Kunt and Huizinga (2010a, Table 6) fail to find a significant relationship between bank rate of return and the assets variable in regressions that do not distinguish between bank absolute and systemic size.

positive coefficient that is statistically insignificant. In regressions 7-10, the included Big variables similarly obtain positive coefficients that only in the case of Big0.5 in regression 8 is statistically significant at 5 percent. Thus, there is no clear evidence that systemically important banks are safer.

Overall, the results of Table3 suggest that absolute size offers a trade-off between bank risk and return. In particular, absolutely large banks are more profitable at a cost of higher risk. Systemically large banks, in contrast, are less profitable without clear evidence of lower risk.

An individual bank obviously cannot choose its absolute and systemic size independently of each other, as long as it remains established in the same country. To calculate the impact of assets growth on return on assets, we need to recognize that such growth simultaneously increases absolute and systemic size. Our parameter estimates imply that assets growth increases return on assets until a bank's assets-to-GDP ratio reaches 0.187.[6] Assets growth thus increases return on assets for most banks in the world, as their assets-to-GDP ratios are less than 0.187. For most banks, growth thus appears to offer a trade-off between risk and return, while for the systemically largest banks asset growth may simultaneously lower the return on assets and increase risk.

3.2. Bank activity mix and funding strategy

In this subsection we consider how absolute and systemic bank size affect various aspects of a bank's earnings mix, its asset allocation and its funding strategy. Differences in the activity mix and funding strategy on the basis of size can potentially explain the relationships between absolute and systemic size with risk and return outcomes.

[6] This is the assets-to-GDP ratio that maximizes return on assets given the estimated coefficients of 0.001 and -0.006 for the log of assets and the liability-to-GDP ratio in regression 1 of Table 3 and an assumed liabilities-to-assets ratio of 0.891 corresponding to a mean equity-to-assets ratio of 0.109 in Table 1. The corresponding liabilities-to-GDP ratio is 0.167.

Table 4 reports regressions that relate aspects of a bank's overall business strategy to its absolute and systemic size in 5 different panels. In Panel A, regressions include the liabilities over GDP variable as a measure of systemic size. In Panels B through E, we reports results of regressions where the liabilities over GDP variable has been replaced by Big0.1, Big0.25, Big0.5 or Big1, respectively. For brevity, Panels B through E only report the estimated coefficients for the Big variables.

In regression 1 of Panel A, the dependent variable is the fee income share, as an indicator of a bank's reliance on non-interest income. In this regression, the assets variable obtains a positive coefficient that is significant at the 1 percent level indicating that larger banks earn relatively more non-interest income, which confirms results in Demirgüç-Kunt and Huizinga (2010a, Table 4). The tendency for large banks to rely relatively more on fee income can explain why these banks tend to be more profitable at a cost of more bank risk, as Demirgüç-Kunt and Huizinga (2010a, Tables 6 and 7) find that a bank's rate of return and its Z-score are positively and negatively related to the fee income share, respectively.

In regression 1, the liabilities over GDP variable obtains a coefficient that is negative and significant at the 5 percent level, implying that systemically large banks generate relatively more interest income. This could reflect that a bank can more easily scale up its interest generating activities than its fee income generating activities relative to the size of the national economy.

In column 1 of Panels B through E, we see that the coefficients on the Big0.1, Big0.25, Big0.5 and Big1 variables are estimated with increasingly negative coefficients of -0.071, -0.083, -0.110, and -0.140 that are significant at the 1 percent level. This confirms that systemically large banks, and especially the very largest banks, earn relatively little non-interest income as a share of their total operating income.

Next, we consider how bank size affects a bank's earnings of net interest income relative to assets and its non-interest income relative to assets in regressions reported in columns 2 and 3, respectively. In column 2 of Panel A, the estimated coefficient for the assets variable is estimated to be negative and significant at 1 percent, while the coefficient for the liabilities over GDP variable is positive and significant at 5 percent. In column 2 of Panel B-D, we similarly see that the Big0.1 and Big0.25 and Big0.5 variables obtain positive coefficients that are significant at 10 percent in the respective regressions. This confirms that banks that are large in absolute size earn relatively little net interest income, while the opposite is true for systemically important banks.

In the non-interest income regression in column 3 of Panel A, neither the assets nor the liabilities over GDP variable enters with statistically significant coefficients. In Panel B, the Big0.25, Big0.5 and Big1.0 variables, however, obtain negative coefficients that are significant at 1, 5 and 10 percent, respectively. Thus, there is some evidence that systemically larger banks earn higher non-interest income relative to assets.

Next, we consider how a bank's asset allocation between loans and other earning assets is affected by its size. Specifically, column 4 reports regressions of the share of loans in total earning assets. In panel A, we see that this loan share is negatively and significantly related the assets variable. This suggests that larger banks allocate a larger share of their earning assets to securities rather than to loans, perhaps because the growth of the loan customer base has not kept up with overall growth. The loans share in assets is not significantly related to liabilities over GDP as an indicator of systemic size. Hence, this relationship is not different for banks that are even systemic in size.

Finally, in column 5 we consider how the share of non-deposit funding in total short-term funding is related to our bank size variables. In Panel A, the coefficient on the assets variable is

estimated to be positive and significant at the 1 percent level, while the coefficient on the liabilities to GDP variable is not significant. In Panels B-D, however, we see that the Big0.1, Big0.25 and Big0.5 variables obtain negative coefficients that are significant at 1percent twice and at 5 percent once in the respective regressions. Thus, the share of non-deposit funding is estimated to increase with absolute bank size, while there is some evidence that it declines with systemic bank size. Banks that are large in absolute size may be relatively sophisticated and thus they are able to attract short-term, wholesale funding. Banks that are systemically large, on the other hand, attract relatively little wholesale funding, perhaps because they are taken to be too risky to attract this type of funding at relatively attractive terms.

3.3. Market discipline

For the US, there is evidence that large banks are too big to fail, leading to less market discipline of banks by depositors on the basis of the bank risk on a stand-alone basis, i.e. abstracting from potential government support in the event of distress. In this paper, we consider an international sample of banks, which allows us to see whether internationally banks with large absolute size are considered too big to fail, as evidenced by reduced market discipline. In addition, in an international context, we can consider how market discipline varies with systemic bank size.

A bank's depositors can discipline a risky bank either by demanding a higher interest rate on deposits or by withdrawing their deposits. Correspondingly, in this subsection we consider how a bank's average liability interest rate and its deposit growth rate depend on bank risk and bank size. Specifically, we include an interaction variable of a bank risk indicator (either equity, liquidity or return on assets) with a bank size variable (either assets or liabilities over GDP) in a regression of either the average interest rate of bank liabilities or the deposit growth rate. A negative estimated

coefficient for such an interaction term in an interest rate regression is taken to be evidence of enhanced market discipline of relatively sizeable banks, as it indicates a heightened sensitivity of the bank funding cost of larger banks to bank risk. Analogously, a positive estimated coefficient of a bank risk and bank size interaction variable in a deposit growth regression is interpreted as enhanced market discipline of relatively sizeable banks, as the deposit growth of bigger banks is more sensitive to bank risk. Previously, Demirgüç-Kunt and Huizinga (2004) examined the impact of the existence of explicit deposit insurance on market discipline in an analogous fashion.

In Table 5, we report regressions of the interest expense and deposit growth variables in columns 1-4 and 5-8, respectively. The table has five panels, with Panel A reporting regression including the liabilities over GDP variable to proxy for systemic size, and Panels B-E reporting results from analogous regressions that include one of four Big variables. Starting with the interest expense regression 1 of Panel A, we see that the coefficient for the assets variable is estimated to be negative and significant at the 1 percent level, while the liabilities over GDP variable is estimated with a positive coefficient that is statistically insignificant. A bank's cost of funds thus appears to decline with absolute size, while there is no significant relationship with systemic size. In regression 1, the equity variable, as an indicator of bank risk, also obtains a positive coefficient that is statistically insignificant, suggesting that depositors do not materially distinguish among banks on the basis of the bank capitalization rate. Next, in regression 2 of Panel A, we include an interaction term of the equity and liabilities over GDP variables to see whether a bank's interest expense is relatively responsive to the bank capitalization for systemically large banks, as evidence of enhanced market discipline of systemically large banks. This interaction term obtains a negative coefficient that is significant at the 10 percent level, which suggests there is indeed enhanced market discipline of systemically large banks through banks' costs of funds.

As an alternative indicator of bank risk, we next consider the liquidity variable. Specifically, in regression 2 we replace the equity variable and its interaction with liabilities over GDP by liquidity and its interaction with liabilities over GDP. The liquidity and interaction variables obtain negative coefficients that are significant at 5 and 10 percent, indicating that depositors demand lower interest rates from banks with large liquid assets, especially if these banks are systemically large.

As a third indicator of bank risk, we take the rate of return on assets. Thus, regression 4 includes the rate of return on assets and its interaction with liabilities over GDP. Coefficients for both of these variables are estimated to be negative, and only the interaction term is significant at 5 percent. This provides evidence that depositors discriminate among banks on the basis of their reported profitability in the case of systemically large banks.

Overall, these results indicate that there is enhanced market discipline of systemically large banks as reflected in bank interest expenses. This finding is consistent with the notion that systemically large banks may be too large to save due to their countries' relatively limited fiscal capacities.

The deposit growth regressions in columns 5-8 of Panel A are analogous to the interest expense regressions in columns 1-4. Starting with column 5, we see that the coefficient on the assets variable is positive and significant at 10 percent, while the coefficient on liabilities over GDP is negative and significant at 1 percent. Thus, large banks tend to be able to realize a higher rate of growth of deposits, while systemically large banks experience lower deposit growth rates. Apparently, banks that are large in absolute terms tend to have further growth opportunities, while systemically large banks grow less, perhaps because they have exhausted growth opportunities in their domestic markets or they are subject to enhanced market discipline. In regression 5, the equity

variable enters with a negative coefficient that is statistically insignificant. In regression 6, we include an interaction of equity and liabilities over GDP. This interaction term obtains a positive coefficient that is insignificant.

In regression 7, liquidity and its interaction with liabilities over GDP are included as risk-related variables, yielding a positive coefficient for the interaction term that is significant at 5 percent. This is evidence of market discipline by depositors of systemically large banks with low liquid assets by way of reduced deposit growth. Finally, regression 8 includes the return on assets and its interaction with liabilities over GDP, yielding positive coefficients for both variables, but only the return on assets variable itself is significant at 1 percent.

Panel B-E report estimated coefficients for the various Big variables if one of these replaces the liabilities over GDP variable in the interest expense and deposit growth regression of Panel A. These coefficients frequently fail to obtain coefficients that are statistically significant, as apparently useful information about systemic size that is relevant in estimating market discipline is lost if we categorize banks into two groups on the basis of systemic size. All the same, in columns 5-8 of Panel E we see that the Big1 variable is estimated with negative coefficients with at least 10 percent significance, while the interaction of Big1 with the included risk factor obtains positive coefficients that are significant at 5 percent in column 6 and 7 and insignificant in column 8. This suggests that a division into banks with liabilities smaller than or bigger than national GDP is a useful one to show that deposit growth of banks in the large-bank category is materially more sensitive to bank risk as proxied by the equity and liquidity variables.

In practice, not all bank liability holders may exercise effective market discipline of risky banks, as they lack information about bank riskiness and as moving deposits to another bank requires some effort. Potentially, therefore, a bank that attracted many deposits before can offer a

lower interest rate to attract the desired level of deposits today. To the contrary, banks that realized a high short-term funding growth rate in an earlier period by offering high interest rate may still need to pay high interest rates today if rates have not yet been reset. To capture these dynamic aspects of deposit supply to a bank, we include the previous year's deposit growth rate in the interest expense regressions 1-4 of Table 5, with the results presented as regressions 1-4 of Table 6. Similarly, we include the previous year's interest expense as an additional variable in the deposit growth regressions 5-8 of Table 5, with the results presented as regressions 5-8 of Table 6.

We see that these added lagged variables obtain positive coefficients, however, are statistically insignificant. On the whole, the inclusion of these lagged variables improves the precision of the estimation of the liabilities over GDP variable and its interactions. Unlike in Table 5, the liabilities over GDP variable in the interest expense regression 1 now obtains a positive coefficient that is statistically significant at 10 percent, as evidence of higher interest expenses of systemically important banks. In Panel B, we now see that interactions of Big0.1 with the included risk factors are estimated with significance at 10 or 5 percent in all of regressions 2-4 and 6-8. This suggest that banks with liabilities exceeding 10 percent of GDP experience significantly higher market discipline through deposit interest rates as well as deposit growth rates than systemically smaller banks. Similarly, interactions of Big1 with the included risk factor have significance of 10 percent in regressions 2-3 and significance of 5 percent in regressions 6-7 in Panel E, suggesting that banks with liabilities exceeding GDP experience significantly stronger market discipline through interest expenses and deposit growth than smaller banks.

So far, we have examined whether market discipline is related to systemic bank size and not to absolute bank size. In principle, market discipline can be related to both size measures. To check this, we include an interaction term of the assets variable and relevant proxy for bank risk in the

interest expense regressions 2-4 of Table 5 and in the deposit growth regressions 6-8 of Table 5, with the results reported as Table 7. The interactions of the respective risk factor with liabilities over GDP are estimated with negative and significant coefficients in the interest expense regressions 1-3 of Table 8, while the interaction is positive and significant in regression 5. In contrast, interactions of assets with the bank risk factor are not estimated to be statistically significant in the regressions of Table 7. For an international sample of banks, market discipline thus appears to depend on systemic size and not on absolute size.

To conclude this section, we examine how market discipline is related to size for a sample of only US banks. In a one-country setting, we cannot distinguish between a bank's absolute and systemic size, as the over-time variation in GDP is insufficient to usefully distinguish between them. In the US sample regressions, the single size variable we include is the log of a bank's real liabilities. The regressions, reported in Table 8, otherwise are analogous to regressions 2-4 and 6-8 in Table 5. In the interest expense regression 3, the coefficients for the return on assets and its interaction with the log of real liabilities obtain negative and positive coefficients that are significant at the 1 percent level. This suggests that market discipline on the basis of a bank's profitability is weaker for larger banks in the US. This is consistent with the view that large banks in the US are too big to fail. Even the largest banks in the US, however, are relatively small compared to US GDP so that there is no doubt about the ability of the US treasury to bail out the largest US banks. This sets the US apart, and can explain the difference between the results regarding the return on assets interaction with the bank size variable in regression 3 of Table 8 for the US sample, and results regarding interactions with absolute and systemic size variables in regression 3 of Table 7 for the international sample.

3.4. The crisis of 2008-2009

The economic and financial crisis of 2008-2009 may have affected the profitability, income and activity mix, and funding strategies of large banks in a distinct way. The profitability of large banks, in particular, has potentially been affected differently, as large bank derive their income from a different mix of activities, which were impacted differently by the crisis. The activity mix and funding strategies of large banks themselves are potentially affected differently as well.

To test this, we reestimate several regressions examining bank performance and strategy from previous subsections, after including interactions of all right hand side variables with a dummy variable that equals one for the years 2008 and 2009 and is zero otherwise. To start, we consider the return on assets in regression 1 of Table 9, based on regression 1 of Table 3. The assets and assets*2008,9 variables both obtain positive coefficients that are significant at the 1 percent level. This implies that a positive relationship between bank profitability and absolute bank size that already existed before 2008 was strengthened in the years 2008 and 2009.

Next, we consider regressions examining bank activity mix and funding strategy in columns 2-6 of Table 9, analogous to Table 4. Here we also find a tendency for the financial crisis to sharpen previously existing relationships between our activity mix and size variables. In regression 2, for instance, we see that the liabilities over GDP and liabilities over GDP*2008,9 variables obtain negative coefficients that are estimated to be significant at the 5 and 1 percent levels, respectively. Thus, systemically large banks earned a relatively small share of their operating income in the form of non-interest income, and this tendency was stronger in the years 2008 and 2009. In regression 6, however, we see that the assets and assets*2008,9 variables obtain coefficients of 0.025 and -0.009 that are both significant at the 1 percent level. This indicates that larger banks attracted a larger

share of nondeposits in total short-term funding before 2008, but that this greater reliance of large banks on nondeposit funding was weakened during the crisis years of 2008 and 2009

5. Conclusions

Given the recent policy interest in understanding the costs and benefits of bank size, this paper examines how a bank's size – defined both as absolute size and systemic size relative to the size of its economy – is associated with its performance, business strategy and the market discipline it faces. For an international sample of banks, we find that banks with large absolute size tend to be more profitable, while they also have a lower Z-score pointing at higher bank risk. Banks with large systemic size, in contrast, tend to be less profitable, while the Z-score appears to be little affected by systemic size. These results imply that bank growth, affecting both absolute and systemic size, will increase profitability relatively more, if a bank is located in a larger country. They also suggest that the optimal bank size, as determined by a trade-off between risk and return, declines with country size.

We also present evidence on market discipline of large banks. Specifically, we examine how absolute and systemic bank size affect the sensitivity of a bank's cost of funds to several indicators of bank risk. We find that this sensitivity increases with bank systemic size, suggesting enhanced market discipline of systemically large banks. In contrast, we do not find enhanced market discipline of banks with large absolute size for our international sample of banks. Greater market discipline of systemically large banks suggests that these banks are too big to save, offsetting the effect of too-big-to-fail subsidies. The higher funding rates faced by systemically large banks are also consistent with their lower profitability.

Our finding that systemically large banks achieve lower profitability and operate with higher risk, as reflected in bank liability interest rates, suggests that it is not in bank shareholders' interest for a bank to become large relative to its national economy. This is consistent with evidence that the market-to-book ratio of a bank's equity tends to decline with systemic size as in Demirgüç-Kunt and Huizinga (2010b), and the estimation that a bank's optimal size from a banking technology point of view is far less than the size of today's huge banks as in Berger and Mester (1997).

This begs the question of why today's systemically large banks ever became so large. One potential answer is that bank growth can be in the interest of bank managers through higher manager pay and status, even if bank growth is at the expense of bank shareholders. This suggests that it is undesirable for banks to grow to reach large systemic size. If so, the question emerges whether the prevention of bank growth to large systemic size can be left to market discipline or should be the object of regulation. Our evidence indicates that market discipline on the basis of systemic size apparently does exist. However, we know that this market discipline in terms of higher funding rates was not effective in preventing the emergence of banks that are very large relative to their national economies in many countries.

In the absence of effective market discipline, regulatory intervention appears to be called for. Such intervention could take the form of a higher taxation of, say, the profits or liabilities of systemically large banks or direct intervention that forces systemically large banks to downsize or split up. Also, reform of corporate governance and pay structures at banks would be useful to ensure that market discipline can be effective. Managers should have incentives to heed market signals, and they should be rewarded for keeping their banks safe rather than for pursuing high-growth strategies at the expense of shareholders.

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Appendix. Variable definitions and data sources

Variable	Description	Sources
Assets	Log of assets in millions of 2000 US dollars	Bankscope and WDI
Liabilities	Log of liabilities in millions of 2000 US dollars	Bankscope and WDI
Liabilities over GDP	Bank liabilities divided by GDP	Bankscope and WDI
Big0.1	Dummy variable that equals one if ratio of bank liabilities to GDP exceeds 0.1 and zero otherwise	Bankscope and WDI
Big0.25	Dummy variable that equals one if ratio of bank liabilities to GDP exceeds 0.25 and zero otherwise	Bankscope and WDI
Big0.5	Dummy variable that equals one if ratio of bank liabilities to GDP exceeds 0.5 and zero otherwise	Bankscope and WDI
Big1	Dummy variable that equals one if ratio of bank liabilities to GDP exceeds 1.0 and zero otherwise	Bankscope and WDI
Return on assets	Pre-tax profits divided by assets	
Z-score	Index of bank solvency constructed as $\frac{ROA + CAR}{SROA}$, where ROA is return on assets, CAR represents capital assets ratio and SROA stands for standard deviation of return on assets	Bankscope
Fee income	Share of non-interest income in total operating income	Bankscope
Interest income	Net interest income divided by assets	Bankscope
Other operating income	Other operating income divided by assets	Bankscope
Loans	Total loans divided by earning assets	Bankscope
Non-deposit short-term funding	Share of non-deposit short-term funding in total deposits and short-term funding.	Bankscope
Interest expense	Interest expense over bank liabilities excluding non-interest bearing debt	Bankscope
Deposit growth	Growth rate of a bank's customer and short term funding after dividing by the GDP deflator in percent	Bankscope and WDI
Equity	Ratio of equity to assets	Bankscope
Liquidity	Ratio of liquid assets to total assets	Bankscope
Overhead	Ratio of personnel and other non-interest expenses to assets	Bankscope
Short term debt	Bank's customer and short term funding divided by total interest-bearing debt	Bankscope
Investment bank	Dummy variable that equals 1 if bank is investment bank or securities firm, and zero otherwise	Bankscope
Non-banking credit institution	Dummy variable that equals 1 if bank is non-banking credit institution, and zero otherwise	Bankscope
Other bank	Dummy variable that equals 1 if bank is cooperative bank, Islamic bank, medium and long term credit bank ,	Bankscope

	real estate and mortgage bank or savings bank, and zero otherwise	
Inflation	Consumer price inflation rate	WDI
GDP growth	Rate of real per capita GDP growth	WDI
GDP per capita	GDP per capita in thousands of 2000 constant U.S. dollars	WDI

Table 1. Summary statistics on bank and country variables

This table presents summary statistics. *Assets* is the natural logarithm of total assets in constant 2000 US dollars. *Liabilities over GDP* are bank liabilities divided by GDP. *Big 0.1, Big 0.25, Big0.5* and *Big 1* are the dummy variables that equal 1 if the liabilities-to-GDP ratio exceeds 0.1, 0.25, 0.5 and 1 respectively and zero otherwise. *Return on assets* is pre-tax profits divided by total assets. *Z-score* is an index of bank solvency constructed as $\frac{ROA + CAR}{SROA}$ where *ROA* is return on assets, *CAR* represents capital assets ratio and *SROA* stands for standard deviation of return on assets. *Fee income* is share of non-interest income in total operating income. *Interest income* is interest income minus interest expense divided by assets. *Other operating income* is other operating income divided by total assets. *Loans* are total net loans divided by earning assets. *Non-deposit funding* is the share of non-deposit short-term funding in total deposits and short-term funding. *Interest expense* is interest expense over bank liabilities excluding non-interest bearing debt. *Deposit growth* is the growth rate of a bank's customer and short term funding after dividing by the GDP deflator in percent. *Equity* is equity divided by assets. *Liquidity* is liquid assets divided by total assets. *Overhead* is personnel expenses and other non-interest expenses over total assets. *Short term debt* is customer and short term funding to total interest paying debt. *Investment bank, Non-banking credit institution* and *Other bank* are dummy variables that equal 1 for specific bank categories and zero otherwise. *Inflation* is the annual change in consumer prices. *GDP growth* is the inflation adjusted growth rate of GDP per capita of the country. *GDP per capita* is GDP per capita in thousands of constant 2000 dollars.

Variable	Observations	Mean	Std. Dev.	Min	Max
Assets	13834	21.766	2.096	14.947	28.550
Liabilities over GDP	13805	0.046	0.221	0.000	4.725
Big0.1	13835	0.080	0.272	0	1
Big0.25	13835	0.038	0.192	0	1
Big0.5	13835	0.019	0.138	0	1
Big1	13835	0.009	0.093	0	1
Return on assets	13806	0.013	0.032	-0.571	0.871
Z-score	1726	23.522	22.793	.0868	146.529
Fee income	13240	0.306	0.211	0	1
Interest income	13588	0.031	0.022	-0.090	0.654
Other operating income	13549	0.024	0.059	0	0.981
Loans	13585	0.676	0.189	0.000	1
Non-deposit short-term funding	13347	0.083	0.143	0	1
Interest expense	13368	0.034	0.031	0.000	0.483
Deposit growth	11505	0.079	0.304	-6.465	7.908

Equity	13825	0.109	0.108	0.001	1.000
Liquidity	8662	0.096	0.133	0.000	0.991
Overhead	13526	0.031	0.022	0.000	0.200
Short term debt	13705	0.841	0.186	0	1
Investment bank	13803	0.050	0.219	0	1
Non-banking credit institution	13803	0.021	0.143	0	1
Other bank	13803	0.031	0.175	0	1
Inflation	13835	0.028	0.029	-0.049	0.460
GDP growth	13504	-0.009	0.023	-0.100	0.119
GDP per capita	13777	28.840	12.398	0.166	56.189

Table 2. Correlations for main bank variables

This table presents pairwise correlations of main bank variables. *Assets* is the natural logarithm of total assets in constant 2000 US dollars. *Liabilities over GDP* are bank liabilities divided by GDP. *Return on assets* is pre-tax profits divided by total assets. *Z-score* is Index of bank solvency constructed as $\frac{ROA+CAR}{SROA}$ where *ROA* is return on assets, *CAR* represents capital assets ratio and *SROA* stands for standard deviation of return on assets. *Fee income* is share of non-interest income in total operating income. *Non-deposit funding* is the share of non-deposit short-term funding in total deposits and short-term funding. *Interest expense* is interest expense over bank liabilities excluding non-interest bearing debt. *Deposit growth* is the growth rate of a bank's customer and short term funding after dividing by the GDP deflator. Correlations of *Z-score* are with means of other variables.

	Assets	Liabilities over GDP	Return on assets	Z-score	Fee income	Non-deposit short-term funding	Interest expense	Deposit growth
Assets	1							
Liabilities over GDP	0.105***	1						
Return on assets	-0.055***	-0.0004	1					
Z-score	-0.227***	-0.015	0.085***	1				
Fee income	0.216***	0.025***	0.128***	-0.084***	1			
Non-deposit short-term funding	0.233***	-0.004	-0.022***	-0.132***	0.311***	1		
Interest expense	-0.040***	0.028***	0.100***	-0.114***	0.173***	0.197***	1	
Deposit growth	0.014	-0.003	0.079***	0.024***	0.016	0.022**	-0.035***	1

Table 3. Determinants of the return on assets and the Z-score

The dependant variable in regressions 1-5 is *Return on assets*, defined as pre-tax profits divided by assets. The dependent variable in regressions 6-10 is *Z-score* defined as $\frac{ROA+CAR}{SROA}$ where *ROA* is return on assets, *CAR* represents capital assets ratio and *SROA* stands for standard deviation of return on assets. *Assets* are natural logarithm of total assets in constant 2000 US dollars. *Liabilities over GDP* are bank liabilities divided by GDP. *Big 0.1, Big 0.25, Big0.5* and *Big 1* are the dummy variables that equal 1 if the liabilities-to-GDP ratio exceeds 0.1, 0.25, 0.5 and 1 respectively and zero otherwise. *Equity* is equity divided by assets. *Short term debt* is customer and short term funding to total interest paying debt. *Investment bank, Non-banking credit institution* and *Other bank* are dummy variables that equal 1 for specific bank categories and zero otherwise. *Inflation* is the annual change in consumer prices. *GDP growth* is the inflation adjusted growth rate of GDP per capita of the country. *GDP per capita* is GDP per capita in thousands of constant 2000 dollars. In *Z-score* regressions variables are mean values over time. Regressions 1-5 include country and time fixed effects and clustering at bank level, and regressions 6-10 include a time fixed effect for the last year of the time series for a specific bank, and clustering at country level. Standard errors are given in parentheses. *, ** and *** denote significance at 10%, 5% and 1%.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	ROA	ROA	ROA	ROA	ROA	Z	Z	Z	Z	Z
Assets	0.001***	0.001***	0.001***	0.001***	0.001***	-1.344***	-1.462***	-1.483***	-1.357***	-1.234**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.495)	(0.516)	(0.486)	(0.492)	(0.486)
Liabilities over GDP	-0.006***					2.282				
	(0.002)					(2.377)				
Equity	0.100***	0.100***	0.100***	0.100***	0.100***	0.911	0.926	0.704	0.807	0.832
	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(9.232)	(9.454)	(9.474)	(9.242)	(9.052)
Short term debt	-0.007*	-0.007*	-0.007*	-0.007*	-0.007	7.620	7.612	7.846*	7.712	7.327
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(4.714)	(4.747)	(4.689)	(4.698)	(4.787)
Investment bank	0.005	0.005	0.005	0.005	0.005	-6.602***	-6.366***	-6.396***	-6.600***	-6.776***
	(0.004)	(0.004)	(0.004)	(0.005)	(0.004)	(2.046)	(2.062)	(2.043)	(2.046)	(2.066)
Non-banking credit institution	-0.007**	-0.008**	-0.008**	-0.007**	-0.007**	3.383	3.631	3.624	3.381	3.142
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(4.683)	(4.688)	(4.674)	(4.692)	(4.711)
Other bank	-0.002	-0.001	-0.001	-0.002	-0.002	8.442	8.612	8.717	8.485	8.267
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(5.268)	(5.293)	(5.258)	(5.247)	(5.252)
Inflation	0.220***	0.219***	0.220***	0.221***	0.220***	1.243	4.142	2.241	1.682	1.746
	(0.046)	(0.046)	(0.046)	(0.046)	(0.046)	(37.061)	(37.636)	(36.681)	(37.100)	(37.250)
GDP growth	0.186***	0.187***	0.186***	0.186***	0.187***	16.941	16.604	17.252	18.854	19.250
	(0.047)	(0.047)	(0.047)	(0.047)	(0.047)	(40.734)	(40.785)	(40.743)	(40.369)	(39.754)
GDP per capita	-0.001	-0.001	-0.001	-0.001	-0.001	0.112	0.129	0.118	0.108	0.107
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.074)	(0.079)	(0.075)	(0.073)	(0.072)

Big0.1		-0.004**					3.517			
		(0.001)					(2.306)			
Big0.25			-0.005***					5.758**		
			(0.002)					(2.829)		
Big0.5				-0.008***					4.181	
				(0.003)					(4.241)	
Big1					-0.010***					-2.687
					(0.004)					(3.866)
Constant	-0.014	-0.014	-0.014	-0.013	-0.011	72.470***	74.541***	75.007***	72.714***	70.561***
	(0.010)	(0.011)	(0.010)	(0.010)	(0.010)	(10.970)	(11.409)	(10.990)	(10.917)	(10.774)
N	13327	13327	13327	13327	13327	1725	1725	1725	1725	1725
R-sq	0.199	0.198	0.198	0.198	0.198	0.138	0.139	0.140	0.138	0.138

Table 4. Bank activity and funding strategy regressions

Fee income is share of non-interest income in total operating income. *Interest income* is interest income minus interest expense divided by assets. *Other operating income* is other operating income divided by total assets. *Loans* are total net loans divided by earning assets. *Non-deposit funding* is the share of non-deposit short-term funding in total deposits and short-term funding. *Assets* are natural logarithm of total assets in constant 2000 US dollars. *Liabilities over GDP* are bank liabilities divided by GDP. *Big 0.1*, *Big 0.25*, *Big0.5* and *Big 1* are the dummy variables that equal 1 if the liabilities-to-GDP ratio exceeds 0.1, 0.25, 0.5 and 1 respectively and zero otherwise. *Equity* is the capital to asset ratio, which is defined as equity as a share of total assets. *Short term debt* is customer and short term funding to total interest paying debt. *Investment bank*, *Non-banking credit institution* and *Other bank* are dummy variables that equal 1 for specific bank categories and zero otherwise. *Inflation* is the annual change in consumer prices. *GDP growth* is the inflation adjusted growth rate of GDP per capita of the country. *GDP per capita* is GDP per capita in thousands of constant 2000 dollars. We estimate all regressions using country and time fixed effects and clustering at bank level. Standard errors are given in parentheses. *, ** and *** denote significance at 10%, 5% and 1%. Panel A shows regressions including *Liabilities over GDP*, whereas panels B through E include *Big 0.1, Big 0.25, Big0.5* and Big1, respectively. Panels B through E only report estimated coefficients for the included Big variable.

Panel A: Liabilities over GDP included

	(1)	(2)	(3)	(4)	(5)
	Fee income	Interest income	Other operating income	Loans	Non-deposit short-term funding
Assets	0.031***	-0.001***	-0.000	-0.014***	0.023***
	(0.003)	(0.000)	(0.001)	(0.003)	(0.002)
Liabilities over GDP	-0.077**	0.002**	-0.007	-0.012	-0.025
	(0.031)	(0.001)	(0.005)	(0.019)	(0.018)
Equity	0.600***	0.042***	0.279***	-0.384***	0.155***
	(0.071)	(0.010)	(0.037)	(0.070)	(0.060)
Short term debt	-0.215***	0.005	-0.064***	0.090**	-0.111***
	(0.037)	(0.004)	(0.014)	(0.039)	(0.037)
Investment bank	0.299***	-0.015***	0.040***	-0.171***	0.196***
	(0.033)	(0.002)	(0.012)	(0.033)	(0.034)
Non-banking credit institution	-0.014	0.066***	-0.008	0.232***	0.077*
	(0.059)	(0.012)	(0.013)	(0.034)	(0.041)
Other bank	-0.035	-0.000	-0.021**	0.072*	0.017
	(0.030)	(0.002)	(0.009)	(0.037)	(0.024)
Inflation	0.238	-0.019	-0.024	-0.335	0.224
	(0.257)	(0.029)	(0.047)	(0.228)	(0.169)
GDP growth	0.405**	0.017	0.043	-0.386**	0.080
	(0.185)	(0.034)	(0.038)	(0.165)	(0.126)

GDP per capita	0.006**	-0.001***	-0.001*	0.006**	0.007***
	(0.003)	(0.000)	(0.001)	(0.003)	(0.002)
Constant	-0.401***	0.073***	0.041	0.957***	-0.304***
	(0.117)	(0.009)	(0.029)	(0.105)	(0.069)
N	12858	13155	13111	13171	12998
R-sq	0.489	0.385	0.431	0.325	0.348

Panel B: A systemic size dummy included

	(1)	(2)	(3)	(4)	(5)
	Fee income	Interest income	Other operating income	Loans	Non-deposit short-term funding
Big0.1	-0.071***	0.003*	-0.005	-0.011	-0.037***
	(0.016)	(0.001)	(0.003)	(0.017)	(0.014)
Big0.25	-0.083***	0.003*	-0.009***	-0.010	-0.046***
	(0.019)	(0.002)	(0.004)	(0.022)	(0.016)
Big0.5	-0.110***	0.004*	-0.012**	-0.030	-0.053**
	(0.027)	(0.002)	(0.005)	(0.029)	(0.022)
Big1	-0.140***	0.002	-0.014*	0.006	-0.028
	(0.043)	(0.002)	(0.007)	(0.035)	(0.026)

Table 5. Market discipline through bank interest expense and deposit growth

The dependent variable in regressions 1-4 is *Interest expense*, which is interest expense over bank liabilities excluding non-interest bearing debt. The dependent variable is *Deposit growth* in regression 5-8, which is the growth rate of a bank's customer and short term funding after dividing by the GDP deflator in percent. *Assets* is the natural logarithm of total assets in constant 2000 US dollars. *Liabilities over GDP* are bank liabilities divided by GDP. *Big 0.1, Big 0.25, Big0.5* and *Big 1* are the dummy variables that equal 1 if the liabilities-to-GDP ratio exceeds 0.1, 0.25, 0.5 and 1 respectively and zero otherwise. *Short term debt* is customer and short term funding to total interest paying debt. *Investment bank, Non-banking credit institution* and *Other bank* are dummy variables that equal 1 for specific bank categories and zero otherwise. *Inflation* is the annual change in consumer prices. *GDP growth* is the inflation adjusted growth rate of GDP per capita of the country. *GDP per capita* is GDP per capita in thousands of constant 2000 dollars. *Equity, Return on assets* and *Liquidity* are entered as alternative risk measures. *Equity* is the capital to asset ratio, which is defined as equity as a share of total assets. *Return on assets* is given by before tax profits divided by total assets. *Liquidity* is defined as liquid assets to total assets. We estimate all regressions using country and time fixed effects and clustering at bank level. Standard errors are given in parentheses. *, ** and *** denote significance at 10%, 5% and 1%. Panel A shows regressions including *Liabilities over GDP*, whereas panels B through E include *Big 0.1, Big 0.25, Big0.5* and Big1, respectively. Panels B through E only report estimated coefficients for the included Big variable and its interactions

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Interest expense	Interest expense	Interest expense	Interest expense	Deposit growth	Deposit growth	Deposit growth	Deposit growth
Assets	-0.001***	-0.001***	-0.001***	-0.001***	0.004*	0.003*	0.002	0.003*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.002)	(0.002)	(0.003)	(0.002)
Liabilities over GDP	0.002	0.007	0.008*	0.003	-0.038***	-0.066**	-0.065**	-0.046***
	(0.003)	(0.004)	(0.004)	(0.003)	(0.015)	(0.026)	(0.026)	(0.015)
Overhead	0.004	0.004	-0.012	0.015	-0.248	-0.248	-0.439	-0.320
	(0.028)	(0.028)	(0.029)	(0.026)	(0.313)	(0.313)	(0.417)	(0.332)
Short term debt	-0.032***	-0.032***	-0.035***	-0.033***				
	(0.004)	(0.004)	(0.006)	(0.004)				
Investment bank	0.011**	0.011**	0.014***	0.011**	0.119***	0.119***	0.116**	0.118***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.039)	(0.039)	(0.045)	(0.038)
Non-banking credit institution	0.002	0.002	0.002	0.003	0.005	0.005	0.059*	-0.001
	(0.006)	(0.006)	(0.004)	(0.006)	(0.026)	(0.026)	(0.033)	(0.022)
Other bank	0.001	0.001	0.000	0.001	0.003	0.003	0.006	0.005
	(0.002)	(0.002)	(0.002)	(0.002)	(0.028)	(0.028)	(0.032)	(0.028)

Inflation	0.011	0.013	-0.021	0.018	0.679	0.675	1.310**	0.528
	(0.033)	(0.033)	(0.041)	(0.033)	(0.470)	(0.469)	(0.610)	(0.445)
GDP growth	-0.134***	-0.133***	-0.133***	-0.129***	1.061***	1.059***	1.438***	0.958**
	(0.028)	(0.028)	(0.029)	(0.029)	(0.410)	(0.409)	(0.522)	(0.397)
GDP per capita	0.003***	0.003***	0.003***	0.003***	-0.003	-0.003	-0.006	-0.001
	(0.000)	(0.000)	(0.000)	(0.000)	(0.004)	(0.004)	(0.004)	(0.004)
Equity	0.008	0.008			-0.006	-0.008		
	(0.009)	(0.009)			(0.131)	(0.131)		
Equity* Liabilities over GDP		-0.112*				0.676		
		(0.059)				(0.504)		
Liquidity			-0.014**				0.049	
			(0.006)				(0.064)	
Liquidity* Liabilities over GDP			-0.105*				0.866**	
			(0.057)				(0.429)	
Return on assets				-0.024				0.856***
				(0.021)				(0.275)
Return on assets* Liabilities over GDP				-0.276**				2.118
				(0.121)				(1.538)
Constant	0.182***	0.181***	0.210***	0.122***	-0.238**	-0.235**	0.301**	0.279***
	(0.009)	(0.009)	(0.011)	(0.009)	(0.105)	(0.105)	(0.120)	(0.087)
N	12832	12832	7890	12839	11154	11154	6835	11159
R-sq	0.597	0.597	0.671	0.597	0.044	0.045	0.055	0.048

Panel B: Big0.1 included

Big0.1	-0.002	0.000	0.002	-0.000	-0.024*	-0.034	-0.046	-0.022
	(0.001)	(0.004)	(0.004)	(0.001)	(0.015)	(0.031)	(0.031)	(0.016)

Equity*Big0.1		-0.039				0.165		
		(0.052)				(0.468)		
Liquidity*Big0.1			-0.050				0.552	
			(0.055)				(0.397)	
Return on assets*Big0.1				-0.226**				0.105
				(0.090)				(0.969)
Panel C: Big0.25 included								
Big0.25	-0.002	-0.000	0.005	-0.001	-0.052**	-0.015	-0.063	-0.025
	(0.002)	(0.004)	(0.004)	(0.003)	(0.026)	(0.057)	(0.046)	(0.032)
Equity *Big0.25		-0.033				-0.684		
		(0.048)				(1.256)		
Liquidity *Big0.25			-0.092*				0.606	
			(0.054)				(0.629)	
Return on assets *Big0.25				-0.153				-2.593
				(0.142)				(4.289)
Panel D: Big0.5 included								
Big0.5	-0.006	-0.003	0.003	-0.005	-0.059**	-0.113**	-0.093	-0.069**
	(0.004)	(0.008)	(0.008)	(0.005)	(0.024)	(0.047)	(0.059)	(0.032)
Equity *Big0.5		-0.057				1.088		
		(0.107)				(0.717)		
Liquidity *Big0.5			-0.116				0.625	
			(0.112)				(0.965)	

Return on assets *Big0.5				-0.056				1.933
				(0.216)				(2.133)

Panel E: Big1 included

Big1	0.007	0.015	0.015	0.008	-0.059*	-0.155***	-0.141***	-0.077**
	(0.005)	(0.010)	(0.010)	(0.006)	(0.032)	(0.053)	(0.052)	(0.038)
Equity *Big1		-0.186				2.221**		
		(0.134)				(1.013)		
Liquidity *Big1			-0.176				2.071**	
			(0.136)				(0.970)	
Return on assets *Big1				-0.186				4.114
				(0.265)				(3.115)

Table 6. Market discipline through bank interest expense and deposit growth: alternative specification

The dependent variable in regressions 1-4 is *Interest expense*, which is interest expense over bank liabilities excluding non-interest bearing debt. The dependent variable is *Deposit growth* in regression 5-8, which is the growth rate of a bank's customer and short term funding after dividing by the GDP deflator in percentage. *Assets* is the natural logarithm of total assets in constant 2000 US dollars. *Liabilities over GDP* are bank liabilities divided by GDP. *Big 0.1, Big 0.25, Big0.5* and *Big 1* are the dummy variables that equal 1 if the liabilities-to-GDP ratio exceeds 0.1, 0.25, 0.5 and 1 respectively and zero otherwise. *Overhead* is personnel expenses and other non-interest expenses over total assets. *Short term debt* is customer and short term funding to total interest paying debt. *Investment bank*, *Non-banking credit institution* and *Other bank* are dummy variables that equal 1 for specific bank categories and zero otherwise. *Inflation* is the annual change in consumer prices. *GDP growth* is the inflation adjusted growth rate of GDP per capita of the country. *GDP per capita* is GDP per capita in thousands of constant 2000 dollars. *Interest expense*$_{t-1}$ and *Deposit growth*$_{t-1}$ are lagged values of interest expense and deposit growth variables respectively. *Equity*, *Return on assets* and *Liquidity* are entered as alternative risk measures. *Equity* is the capital to asset ratio, which is defined as equity as a share of total assets. *Return on assets* is given by before tax profits divided by total assets. *Liquidity* is defined as liquid assets to total assets. We estimate all regressions using country and time fixed effects and clustering at bank level. Standard errors are given in parentheses. *, ** and *** denote significance at 10%, 5% and 1%. Panel A shows regressions including *Liabilities over GDP*, whereas panels B through E include *Big 0.1, Big 0.25, Big0.5* and Big1, respectively. Panels B through E only report estimated coefficients for the included Big variable and its interactions.

Panel A: Liabilities over GDP included

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Interest expense	Interest expense	Interest expense	Interest expense	Deposit growth	Deposit growth	Deposit growth	Deposit growth
Assets	-0.001***	-0.001***	-0.001***	-0.001***	0.005**	0.004**	0.005*	0.005***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.002)	(0.002)	(0.003)	(0.002)
Liabilities over GDP	0.004*	0.012***	0.013***	0.005***	-0.059***	-0.098***	-0.090***	-0.071***
	(0.002)	(0.004)	(0.004)	(0.002)	(0.015)	(0.028)	(0.031)	(0.016)
Overhead	-0.011	-0.012	0.005	0.003	-0.384	-0.383	-0.658	-0.612*
	(0.029)	(0.029)	(0.037)	(0.025)	(0.313)	(0.313)	(0.461)	(0.317)
Short term debt	-0.030***	-0.030***	-0.031***	-0.031***				
	(0.005)	(0.005)	(0.007)	(0.005)				
Investment Bank	0.013**	0.013**	0.017***	0.013**	0.042	0.042	0.034	0.035
	(0.005)	(0.005)	(0.005)	(0.005)	(0.029)	(0.029)	(0.035)	(0.029)
Non-banking credit institution	0.001	0.000	0.003	0.002	0.034	0.035	0.060*	0.014
	(0.004)	(0.004)	(0.005)	(0.004)	(0.028)	(0.029)	(0.032)	(0.025)
Other bank	0.002	0.002	0.001	0.002	-0.005	-0.004	-0.006	-0.005
	(0.002)	(0.002)	(0.002)	(0.002)	(0.029)	(0.029)	(0.033)	(0.028)
Inflation	-0.033	-0.034	-0.092*	-0.026	0.761**	0.757**	1.185***	0.636*
	(0.042)	(0.042)	(0.054)	(0.042)	(0.369)	(0.369)	(0.413)	(0.357)

GDP growth	-0.167***	-0.166***	-0.197***	-0.159***	1.336***	1.337***	1.537***	1.255***
	(0.031)	(0.031)	(0.038)	(0.032)	(0.310)	(0.310)	(0.351)	(0.304)
GDP per capita	0.003***	0.003***	0.003***	0.003***	-0.003	-0.003	-0.004	-0.001
	(0.000)	(0.000)	(0.001)	(0.000)	(0.004)	(0.004)	(0.005)	(0.004)
Deposit growth$_{t-1}$	0.005	0.005	0.007	0.005				
	(0.004)	(0.004)	(0.006)	(0.004)				
Interest expense$_{t-1}$					0.263	0.279	0.202	0.274
					(0.271)	(0.272)	(0.319)	(0.263)
Equity	0.010	0.011			-0.139	-0.142		
	(0.011)	(0.011)			(0.134)	(0.135)		
Equity* Liabilities over GDP		-0.231**				0.959**		
		(0.100)				(0.460)		
Liquidity			-0.015**				0.026	
			(0.007)				(0.064)	
Liquidity* Liabilities over GDP			-0.205**				0.867*	
			(0.093)				(0.471)	
Return on assets				-0.036				0.790***
				(0.024)				(0.303)
Return on assets* Liabilities over GDP				-0.386**				3.145**
				(0.180)				(1.270)
Constant	0.169***	0.167***	0.194***	0.155***	-0.170	-0.167	-0.054	-0.153
	(0.011)	(0.011)	(0.014)	(0.016)	(0.113)	(0.113)	(0.129)	(0.112)
N	9136	9136	5568	9141	10750	10750	6524	10755
R-sq	0.664	0.665	0.711	0.664	0.050	0.051	0.059	0.053
Panel B: Big0.1 included								
Big0.1	-0.002	0.004	0.006*	0.001	-0.031**	-0.078***	-0.074**	-0.039***
	(0.001)	(0.003)	(0.003)	(0.002)	(0.013)	(0.028)	(0.032)	(0.015)
Equity*Big0.1		-0.098**				0.806**		
		(0.047)				(0.367)		
Liquidity*Big0.1			-0.089*				0.786**	
			(0.047)				(0.391)	

Return on assets*Big0.1				-0.269**				1.380*
				(0.107)				(0.710)
Panel C: Big0.25 included								
Big0.25	-0.001	0.006	0.011*	0.001	-0.053***	-0.090**	-0.104**	-0.070***
	(0.002)	(0.005)	(0.006)	(0.003)	(0.017)	(0.037)	(0.048)	(0.026)
Equity*Big0.25		-0.124				0.679		
		(0.081)				(0.500)		
Liquidity*Big0.25			-0.170*				0.914	
			(0.088)				(0.650)	
Return on assets*Big0.25				-0.220				2.038
				(0.172)				(1.491)
Panel D: Big0.5 included								
Big0.5	-0.003	0.007	0.013	-0.002	-0.094***	-0.162***	-0.150**	-0.109***
	(0.004)	(0.009)	(0.009)	(0.004)	(0.025)	(0.048)	(0.061)	(0.033)
Equity*Big0.5		-0.203				1.385*		
		(0.146)				(0.732)		
Liquidity*Big0.5			-0.269*				1.039	
			(0.160)				(0.969)	
Return on assets*Big0.5				-0.189				2.662
				(0.269)				(2.249)
Panel E: Big1 included								
Big1	0.011**	0.027**	0.029**	0.012*	-0.098***	-0.209***	-0.194***	-0.119***
	(0.005)	(0.012)	(0.013)	(0.006)	(0.035)	(0.056)	(0.055)	(0.040)
Equity*Big1		-0.380*				2.583**		
		(0.215)				(1.030)		
Liquidity*Big1			-0.400*				2.378**	
			(0.221)				(0.989)	
Return on assets*Big1				-0.264				4.924
				(0.351)				(3.168)

Table 7. Market discipline through bank interest expense and deposit growth with absolute size interaction

The dependent variable in regressions 1-4 is *Interest expense*, which is interest expense over bank liabilities excluding non-interest bearing debt. The dependent variable is *Deposit growth* in regression 5-8, which is the growth rate of a bank's customer and short term funding after dividing by the GDP deflator in percent. *Assets* is the natural logarithm of total assets in constant 2000 US dollars. *Liabilities over GDP* are bank liabilities divided by GDP. *Overhead* is personnel expenses and other non-interest expenses over total assets. *Short term debt* is customer and short term funding to total interest paying debt. *Investment bank, Non-banking credit institution* and *Other bank* are dummy variables that equal 1 for specific bank categories and zero otherwise. *Inflation* is the annual change in consumer prices. *GDP growth* is the inflation adjusted growth rate of GDP per capita of the country. *GDP per capita* is GDP per capita in thousands of constant 2000 dollars. *Equity* is the capital to asset ratio, which is defined as equity as a share of total assets. *Return on assets* is given by before tax profits divided by total assets. *Liquidity* is defined as liquid assets to total assets. We estimate all regressions using country and time fixed effects and clustering at bank level. Standard errors are given in parentheses. *, ** and *** denote significance at 10%, 5% and 1%.

	(1)	(2)	(3)	(4)	(5)	(6)
	Interest expense	Interest expense	Interest expense	Deposit growth	Deposit growth	Deposit growth
Assets	-0.001***	-0.001***	-0.001***	-0.002	0.001	0.002
	(0.000)	(0.000)	(0.000)	(0.005)	(0.003)	(0.003)
Liabilities over GDP	0.006	0.008*	0.003	-0.047*	-0.066**	-0.040***
	(0.004)	(0.005)	(0.003)	(0.026)	(0.026)	(0.015)
Overhead	0.004	-0.011	0.015	-0.286	-0.434	-0.340
	(0.028)	(0.028)	(0.026)	(0.318)	(0.428)	(0.336)
Short term debt	-0.032***	-0.035***	-0.033***			
	(0.004)	(0.006)	(0.004)			
Investment bank	0.011**	0.014***	0.011**	0.125***	0.116**	0.120***
	(0.005)	(0.005)	(0.005)	(0.040)	(0.045)	(0.039)
Non-banking credit institution	0.002	0.002	0.003	-0.011	0.059*	-0.004
	(0.007)	(0.004)	(0.006)	(0.025)	(0.033)	(0.022)
Other bank	0.001	0.000	0.001	0.003	0.006	0.005
	(0.002)	(0.002)	(0.002)	(0.028)	(0.032)	(0.028)
Inflation	0.013	-0.021	0.018	0.676	1.308**	0.523
	(0.033)	(0.041)	(0.033)	(0.467)	(0.610)	(0.446)
GDP growth	-0.133***	-0.133***	-0.129***	1.059***	1.437***	0.946**
	(0.029)	(0.030)	(0.029)	(0.408)	(0.521)	(0.402)
GDP per capita	0.003***	0.003***	0.003***	-0.003	-0.006	-0.001
	(0.000)	(0.000)	(0.000)	(0.004)	(0.004)	(0.004)
Equity	0.031			-1.329		

	(0.068)			(1.287)		
Equity*Assets	-0.001			0.065		
	(0.003)			(0.060)		
Equity* Liabilities over GDP	-0.108*			0.423		
	(0.059)			(0.530)		
Liquidity		-0.016			0.004	
		(0.054)			(0.440)	
Liquidity *Assets		0.000			0.002	
		(0.002)			(0.018)	
Liquidity * Liabilities over GDP		-0.105*			0.869**	
		(0.058)			(0.430)	
Return on assets			0.046			-1.968
			(0.237)			(3.947)
Return on assets *Assets			-0.003			0.133
			(0.011)			(0.177)
Return on assets * Liabilities over GDP			-0.263**			1.546
			(0.119)			(1.628)
Constant	0.180***	0.210***	0.121***	-0.121	0.308**	0.317***
	(0.012)	(0.011)	(0.010)	(0.152)	(0.129)	(0.114)
N	12832	7890	12839	11154	6835	11159
R-sq	0.597	0.671	0.597	0.046	0.055	0.048

Table 8. Market discipline through bank interest expense and deposit growth of US banks

The dependent variable in regressions 1-4 is *Interest expense*, which is interest expense over bank liabilities excluding non-interest bearing debt. The dependent variable is *Deposit growth* in regression 5-8, which is the growth rate of a bank's customer and short term funding after dividing by the GDP deflator in percent. *Liabilities* is the natural logarithm of total liabilities in constant 2000 US dollars. *Overhead* is personnel expenses and other non-interest expenses over total assets. *Short term debt* is customer and short term funding to total interest paying debt. *Investment bank, Non-banking credit institution* and *Other bank* are dummy variables that equal 1 for specific bank categories and zero otherwise. *Inflation* is the annual change in consumer prices. *GDP growth* is the inflation adjusted growth rate of GDP per capita of the country. *GDP per capita* is GDP per capita in thousands of constant 2000 dollars. *Inflation* and *GDP growth* are dropped due to the collinearity. *Equity* is the capital to asset ratio, which is defined as equity as a share of total assets. *Return on assets* is given by before tax profits divided by total assets. *Liquidity* is defined as liquid assets to total assets. We estimate all regressions using country and time fixed effects and clustering at bank level. Standard errors are given in parentheses. *, ** and *** denote significance at 10%, 5% and 1%. Sample includes only US banks.

	(1)	(2)	(3)	(4)	(5)	(6)
	Interest expense	Interest expense	Interest expense	Deposit growth	Deposit growth	Deposit growth
Liabilities	-0.001**	-0.001***	-0.001***	-0.010	0.002	0.004
	(0.001)	(0.000)	(0.000)	(0.010)	(0.005)	(0.005)
Overhead	0.019	-0.016	-0.003	-0.531	-0.166	-0.487
	(0.033)	(0.040)	(0.033)	(0.459)	(0.794)	(0.466)
Short term debt	-0.039***	-0.050***	-0.038***			
	(0.005)	(0.013)	(0.005)			
Investment bank	0.021	0.030*	0.021	0.219**	0.255**	0.204**
	(0.014)	(0.018)	(0.014)	(0.098)	(0.128)	(0.098)
Non-banking credit institution	0.001	0.001	0.001	0.162***	0.171***	0.170***
	(0.006)	(0.006)	(0.006)	(0.045)	(0.023)	(0.045)
Other bank	0.007***	0.003	0.008***	0.045	0.096	0.035
	(0.002)	(0.005)	(0.002)	(0.100)	(0.146)	(0.095)
GDP per capita	-0.002***	-0.003***	-0.003***	-0.007	0.001	-0.004
	(0.000)	(0.000)	(0.000)	(0.005)	(0.002)	(0.005)
Equity	-0.021			-1.084		
	(0.031)			(0.800)		
Equity*Liabilities	0.003			0.165		
	(0.005)			(0.106)		
Liquidity		0.010			-0.064	

		(0.034)			(0.440)	
Liquidity*Liabilities		-0.005			-0.015	
		(0.005)			(0.037)	
Return on assets			-0.388***			1.023
			(0.050)			(1.924)
Return on assets*Liabilities			0.042***			0.005
			(0.008)			(0.254)
Constant	0.164***	0.180***	0.166***	0.393**	0.032	0.207
	(0.015)	(0.016)	(0.013)	(0.200)	(0.101)	(0.184)
N	7870	3873	7877	6777	3290	6782
R-sq	0.495	0.498	0.503	0.051	0.064	0.047

Table 9. Bank activity and funding strategy regressions with crisis years interactions

Return on assets (ROA) is given by before tax profits divided by total assets. *Fee income* is share of non-interest income in total operating income. *Interest income* is interest income minus interest expense divided by assets. *Other operating income* is other operating income divided by total assets. *Loans* are total net loans divided by earning assets. *Non-deposit funding* is the share of non-deposit short-term funding in total deposits and short-term funding. *Assets* are natural logarithm of total assets in constant 2000 US dollars. *Liabilities over GDP* are bank liabilities divided by GDP. *Short term debt* is customer and short term funding to total interest paying debt. *Investment bank, Non-banking credit institution* and *Other bank* are dummy variables that equal 1 for specific bank categories and zero otherwise. *2008,9* is a dummy variable, which is 1 for the years 2008 and 2009 and zero otherwise. *Inflation* is the annual change in consumer prices. *GDP growth* is the inflation adjusted growth rate of GDP per capita of the country. *GDP per capita* is GDP per capita in thousands of constant 2000 dollars. *Equity* is the capital to asset ratio, which is defined as equity as a share of total assets. We estimate all regressions using country and time fixed effects and clustering at bank level. Standard errors are given in parentheses.*, ** and *** denote significance at 10%, 5% and 1%.

	(1)	(2)	(3)	(4)	(5)	(6)
	ROA	Fee income	Interest income	Other operating income	Loans	Non-deposit short-term funding
Assets	0.001***	0.031***	-0.001***	-0.000	-0.013***	0.025***
	(0.000)	(0.003)	(0.000)	(0.001)	(0.003)	(0.002)
Assets*2008,9	0.003***	0.000	-0.000	0.000	-0.010***	-0.009***
	(0.001)	(0.003)	(0.000)	(0.001)	(0.003)	(0.002)
Liabilities over GDP	-0.006***	-0.059**	0.002**	-0.007	-0.013	-0.022
	(0.002)	(0.028)	(0.001)	(0.005)	(0.019)	(0.017)
Liabilities over GDP*2008,9	-0.002	-0.131***	0.003	-0.001	0.026	-0.008
	(0.003)	(0.026)	(0.002)	(0.004)	(0.022)	(0.016)
Short term debt	-0.004	-0.215***	0.005	-0.066***	0.086**	-0.107***
	(0.004)	(0.038)	(0.004)	(0.014)	(0.039)	(0.038)
Short term debt*2008,9	0.019	-0.025	0.003	0.018	0.051	-0.032
	(0.014)	(0.048)	(0.005)	(0.015)	(0.050)	(0.046)
Investment Bank	-0.007	0.304***	-0.016***	0.043***	-0.181***	0.201***
	(0.004)	(0.035)	(0.002)	(0.012)	(0.033)	(0.035)
Investment Bank*2008,9	0.000	-0.060	0.010***	-0.026*	0.087**	-0.054
	(0.011)	(0.047)	(0.003)	(0.013)	(0.041)	(0.040)
Non-banking credit institution	0.007	-0.025	0.063***	-0.008	0.238***	0.071
	(0.005)	(0.062)	(0.013)	(0.015)	(0.035)	(0.047)
Non-banking credit institution*2008,9	-0.011	0.058	0.018	0.002	-0.030	0.040
	(0.014)	(0.073)	(0.018)	(0.015)	(0.044)	(0.094)
Other bank	-0.007**	-0.028	-0.000	-0.021**	0.075**	0.019

	(0.003)	(0.032)	(0.002)	(0.009)	(0.038)	(0.026)
Other bank*2008,9	0.001	-0.064**	0.001	0.002	-0.027	-0.023
	(0.006)	(0.029)	(0.002)	(0.006)	(0.031)	(0.020)
Inflation	0.194***	0.368	-0.031	-0.027	-0.674***	0.368**
	(0.048)	(0.285)	(0.033)	(0.049)	(0.240)	(0.181)
Inflation*2008,9	-0.052	0.165	-0.003	-0.018	0.144	-0.498
	(0.114)	(0.377)	(0.055)	(0.103)	(0.361)	(0.342)
GDP growth	0.178***	0.361*	0.020	0.040	-0.480***	0.088
	(0.038)	(0.199)	(0.037)	(0.040)	(0.175)	(0.133)
GDP growth*2008,9	0.053	0.628*	-0.043	-0.046	-0.786**	0.012
	(0.133)	(0.333)	(0.047)	(0.090)	(0.348)	(0.261)
GDP per capita	-0.001	0.005*	-0.001***	-0.001*	0.010***	0.007***
	(0.001)	(0.003)	(0.000)	(0.001)	(0.003)	(0.002)
GDP per capita*2008,9	-0.000	0.000	-0.000	0.000	-0.000***	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Equity	0.091***	0.601***	0.044***	0.270***	-0.382***	0.175***
	(0.017)	(0.074)	(0.010)	(0.036)	(0.071)	(0.062)
Equity*2008,9	0.080	-0.012	-0.009	0.103	0.018	-0.182**
	(0.075)	(0.095)	(0.011)	(0.066)	(0.107)	(0.074)
Constant	-0.021*	-0.448***	0.041***	0.092***	0.929***	-0.545***
	(0.012)	(0.123)	(0.009)	(0.031)	(0.116)	(0.083)
N	13327	12858	13155	13111	13171	12998
R-sq	0.208	0.492	0.387	0.433	0.331	0.351

Figure 1. Distribution of the liabilities-to-GDP ratio

This figure shows the percentages of banks with a liabilities-to-GDP ratio in successive bins of size 0.05. The banks with a liabilities-to-GDP ratio larger than 1 are represented in the bin on the right.