

# **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 on assets, 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 on assets 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 in part explain why a bank's rate of return on assets declines with systemic size. Overall, our results cast doubt on the need to have very large banks, especially in small countries. 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

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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 is to force them to downsize or split up. 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.<sup>2</sup> 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% of the aggregate consolidated liabilities of all financial companies to prevent the emergence of an oversized bank.<sup>3</sup>

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, i.e. size relative to the national economy, 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 a different performance in terms of risk and return outcomes. Second, we consider whether large banks have different business models as to their activity mixes and funding strategies. Third, we investigate whether large banks are subject to market discipline to a

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<sup>2</sup> 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>.

<sup>3</sup> 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.

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 the 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. Conversely, 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, growth may have reduced a bank's rate of 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 is consistent with empirical evidence in Hughes, Lang, Mester, Moon, and Pagano (2003) that entrenched bank managers sacrifice value to build empires.

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. Demsetz 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.<sup>4</sup> 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 are also shown to be riskier. Demirgüç-Kunt and Huizinga (2010a) further demonstrate that the noninterest income

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<sup>4</sup> 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) 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 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 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. Our main proxies for a bank's absolute and systemic size are constructed using bank balance sheet information. 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 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. Unfortunately, Bankscope does not provide information on the size of a bank's off-balance sheet activities that add to its absolute and systemic importance. Income and expenses related to these activities, however, are reflected in a bank's income statement. Therefore, we use the gross income variable, which is

the log of gross income in constant dollars, as an alternative measure of absolute size. The ratio of gross income to GDP is the corresponding alternative index of systemic size.

In Table 1 with summary statistics, we see that liabilities over GDP has a sample mean of 0.043. 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 86.9% of banks have liabilities over GDP of less than 0.05. However, a considerable number of banks are sizeable relative to GDP, as 8.2% of banks have liabilities that exceed 10% of GDP, while 1.0% of banks have total liabilities exceeding GDP. Figure 2 displays the development of the average liabilities to GDP ratio over the 2000-2009 period for those banks that are in the sample throughout these years. The average liabilities to GDP ratio is seen to rise from 0.0297 in 2000 to 0.0402 in 2007, to fall back to 0.0318 in 2008 during the crisis. Interestingly, the average liabilities to GDP ratio is slightly higher at 0.0321 again in 2009, in part due to negative output growth in many countries in that year. In Table 1, the average gross income to GDP ratio is seen to be 0.003.

In the empirical work below, we examine how bank size affects bank performance as proxied by three variables. To proxy for bank profitability, we first consider its return on assets, computed as pre-tax profits divided by assets, with a mean of 0.013 in the sample. Second, we consider a bank's return on equity, defined as pre-tax profits divided by equity, to see whether shareholder return reflects our bank size variables. The return on equity has a mean value of 0.120. Third, we use the Z-score, 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) to measure bank solvency. The Z-score indicates 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 23.555.

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 30.5% 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. Further, as an indicator of customer focus we define loans as the ratio of loans to total earning assets, reflecting to what extent as bank originates loans rather than holds other assets such as securities. The mean loans variable is 0.678. As an indicator of customer focus on the liability side, we in addition construct the non-deposit short-term funding variable as the share of non-deposit funding in total customer and short-term funding. A higher non-deposit short-term 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 an interest expense and a deposit growth 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 0.108. Second, liquidity is constructed as the ratio of liquid assets to total assets, with a mean of 0.095. Third, the return on assets, measuring bank performance, is also used as a proxy for 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 0.842. 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% of banks fit this category. Second, non-banking credit institution is a dummy signaling a non-banking credit institution, which applies to 2.1% 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% of all banks. The remainder category of commercial banks comprises the lion's share, or 89.8%, of all banks in the sample. Bank behavior may also depend on market power. Thus, we construct the variable market share as a bank's assets divided by the assets of all banks in a country, with a mean of 6.1%. Market discipline

of banks on the basis of systemic size may further depend on whether the liabilities are contracted domestically or abroad. Hence, we construct the foreign liabilities over GDP variable as the sum of the liabilities of a bank's majority-owned foreign subsidiaries, if any, divided by GDP. The bank ownership information necessary to construct this variable is only available for about a fifth of our sample. The foreign liabilities over GDP variable has a mean of 0.009.<sup>5</sup>

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 principle performance, business model and market discipline variables. Importantly, the correlation between assets and liabilities over GDP is rather low at 0.101. In an international context, this indicates 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 -0.039, while the correlation between liabilities over GDP and interest expense is positive at 0.029. This suggests 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 economically important. The assets variable and gross income variables have a high correlation of 0.963, while the liabilities over GDP and gross income over GDP variables have a correlation of 0.874. This suggests that the assets and liabilities over GDP variables are reasonable indices of absolute and systemic bank size, despite the fact that these variables, as based on balance sheet information, do not take into account off-balance sheet items.

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<sup>5</sup> The corresponding mean liabilities to GDP variable, comprising domestic and foreign liabilities, for the reduced sample is 0.114.

### **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 and strategy**

Table 3 presents results of regressions of proxies for bank performance and strategy on the assets and liabilities over GDP variables, as indices of absolute and systemic bank size, and a set of bank-level and country-level control variables. All regressions include country and year fixed effects and correct for error clustering at the bank level, with the exception of regression 3. This regression, with the Z-score as the dependent variable, includes a time fixed effect for the last year of the time series for a specific bank, and corrects for error clustering at the country level.

In the return on assets regression 1, the assets variable obtains a positive coefficient of 0.002 that is significant at the 1% 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. In contrast, in regression 1 the liabilities over GDP variable obtains a negative coefficient of -0.007 that is significant at the 1% level, 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, possibly reflecting doubts whether they can be bailed out by their national governments.

In regression 2, the dependent variable is a bank's return on equity, as a proxy for the return to shareholders. The regression is otherwise analogous to regression 1. The assets variable obtains a positive coefficient of 0.019 that is significant at 1%, while the coefficient for the liabilities over GDP variable is negative at -0.027 and significant at 1%. These results suggest that absolute and systemic size affect shareholder return positively and negatively, respectively.

In the Z-score regression 3, the assets variable is seen to obtain a negatively coefficient of -1.322 that is significant at the 1% level. Thus, banks with large absolute size tend to be riskier, perhaps because they undertake riskier activities. In regression 3, the liabilities over GDP variable obtains a positive coefficient that is statistically insignificant.

Overall, the results of regressions 1-3 suggest that absolute size offers a trade-off between bank risk and return. In particular, absolutely large banks are found to be 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, say, 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 0.320, and it increases return on equity until the assets-to-GDP ratio attains 0.789.<sup>6</sup> Assets growth thus increases return on assets and return on equity for most banks in the world, as 3.3 percent of banks have an assets-to-GDP ratios more than 0.320, and 1.2 percent have an assets-to-GDP ratio more than 0.789. For the

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<sup>6</sup> The assets-to-GDP ratio that maximizes return on assets is found by maximizing return on assets with respect to assets given the estimated coefficients of 0.002 and -0.007 for the log of assets and the liabilities-to-GDP ratio in regression 1 of Table 3 and an assumed liabilities-to-assets ratio of 0.892 corresponding to a mean equity-to-assets ratio of 0.108 in Table 1. The assets-to-GDP ratio that maximizes return on equity is found in an analogous fashion using the estimated coefficients of 0.019 and -0.027 for the log of assets and the liabilities-to-GDP ratio in regression 2 in Table 3.

large majority of 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 the return on equity, and increase risk. For the systemically largest banks, growth thus appears to have progressed beyond the point where it can be rationalized on the grounds of shareholder interest.

Next, we consider how absolute and systemic bank size affect various aspects of a bank's earnings mix, its asset allocation and its funding strategy. In regression 4, 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% 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 on assets and its Z-score are positively and negatively related to the fee income share, respectively. In regression 4, the liabilities over GDP variable obtains a coefficient that is negative and significant at the 5% 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.

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 5 and 6, respectively. In the net interest income regression 5, the estimated coefficient for the assets variable is estimated to be negative and significant at 1%, while the coefficient for the liabilities over GDP variable is positive and significant at 5%. In the non-interest income regression in regression 6, neither the assets nor the liabilities over GDP variable enters with statistically significant coefficients.

In regression 7, we relate the share of loans in total earning assets to our bank size variables. We see that this loan share is negatively and significantly related to 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 earning assets is not significantly related to liabilities over GDP as an indicator of systemic size.

Finally, in regression 8 we consider how the share of non-deposit funding in total short-term funding is related to our bank size variables. The coefficient on the assets variable is estimated to be positive and significant at the 1% level, while the coefficient on the liabilities to GDP variable is not significant.

Overall, our results suggest that banks that are large in an absolute sense are less traditional in focus, with a larger fee income share and a larger non-deposit funding share. Systemically large banks, instead, have a smaller fee income share, which renders them more traditional in focus.

To conclude this section, we examine whether these results are robust to replacing the assets and liabilities over GDP variables, as indices of absolute and systemic bank size, by the gross income and gross income over GDP variables. These additional regressions, reported in Table 4, are otherwise analogous to those in Table 3. Overall, the results in Tables 3 and 4 are rather similar. In regression 1 of Table 4, in particular, the bank return on assets is positively and significantly related to gross income proxying for absolute bank size, and it is negatively and significantly related to gross income over GDP standing for bank systemic size. In the return on equity regression 2, the gross income variable enters with a positive and significant coefficient, while the gross income over GDP variable enters with a negative coefficient that is insignificant, unlike in the corresponding regression 2 of Table 3. Our earlier result that return on equity declines significantly with bank

systemic size thus is not robust to replacing the liabilities to GDP variable by the gross income over GDP variable. In regression 3, the Z-score declines significantly with gross income, similar to regression 3 in Table 3. In regressions 4-8, we find that banks with high gross income are less traditional in focus, as evident in a relatively high stress on the generation of non-interest income, a low loans variable and a high non-deposit funding share. Systemically large banks, in contrast, are more traditional in focus, as seen from a relatively high stress on the generation of interest income.

### **3.2. Market discipline**

For the US, there is evidence that large banks are too big to fail, leading to a lower cost of funds and less market discipline of banks by depositors on the basis of the bank risk, even if the strength of ‘too big to fail’ guarantees appears to vary over time. Flannery and Sorescu (1996, Table III), specifically, find that spreads on subordinated debentures issued by banks declined with bank asset size and did not reflect bank risk, as measured by nonaccruing loans and loans past due 90 days or more, during 1983-1984 when ‘too big to fail’ guarantees were believed to be strong. Conversely, these spreads did reflect delinquent loans, but not asset size, during 1989-1991, when beliefs in ‘too big to fail’ subsidies apparently were tempered.<sup>7</sup> 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

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<sup>7</sup> Baker and McArthur (2009) report that larger US banks, with assets in excess of 100 billion dollars, had a cost of funds that on average was 0.29% lower than smaller banks during the 2000-2007 period. In the period from the fourth quarter of 2008 through the second quarter of 2009, this cost advantage of large banks on average was 0.78%. These figures are consistent with the existence of ‘too big to fail’ subsidies, especially at a time of financial crisis.



bank's average liability interest rate and its deposit growth rate depend on bank risk and bank size. Specifically, we include interaction variables of a bank risk indicator (either equity, liquidity or return on assets) with a bank size variable in regressions of either the average interest rate on bank liabilities or the deposit growth rate. A negative estimated coefficient for such an interaction term in an interest expense 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 more 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 by depositors in an analogous fashion. In this section, we consider market discipline with respect to bank interest expenses and deposit growth rates in turn.

### **3.2.1. Market discipline through bank interest expenses**

Table 5 provides the results of regressions of bank interest expenses on bank size variables, indices of bank risk, and a set of controls. To start, regression 1 relates the interest expense variable to the assets variable to represent absolute bank size and the equity variable as a proxy for bank risk. The assets variable obtains a coefficient that is negative and significant at the 1% level, indicating that banks that are large in an absolute sense face lower interest expenses. The equity variable is estimated with a positive and insignificant coefficient. In regression 2, we add the liabilities to GDP ratio to the specification, yielding a positive and insignificant coefficient for this variable. Next, in regression 3 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 rate for

systemically large banks, as evidence of enhanced market discipline of systemically important banks. In this regression, the liabilities variable obtains a positive coefficient of 0.009 that is significant at 10%, while the interaction term obtains a negative coefficient of -0.167 that is significant at 5%. This suggests that there is enhanced market discipline of systemically large banks through a bank's cost of funds.

In regressions 4-6, we include the gross income variable as an index of absolute bank size, and the ratio of gross income to GDP to present systemic bank size. These regressions are otherwise analogous to regressions 1-3. In regression 4, the gross income variable is estimated with a negative but insignificant coefficient. In regression 5, the gross income variable, however obtains a negative coefficient that is significant at 10%, while the gross income to GDP ratio obtains a positive coefficient that is significant at 5%. Banks with large gross income in absolute terms thus appear to have lower interest expenses, while banks with large gross income relative to GDP face higher interest expenses. In regression 6, the interaction term of equity and gross income relative to GDP receives a negative coefficient that is significant at 1%, providing evidence that there is enhanced market discipline of systemically important banks through their interest expenses.

Table 6 provides a set of robustness checks of our interest expense regressions. To start we consider two alternative proxies for bank risk. Specifically, regression 1 includes the liquidity variable and its interaction with the liabilities to GDP ratio, to replace the equity variable and its interaction with liabilities relative to GDP as in regression 3 of Table 5. In this regression, the liquidity variable obtains a negative coefficient that is significant at 5%, while the liabilities to GDP ratio and its interaction with liquidity receive positive and negative coefficients, respectively, that are both significant at 5%. Alternatively, regression 2 includes the rate of return on assets variable as a proxy for bank risk and its interaction with the liabilities to GDP ratio. The coefficient for the

rate of return variable is negative and significant at 10%, while its interaction with the liabilities to GDP ratio is negative and significant at 5% (the liabilities to GDP ratio obtains a positive but insignificant coefficient). Regression 1 and 2 together provide further evidence of stronger market discipline of systemically large banks via bank interest expenses.

So far, we have examined whether market discipline is related to systemic bank size, but not to absolute bank size. In principle, market discipline can be related to both size measures. To check this, we take regression 3 of Table 5 (with equity as the risk proxy) and regressions 1-2 of Table 6 (with liquidity and return on assets as risk proxies), and add an interaction term of the assets variable and the included risk proxy to each of the regressions. The results are reported as regression 3-5 in Table 6. The interactions of the included risk proxy with liabilities over GDP are estimated with negative coefficients that are significant at 5% in all three regressions, while the interactions of the included risk factor with assets obtain insignificant coefficients throughout. For an international sample of banks, market discipline thus appears to depend on systemic size and not on absolute size.

Next, we consider whether our results on the impact of systemic size on market discipline are robust to controlling for an index of a bank's market power. Systemically large banks potentially have considerable market power, as they are likely to be large relative to other banks in the same country. The market share variable, constructed as individual bank assets divided by the assets of all banks in a country, measures a bank's size relative to other national banks. The correlation between the systemic size and market share variables is positive at 0.209 and significant at 1%. Banks with a large market power potentially have high charter values, which reduces incentives for risk taking (see Keeley (1990), and Hellman, Murdock and Stiglitz (2000)).<sup>8</sup> The

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<sup>8</sup> Keeley (1990) finds that banks with more market power, as reflected in larger market-to-book asset ratios, hold more capital and have a lower default risk as reflected in interest rates on large, uninsured certificates of deposit.

impact of bank market share on bank interest expenses, and generally on market discipline, thus is expected to be opposite to the effect of systemic size as a proxy for potential too-big-to-save status. Specifically, depositors may demand lower interest rates from banks with a high market share, and the sensitivity of interest expenses to bank risk factors may be reduced.

Regressions 6-8 of Table 6 include the market share variable and interactions of this variable with the included risk proxy. In regressions 6 and 7 (with the equity and liquidity variables as risk proxies), the market share variable obtains negative coefficients that are significant at 10% and 5%, while the interaction of market share with equity is positive and significant at 1% in regression 6. This provides some evidence that market share reduces bank interest expenses and the sensitivity of interest expenses to bank risk, mitigating market discipline. In regressions 6-8, the liabilities to GDP variable is estimated with positive coefficients that are significant at 10% or 5%, while its interactions with the included risk proxy are all negative and significant at 5%, consistent with enhanced market discipline imposed on systemically large banks.

Table 7 presents additional robustness checks of the interest expense regressions. From Table 3, we saw that a bank's fee income share is related positively and negatively to the assets and liabilities over GDP variables respectively, while the non-deposit funding share is related positively to the assets variable. This raises the question of whether bank absolute and systemic size affect interest expenses only through a bank's bank activity and funding strategies. To check this, regressions 1-3 of Table 7 include the fee income and non-deposit funding variables in our interest expense regressions as additional controls. The fee income variable enters regressions 1-3 with negative coefficients that are significant at 5% or 1%, perhaps reflecting that the generation of some non-interest income can reduce bank risk. The non-deposit funding share variable obtains a positive coefficient that is significant at 10% in regression 1, which could reflect that non-deposit funding is

potentially more expensive than deposit funding. In regression 2, the liabilities over GDP variable obtains a positive coefficient that is positive at 10%. Further, in regressions 1-3 the interactions of the liabilities to GDP ratio with the included risk proxy enter with negative coefficients that are significant at 10% or 5%. Hence, there is evidence of more pronounced market discipline of systemically large banks via interest expenses even after we control for the impact of the fee income and non-deposit funding shares on interest expenses.

Next, we examine how market discipline is related to bank 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 regressions 4-6, the single size variable we include is the log of a bank's real liabilities. In these regressions, this liabilities variable obtains a negative coefficient that is significant at 5% or 1% to suggest that the interest expenses of US banks decline with absolute bank size. In regression 6, the coefficients for the return on assets and its interaction with the liabilities variable obtain negative and positive coefficients that are significant at the 1% 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 rather than too big to save. Even the largest banks in the US are relatively small compared to US GDP so that there is little doubt about the ability of the US treasury to bail out the largest US banks.

Very large banks tend to be international in nature with substantial activities abroad. International banks, in particular, may obtain some of their funding abroad through foreign subsidiaries. This raises the question of whether market discipline on the basis of a bank's liabilities-to-GDP ratio depends on whether these liabilities are foreign or domestic. In principle, more foreign liabilities – for a given total amount of liabilities - can give rise to either stronger or

weaker market discipline. Stronger market discipline can arise if bank liability holders take into account that national regulatory authorities have reduced incentives to bail out a bank with substantial foreign liabilities, given that the benefits of such a bailout accrue to foreign liability holders. Weaker market discipline, in contrast, would result if bank liability holders think that regulatory authorities will be forced to bail out a distressed international bank anyway, as an international bank may be too difficult to wind down. To try to address this issue empirically, we construct a bank's foreign liabilities to GDP ratio as the ratio of the liabilities of its majority-owned foreign subsidiaries to domestic GDP using subsidiary ownership information available from Bankscope. Ownership information of this kind is available for only about a fifth of our sample. Regressions 7-9 of Table 7 include the additional foreign liabilities to GDP variable and its interactions with the included risk proxy. In regression 8, the foreign liabilities to GDP variable and its interaction with liquidity enter with positive and negative coefficients that are both significant at 10%, providing some evidence that foreign liabilities relative to GDP lead to relatively strong market discipline via interest expenses, especially for systemically large banks.

Finally, we consider that a bank's size is potentially endogenous to its interest expenses. A bank that experiences a negative funding shock leading to higher interest expenses, in particular, may decide to adjust its size so as to bring its interest expenses back down. The direction of the necessary size adjustment will depend on the bank's size and on the size of the national economy, given that interest expenses are found to decline with absolute size and to increase with systemic size (for instance, in regression 3 in Table 5). At any rate, to reduce the potential for reverse causation regressions 10-12 of Table 7 include lagged values of all explanatory variables that are based on bank-level information (these are all variables apart from inflation, GDP growth and GDP per capita). In regression 10, the liabilities variable obtains a coefficient of 0.009 that is significant

at 1%. In the corresponding regression 3 of Table 5, the liabilities variable obtains a coefficient of 0.009 that is significant at 10%. Similarly, in regressions 11 and 12 of Table 7 the liabilities to GDP ratio enters with estimated coefficients that are very similar to those in the corresponding regressions 1 and 2 in Table 6. This suggests that any bias in the estimation on account of reverse causation is only minor. The interactions of the liabilities to GDP ratio with the equity and liquidity variables continue to be estimated with negative coefficients that are significant at 5% in regressions 10 and 11, while the interaction of the liabilities to GDP ratio with the return on assets variable is estimated to be insignificant in regression 12.

Overall, our 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.

### **3.2.2. Market discipline through bank deposit growth**

Next, we consider whether there is market discipline of systemically large banks via deposit growth rates. The results are presented in Tables 8-10. These tables are largely analogous to the earlier Tables 5-7 with interest expense regressions.

To start, Table 8 presents results of regressions where we relate the deposit growth rate to our bank size variables using equity as a proxy for bank risk. In regression 1, we see that the coefficient on the assets variable is positive and significant at 10%, while the equity variable enters with an insignificant coefficient. Regression 2, in addition, includes the liabilities to GDP ratio, which obtains a coefficient that is negative and significant at 1%. Large banks in an absolute sense thus 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 3, we include an interaction of equity and liabilities over GDP. This interaction term obtains a positive coefficient that is insignificant.

Regressions 4-6 of Table 8 include the gross income and gross income relative to GDP variables as alternative indices of absolute and relative bank size. In regression 5, the gross income variable obtains a positive coefficient that is significant at 10%, indicating that larger banks experience higher deposit growth rates. In regression 6, the gross income to GDP ratio and its interaction with equity obtain negative and positive coefficients that are significant at 5%, consistent with enhanced market discipline of systemically large banks through deposit growth rates.

Table 9 provides a set of robustness checks of the deposit growth regressions. To start, in regression 1 the liquidity variable and its interaction with liabilities over GDP are included as alternative bank risk-related variables, yielding a positive coefficient for the interaction term that is significant at 5%. This is evidence of intensified market discipline by depositors of systemically large banks with low liquid assets by way of reduced deposit growth. In regression 2, the return on assets variable and its interaction with liabilities over GDP are included instead, yielding positive coefficients for both variables that are significant at 1% and 5% respectively, yielding additional evidence of enhanced market discipline of systemically large banks through deposit growth rates.

Regressions 3-5 include interactions of the assets variable with the included risk proxy to check whether there is market discipline through deposit growth rates on the basis of absolute bank size. In all three regressions, the interactions of the assets variable with the included risk proxy



enter with insignificant coefficients, while the interactions of the liabilities to GDP ratio with liquidity and the return on assets receive positive coefficients in regressions 4 and 5 that are both significant at 5%. Hence, we find that stronger market discipline through deposit growth rates occurs on the basis of systemic bank size, but not on the basis of absolute size.

Banks with a high market share may be able to attract additional deposits to the extent that market power makes them safer, and correspondingly the sensitivity of deposit growth to risk factors may be reduced. To check this, regressions 6-8 include the market share variable and its interactions with the included bank risk factor as additional controls. These additional controls are all estimated with insignificant coefficients. The interaction of the liabilities-to-GDP ratio with equity in regression 6 is estimated with a positive coefficient that is significant at 10% (while the corresponding coefficient in regression 3 of Table 8 is insignificant). In regressions 7 and 8, the interactions of liabilities relative to GDP with liquidity and return on assets obtain positive coefficients that are significant at 5% and 1%, similar to regressions 1 and 2. Hence, we continue to find evidence of enhanced market discipline of systemically large banks through deposit growth rates when we control for market share.

Table 10 presents some further robustness checks of our deposit growth regressions. To start, we include the fee income and non-deposit funding share variables as additional controls in regressions 1-3. The fee income share is estimated with positive coefficients that are significant at 5%, indicating that banks with substantial non-interest income tend to grow faster. The non-deposit funding share enters with insignificant coefficients. The interactions of the liabilities-to-GDP ratio with the included risk proxy are statistically significant in all three regressions at 5%, 10%, and 1% respectively, providing further evidence of the more intense market discipline of systemically sizeable banks via deposit growth rates.

In regressions 4-6, we restrict the sample to only US banks. In these regressions, the liabilities variable, measuring the absolute size of bank liabilities, obtains insignificant coefficients. Similarly, the interactions of the liabilities variable with the included risk variable enter with insignificant coefficients. Hence, we find no evidence of market discipline of US banks through deposit growth on the basis of bank size.

Regression 7-9 include the ratio of foreign liabilities to GDP and its interactions with the included risk proxy as additional control variables to see whether market discipline via deposit rates depends on whether funds are raised abroad or domestically. These additional control variables are estimated with insignificant coefficients throughout. The liabilities to GDP variable continues to be estimated with negative coefficients that are significant at 10% in regression 8 and at 5% in regression 9, while the interaction of the liabilities to GDP variable with return on assets is positive and significant at 10% in regression 9. These results suggest that banks experience market discipline through deposit growth rates on the basis of systemic size, regardless of whether funds are raised abroad or domestically. However, these results are obtained for the much reduced sample for which we have information on a bank's foreign liabilities.

To conclude, regressions 10-12 include lagged values of all explanatory variables that are based on bank-level information to reduce the potential for reverse causation in our estimation. A bank that experiences a low deposit growth rate could interpret this as a signal of waning market confidence, possibly causing it to adjust its size to win back market confidence. The direction in which size would have to be adjusted to regain market confidence (and the potential to experience high deposit growth) is generally ambiguous, as deposit growth is estimated to be related positively and negatively to absolute and systemic size respectively (for instance, in regression 3 of Table 8). In regressions 10-12, the assets and liabilities-to-GDP variables, and the interactions of the latter

variable with the included risk factor, are all estimated with insignificant coefficients. Hence, we find no evidence of enhanced market discipline through deposit growth rates on the basis of the lagged value of systemic size.

Overall, Tables 8-10 provide evidence of a negative impact of bank systemic size on deposit growth rates, especially for risky banks, to suggest intensified market discipline on the basis of systemic size. This evidence, however, is not robust to lagging variables that are based on bank-level information, including the systemic size variable.

### **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 banks 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 re-estimate the regressions of Table 3 (apart from the Z-score regression), 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 11, based on regression 1 of Table 3. The assets and assets\*2008,9 variables both obtain positive coefficients that are significant at the 1% 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. Similarly, in the return on equity regression 2 the assets variable and its interaction with the crisis years dummy variable obtain positive coefficients that are

significant at 1% to suggest that the positive relationship between the rate of return on equity and absolute size that pre-dated the crisis became stronger during the crisis.

Next, we consider regressions examining bank activity mix and funding strategy variables in columns 3-7 of Table 11. Here we also find a tendency for the financial crisis to sharpen previously existing relationships between our activity mix and size variables. In the fee income regression 3, in particular, 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% 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 the non-deposit funding share 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% 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 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 as indicated by the return on assets, 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 in Demirgüç-Kunt and Huizinga (2010b) that the market-to-book ratio of a bank's equity tends to decline with systemic size and with results in Berger and Mester (1997) that suggest that a bank's optimal size from a banking technology point of view is far less than the size of today's huge banks.

This begs the question of why today's systemically large banks ever became so large. One potential answer is that bank managers may have been interested in expanding their bank to achieve higher 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 should claw back the incentives for banks to become systemically large and can take the form of higher capital requirements for such banks, taxation in the form of ‘bank levies’ on their liabilities, or the introduction of living wills and shelf bankruptcies to make their resolution feasible. Alternatively, direct intervention can force 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 2000 US dollars	Bankscope and WDI
Liabilities	Log of liabilities in 2000 US dollars	Bankscope and WDI
Gross income	Log of bank gross income in 2000 US dollars	Bankscope and WDI
Liabilities over GDP	Bank liabilities divided by GDP	Bankscope and WDI
Gross income over GDP	Bank gross income divided by GDP	Bankscope and WDI
Return on assets	Pre-tax profits divided by assets	Bankscope
Return on equity	Pre-tax profits divided by equity	Bankscope
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, real estate and mortgage bank or savings bank, and zero otherwise	Bankscope
Market share	Assets of a bank divided by the assets of all banks in a country	Bankscope
Foreign liabilities over GDP	Sum of the liabilities of majority owned foreign subsidiary banks divided by GDP	Bankscope and WDI
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* is the natural logarithm of total liabilities in constant 2000 US dollars. *Liabilities over GDP* is bank liabilities divided by GDP. *Gross income* is the natural logarithm of gross income in constant 2000 US dollars. *Gross income over GDP* is bank gross income divided by GDP. *Return on assets* is pre-tax profits divided by total assets. *Return on equity* is pre-tax profits divided by equity. *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. *Market share* is the assets of a bank divided by the assets of all banks in a country. *Foreign liabilities over GDP* is the sum of the liabilities of majority-owned foreign subsidiary banks divided by GDP. *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	13751	21.764	2.093	14.947	28.550
Liabilities	14096	21.643	2.161	10.429	28.535
Liabilities (US banks)	7984	20.882	1.770	11.451	28.181
Liabilities over GDP	13732	0.043	0.207	0.000	4.725
Gross income	10930	19.164	1.997	13.669	25.605
Gross income over GDP	10938	0.003	0.015	-0.006	0.364
Return on assets	13723	0.013	0.031	-0.571	0.871
Return on equity	13664	0.120	0.191	-1.921	0.974
Z-score	1707	23.555	22.828	0.087	146.529
Fee income	13165	0.305	0.210	0	1
Interest income	13506	0.031	0.022	-0.090	0.654
Other operating income	13468	0.024	0.059	0	0.981
Loans	13504	0.678	0.187	0.000	1
Non-deposit short-term funding	13264	0.083	0.143	0	1

Interest expense	13286	0.034	0.030	0.000	0.483
Deposit growth	11466	0.079	0.304	-6.465	7.908
Equity	13742	0.108	0.107	0.001	1.000
Liquidity	8590	0.095	0.133	0.000	0.991
Overhead	13450	0.031	0.022	0.000	0.200
Short term debt	13622	0.842	0.185	0	1
Investment bank	13724	0.050	0.217	0	1
Non-banking credit institution	13724	0.021	0.143	0	1
Other bank	13724	0.031	0.174	0	1
Market share	13751	0.061	0.169	0.000	1
Foreign liabilities over GDP	2827	0.009	0.100	0	2.591
Inflation	13752	0.028	0.029	-0.049	0.460
GDP growth	13683	0.017	0.023	-0.176	0.124
GDP per capita	13711	28.907	12.371	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. *Gross income* is the natural logarithm of gross income in constant 2000 US dollars. *Gross income over GDP* is bank gross income divided by GDP. *Return on assets* is pre-tax profits divided by total assets. *Return on equity* is pre-tax profits divided by equity. *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. *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. \*, \*\*, and \*\*\* denote significance at 10%, 5% and 1%.

	Assets	Liabilities over GDP	Gross income	Gross income over GDP	Return on assets	Return on Equity	Z-score	Fee income	Non-deposit short-term funding	Interest expense	Deposit growth
Assets	1										
Liabilities over GDP	0.101***	1									
Gross income	0.963***	0.106***	1								
Gross income over GDP	0.249***	0.874***	0.276***	1							
Return on assets	-0.059***	-0.001	0.020**	0.018*	1						
Return on equity	0.001	0.005	0.014	0.012	0.236***	1					
Z-score	-0.231***	-0.017**	-0.277***	-0.087***	0.085***	0.065***	1				
Fee income	0.220***	0.023***	0.364***	0.141***	0.136***	0.016*	-0.227***	1			
Non-deposit short-term funding	0.236***	-0.006	0.282***	-0.019*	-0.024***	-0.004	-0.133***	0.312***	1		
Interest expense	-0.039***	0.029***	0.137***	0.100***	0.103***	-0.012	-0.113***	0.171***	0.194***	1	
Deposit growth	0.014	-0.004	0.011	0.024**	0.079***	0.051***	0.0109	0.017*	0.026***	-0.032***	1

Table 3. Determinants of bank performance and strategy

*Return on assets* is pre-tax profits divided by total assets. *Return on equity* is pre-tax profits divided by equity. *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 and *Non-deposit short-term funding* is the share of non-deposit short-term funding in total deposit, 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. *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. All regressions except regression 3 include country and time fixed effects and control for clustering at bank level. In *Z-score* regression 3 variables are mean values over time and 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)
	ROA	ROE	Z-score	Fee income	Interest income	Other operating income	Loans	Non-deposit short-term funding
Assets	0.002*** (0.000)	0.019*** (0.002)	-1.322*** (0.498)	0.031*** (0.003)	-0.001*** (0.000)	0.000 (0.001)	-0.015*** (0.003)	0.024*** (0.002)
Liabilities over GDP	-0.007*** (0.002)	-0.027*** (0.008)	1.105 (2.551)	-0.073** (0.032)	0.003** (0.001)	-0.008 (0.005)	-0.025 (0.020)	-0.025 (0.020)
Equity	0.102*** (0.018)	0.129*** (0.033)	1.767 (9.404)	0.595*** (0.070)	0.043*** (0.010)	0.276*** (0.036)	-0.388*** (0.069)	0.153*** (0.059)
Short term debt	-0.000 (0.004)	0.049*** (0.016)	7.361 (4.978)	-0.208*** (0.037)	0.005 (0.004)	-0.059*** (0.013)	0.082** (0.039)	-0.102*** (0.036)
Investment bank	-0.007* (0.004)	0.006 (0.014)	-6.468*** (2.101)	0.297*** (0.033)	-0.015*** (0.002)	0.041*** (0.012)	-0.173*** (0.032)	0.195*** (0.034)
Non-banking credit institution	0.005 (0.004)	0.055** (0.023)	3.396 (4.710)	-0.013 (0.058)	0.065*** (0.012)	-0.006 (0.013)	0.229*** (0.034)	0.077* (0.040)
Other bank	-0.009** (0.003)	-0.024 (0.015)	9.132* (5.376)	-0.036 (0.030)	0.000 (0.002)	-0.020** (0.009)	0.071** (0.036)	0.016 (0.023)
Inflation	-0.003 (0.026)	0.353* (0.198)	-3.028 (24.988)	-0.052 (0.107)	-0.023 (0.021)	0.008 (0.027)	-0.169 (0.106)	0.121 (0.078)
GDP growth	0.211*** (0.042)	1.947*** (0.213)	66.858* (37.016)	0.312** (0.147)	0.015 (0.020)	0.027 (0.030)	-0.294*** (0.111)	0.220** (0.091)
GDP per capita	-0.001	-0.009***	0.150**	0.006**	-0.001***	-0.001	0.006**	0.007***

Constant	(0.001)	(0.003)	(0.069)	(0.003)	(0.000)	(0.001)	(0.003)	(0.002)
	-0.048**	-0.139*	68.707***	0.133	0.070***	0.058**	0.936***	-0.257***
	(0.023)	(0.082)	(10.757)	(0.102)	(0.009)	(0.026)	(0.097)	(0.072)
N	13499	13448	1701	12995	13312	13262	13345	13169
R-sq	0.196	0.208	0.141	0.484	0.387	0.424	0.327	0.353

Table 4. Determinants of bank performance and strategy including alternative bank size variables

*Return on assets* is pre-tax profits divided by total assets. *Return on equity* is pre-tax profits divided by equity. *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 and *Non-deposit short-term funding* is the share of non-deposit short-term funding in total deposit, and short-term funding. *Gross income* is the natural logarithm of gross income in constant 2000 US dollars. *Gross income over GDP* is bank gross income divided by GDP. *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. All regressions except regression 3 include country and time fixed effects and control for clustering at bank level. In *Z-score* regression 3 variables are mean values over time and 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)
	ROA	ROE	Z-score	Fee income	Interest income	Other operating income	Loans	Non-deposit short-term funding
Gross income	0.002*** (0.000)	0.023*** (0.002)	-1.322*** (0.468)	0.039*** (0.003)	-0.001*** (0.000)	0.003*** (0.001)	-0.012*** (0.004)	0.024*** (0.002)
Gross income over GDP	-0.084** (0.033)	-0.287 (0.201)	20.900 (21.995)	-0.926** (0.427)	0.014 (0.016)	-0.118* (0.063)	-0.260 (0.308)	-0.362 (0.260)
Equity	0.123*** (0.020)	0.155*** (0.038)	2.795 (7.958)	0.601*** (0.082)	0.054*** (0.011)	0.297*** (0.047)	-0.381*** (0.083)	0.145* (0.086)
Short term debt	0.005 (0.005)	0.099*** (0.019)	9.280 (5.997)	-0.160*** (0.042)	0.007 (0.004)	-0.029*** (0.009)	0.097** (0.045)	-0.118** (0.048)
Investment bank	-0.013*** (0.005)	-0.008 (0.016)	-2.936 (2.012)	0.310*** (0.037)	-0.017*** (0.003)	0.035*** (0.011)	-0.180*** (0.038)	0.212*** (0.039)
Non-banking credit institution	0.002 (0.006)	0.031 (0.029)	2.218 (6.046)	-0.063 (0.071)	0.078*** (0.014)	-0.025* (0.014)	0.301*** (0.037)	0.132 (0.082)
Other bank	-0.004 (0.002)	-0.008 (0.014)	10.833* (6.084)	-0.033 (0.031)	-0.001 (0.002)	-0.011* (0.007)	0.065 (0.042)	-0.005 (0.024)
Inflation	0.013 (0.029)	0.255 (0.244)	-21.558 (26.540)	-0.043 (0.130)	-0.016 (0.023)	0.018 (0.025)	-0.140 (0.123)	0.100 (0.074)
GDP growth	0.180*** (0.038)	1.790*** (0.214)	70.000* (35.620)	0.416** (0.166)	-0.005 (0.022)	0.025 (0.032)	-0.288** (0.131)	0.228** (0.113)
GDP per capita	-0.000	-0.007***	0.023	0.008***	-0.001**	-0.000	0.007**	0.009***

Constant	(0.001) -0.058***	(0.003) -0.571***	(0.065) 25.416**	(0.003) -0.233**	(0.000) 0.052***	(0.001) -0.047**	(0.003) 0.985***	(0.002) -0.277***
N	(0.014) 10809	(0.116) 10773	(12.671) 1471	(0.117) 10540	(0.011) 10788	(0.022) 10630	(0.115) 10715	(0.077) 10576
R-sq	0.251	0.217	0.161	0.494	0.429	0.424	0.343	0.397



Table 5. Market discipline through bank interest expenses

*Assets* is the natural logarithm of total assets in constant 2000 US dollars. *Liabilities over GDP* are bank liabilities divided by GDP. *Gross income* is the natural logarithm gross income in constant 2000 US dollars. *Gross income over GDP* is bank gross income divided by GDP. *Equity* is the capital to asset ratio, which is defined as equity as a share of 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. 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	Interest expense	Interest expense	Interest expense
Assets	-0.001*** (0.000)	-0.001*** (0.000)	-0.001*** (0.000)			
Liabilities over GDP		0.002 (0.003)	0.009* (0.005)			
Equity * Liabilities over GDP			-0.167** (0.076)			
Gross income				-0.000 (0.000)	-0.000* (0.000)	-0.000* (0.000)
Gross income over GDP					0.112** (0.052)	0.264*** (0.083)
Equity * Gross income over GDP						-3.355*** (1.206)
Equity	0.006 (0.009)	0.007 (0.009)	0.007 (0.009)	0.018 (0.012)	0.020 (0.012)	0.022* (0.013)
Overhead	0.011 (0.028)	0.011 (0.028)	0.012 (0.028)	0.040 (0.039)	0.045 (0.039)	0.045 (0.039)
Short term debt	-0.033*** (0.004)	-0.033*** (0.004)	-0.033*** (0.004)	-0.028*** (0.006)	-0.027*** (0.006)	-0.027*** (0.006)
Investment bank	0.011** (0.005)	0.011** (0.005)	0.011** (0.005)	0.013** (0.006)	0.014** (0.006)	0.014** (0.006)
Non-banking credit institution	0.001 (0.006)	0.001 (0.006)	0.001 (0.006)	0.002 (0.010)	0.002 (0.010)	0.002 (0.010)
Other bank	0.001 (0.002)	0.002 (0.002)	0.001 (0.002)	0.001 (0.002)	0.002 (0.002)	0.002 (0.002)

Inflation	0.156*** (0.024)	0.156*** (0.024)	0.156*** (0.024)	0.171*** (0.028)	0.169*** (0.028)	0.170*** (0.028)
GDP growth	-0.168*** (0.020)	-0.168*** (0.020)	-0.167*** (0.020)	-0.157*** (0.023)	-0.156*** (0.023)	-0.157*** (0.023)
GDP per capita	0.003*** (0.000)	0.003*** (0.000)	0.003*** (0.000)	0.003*** (0.000)	0.003*** (0.000)	0.003*** (0.000)
Constant	0.126*** (0.013)	0.127*** (0.013)	0.127*** (0.013)	0.133*** (0.014)	0.136*** (0.014)	0.134*** (0.014)
N	12994	12994	12994	10517	10517	10517
R-sq	0.618	0.618	0.618	0.643	0.645	0.646

Table 6. Market discipline through bank interest expenses: robustness checks

The dependent variable is *Interest expense*, which is interest expense over bank liabilities excluding non-interest bearing debt. *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. *Liquidity* is defined as liquid assets to total assets. *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. *Market share* is the assets of a bank divided by the assets of all banks in a country. 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)	(7)	(8)
Assets	Interest expense -0.001*** (0.000)	Interest expense -0.001*** (0.000)	Interest expense -0.001*** (0.000)	Interest expense -0.001*** (0.000)	Interest expense -0.001*** (0.000)	Interest expense -0.001*** (0.000)	Interest expense -0.001*** (0.000)	Interest expense -0.001*** (0.000)
Liabilities over GDP	0.010** (0.004)	0.004 (0.003)	0.008* (0.005)	0.009** (0.005)	0.004 (0.003)	0.011** (0.005)	0.010** (0.005)	0.005* (0.003)
Overhead	0.003 (0.028)	0.023 (0.025)	0.012 (0.028)	0.004 (0.027)	0.022 (0.026)	0.010 (0.027)	0.003 (0.028)	0.022 (0.025)
Short term debt	-0.034*** (0.006)	-0.034*** (0.004)	-0.033*** (0.004)	-0.034*** (0.006)	-0.034*** (0.004)	-0.033*** (0.004)	-0.034*** (0.006)	-0.034*** (0.004)
Investment bank	0.014*** (0.005)	0.011** (0.004)	0.011** (0.005)	0.014*** (0.005)	0.011** (0.004)	0.011** (0.005)	0.014*** (0.005)	0.011** (0.004)
Non-banking credit institution	-0.000 (0.005)	0.002 (0.006)	0.001 (0.007)	-0.000 (0.005)	0.002 (0.006)	0.001 (0.006)	-0.001 (0.005)	0.002 (0.006)
Other bank	0.001 (0.002)	0.001 (0.002)	0.001 (0.002)	0.001 (0.002)	0.001 (0.002)	0.001 (0.002)	0.000 (0.002)	0.001 (0.002)
Inflation	0.129*** (0.029)	0.154*** (0.023)	0.156*** (0.024)	0.129*** (0.029)	0.154*** (0.023)	0.157*** (0.024)	0.130*** (0.029)	0.156*** (0.023)
GDP growth	-0.162*** (0.022)	-0.156*** (0.020)	-0.167*** (0.020)	-0.162*** (0.022)	-0.157*** (0.020)	-0.166*** (0.020)	-0.161*** (0.022)	-0.158*** (0.021)
GDP per capita	0.003*** (0.000)	0.003*** (0.000)	0.003*** (0.000)	0.003*** (0.000)	0.003*** (0.000)	0.003*** (0.000)	0.003*** (0.000)	0.003*** (0.000)
Liquidity	-0.014** (0.006)			-0.020 (0.054)			-0.016** (0.006)	
Liquidity * Liabilities over GDP	-0.153** (0.006)			-0.153** (0.006)			-0.141** (0.006)	

Return on assets	(0.074)	-0.045* (0.024)	(0.075)	-0.181 (0.300)	(0.071)	-0.053** (0.025)
Return on assets * Liabilities over GDP		-0.394** (0.162)		-0.428** (0.168)		-0.473** (0.190)
Equity		0.032 (0.068)		0.004 (0.009)		
Equity * Liabilities over GDP		-0.162** (0.077)		-0.192** (0.077)		
Equity * Assets		-0.001 (0.003)				
Liquidity * Assets			0.000 (0.002)			
Return on assets * Assets				0.006 (0.014)		
Market share						
Equity * Market share				-0.008* (0.004)	-0.009** (0.004)	-0.003 (0.003)
Liquidity * Market share				0.096*** (0.028)		
Return on assets * Market share					0.019 (0.017)	
Constant		0.169*** (0.014)	0.169*** (0.014)	0.131*** (0.012)	0.172*** (0.014)	0.184 (0.173)
N		8025	8025	13001	8025	13001
R-sq		0.687	0.687	0.619	0.687	0.619

Table 7. Market discipline through bank interest expenses: additional robustness checks

The dependent variable is *Interest expense*, which is interest expense over bank liabilities excluding non-interest bearing debt. *Assets* is the natural logarithm of total assets in constant 2000 US dollars. *Liabilities over GDP* are bank liabilities divided by GDP. *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. *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. *Equity* is the capital to asset ratio, which is defined as equity as a share of total assets. *Liquidity* is defined as liquid assets to total assets. *Return on assets* is given by before tax profits divided by total assets. *Foreign liabilities over GDP* is the sum of the liabilities of majority owned foreign subsidiary banks divided by GDP. We estimate all regressions using country fixed effects (except regressions 4-6) and time fixed effects and clustering at bank level. In regressions 4, 5 and 6, only US banks are included and *Inflation* and *GDP growth* are dropped due to the collinearity. In the regressions 10, 11 and 12, all variables based on bank-level information are lagged one period. Standard errors are given in parentheses. \*, \*\*, and \*\*\* denote significance at 10%, 5% and 1%.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Interest expense	Interest expense	Interest expense	Interest expense	Interest expense	Interest expense	Interest expense	Interest expense	Interest expense	Interest expense	Interest expense	Interest expense
Assets	-0.001*** (0.000)	-0.001*** (0.000)	-0.001*** (0.000)	-0.001*** (0.000)	-0.001*** (0.000)	-0.001*** (0.000)	-0.001*** (0.000)	-0.001** (0.000)	-0.001*** (0.000)	-0.001*** (0.000)	-0.001*** (0.000)	-0.001*** (0.000)
Liabilities over GDP	0.006 (0.004)	0.008* (0.004)	0.004 (0.003)	0.004 (0.003)	0.003* (0.003)	0.007 (0.004)	0.007 (0.004)	0.009** (0.004)	0.004 (0.003)	0.009*** (0.003)	0.010*** (0.003)	0.003* (0.002)
Liabilities				-0.001** (0.001)	-0.001*** (0.000)	-0.001*** (0.000)						
Overhead	0.047 (0.042)	0.018 (0.032)	0.056 (0.042)	0.019 (0.033)	-0.017 (0.040)	-0.004 (0.033)	-0.006 (0.043)	0.048 (0.040)	-0.000 (0.040)	-0.047* (0.027)	-0.071** (0.032)	-0.041 (0.027)
Short term debt	-0.030*** (0.005)	-0.032*** (0.007)	-0.030*** (0.005)	-0.039*** (0.005)	-0.050*** (0.013)	-0.038*** (0.005)	-0.021*** (0.005)	-0.015*** (0.005)	-0.021*** (0.005)	-0.029*** (0.005)	-0.031*** (0.007)	-0.030*** (0.005)
Investment Bank	0.008 (0.006)	0.014** (0.006)	0.008 (0.005)	0.021 (0.014)	0.030* (0.018)	0.021 (0.014)	0.017*** (0.004)	0.015*** (0.003)	0.018*** (0.004)	0.013** (0.005)	0.017*** (0.006)	0.013** (0.005)
Non-banking credit institution	0.016 (0.016)	0.003 (0.004)	0.017 (0.016)	0.001 (0.006)	0.001 (0.006)	0.001 (0.006)				0.004 (0.006)	-0.005 (0.006)	0.004 (0.006)
Other bank	0.001 (0.002)	0.000 (0.002)	0.001 (0.002)	0.007*** (0.002)	0.003 (0.005)	0.008*** (0.002)	0.001 (0.002)	0.002 (0.002)	0.001 (0.002)	0.002 (0.002)	0.001 (0.002)	0.002 (0.002)
Inflation	0.131*** (0.002)	0.110*** (0.002)	0.130*** (0.002)				0.136*** (0.002)	0.117*** (0.002)	0.136*** (0.002)	0.124*** (0.002)	0.073** (0.002)	0.123*** (0.002)

GDP growth	(0.021)	(0.026)	(0.021)	(0.027)	(0.034)	(0.027)	(0.026)	(0.029)	(0.026)
	-0.156***	-0.150***	-0.150***	-0.134***	-0.130***	-0.132***	-0.205***	-0.241***	-0.204***
	(0.020)	(0.022)	(0.020)	(0.032)	(0.034)	(0.032)	(0.034)	(0.042)	(0.034)
GDP per capita	0.003***	0.003***	0.003***	0.002***	0.001***	0.001***	0.003***	0.003***	0.003***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)
Fee income	-0.011***	-0.006**	-0.011**						
	(0.004)	(0.003)	(0.005)						
Non-deposit funding	0.014*	0.008	0.014						
	(0.009)	(0.007)	(0.009)						
Equity	0.014			0.010			0.002		
	(0.010)			(0.017)			(0.010)		
Equity * Liabilities over GDP	-0.121*			-0.109			-0.173**		
	(0.067)			(0.081)			(0.073)		
Equity * Liabilities			0.004						
			(0.005)						
Liquidity		-0.015***		0.085	0.005			-0.010	
		(0.005)		(0.095)	(0.005)			(0.007)	
Liquidity * Liabilities over GDP		-0.122*			-0.115			-0.166**	
		(0.064)			(0.087)			(0.077)	
Liquidity * Liabilities									
Return on assets			-0.019						-0.032
			(0.028)						(0.026)
Return on assets * Liabilities over GDP			-0.392**						-0.150
			(0.159)						(0.263)
Return on assets * Liabilities									
Foreign liabilities over GDP									
Equity * Foreign liabilities over GDP				0.011	0.063*	0.009			
				(0.019)	(0.034)	(0.010)			
Equity * Foreign liabilities over GDP				-0.095					
				(0.441)					
Liquidity * Foreign liabilities over GDP									
Return on assets * Foreign liabilities over GDP									
Constant	0.117***	0.122***	0.133***	0.183***	0.195***	0.188***	0.125***	0.161***	0.124***
	(0.012)	(0.011)	(0.008)	(0.022)	(0.020)	(0.016)	(0.023)	(0.014)	(0.022)
N	12464	7729	12468	7870	3873	7877	10896	6355	10896
R-sq	0.637	0.700	0.636	0.495	0.498	0.503	0.637	0.679	0.637

Table 8. Market discipline through bank deposit growth

The dependent variables is *Deposit growth* 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. *Gross income* is the natural logarithm of gross income in constant 2000 US dollars. *Gross income over GDP* is bank gross income divided by GDP. *Gross income over GDP* is bank gross income divided by GDP. *Overhead* is personnel expenses and other non-interest expenses over total assets. *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%.

	(1)	(2)	(3)	(4)	(5)	(6)
	Deposit growth	Deposit growth	Deposit growth	Deposit growth	Deposit growth	Deposit growth
Assets	0.004* (0.002)	0.005** (0.002)	0.005** (0.002)			
Liabilities over GDP		-0.040*** (0.015)	-0.074** (0.029)			
Equity * Liabilities over GDP			0.913 (0.579)			
Gross income				0.003 (0.002)	0.004* (0.002)	0.003 (0.002)
Gross income over GDP					-0.270 (0.233)	-1.161** (0.541)
Equity * Gross income over GDP						20.984** (9.552)
Equity	0.051 (0.130)	0.045 (0.130)	0.043 (0.131)	-0.096 (0.152)	-0.099 (0.153)	-0.114 (0.154)
Overhead	-0.432 (0.312)	-0.436 (0.312)	-0.436 (0.312)	-0.756** (0.344)	-0.761** (0.343)	-0.753** (0.343)
Investment bank	0.135*** (0.039)	0.132*** (0.039)	0.132*** (0.039)	0.164*** (0.045)	0.163*** (0.045)	0.163*** (0.045)
Non-banking credit institution	-0.002 (0.027)	-0.002 (0.027)	-0.001 (0.027)	-0.011 (0.035)	-0.011 (0.035)	-0.009 (0.035)
Other bank	0.008 (0.028)	0.006 (0.027)	0.007 (0.028)	-0.014 (0.025)	-0.015 (0.025)	-0.015 (0.025)
Inflation	-0.779** (0.335)	-0.777** (0.334)	-0.780** (0.335)	-0.897** (0.418)	-0.896** (0.418)	-0.894** (0.417)

GDP growth	0.292	0.288	0.288	0.280	0.279	0.287
	(0.442)	(0.442)	(0.442)	(0.514)	(0.514)	(0.511)
GDP per capita	-0.004	-0.004	-0.004	-0.001	-0.001	-0.001
	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)
Constant	0.279***	0.252**	0.250**	-0.065	-0.074	-0.065
	(0.102)	(0.101)	(0.101)	(0.071)	(0.070)	(0.070)
N	11277	11277	11277	9197	9197	9197
R-sq	0.042	0.043	0.043	0.061	0.061	0.062



Table 9. Market discipline through bank deposit growth: robustness checks

The dependent variable is *Deposit growth* 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. *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. *Liquidity* is defined as liquid assets to total assets. *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. *Market share* is the assets of a bank divided by the assets of all banks in a country. 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)	(7)	(8)
Assets	Deposit growth 0.003 (0.003)	Deposit growth 0.004** (0.002)	Deposit growth -0.001 (0.005)	Deposit growth 0.002 (0.003)	Deposit growth 0.004 (0.004)	Deposit growth 0.005** (0.002)	Deposit growth 0.003 (0.003)	Deposit growth 0.004** (0.002)
Liabilities over GDP	-0.075*** (0.029)	-0.054*** (0.016)	-0.053* (0.028)	-0.077*** (0.029)	-0.052*** (0.016)	-0.071** (0.028)	-0.079*** (0.029)	-0.057*** (0.018)
Overhead	-0.575 (0.410)	-0.452 (0.329)	-0.479 (0.318)	-0.564 (0.420)	-0.459 (0.335)	-0.436 (0.312)	-0.569 (0.412)	-0.447 (0.330)
Investment bank	0.136*** (0.045)	0.133*** (0.038)	0.139*** (0.040)	0.135*** (0.045)	0.133*** (0.039)	0.132*** (0.039)	0.137*** (0.045)	0.132*** (0.039)
Non-banking credit institution	0.025 (0.051)	-0.005 (0.023)	-0.018 (0.027)	0.025 (0.051)	-0.006 (0.023)	-0.001 (0.027)	0.026 (0.051)	-0.006 (0.023)
Other bank	0.010 (0.031)	0.011 (0.026)	0.006 (0.027)	0.010 (0.031)	0.011 (0.026)	0.005 (0.028)	0.011 (0.032)	0.010 (0.027)
Inflation	-0.611 (0.415)	-0.753*** (0.330)	-0.775** (0.333)	-0.612 (0.415)	-0.752*** (0.331)	-0.777** (0.335)	-0.619 (0.416)	-0.759*** (0.330)
GDP growth	0.021 (0.605)	0.089 (0.446)	0.290 (0.441)	0.020 (0.605)	0.083 (0.456)	0.289 (0.442)	0.021 (0.605)	0.111 (0.450)
GDP per capita	-0.005 (0.004)	-0.002 (0.004)	-0.004 (0.003)	-0.005 (0.004)	-0.002 (0.004)	-0.004 (0.004)	-0.005 (0.004)	-0.002 (0.004)
Liquidity	0.018 (0.067)			-0.088 (0.449)			0.009 (0.074)	
Liquidity * Liabilities over GDP	1.172** (0.504)			1.179** (0.506)			1.163** (0.505)	

Return on assets	1.047*** (0.341)		0.097 (5.237)		1.088*** (0.354)
Return on assets * Liabilities over GDP	3.846*** (1.582)		3.622*** (1.518)		4.467*** (1.428)
Equity		-1.467 (1.292)		0.040 (0.136)	
Equity * Liabilities over GDP		0.605 (0.592)		0.948* (0.553)	
Equity * Assets		0.074 (0.060)			
Liquidity * Assets			0.005 (0.018)		
Return on assets * Assets			0.045 (0.238)		
Market share				-0.022 (0.047)	0.001 (0.045)
Equity * Market share				0.028 (0.289)	
Liquidity * Market share				0.115 (0.201)	
Return on assets * Market share					-1.214 (1.594)
Constant	0.397*** (0.146)	-0.200** (0.086)	-0.188** (0.095)	0.401*** (0.147)	-0.199** (0.099)
N	6934	11282	11282	6934	11282
R-sq	0.048	0.048	0.048	0.048	0.048

Table 10. Market discipline through bank deposit growth: additional robustness check

The dependent variable is *Deposit growth* 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. *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. *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. *Non-deposit funding* is the share of non-deposit short-term funding in total deposits. *Fee income* is share of non-interest income in total operating income. *Equity* is the capital to asset ratio, which is defined as equity as a share of total assets. *Liquidity* is defined as liquid assets to total assets. *Return on assets* is given by before tax profits divided by total assets. *Foreign liabilities over GDP* is the sum of the liabilities of majority owned foreign subsidiary banks divided by GDP. We estimate all regressions using country fixed effects (except regressions 4-6) and time fixed effects and clustering at bank level. In regressions 4, 5 and 6, only US banks are included and *Inflation* and *GDP growth* are dropped due to the collinearity. In the regressions 10, 11 and 12, all variables based on bank-level information are lagged one period. Standard errors are given in parentheses. \*, \*\* and \*\*\* denote significance at 10%, 5% and 1%.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Deposit growth	Deposit growth	Deposit growth	Deposit growth	Deposit growth	Deposit growth	Deposit growth	Deposit growth	Deposit growth	Deposit growth	Deposit growth	Deposit growth
Assets	0.001 (0.002)	-0.002 (0.003)	0.000 (0.002)				0.004 (0.003)	-0.002 (0.003)	-0.000 (0.003)	0.001 (0.002)	-0.000 (0.003)	-0.001 (0.002)
Liabilities over GDP	-0.069** (0.029)	-0.064** (0.032)	-0.060*** (0.020)				-0.020 (0.043)	-0.058* (0.033)	-0.057** (0.028)	-0.030 (0.035)	-0.044 (0.039)	-0.020 (0.026)
Liabilities				-0.010 (0.010)	0.002 (0.005)	0.004 (0.005)						
Overhead	-1.228*** (0.380)	-1.413*** (0.432)	-1.076** (0.424)	-0.532 (0.459)	-0.164 (0.794)	-0.482 (0.465)	-1.708*** (0.450)	-1.502* (0.784)	-1.118* (0.654)	0.182 (0.297)	0.673 (0.415)	0.372 (0.307)
Investment Bank	0.105** (0.046)	0.116** (0.050)	0.109** (0.046)	0.219** (0.098)	0.255** (0.128)	0.204** (0.098)	0.150*** (0.042)	0.178*** (0.059)	0.189*** (0.054)	0.058 (0.037)	0.065 (0.041)	0.063* (0.036)
Non-banking credit institution	0.094** (0.043)	0.096*** (0.036)	0.089** (0.042)	0.163*** (0.044)	0.171*** (0.024)	0.170*** (0.044)				-0.043 (0.029)	0.075 (0.060)	-0.039 (0.026)
Other bank	0.010 (0.026)	0.034 (0.029)	0.013 (0.026)	0.045 (0.100)	0.096 (0.146)	0.035 (0.095)	-0.028 (0.025)	-0.005 (0.018)	-0.014 (0.019)	0.007 (0.026)	0.016 (0.028)	0.012 (0.025)
Inflation	-0.710** (0.337)	-0.585 (0.433)	-0.703** (0.339)				-0.492 (0.464)	-1.211** (0.542)	-0.495 (0.531)	-0.669** (0.301)	-0.787* (0.422)	-0.645** (0.298)
GDP growth	0.252 (0.459)	-0.021 (0.642)	0.144 (0.469)				-0.261 (1.202)	-0.740 (1.449)	-0.356 (1.235)	0.025 (0.469)	-0.157 (0.631)	0.007 (0.467)
GDP per capita	-0.005 (0.007)	-0.005 (0.007)	-0.004 (0.007)	-0.007 (0.007)	0.001 (0.001)	-0.004 (0.004)	-0.001 (0.001)	0.001 (0.001)	-0.001 (0.001)	-0.015 (0.015)	-0.020 (0.020)	-0.014 (0.014)

Fee income	(0.004) 0.076** (0.030)	(0.004) 0.092** (0.038)	(0.004) 0.067** (0.031)	(0.005)	(0.002)	(0.005)	(0.009)	(0.009)	(0.009)	(0.012)	(0.017)	(0.012)
Non-deposit funding	(0.053) (0.045)	(0.064) (0.060)	(0.055) (0.044)									
Equity	0.105 (0.158)			-3.328 (2.248)			0.661** (0.297)	0.242** (0.105)				
Equity * Liabilities over GDP	1.069** (0.499)						0.168 (0.767)	0.343 (0.633)				
Equity * Liabilities				0.164 (0.106)								
Liquidity		0.002 (0.071)			0.131 (0.927)		0.022 (0.056)				-0.049 (0.054)	
Liquidity * Liabilities over GDP		1.016* (0.534)					0.782 (0.518)				0.664 (0.642)	
Liquidity * Liabilities					-0.015 (0.037)							
Return on assets			0.464 (0.423)			1.239 (5.439)			0.891 (0.617)			1.259*** (0.313)
Return on assets * Liabilities over GDP			5.453*** (1.711)						5.640* (3.164)			1.015 (2.199)
Return on assets * Liabilities						-0.009 (0.257)						
Foreign liabilities over GDP							0.077 (0.101)		0.020 (0.053)			
Foreign liabilities over GDP							-0.145 (0.169)					
Equity * Foreign liabilities over GDP							-3.505 (3.665)					
Liquidity * Foreign liabilities over GDP									0.526 (0.507)			
Return on assets * Foreign liabilities over GDP	-0.204** (0.101)	2.380*** (0.131)	-0.204** (0.100)	0.526* (0.290)	0.001 (0.162)	0.151 (0.213)	0.119 (0.484)	0.263*** (0.079)	0.167 (0.137)	0.034 (0.157)	0.078 (0.148)	0.081 (0.158)
Constant	10730	6640	10733	6777	3290	6782	2511	1858	2515	11088	6492	11088
N	0.050	0.057	0.051	0.051	0.064	0.047	0.105	0.078	0.099	0.042	0.044	0.045
R-sq												

Table 11. Bank performance and strategy regressions with crisis years interactions

*Return on assets (ROA)* is given by before tax profits divided by total assets. *Return on equity (ROE)* is pre-tax profits divided by equity. *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. The variables *Short term debt*, *Investment bank*, *Non-banking credit institution*, *Other bank*, *Inflation*, *GDP growth* and *GDP per capita* and corresponding interaction variables with the crisis years dummy variable are included in the regressions but not reported. Standard errors are given in parentheses. \*, \*\*, and \*\*\* denote significance at 10%, 5% and 1%.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	ROA	ROE	Fee income	Interest income	Other operating income	Loans	Non-deposit short-term funding
Assets	0.001*** (0.000)	0.001*** (0.000)	0.031*** (0.003)	-0.001*** (0.000)	-0.000 (0.001)	-0.013*** (0.003)	0.025*** (0.002)
Assets * 2008,9	0.003***	0.003***	0.000	-0.000	0.000	-0.010***	-0.009***
Liabilities over GDP	(0.001)	(0.001)	(0.003)	(0.000)	(0.001)	(0.003)	(0.002)
	-0.006***	-0.006***	-0.059**	0.002**	-0.007	-0.013	-0.022
Liabilities over GDP * 2008,9	(0.002)	(0.002)	(0.028)	(0.001)	(0.005)	(0.019)	(0.017)
	-0.002	-0.002	-0.131***	0.003	-0.001	0.026	-0.008
Equity	(0.003)	(0.003)	(0.026)	(0.002)	(0.004)	(0.022)	(0.016)
	0.091***	0.091***	0.601***	0.044***	0.270***	-0.382***	0.175***
Equity * 2008,9	(0.017)	(0.017)	(0.074)	(0.010)	(0.036)	(0.071)	(0.062)
	0.080	0.080	-0.012	-0.009	0.103	0.018	-0.182**
N	(0.075)	(0.075)	(0.095)	(0.011)	(0.066)	(0.107)	(0.074)
	13327	13327	12858	13155	13111	13171	12998
R-sq	0.208	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.

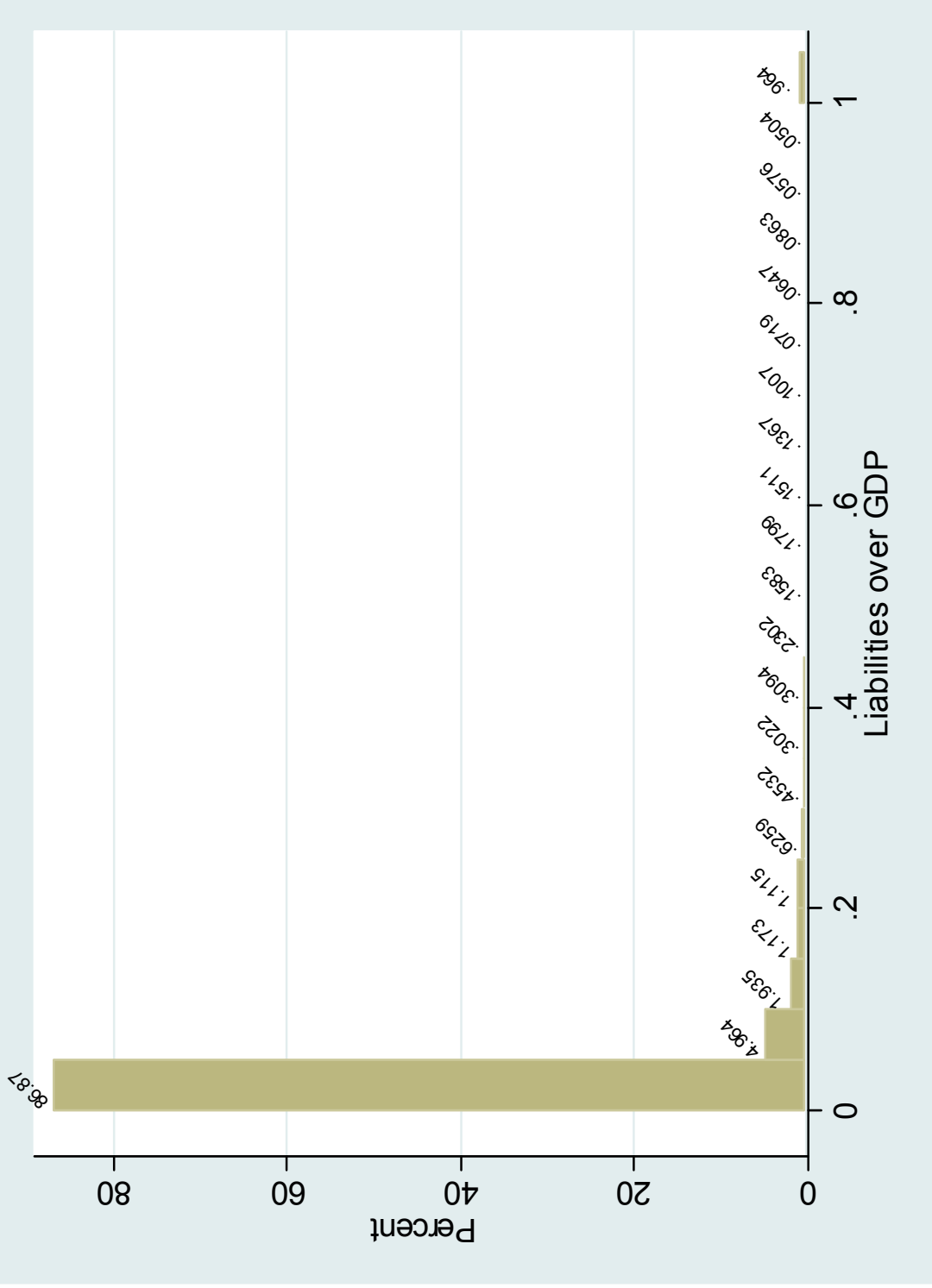


Figure 2. Mean liabilities-to GDP ratios during 2000-2009 period

This figure shows the yearly mean liabilities-to-GDP ratios for the banks, which are in the dataset throughout the relevant period. For the period 2000-2009 there are 365 banks.

