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Multinational banks' deleveraging in the crisis driven by pre-crisis characteristics and behavior

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Non-technical summary

Research Question

Balance sheet deleveraging in the financial crisis was preceded by sizable balance sheet growth in the run-up to the crisis and was due, for the most part, to international activities. Thus, the most obvious thing is to ask - not least from a regulatory perspective - whether the balance sheet expansion was unsustainable, as excessive risk taking was maybe going on.

Contribution

The deleveraging process of banks often refers to the shrinkage of the total balance sheet. We ask whether it is also fruitful to differentiate between deleveraging in total assets, overall foreign activities, foreign activities vis-à-vis non-financial centers and vis-à-vis financial centers, as well as in home activities. We locate the drivers of the shrinkage primarily in the pre-crisis stage. In this context, we consider not only the banks' balance sheet positions but also their behavior. With respect to bank structure prior to the crisis, we look, among other things, at specific exposures abroad, the funding structure, the capacity to buffer losses, liquidity endowment, and profitability of banks. In addition, we also analyze the effect from the banks' behavior in the run-up of the crisis both from 2002 to mid-2008 and - shorter - from 2005 to mid-2008.

Results

Apart from the pure relevance of bank characteristics during the crisis, banks' pre-crisis characteristics as well as their pre-crisis behavior affected their strategies in the crisis. Excessive developments are mainly found in the period from 2005 to mid-2008. Our results are generally strongest for banks with large amounts of foreign assets and for the shrinkage of their exposures vis-à-vis countries without financial centers.

Nichttechnische Zusammenfassung

Fragestellung

Dem Deleveraging der Banken in der Finanzkrise ging ein umfangreiches Bilanzwachstum insbesondere bei ihren internationalen Aktivitäten voraus. Es ist deshalb naheliegend zu fragen - nicht zuletzt auch aus regulatorischer Sicht - inwieweit dieser Bilanzanstieg nachhaltig war oder ob unverhältnismäßig hohe Risiken eingegangen wurden.

Beitrag

Das Deleveraging wird häufig am Schrumpfen der Bankbilanz festgemacht. Wir fragen, ob es nicht sinnvoll ist, zwischen dem Abbau bei der gesamten Bilanz, bei den gesamten ausländischen Aktivitäten, bei den Auslandsforderungen gegenüber Ländern mit und ohne Finanzzentren sowie bei den heimischen Geschäften in Deutschland zu unterscheiden. Die Ursachen des Bilanzrückgangs verorten wir in erster Linie im Zeitraum vor der Krise und betrachten dazu nicht nur zahlreiche Bankenkennziffern, sondern auch das Verhalten der Banken vor dem Zusammenbruch von Lehman Brothers. In Hinblick auf die Struktur der Banken greifen wir unter anderem auf eventuell kritische Auslandsengagements, die Finanzierunggstruktur, die Fähigkeit Verluste abzufedern, die Liquiditätsausstattung sowie die Profititabilität der Banken zurück. Zusätzlich analysieren wir auch die Auswirkungen des Verhaltens der Banken im Vorfeld der Krise für den Zeitraum von 2002 bis Mitte 2008 wie auch - verkürzt - von 2005 bis Mitte 2008.

Ergebnisse

Es zeigt sich, dass neben der Relevanz der Bankcharakteristika in der Krise auch jene von vor dem Ausbruch der Krise sowie das Vorkrisenverhalten der Banken für ihre Strategien im Krisenzeitraum ausschlaggebend waren. Exzessive Entwicklungen konnten in erster Linie für den Zeitraum von 2005 bis Mitte 2008 gefunden werden. Unsere Ergebnisse werden vor allem von den Banken mit hohen Engagements im Ausland und hier von ihrem Exposure gegenüber Ländern ohne Finanzzentren getrieben.

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Abstract

After the collapse of Lehman Brothers, a rapid and far-reaching shrinkage of international banks' assets with a focus on foreign claims took place. For the largest 67 German banking groups, we find that both their characteristics and behavior in the pre-crisis episode had repercussions for the crisis period. Above all, prior non-traditional banking activities - proxied by the relevance of securities and non-interest income - resulted in balance sheet contraction in the crisis. While, from 2002 to mid-2008, a disproportionately high growth rate in profits to assets is found to be indicative of too much risk taking, both high average income and a strong balance sheet expansion in the pre-crisis period are found to be positive per se. In contrast, a high average income or a strong growth in assets in just the last three and a half years before the outbreak of the crisis put balance sheets during the crisis under adjustment pressure. During the crisis, short-term wholesale funding proved to be a disadvantage, while good capital endowment (core Tier 1 capital to RWA ratio), deposit funding and strong affiliate presence abroad had a stabilizing impact. Most of these variables lose their significance in normal times.

Keywords: banks, deleveraging, foreign assets, financial crisis, pre crisis

JEL classification: G21, F23, F34.

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1 Introduction

Balance sheet deleveraging in the crisis was preceded by sizable balance sheet growth in the run-up to the crisis and was due, for the most part, to international activities. Thus, the most obvious thing is to ask - not least from a regulatory perspective - whether the balance sheet expansion was unsustainable, as excessive risk taking was maybe going on. To answer this, our study tries to isolate pre-crisis drivers of the multinationals' contractionary policies in the crisis.[1] We focus on supply-side factors, as these may be accompanied by a credit constraint with harmful implications for the real economy. With their strong balance sheet shrinkage, especially in foreign assets during the financial crisis,[2] the large and international banks attracted a great deal of public attention during the crisis. On account of their size alone, they have major relevance for the economies in which they are substantially engaged, and some might even be classified as systemically relevant. A negative effect on economies may arise in the event of a sharp increase in risk aversion or even if large losses materialize on the banks' balance sheets, which may force banks to adjust their exposures not only in risky assets but also in broader areas of their business. Furthermore, we interpret the supply-driven part of the balance sheet shrinkage as an indicator of banks' fragility.

Thus, our aim is to examine whether the contraction of large German banks' total foreign and total assets in the crisis can be explained by their pre-crisis structures and behavior.[3] Especially in terms of the broadness of the pre-crisis variables which are captured, our approach goes beyond the existing literature, in which, commonly, a bank is shocked by a critical exposure or where solely the balance sheet structure within the crisis is considered. To gain a deeper - but also new - insight into this, we split off the withdrawal in foreign assets further into the reduction of assets vis-à-vis non-financial centers and vis-à-vis financial centers. We locate the drivers of the shrinkage primarily in the pre-crisis stage. In this context, we consider not only the banks' balance sheet positions but also their behavior. With respect to bank structure prior to the crisis, we look, among other things, at specific exposures abroad (total foreign assets, assets vis-à-vis financial centers, assets vis-à-vis the periphery euro-area countries[4] - all relative to total size), the funding structure (deposits versus short-term wholesale funding), the bank's capacity to buffer losses (core Tier 1 capital ratio), liquidity endowment, and income generation. In addition, we analyze the effect from the banks' behavior - pre-crisis growth rates of the above-mentioned balance sheet variables - in the run-up of the crisis from 2002 to mid-2008. We further look to see whether the implications of the banks' pre-crisis behavior change if we shorten the pre-crisis period by choosing 2005 as the starting

[1] For Germany, we see no sizeable ongoing leveraging process in the pre-crisis period though there was a large balance sheet expansion over this time horizon. In the crisis, we see the deleveraging already stopped to the end of 2010 while the balance sheet shrinkage in foreign assets continued. Kalemli-Ozcan, Sorensen, and Yesiltas (2012) find a procyclicality of the leverage ratio for US investment banks and large commercial banks and, to a lesser extent, for Europe.

[2] In accordance, Giannetti and Laeven (2012) find a flight home effect in financial crises.

[3] Sinkey and Greenawalt (1991) only consider the risk-taking behavior at large US commercial banks. They see large banks as representing the greatest risk to the financial system and they are the ones which are rescued by the government in order to maintain confidence in the national banking system. de Jonghe (2010) finds that risk increases with size and sees large banks as more exposed to region-wide shocks.

[4] This group consists of Greece, Ireland, Italy, Portugal and Spain (GIIPS countries) plus Cyprus

year. Afterwards, in a panel estimation, we explain the withdrawals in the crisis with the same choice of bank characteristics, but now with their realizations during the crisis period. By doing this, we are able to detect potential similarities in the relevance of the bank's setup before and during the crisis, which also adds to the existing literature. We close our panel approach by categorical estimations for the crisis period, where the banks are grouped according to their pre-crisis characteristics and behavior - which, so to speak, reconciles our different approaches with bank characteristics from the pre-crisis and from the crisis. Our analysis relies on various Bundesbank bank statistics: balance sheet, external positions, accounting and banking supervision data.

With respect to the pre-crisis characteristics, we find that banks' securities investment, activities in the financial markets, short-term funding and disproportionately high profit growth had a dampening effect on their activities in the financial crisis. In contrast, banks which succeeded in generating income throughout the pre-crisis period from 2002 to mid-2008 were less compelled to cut their balance sheet positions in the crisis. In general, already banks' expansionary policies in such balance sheet positions in the run-up to the crisis were enough to produce the described effects. When we shorten the pre-crisis period to begin in 2005, not only pre-crisis expansions in foreign and total assets but also average income exerted a negative impact on banks' activities during the crisis - which is a reversal of the outcomes for the longer pre-crisis periods. When we turn to the relevance of the banks' balance sheet variables during the crisis period, the additional outcomes occur that strong capital endowment and strong affiliate presence abroad have a stabilizing impact on foreign activities, while short-term funding, securities investment and activities in the periphery euro-area countries result in a reduction. Thus, apart from the pure relevance of bank characteristics during the crisis, banks' pre-crisis characteristics as well as their pre-crisis behavior affected their strategies in the crisis. Our results are generally strongest for banks with large amounts of foreign assets and for the shrinkage of their exposures in countries without financial centers.

The paper is organized as follows: Section 2 reviews the relevant literature, section 3 continues by introducing our data. Section 4 describes our approach and our estimation output, and section 5 concludes.

2 Literature

One of the first motivations to look more deeply at the drivers of banks' foreign claims was the analysis of vulnerability faced by emerging countries due to their reliance on international financing (see Calvo, Leiderman, and Reinhart (1993); Chuhan, Claessens, and Mamingi (1998)). Afterwards, the analysis of banks' behavior abroad was broadened and the explanation for this in terms of supply-side and demand factors was further refined (e.g. Jeanneau and Micu (2002) with aggregated data and de Haas and van Lelyfeld (2006, 2010) at bank level). In line with the literature's increasing focus on supply-side factors for bank activities, we also concentrate on supply-side bank variables and construct a set of the likely most relevant variables for banks' behavior in crises: In the literature, bad bank capitalization proves to be restrictive for lending (e.g. Kishan and Opiela (2000)) and banks risk position/risk aversion becomes significant (Altunbas, Gambacorta, and Marques-Ibanez (2009) and Duewel/Kerl, Frey, and Lipponer (2011)). Risk taking is also reflected in the asset holdings (see Acharya and Steffen (2015)for banks'

appetite on periphery government bonds in the run up to the crisis). Furthermore, banks' funding turns out to affect their lending: Due to a loss of confidence between the economic actors, the market for wholesale funding broke down and affected the banks during the crisis (Cetorelli and Goldberg (2011), Cremers, Huang, and Sautner (2011), and for the funding of subsidiaries abroad Frey and Kerl (2015)).[5] [6] Conversely, deposit funding (see, for example, Ivashina and Scharfstein (2010)) and the banking groups' internal capital market (Frey and Kerl (2015)) have a stabilizing impact in difficult times.

In addition, banks' business models affect their fragility in a crisis (see Roengpitya, Tarashev, and Tsatsaronis (2014)).[7] One measure for non-traditional banking applied in literature is, for example, non-interest income: Demirguec-Kunt and Huizinga (2010) find bank fragility increases in short-term wholesale funding and in non-interest income business, and in de Jonghe (2010) non-interest generating activities lead to higher risk. Furthermore, better financial performance before the crisis may be associated with increased risk-taking. In Beltratti and Stulz (2012), banks that had a better performance in the stock market price development in 2006 show substantially worse returns in the crisis. Nevertheless, we also look at a priori critical exposures vis-à-vis the euro-area periphery countries and financial centers; however our data does not allow to identify asset-backed commercial conduits, which, in some cases, also led to severe pressure on their owner banks in the crisis (see Acharya, Schnabl, and Suarez (2013)). Furthermore, we do not address the stabilizing effect of government rescue and central bank liquidity measures within the crisis (see Buch, Koch, and Koetter (2011) and Rose and Wieladek (2011)).

Besides, we also take care of dynamical patterns in the run-up to the crisis. For example, in a period of increasing asset prices, banks' balance sheets become "stronger", which results in banks further actively expanding their balance sheets while financing is extended primarily through short-term wholesale funds (Adrian and Shin (2010)). Banks with large exposures in assets with a crisis-driven sharp and rapid decline in value may face funding difficulties (Morris and Shin (2004)). Moreover, Hahm, Shin, and Shin (2012) see evidence for a lending boom if deposit growth cannot keep up with the growth of total assets, and Schularick and Taylor (2012) find that a credit boom over five years increases the risk of a financial crisis. At the micro level, excessive balance sheet growth may negatively affect the bank's performance indicators: Foos, Norden, and Weber (2010) provide empirical evidence that abnormal loan growth is accompanied by an increase in loan loss provisions, with a decrease in relative interest income and lower capital ratios. Furthermore, Kick, Pausch, and Ruprecht (2013) find higher non-performing loan ratios

[5] In the case of wholesale funding, the financing is directly done at the capital market or a borrowing from other banks is undertaken - where the funds providers may finance themselves at the capital market too (Bruno and Shin (2013))

[6] The currency used for funding may also play a role. Ivashina, Scharfstein, and Stein (2012) find dollar lending by European banks decreases along with the rationing of their dollar funding through US money market funds.

[7] Roengpitya et al. (2014) show how to derive bank business models from balance sheet characteristics. With statistical clustering, they identify three business models: retail-funded commercial banks, wholesale funded commercial banks, and capital market banks. The first two have a large share of loans on their balance sheet and differ in terms of their funding structures with deposits compared with wholesale funding. Capital market banks have a higher exposure in trading activities with a predominately wholesale funds. All these properties are captured in our study, too.

for German banks that extended their loan provision especially quickly (see similar results in case in the case of Spanish banks Jimenez and Saurina (2006)). Fahlenbrach, Prilmeier, and Stulz (2012) shows a negative impact of the bank's growth in the three years prior to the crisis on the performance of its stock price. Additionally, they find that banks which performed poorly in the financial crisis in 1998 also underperformed in the recent financial crisis, what means that they largely sticked to their former business models. In a subsequent downturn, however, a reversal and a rapid reduction of assets may occur. Financial pressure on banks may be increased in downturns due to regulatory requirements, such as requests for additional capital (see Kashyap and Stein (2004) for the effects of Basel II and Aiyar, Calomiris, Hooley, Korniyenko, and Wieladek (2014) for the impact of a tightening of capital requirements on foreign lending). Finally, the effects of bank characteristics may differ over time. Berger and Bouwman (2013) show that the capital ratio gains relevance for the survival probability of medium-sized and large banks in the crisis vis-à-vis normal times.

3 Data

3.1 Sample and data sources

In our study, we look at German banking groups from 2002Q1 to 2012Q4. This time span includes, on the one hand, the pre-crisis period up to the Lehman collapse with an expansionary German banking system. On the other hand, our crisis period with a pronounced balance sheet shrinkage starts with 2008Q3 and terminates with 2012Q4.[8] Thus, it probably covers the time span during which banks were most directly concerned with the financial crisis. Regulatory regime shifts already have been playing a role, especially towards the end of our sample, but it should be of minor importance with respect to the crisis period as a whole.[9] As the reduction in foreign activities is key to the banking system's overall balance sheet shrinkage, we focus on the 100 largest German banks (taken at 2009Q4) - as, for the small banks, foreign business is negligible. When we exclude foreign-owned and promotional banks with their narrow business orientation as supporters of specific investment activities, and additionally control for mergers within the remaining group, the number of banks goes down to 67.[10]

We work with micro data collected by the Deutsche Bundesbank. Depending on the data source, we can either rely directly on consolidated data for the banking groups or we can aggregate the data of the parents, as well as their branches and subsidiaries abroad in cases where consolidated data are missing. Most bank data stem from the monthly balance sheet statistics. As we focus on foreign activities, we additionally gain highly valuable information from the banks' external position statistics. For instance, these

[8] After the collapse of Lehman Brothers, the aggregate balance sheet of the German banking system shows a broad withdrawal. However according to our robustness checks, a termination of the pre-crisis period at mid-2007 does not influence our main results in general.

[9] The influence of regulation on foreign activities may be a priori unclear. Ongena, Popov, and Udell (2013) see tighter home-country regulation and higher home-country minimum capital requirements as being accompanied by lower lending standards abroad.

[10] Moreover, due to mergers in the period under review with banks outside the initial 100, which we handle by backward integration, we end up with 150 banks overall.

data allow us to isolate business with financial centers[11] and with the euro-area periphery countries.[12] Our data set is further refined by the statistics of the banks' profit and loss accounts in order to assess banks' profitability and by banking supervision data to capture their fragility.

Finally, we use macro data from the IMF (IFS) and work with financial data from Bloomberg and Thomson Reuters Datastream. To capture the relevance of effects from the countries banks are in touch with, we construct aggregate measures of economic conditions for the crisis period. For this, we calculate weighted averages of national stock market indices and GDPs.

All data are calculated on a quarterly basis and expressed in real terms (see more about the data construction in Section 4.1 and for descriptive statistics in Tables 1-3 in the Appendix).

3.2 Balance sheet shrinkage driven by foreign assets of the large multinationals

As described above, the balance sheet shrinkage of the German banking system is dominated by the contraction in foreign activities (see Figure 2).[13] Foreign business is driven largely by a rather limited number of multinational banks. Our sample of 67 out of roughly 2,000 banking groups account for nearly all of the foreign exposure of German banks, although the banks in the sample represent just around 60% of the overall balance sheet of the German banking system (see Figure 3).

However, it is still going quite far to speak of 67 multinationals in Germany, as the aggregate figures are dominated by a much smaller subgroup of banks. The foreign assets are largely held by half of the banks in our sample (see Figure 4).[14] Finally, when we restrict our analysis to the 10% quantile of banks with the largest foreign assets, we still cover around 70% of foreign business, although these 7 banks account for less than a quarter of the German banking system's home activities (see Figure 5). Thus, when we analyze the determinants of the sharp decline in the German banking system's foreign assets in the crisis, it seems appropriate to concentrate on the most relevant players.

[11] For the classification of offshore financial centers, we make use of the definition of the Financial Stability Forum – the predecessor of the present Financial Stability Board – published in 2000, and additionally exclude the UK and the US, as both countries represent large financial hubs for German banks. This is in line with the practice of the IMF, which also regards the UK and the US as hosting financial centers.

[12] This country group covers Portugal, Ireland, Italy, Greece, Spain and Cyprus. All countries have been in the focus of interest during the financial crisis owing to sovereign debt problems and/or bursting real estate bubbles.

[13] With our interest in the analysis of the balance sheet contraction during the crisis, we look in particular at foreign assets and at the total balance sheet. Furthermore, we distinguish between exposure vis-à-vis non-financial centers and vis-à-vis financial centers.

[14] While in the subgroup with the 34 banks with largest foreign assets 76 % of the banks conduct a balance sheet shrinkage in the post crisis this number goes down to 61 % in the overall sample.

4 Empirical Approach

4.1 Model

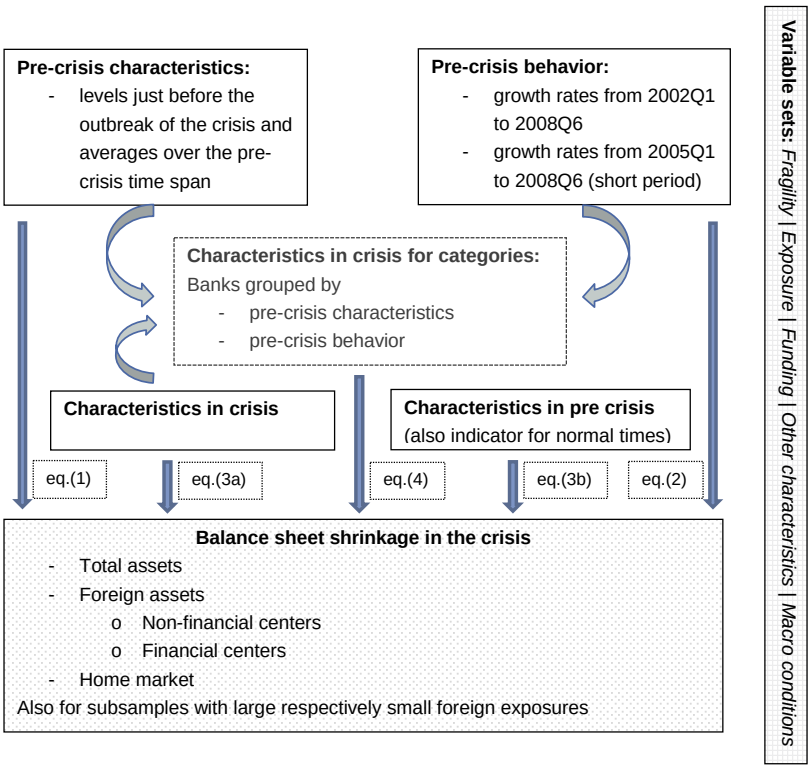
In our analysis, we look in particular at pre-crisis drivers in the form of balance sheet characteristics and in form of bank behavior for the deleveraging in the crisis. For this, we first rely on OLS estimations with "time-collapsed" observations, which we find in the literature in comparable settings - although we also build on the typically applied panel estimations with fixed effects later on. In our "collapsing" approach, we transform for every bank both its pre-crisis structure from 2002Q1 to 2008Q2 and - for the shorter period - from 2005Q1 to 2008Q2,[15] and its reaction in the crisis (2008Q3 to 2012Q4) by collapsing the time dimension. This leaves us with one pre-crisis or one crisis observation for each variable series which enters our standard OLS estimations. Khwaja and Mian (2008) and Kapan and Minoiu (2013) prefer this time-collapsed data approach to panels with fixed effects. While the two methods produce similar results, collapsing the time dimension results in more conservative standard errors. Bertrand, Duflo, and Mullainathan (2004) emphasize that this approach even works well when the number of observations is small. Furthermore, in the literature with difference-in-difference estimations, they find that emerging correlation issues are often neglected, which results in inconsistent standard errors. In doing so, we are able to take into account various pre-crisis variables for the balance sheet shrinkage in the crisis which makes the approach so attractive for our research question. In our first analysis, we therefore consider most of our bank characteristics just before the outbreak of the crisis - with the exception of highly volatile variables, where we take recourse to averages for specified pre-crisis periods. Besides, like in Berger and Bouwman (2013) we take the average of the banks' capital ratio from the pre-crisis period to get a rather general risk attitude from the bank. Second, we consider the pre-crisis in terms of the banks' pre-crisis behavior. For this, we work with the growth rates of the bank characteristics we applied above. Afterwards, we switch to fixed-effects panel estimations to analyze the relevance of bank characteristics realizations within the crisis period. Here, we also conduct categorical panel regressions with our banks grouped according to pre-crisis properties. A visual representation of the model you is presented in Figure 1 and more details on the estimation equations applied are given in Sections 4.2 to 4.5.

For our dependent variable - the shrinkage process in the crisis period - we rely on the growth rates of foreign and total assets. Our independent variables get sorted into the following variable sets. Bank's fragility ($frag_{pre-crisis,i}$) captures different risk measures: average *Tier 1 capital to risk weighted assets* (RWA) ratio - here, we take the mean of the pre-crisis period to obtain a rather general perception of bank's willingness to take risks, their *liquidity* situation[16] and their *loans to deposits* ratio just before the outbreak of the crisis. Next, we turn to bank's pre-crisis potentially critical exposures ($exp_{pre-crisis,i}$). First, we look at the share of *securities,* which may indicate the relevance of capital market activities relative to traditional loan provision business. A bank may suffer from securities

[15] Roengpitya et al. (2014)find that some banks switched their business model between 2005 and 2007 and, in particular, that wholesale funding became much more significant. Thus, movements in balance sheet positions just before the crisis may be indicative of a bank's stance, say, vis-à-vis risk-taking.

[16] The liquid assets comprise cash, deposits at central banks and overnight deposits at other banks.

Figure 1: Model for banks' balance sheet shrinkage in the crisis



if the share of contaminated "bad" assets is high. Next, a high share of *international activities* may result in an accelerated shrinkage abroad, as banks may shift their priorities to the home market in difficult times; however, bank's foreign business may be stabilized when it is accompanied by a high *local presence* (share of assets of affiliates abroad to total foreign assets of the banking group). Moreover, it may be that it is less the foreign activities in total but rather certain regional investments that led to pressure on banks in the crisis: Here, we address *exposures both vis-à-vis financial centers* and the *periphery* euro-area countries. The relative exposure in financial centers may indicate the size of a bank's global financial business model. The periphery euro-area countries constitute the group of European countries which ran into the greatest trouble in the aftermath of the Lehman collapse: Their national difficulties show up, in particular, in bursting domestic real estate bubbles and/or high debt levels of the sovereigns. With respect to the bank's funding structure ($fund_{pre-crisis,i}$), we look for evidence for stabilization from non-banks *deposits* compared with destabilization from *short-term* wholesale *funding*. The group of other bank characteristics ($char_{pre-crisis,i}$) comprises the log of balance sheet *size* (total assets) and *leverage,* which are rather standard. Here, we try to answer such questions as whether it is more small or large banks or whether it is highly leveraged or low-leveraged banks that reduce their activities, for example, abroad.[17] Furthermore, we take the share of *income from non-interest activities* in the last year before crisis - as an

[17]Often, a high leverage is seen as a source of fragility. However, with our variable "short-term wholesale funding" we may already capture this fragility to some extent.

indicator of capital market activities - and average *return on capital* over the pre-crisis period, which reflects profitability. Finally, our macro variable ($macro_{crisis,i}$) measures the *economic conditions across countries* in the crisis. It is calculated as the growth of a bank-specific country-exposure weighted stock price index over the crisis period in the OLS estimations.[18] When we look at the reduction of the bank's total balance sheet, this measure additionally includes the German stock price index. It combines demand aspects of the countries and and future prospects.[19] In the panel estimations, our measure for economic conditions is based on the weighted four-quarter growth rates of GDP as with quarterly data, actual demand for bank service gains relevance.[20] The weights correspond to the relative foreign exposures of a bank vis-à-vis the various countries just prior to the outbreak of the crisis (2008Q2).[21] In doing so, we take at least some account of macroeconomic conditions, though it is clear to us that it is difficult to address the demand side appropriately, as we are interested in the developments of all foreign assets and/or of the whole balance sheet. For this in our study, we give prority to the bank-specific drivers.

4.2 OLS regression with time-collapsed data - Impact of pre-crisis bank characteristics on banks in the crisis

Thus, in our OLS setting, we regress time-collapsed characteristics of the pre-crisis area on variables reflecting the deleveraging effect in the crisis period:

$$\begin{aligned} \Delta d_{crisis,i} &= \alpha_0 + \alpha_1 frag_{pre-crisis,i} + \alpha_2 exp_{pre-crisis,i} + \alpha_3 fund_{pre-crisis,i} + \\ &\quad \alpha_4 char_{pre-crisis,i} + \alpha_5 \Delta macro_{crisis,i} + \varepsilon_i. \end{aligned} \tag{1}$$

where i =1 ,..., N, N is the number of banks in the sample, $crisis$ ($pre-crisis$) is the index for variables taken from the crisis (pre-crisis) period and Δ stands for growth rate. The pre-crisis characteristics are either the value just before the outbreak of the crisis or the average over the pre-crisis period. ε_i represents an idiosyncratic error term.

$\Delta d_{crisis,i}$ is our *deleveraging or shrinkage variable*. Here, we address the growth of total foreign assets, foreign assets vis-à-vis non-financial centers, foreign assets vis-à-vis financial centers and of total assets from 2008Q3 to 2012Q4. First, we run the estimations for our complete bank sample and split for the banks with large and small amounts of foreign assets in a second step. With regard to the exogenous pre-crisis variables, we

[18] For the sake of smoothing and seasonal adjustment, the average value of the last four quarters of the crisis period is set in relation to the one of the first four quarters.

[19] We also checked for the significance of weighted GDP - a measure closer to the actual demand - but it did not show up. Moreover, stock market volatility as a measure of macroeconomic risk in a given country did not indicate any relevance either. In Duewel/Kerl et al. (2011) we found for German banks that local macroeconomic conditions are relevant solely for the lending through affiliates abroad.

[20] Besides, with a higher frequency, the variability of share indices would increase and short-term dynamics would gain significance, which considerably reduces the explanatory power for our analysis.

[21] See also Avdjiev, Kuti, and Takats (2012) for the construction of weighted macro variables. For our weighted macro conditions, we consider only countries without financial centers. For the countries with financial centers, the national macros have much less relevance for the activities of foreign banks, since they serve more as a hub for financial transactions.

generally take the stocks at 2008Q2 - in other words, just before the outbreak of the financial crisis defined by the collapse of Lehman Brothers.

4.3 OLS regression with time-collapsed data - Impact of pre-crisis bank behavior on banks in the crisis

In our second regression, the underlying hypothesis is that already an expansion of the risky business in the years before the outbreak of the crisis - which may have been driven by herding behavior - required adjustments in the crisis. Thus, we look to see whether, apart from the levels we addressed above, there were already trends in these exogenous variables in the run-up to the crisis - 2002Q1 to 2008Q2 - and for the shortened time horizon from 2005Q1 to 2008Q2 - that led to a contraction:

$$\begin{aligned} \Delta d_{crisis,i} &= \alpha_0 + \alpha_1 \Delta frag_{pre-crisis,i} + \alpha_2 \Delta exp_{pre-crisis,i} + \alpha_3 \Delta fund_{pre-crisis,i} + \\ &\quad \alpha_4 \Delta char_{pre-crisis,i} + \alpha_5 \Delta macro_{crisis,i} + \varepsilon_i. \end{aligned} \tag{2}$$

In general, the exogenous variables from equation (1) now enter the regression in the form of their growth rates. However, due to high volatility of the variable *profitability development*, we split the pre-crisis period at end-2004, calculate averages of profitability (return on capital) for both new subsamples and place these averages in relation to each other in order to obtain a reliable measure. In an extension to this regression, we investigate the role of *profitable expansion* (and *profitable expansion abroad*). This variable is calculated as our variable profitability development less the growth in total (foreign) assets.

4.4 Panel regression - Impact of bank characteristics during the crisis and pre-crisis period

In regressions (1) and (2), we try to explain the balance sheet shrinkage in the crisis in terms of pre-crisis drivers. Now, we consider the realizations of the balance sheet characteristics within the crisis period. For this, we use a non-dynamic panel estimation with fixed effects (see for example, Demirguec-Kunt and Huizinga (2010)):[22] [23]

$$\begin{aligned} \Delta d_{i,t} &= \alpha_0 + \alpha_1 frag_{i,t-1} + \alpha_2 exp_{i,t-1} + \alpha_3 fund_{i,t-1} + \\ &\quad \alpha_4 char_{i,t-1} + \alpha_5 \Delta macro_{i,t-1} + \eta_i + \gamma_t + \varepsilon_{it}. \end{aligned} \tag{3}$$

where t=1, ..., T is the time period in quarters for the crisis (2008Q3-2012Q4) in the first set of regressions and for the pre-crisis (2002Q2-2008Q2) in the later regressions, and η_i and γ_t are bank and time fixed effects.$\varepsilon_{i,t}$ represents an idiosyncratic error term.

[22] Although we feel comfortable with our previous collapsing approach for the consideration of the pre-crisis variables, the more commonly used fixed effects panel estimation provides us, besides other insights, with a robustness check.

[23] The application of a fixed effect estimation is indicated by the Hausman test. Besides, a joint test on the time dummies reveals that they are signficantly different from zero. Furthermore, we did not find evidence for autocorrelation or a dynamic modellation.

To avoid endogeneity issues, we include the exogenous variables with a lag of one quarter. For the variables *Tier 1 capital to risk weighted assets* and *profitability* we rely on the average of the previous four quarters to smooth potential disturbing fluctuations and outliers. In these panel estimations, our measure for economic conditions is based on the weighted GDPs of the countries where the banks are exposed and enters our estimation as a four-quarter growth rate.

4.5 Categorical panel regression - Impact of bank characteristics in the crisis with banks grouped on pre-crisis criteria

In our last approach, we again estimate a panel. However, we now group our banks according to pre-crisis variables/trends - which reconciles, to some extent, our two approaches OLS with collapsed data and panel with fixed effectst. In doing so, we run our estimations for the crisis period for a benchmark group and values for the categorical variable below and above those of the benchmark group.

$$\begin{aligned}\Delta d_{crisis,it} \;=\; & \alpha_{0,C_k=1|2|3} + \alpha_{1,C_k=1|2|3} frag_{crisis,C_k=1|2|3,it-1} + \alpha_{2,C_k=1|2|3} exp_{crisis,C_k=1|2|3,it-1} + \\ & \alpha_{3,C_k=1|2|3} fund_{crisis,C_k=1|2|3,it-1} + \alpha_{4,C_k=1|2|3} char_{crisis,C_k=1|2|3,it-1} + \\ & \alpha_{5,C_k=1|2|3} \Delta macro_{crisis,C_k=1|2|3,it-1} + \eta_i + \varepsilon_{it} \end{aligned} \tag{4}$$

where $C_k = 1|2|3$ is our categorical variable with three equally-sized groups.

For the choice of the categories, we take some of the pre-crisis exogenous variables we have already considered in equations (1) and (2): total amount of foreign assets, growth in foreign assets and profitability. This additionally allows us to compare/check the results of the previous outcomes in a consistent setting.

5 Empirical outcome

5.1 Shrinkage of foreign and total assets determined by pre-crisis bank structure

In our sample of 67 banking groups, the higher the share of securities on the balance sheet was just before the crisis, the more the bank responded with a reduction of its foreign and total assets (see significantly negative coefficients for variable *securities* in Table 4, columns 1 and 2). Thus, firms more engaged in fields aside from traditional lending are found to have been in greater trouble during the crisis.[24] This arguments is supported by the fact that, as total assets shrink more strongly, the more non-interest income was generated before the crisis. In contrast, banks with rather strong "long run" profitability on average in the run up to the crisis (here recourse on long pre-crisis period from 2002Q1 to 2008Q2) decreased their foreign and total assets to a lesser extent during the crisis - which is another significant and robust outcome of our regressions. This gives us an indication that, with respect to the overall pre-crisis period starting in 2002, successful

[24] An alternative explanation is that banks with high stocks of securities may deleverage more easily. However, we find that the deleveraging process took place not only in securities, but also in loans.

income generation by a bank should be interpreted more as a sign of strength or efficiency and less as a reflection of excessive risk-taking. Additionally, more sizeable international activities had an anchoring function for banks' foreign - on the part of banks with large exposures abroad - and total assets in the crisis. However a component of the foreign assets, the pre-crisis exposures to financial centers, was a driver for the withdrawal process (see Table 4, columns 2 to 4). Moreover, in the crisis the group of 34 banks with a large exposure in foreign assets was also faced with significant pressure on its overall foreign business from its activities in the euro-area periphery countries (see Table 4, column 3). For the banks with rather limited activities abroad (subsample of 33 banks with small foreign exposures), the presence of strong affiliates abroad had a stabilizing influence on foreign activities (see column 5 in Table 4). Furthermore, the development of total assets is positively related to economic demand and economic prospects (see coefficient of the weighted macroeconomic conditions index, columns 2, 4, and 5 in Table 4).

However, some pre-crisis variables for which we expected to see some relevance for the balance sheet shrinkage in the crisis period do not show any impact: liquidity, leverage, core Tier 1 capital to RWA-ratio, loans-to-deposits ratio and deposit funding. However, to our surprise, short-term wholesale funding had a significantly positive effect on total assets.[25]

5.2 Pre-crisis bank structure explains shrinkage of exposures especially vis-à-vis non-financial centers abroad and the home market

A strength of our data is that we know precisely in which countries the consolidated foreign business of the banks is domiciled. Armed with this knowledge, we find that the results we derived above for foreign assets in the crisis were driven mainly by banks' activities in countries with no financial centers. This is indicated not only by a higher number of significant coefficients, but also by adjusted R^2 higher than those for the estimations relying on the exposures vis-à-vis financial centers (Table 5, columns 1 - 3 for regressions vis-à-vis non-financial centers: column 1 for the complete sample of banks, columns 2 and 3 for the banks with large or small amounts of foreign assets; and columns 4 to 6 for their counterparts with respect to activities in financial centers). For foreign non-financial activities, there is again a negative impact of pre-crisis securities and a positive impact of pre-crisis profitability. Furthermore, for the 34 banks with large foreign assets, foreign assets vis-à-vis non financial centers are positively affected by the pre-crisis size of total foreign assets, while its components vis-à-vis financial centers and euro-area periphery countries are shown to have a negative impact. Thus, for the banks with large foreign assets risky exposures revealed to be relevant and lead to a contractive policy in the crisis. For the banks with relatively small activities abroad, potentially risky exposures have no effect on their activities abroad - maybe they are of minor relevance within the foreign business - but strong affiliate presence and high profitability in the pre-crisis period again prove to be a supporting factors in the crisis. Thus, a stable strategy abroad is anchored by an established infrastructure abroad and the availabilty of financial ressources. Turning

[25] In contrast, in the panel estimations below the impact of short term funding gets - as expected - negative.

to the assets vis-à-vis financial centers, among the variables of interest it is solely the stock of securities that turns out to have a significantly negative impact (see Table 5, column 4). Additionally, for banks with small foreign assets (see Table 5, column 6), a better pre-crisis performance along with strong affiliate relevance helped them to stabilize their activities in financial centers. The outcome with only a few relevant determinants for the financial centers was to expect as financial deals are presumably more eratic and more short-term driven. For the banks' home business (see Table 5, columns 7-9), pre-crisis performance again has a positive effect, while both security stocks and higher non-interest income are accompanied by adjustment pressure. Finally, when turning to the growth of the ratio of foreign to total assets for the banks with large foreign assets as a dependent variable (see Table 5, column 10),[26] again we find pre-crisis total investment abroad to be supportive, while exposures in financial centers and the euro-area periphery countries have a negative impact. Also, pre-crisis liquidity acts as an anchor for foreign activities, while pre-crisis performance seems to be more in favor of home market activities (significantly negative, however, at the 10% level).

5.3 Shrinkage of foreign and total assets in the crisis period also driven by pre-crisis bank behavior

Now, we investigate whether the banks' behavior in the run-up to the crisis from 2002Q2 to 2008Q2 already hinted at the vulnerabilities from which the financial institutions suffered in the subsequent crisis period. Matching the outcomes for the pre-crisis balance sheet structure from above, the trend in foreign and total assets within the crisis is already positively linked to pre-crisis growth in the relative importance of bank's international activities, but also to pre-crisis growth in foreign and total assets per se (see Table 6, column (1) and (2)). Thus, banks with a more expansionary policy in the six and a half years up to the crisis revealed less balance sheet shrinkage during the crisis. However, growth of assets vis-à-vis the euro-area periphery countries resulted in adjustment pressure after the collapse of Lehman Brothers. Moreover, a pre-crisis build-up of security stocks has negative implications for foreign assets in the crisis. While an increase in profits was revealed to be insignificant, an increase in profits higher than asset growth abroad or in total assets - noted as foreign assets and total assets profitability respectively - ended up in a balance sheet shrinkage. Thus, disproportionate profit increases seem to be linked to elevated risks. With respect to total assets (see Table 6, column (2)), pre-crisis growth in the Tier 1 to RWA-ratio and - at the 10% significance level - of deposits lead to a stabilization of banking activities in the later crisis.

Finally, we shorten our pre-crisis period with the choice of a later starting date (2005Q1; for the outcome, see Table 6, columns (5) and (6)). As before, growth in securities has a negative impact on later developments in both foreign and total assets. The main finding, however, is that pre-crisis growth in both total assets and in - significant at the 10% level - foreign assets is mirrored by a contraction of assets in the crisis period.[27] Thus, the last stage of the balance sheet expansion before the outbreak of the crisis seems to have been excessive and led to a correction by reverse developments in the

[26] This can be also interpreted as the reverse of a home bias in bank investment.

[27] This is consistent with Fahlenbrach et al. (2012) who also find a negative impact of total asset growth in the three years prior to the crisis.

crisis. According to the sizes of the coefficients, the reversal was much more pronounced in the case of the foreign assets. In addition, higher profitability in the shortened pre-crisis period leads to a reduction of total assets in the crisis - again an indication of excessive risk-taking. Thus, the shortening of the observation period resulted in a switching of the sign of the coefficient on profitability.

5.4 Banks' balance sheet shrinkage and bank's structure during the crisis (and during the pre-crisis period)

In this section, we turn to the question of whether the relevant bank characteristics taken thus far from the pre-crisis period remain significant during the crisis. For this, we estimate a panel with fixed effects based on quarterly data and the bank characteristics enter with a lag of one period (see equation (3)).

As an outcome, growth in total foreign assets, foreign assets vis-à-vis non-financial centers, the share of foreign assets and - with some limitations - total assets largely share the same drivers in the crisis (see Table 7, columns (1), (2), (4) and (5)). Some of the findings for the pre-crisis characteristics above emerge again: a larger stock of securities during the crisis made banks reduce their activities abroad and in total. Additionally, banks that generate more profits through trading and provisions and banks with larger exposures in the euro-area periphery countries tend to reduce their foreign activities and their share of foreign activities. However, a stronger presence abroad through affiliates has a stabilizing effect. Going beyond the previous output, short-term funding during the crisis period comes as a disadvantage for maintaining foreign business, and higher capital endowment in the context of the Tier 1 capital ratio has a positive effect on both foreign and total assets.[28]

In the last five columns of Table 7 (columns (6) to (10)), we take a look at the explanatory power of these variables for foreign and total assets in the pre-crisis context. We find that in "normal" times, most of these variables lose significance. However, a higher Tier 1 to RWA capital ratio still encourages banks to extend their stocks of foreign assets - though it has a hampering effect on total assets. Also, with a higher return on assets, banks increased their foreign and total assets in the run-up to the crisis. The same applies to liquidity, but only in the context of foreign assets. With respect to total assets, a larger share of deposits results in a more expansionary policy, while higher short-term funding has a contractionary impact.

5.5 Banks' balance sheet shrinkage and their structure during the crisis for the banks grouped on pre-crisis features

In this section, we conduct a kind of combination of the models above what may be also seen as a robustness check. Above, we first started with the analysis of the relevance of pre-crisis factors for the deleveraging behavior of banks in the crisis. Afterwards, we looked at the relevance of these factors when we take their realizations within the crisis into

[28] In additional regressions (see Table 9 in Appendix A), we estimate separately for private banks, Landesbanken, savings banks, cooperatives banks and mortgage banks. The highest explanatory power measured in R^2 is found for Landesbanken and mortgage banks. Institutions in these two groups were revealed to be fragile in the crisis.

account. Now, we end up with grouping the banks according to pre-crisis characteristics and behavior what allows us to consider if the pre-crisis affects the relevance of balance sheet characteristics within the crisis. The outcome points in the direction of the results already obtained before. For this reason, we keep this section rather short.

5.5.1 Pre-crisis size of foreign assets and the drivers of shrinkage abroad during the crisis: Outcome determined by banks with high pre-crisis levels of foreign assets

For the group of banks which entered the financial crisis with larger stocks of foreign assets than the benchmark group, a high capital endowment - measured as Tier 1 capital to RWA - had a stabilizing function for their foreign assets in the crisis (see Table 8, column 1). It is also possible to ascribe to this group the highly relevant previous outcomes that larger securities, higher trading and provision income, and higher short-term wholsale funding are accompanied by a reduction of foreign assets. Furthermore, the higher their relative foreign activities are and even their total size is, the more likely is a reduction of business abroad in the crisis - although presence through affiliates abroad works as a stabilizer. Thus, in the third of the sample with the largest banks size comes as a burden, what is a reversal of the picture we obtained for the half of the sample with large foreign assets. Thus, size shows up to be crucial for the behavior of banks in the crises. In contrast, within the thirds of banks with small and medium pre-crisis stocks of foreign assets, a higher return on capital positively affects foreign activities in the crisis. For the benchmark group, exposure vis-à-vis the euro-area periphery countries shows up negatively.

5.5.2 Pre-crisis growth in foreign assets and the drivers of shrinkage abroad during the crisis: Evidence for stabilizers in the case of banks with slow growth in the run-up to the crisis

With respect to the pre-crisis balance sheet expansion abroad, it is in the group with the slowest pre-crisis growth path where we find the expected outcome (see Table 8, column 2): Capital endowment, liquidity, deposits and affiliate presence are supportive of foreign assets in the crisis, while foreign activities as well as size in general come as a burden. The outcome, that we find most significance for the determinants of the third with the slowest growth path may reflect that results above for fast growing banks have been partly depending on the starting point of our pre-crisis sample (2002Q1 onwards or 2005 Q1 onwards).

5.5.3 Pre-crisis profitability and the drivers of shrinkage abroad during the crisis: Banks with low profitability struggling with non-traditional banking business

In our estimation above, pre-crisis profitability was a stabilizing element. Accordingly, it is here the bank group with below-average pre-crisis profitability that is negatively affected by a larger stock of securities, a higher share of of non-interest income, and greater activities at financial centers (see Table 8, column 3). Capital endowment, deposit funding, overall international exposure and high affiliate presence abroad act as stabilizers

for the less profitable banks (while - surprisingly - activities in the euro-area periphery countries ease pressure on the balance sheet).

6 Conclusions

From a regulatory point of view, excesses in the banking industry has to be avoided as public interests may be violated when risks materialize. If banks respond to a crisis with a rapid and far-reaching shrinkage of the balance sheet, the real economy may suffer from a cut in funding. In such a situation, a banking crisis would spill over to the real economy via credit rationing. Furthermore, if banking groups are systemically relevant and get into financial distress, the economy and/or several economies and financial markets will be exposed to large risks.

Thus, as a measure of disrupted financial intermediation through banks, we rely on the supply-driven part of the balance sheet shrinkage from autumn 2008 - immediately following the collapse of Lehman Brothers - to end-2012. As most of the withdrawal took place in foreign activities, we also address balance sheet shrinkage in foreign assets separately from total assets. Since foreign assets are held almost entirely by sizable German banks, we restrict our sample to the group of - ultimately - 67 largest banking conglomerates. In some analyses, we even condense our sample to the 34 banks with the highest foreign exposure, as we expect this group to act even more strategically in the adjustment of its foreign business and as this group already accounts for the overwhelming majority of foreign assets.

The focus of this study is the identification of excessive developments in the financial sector prior to the financial crisis. To do this, we look for variables and trends in the run-up of the crisis that prove to be relevant for the strong contraction in the foreign and total business of German banks in its aftermath. As an outcome, the fragility from which banks suffered in the crisis is already apparent in the pre-crisis period: The balance sheet structure just before the outbreak of the crisis is highly relevant for the constraints faced by banks during the crisis. However, already their pre-crisis behavior – reflected by the growth rates in "crisis-relevant" characteristics in the run-up to the crisis - affected the deleveraging in the crisis. Additionally, the critical variables of the pre-crisis balance sheet retain their importance when we look at them throughout the crisis. Thus, it was not possible for the banks to make a rapid adjustment to the crisis scenario under the restrictions imposed by the crisis. Moreover, a grouping of our banks by specified pre-crisis characteristics or behavior is of relevance for banks' balance sheet characteristics during the crisis in terms of deleveraging. In contrast, outside the crisis, these same characteristics are mostly unremarkable.

Pre-crisis variables which - when they are high in comparison with the other banks - in general were followed by deleveraging in the crisis are: share of securities, share of non-interest income, exposures vis-à-vis financial centers, and, to a lesser extent, exposures vis-à-vis the euro-area periphery countries. This may be in line with expectations and seems reasonable given that withdrawals were chiefly in foreign business, while domestic activities - dominated by traditional lending - did not see such a decrease. In contrast, a stabilizing effect stems from high profitability, overall foreign activities and a strong presence with affiliates abroad. However, pre-crisis capital endowment (Tier 1 capital to

RWA ratio) and deposit funding prove to be stabilizing for total assets in the crisis only when they were raised in the pre-crisis period. Thus, financial institutions that enhanced their capital position and increased their stable funding base showed an attitude of risk aversion, which was accommodated by positive effects in the subsequent crisis. In our analysis, we are especially interested in the drivers of foreign assets in the crisis. Of course, the question arises as to whether these determinants primarily explain the development of certain components of foreign assets. And, in fact, our drivers explain pretty well in general the development of the assets vis-à-vis non-financial centers in the crisis. In addition, that half of our sample comprising the banks with the largest foreign exposures is often where the action is.

With respect to the banks' pre-crisis behavior, we address the central question of whether the withdrawals in the crisis are the outcome of excessive expansions before the outbreak of the crisis. First, for our pre-crisis sample starting in 2002, the balance sheet expansion both with respect to foreign and total assets lead in fact to stable balance sheets in the crisis. However, when pre-crisis profit growth was disproportionately high, the banks came under adjustment pressure in the crisis. Thus, excessive profits seem to be accompanied by higher risks and this is punished later in the crisis. In contrast, when we shorten our pre-crisis period to the time span from 2005 to mid 2008, pre-crisis balance sheet growth abroad and in total already negatively affects bank's foreign and total positions in the crisis and a high pre-crisis return on capital has a negative impact on total assets in the crisis. This additionally indicates that extraordinary risk-taking was taking place relatively close to the outbreak of the crisis.

Next, when we turn to the relevance of the balance sheet structure during the crisis in terms of asset withdrawal in this period, high securities and a large share of non-interest income again came as a burden. Moreover, short-term funding and exposures vis-à-vis the euro-area periphery countries show a significantly negative effect. In contrast, stabilization is provided by a strong capital endowment and a high presence through affiliates abroad. However, when we conduct the same analysis for the pre-crisis period, these bank characteristics are most often insignificant. Thus, in a crisis variables are shown to be relevant that have no importance for banks' behavior in normal times.

Finally, during the crisis the role of the balance sheet structures for the dynamics of the asset positions is found to be dependent on the banks' pre-crisis characteristics and behavior. First, we get confirmed that banks which entered the crisis with a large - absolute - amount of foreign assets strongly drive the results for our bank sample in the crisis period. In contrast, mainly for the group of banks which showed the slowest pre-crisis increase in foreign assets, we find empirical evidence for bank characteristics stabilizing their activities: capital endowment, liquidity, deposits and affiliate presence. Last, we see that the least profitable banks in the entire pre-crisis period from 2002 up to the collapse of Lehman Brothers expierenced most adjustment pressure from non-traditional banking business in the crisis. Here, securities, non-interest income and activities at financial centers reveal a contractionary effect.

Summing up, a comprehensive assessment exercise for banks' stability is far removed from a single balance sheet inventory at a given moment in time.[29] It is not only the

[29]Thus, with Greenwood, Landier, and Thesmar (2012), we doubt that policies which target solely bank solvency at one moment, such as was implicit in both the European and US stress tests right after the outbreak of the crisis, are sufficient.

structure with which a bank enters a crisis period but also its pre-crisis behavior that matters. Thus, banks' pre-crisis business model and their willingness to take risks, along with pre-crisis changes in their attitudes came to play a role in the subsequent crisis. Accordingly, the relevance of banks' balance sheet structures during the crisis is found to be dependent on their pre-crisis characteristics and behavior. Finally, balance sheet structures that are problematic in a crisis are found to be irrelevant for the banks' business in normal times.

References

Acharya, V. V., P. Schnabl, and G. Suarez (2013). Securitization without risk transfer. *Journal of Financial Economics 107*, 515–536.

Acharya, V. V. and S. Steffen (2015). The "greatest" carry trade ever? understanding eurozone bank risks. *Journal of Financial Economics 115*, 215–236.

Adrian, T. and H. S. Shin (2010). Liquidity and leverage. *Journal of Financial Intermediation 19*, 418–437.

Aiyar, S., C. W. Calomiris, J. Hooley, Y. Korniyenko, and T. Wieladek (2014). The international transmission of bank capital requirements: Evidence from the uk. *Journal of Financial Economics 113*, 368–382.

Altunbas, Y., L. Gambacorta, and D. Marques-Ibanez (2009). Bank risk and monetary policy. *ECB Working Paper Series, No. 1075*.

Avdjiev, S., Z. Kuti, and E. Takats (2012). The euro area crisis and cross-border bank lending to emerging markets. *BIS Quarterly Review, December 2012*, 37–47.

Beltratti, A. and R. M. Stulz (2012). The credit crisis around the globe: Why did some banks perform better? *Journal of Financial Economics 105*, 1–171.

Berger, A. N. and C. H. S. Bouwman (2013). How does capital affect bank performance during financial? *Journal of Financial Economics 109*, 146–176.

Bertrand, M., E. Duflo, and S. Mullainathan (2004). How much should we trust differences-in-differences estimates? *Quarterly Journal of Economics 119*, 249–275.

Bruno, V. and H. S. Shin (2013). Capital flows, cross-border banking and global liquidity. *NBER WORKING PAPER SERIES, No. 19038*.

Buch, C., C. Koch, and M. Koetter (2011). Crises, rescues, and policy transmission through international banks. *Discussion Paper, Series 1, Economic Studies, No 15/2011, Economic Research Centre*.

Calvo, G., L. Leiderman, and C. Reinhart (1993). Capital inflows and real exchange rate appreciation in latin america - the role of external factors. *IMF Staff Papers 40*, 108–151.

Cetorelli, N. and L. Goldberg (2011). Global banks and international shock transmission: Evidence from the crisis. *IMF Economic Review 59*, 41–76.

Chuhan, P., S. Claessens, and N. Mamingi (1998). Equity and bond flows to latin america and asia: the role of global and country factors. *Journal of Development Economics 55*, 439–463.

Cremers, K. J. M., R. Huang, and Z. Sautner (2011). Internal capital markets and corporate control in a banking group. *Review of Financial Studies 24*, 358–401.

de Haas, R. and I. van Lelyfeld (2006). Foreign banks and credit stability in central and eastern europe. a panel data analysis. *Journal of Banking and Finance 30*, 1927–1952.

de Haas, R. and I. van Lelyfeld (2010). Internal capital markets and lending by multinational bank subsidiaries. *Journal of Financial Intermediation 19*, 1–25.

de Jonghe, O. (2010). Back to the basics in banking? a micro-analysis of banking system stability. *Journal of Financial Intermediation 19*, 387–417.

Demirguec-Kunt, A. and H. Huizinga (2010). Bank activity and funding strategies:the impact on risk and returns. *Journal of Financial Economics 98*, 626–650.

Duewel/Kerl, C., R. Frey, and A. Lipponer (2011). Cross-border bank lending, risk aversion and the financial crisis. *Discussion Paper, Series 1, Economic Studies, No 29/2011, Economic Research Centre, Deutsche Bundesbank*.

Fahlenbrach, R., R. Prilmeier, and R. M. Stulz (2012). This time is the same: Using bank performance in 1998 to explain bank performance during the recent financial crisis. *Journal of Finance 67*, 2139–2185.

Foos, D., L. Norden, and M. Weber (2010). Loan growth and riskiness of banks. *Journal of Banking & Finance 34*, 2929–2940.

Frey, R. and C. Kerl (2015). Multinational banks in the crisis: Foreign affiliate lending as a mirror of funding pressure and competition on the internal capital market. *Journal of Banking & Finance 50*, 52–68.

Giannetti, M. and L. Laeven (2012). The flight home effect: Evidence from the syndicated loan market during financial crises. *Journal of Financial Economics 104*, 23–43.

Greenwood, R., A. Landier, and D. Thesmar (2012). Vulnerable banks. *NBER WORKING PAPER SERIES, No. 18537*.

Hahm, J.-H., H. S. Shin, and K. Shin (2012). Non-core bank liabilities and financial vulnerability. *NBER WORKING PAPER SERIES, No. 18428*.

Ivashina, V. and D. S. Scharfstein (2010). Bank lending during the financial crisis of 2008. *Journal of Financial Economics 97*, 319–338.

Ivashina, V., D. S. Scharfstein, and J. C. Stein (2012). Dollar funding and the lending behavior of global banks. *NBER WORKING PAPER SERIES, No. 18528*.

Jeanneau, S. and M. Micu (2002). Determinants of international bank lending to emerging market countries. *BIS Working Paper No. 112*.

Jimenez, G. and J. Saurina (2006). Credit cycles, credit risk, and prudential regulation. *International Journal of Central Banking 2*, 65–98.

Kalemli-Ozcan, S., B. Sorensen, and S. Yesiltas (2012). Leverage across firms, banks, and countries. *Journal of International Economics 88*, 284–298.

Kapan, T. and C. Minoiu (2013). Balance sheet strength and bank lending during the global financial crisis. *Deutsche Bundesbank Discussion Paper, No. 33*.

Kashyap, A. K. and J. C. Stein (2004). Cyclical implications of the basel ii capital standards. *Federal Reserve Bank of Chicago Economic Perspectives 1Q*, 18–31.

Khwaja, A. I. and A. Mian (2008). Tracing the impact of bank liquidity shocks: Evidence from an emerging market. *American Economic Review 98*, 1413–1442.

Kick, T., T. Pausch, and B. Ruprecht (2013). The winner's curse - evidence on the danger of aggressive credit growth in banking. *mimeo*.

Kishan, R. and T. Opiela (2000). Bank size, bank capital, and the bank lending channel. *Journal of Money, Credit and Banking 32*, 121–141.

Morris, S. and H. S. Shin (2004). Liquidity black holes. *Review of Finance 8*, 1–18.

Ongena, S., A. Popov, and G. F. Udell (2013). "when the cat's away the mice will play": Does regulation at home affect bank risk-taking abroad? *Journal of Financial Economics 108*, 727–750.

Roengpitya, R., N. Tarashev, and K. Tsatsaronis (2014). Bank business models. *BIS Quarterly Review, December 2014*, 55–65.

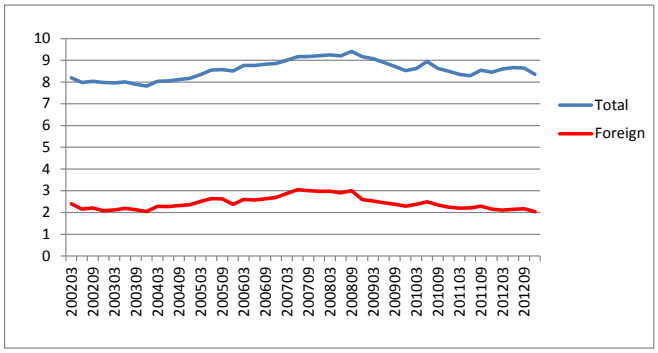
Rose, A. and T. Wieladek (2011). Financial protectionism: the first tests. external mpc unit. *Bank of England Discussion Paper, No. 32*.

Schularick, M. and A. M. Taylor (2012). Credit booms gone bust: Monetary policy, leverage cycles, and financial crises, 1870-2008. *American Economic Review 102*, 1029–1061.

Sinkey, J. F. and M. B. Greenawalt (1991). Loan-loss experience and risk-taking behavior at large commercial banks. *Journal of Financial Services Research 5*, 43–59.

A Appendix

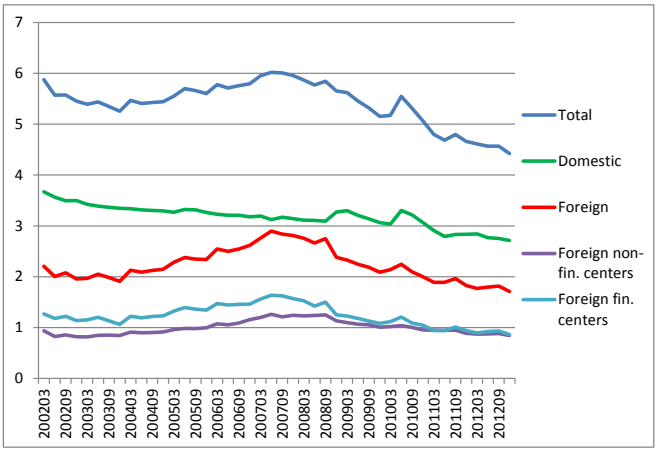
Figure 2: German banking systems total and foreign assets (in EUR trillion)



Source: Deutsche Bundesbank.

This graph is a overall picture of the German banking sector's aggregate balance sheet with total and foreign positions. The data are consolidated for the banking groups and thus include, alongside data of the parent banks located in Germany, data of their branches and subsidiaries abroad. The series are reported to the Deutsche Bundesbank by the German banks and their affiliates located abroad.

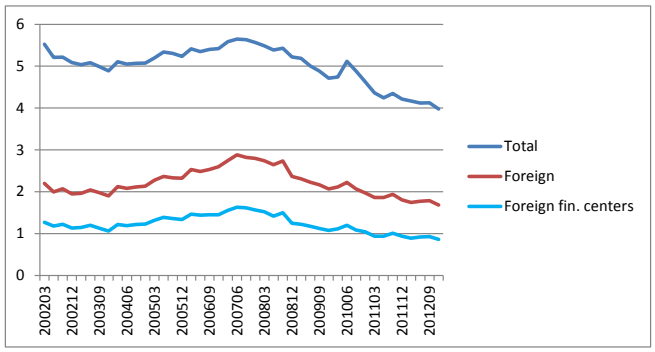
Figure 3: Banks' total, domestic and foreign assets (sample, in EUR trillion)



Source: Deutsche Bundesbank.

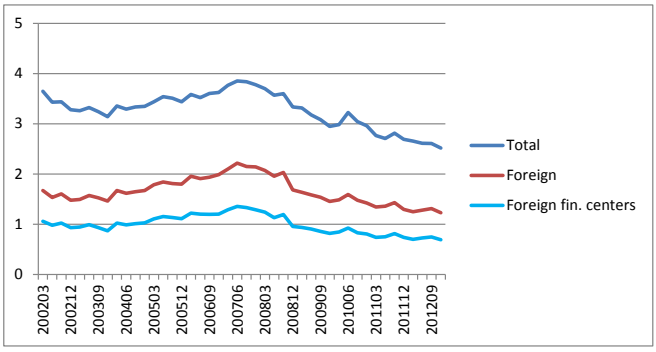
The sample comprises 67 banking groups. The database external positions allows a regional assignment of the assets.

Figure 4: Total and foreign assets of banks with high foreign activity (half of sample, in EUR trillion)



Source: Deutsche Bundesbank.
Here, 34 of the banks in the sample are taken. We look at the group of banks with the largest amount of foreign assets in 2008Q2.

Figure 5: Total and foreign assets of banks with highest foreign activity (90% quantile of sample, in EUR trillion)



Source: Deutsche Bundesbank.
Here, the 90% quantile of the sample is considered which corresponds to the seven banks most active abroad. Again, we look at the group of banks with the largest amount of foreign assets in 2008Q2.

Table 1: Descriptive statistics: Pre-crisis bank characteristics for OLS estimations with time-collapsed data

These data are applied in regression equation (1) in which the pre-crisis (2002Q1 to 2008Q2) and the crisis period (2008Q3 to 2012Q4) are time-collapsed and characterized by one observation for each variable series - which characterizes this episode (both for the complete sample with 67 banks and for the 34 banks with the largest foreign assets). The dependend variables for deleveraging are calculated as growth rates (Δ) - for the sake of smoothing and seasonal adjustment, the average of the value of the last four quarters of the crisis period is set in relation to the one of the first four quarters. The variables for the pre-crisis period are generally taken at the end of Q2 2008, which means just before the collapse of Lehman Brothers. Exceptions are the Tier 1 to RWA capital ratio, the share of non-interest income to total income and return on capital, where the means over the pre-crisis period are taken. If they are no ratios they are expressed relative to total assets and in case of size the log is taken.

	N	mean	sd	min	max
Sample					
Crisis period:					
Δ Foreign assets	67	0.402	2.500	-1	18.46
Δ Size	67	0.00688	0.369	-0.652	1.952
Δ Foreign assets: Non-fin. centers	67	0.757	2.951	-1	20.21
Δ Foreign assets: Fin. centers	67	0.0677	1.584	-1	7.714
Δ Domestic assets	67	0.0146	0.296	-0.590	1.191
Δ Foreign to total assets	67	0.206	1.131	-1	5.591
Δ Foreign economies	67	-0.427	0.0745	-0.635	-0.259
Δ All economies	67	-0.229	0.0519	-0.403	-0.118
Pre-crisis period:					
Tier 1 to RWA	67	0.0876	0.0494	confidential*	confidential*
Liquidity	67	0.0516	0.0447	confidential*	confidential*
Loans to deposits	67	15.26	37.05	confidential*	confidential*
Securities	67	0.247	0.129	confidential*	confidential*
International activities	67	0.217	0.211	confidential*	confidential*
Affiliate relevance	67	0.0753	0.141	confidential*	confidential*
Financial center exposure	67	0.0908	0.107	confidential*	confidential*
Peripheral exposure	67	0.0595	0.0589	confidential*	confidential*
Deposit funding	67	0.499	0.412	confidential*	confidential*
Short term funding	67	0.126	0.142	confidential*	confidential*
Size	67	3.294	1.376	confidential*	confidential*
Leverage	67	29.81	18.73	confidential*	confidential*
Non-interest income	67	1.123	1.851	confidential*	confidential*
Return on cap	67	0.000814	0.000679	confidential*	confidential*
Banks with large foreign assets					
Crisis period:					
Δ Foreign assets	34	-0.256	0.440	-0.999	0.927
Δ Size	34	-0.124	0.291	-0.652	0.692
Δ Foreign assets: Non-fin. centers	34	-0.281	0.433	-1	0.882
Δ Foreign assets: Fin. centers	34	-0.257	0.499	-0.997	1.144
Δ Domestic assets	34	-0.0775	0.275	-0.590	0.546
Δ Foreign to total assets	34	-0.152	0.385	-0.999	0.630
Δ Foreign economies	34	-0.403	0.0538	-0.495	-0.259
Δ All economies	34	-0.264	0.0467	-0.403	-0.188
Pre-crisis period:					
Tier 1 to RWA	34	0.0767	0.0129	confidential*	confidential*
Liquidity	34	0.0611	0.0566	confidential*	confidential*
Loans to deposits	34	29.28	48.32	confidential*	confidential*
Securities	34	0.268	0.123	confidential*	confidential*
International activities	34	0.377	0.179	confidential*	confidential*
Affiliate relevance	34	0.147	0.171	confidential*	confidential*
Financial center exposure	34	0.159	0.113	confidential*	confidential*
Periphery exposure	34	0.100	0.0530	confidential*	confidential*
Deposit funding	34	0.165	0.233	confidential*	confidential*
Short term funding	34	0.209	0.157	confidential*	confidential*
Size	34	4.287	1.227	confidential*	confidential*
Leverage	34	36.89	23.26	confidential*	confidential*
Non-interest income	34	0.882	1.173	confidential*	confidential*
Return on cap	34	0.000485	0.000521	confidential*	confidential*

* Not to be published due to confidentiality rules (as minima and maxima are single observations).

Table 2: Descriptive statistics: Pre-crisis bank behavior for OLS estimations with time-collapsed data

This table reports the descriptive statistics for the data applied in regression equation (2) in which the variables of the pre crisis (2002Q1 to 2008Q2) and of the crisis (2008Q3 to 2012Q4) are "time-collapsed" and thus characterized by one observation for each series. Here, we additionally introduce a shortened pre-crisis period (2005Q1 to 2008Q2). The variables for the crisis and the pre-crisis period are calculated as growth rates (Δ) - for the sake of smoothing and seasonal adjustment, the average of the value of the last four quarters of the crisis (pre-crisis) period is set in relation to the one of the first four quarters of the crisis (pre-crisis). Deviating from that, to take the strong fluctuations in the variable return on cap into account, we calculate its growth rate as the increase in the average return on capital in period 2005Q1 to 2008Q2 in relation to the average in period 2002Q1 to 2004Q4. Last, foreign (total) asset profitability is return on capital minus growth in foreign (total) assets.

	N	mean	sd	min	max
Crisis period					
Δ Foreign assets	67	0.402	2.500	-1	18.46
Δ Size	67	0.00688	0.369	-0.652	1.952
Δ Foreign economies	67	-0.427	0.0745	-0.635	-0.259
Δ All economies	67	-0.229	0.0519	-0.403	-0.118
Long pre-crisis period					
Δ Tier 1 to RWA	67	0.182	0.283	-0.544	1.394
Δ Liquidity	67	1.165	6.277	-0.744	50.59
Δ Securities	67	0.103	0.442	-0.913	1.586
Δ International activities	67	2.552	11.58	-0.617	94.29
Δ Financial center exposure	67	12.68	44.73	-0.822	248.5
Δ Periphery exposure	67	29.84	206.7	-0.641	1,694
Δ Deposit funding	67	0.133	0.706	-0.895	4.001
Δ Short term funding	67	0.350	0.851	-0.679	3.087
Δ Foreign assets - pre crisis	67	5.903	36.59	-0.647	300.1
Δ Size - pre crisis	67	0.124	0.366	-0.391	2.160
Δ Leverage	67	-0.00978	0.529	-0.610	3.890
Δ Non-interest income	67	1.331	14.80	-16.36	117.8
Δ Return on cap	67	0.000124	0.000790	-0.00193	0.00381
Δ Foreign asset profitability	67	-5.903	36.59	-300.1	0.647
Δ Total asset profitability	67	-0.124	0.366	-2.156	0.392
Short pre-crisis period					
Δ Tier 1 to RWA	67	0.110	0.231	-0.772	0.846
Δ Liquidity	67	0.268	1.027	-0.621	6.926
Δ Securities	67	-0.0505	0.269	-0.974	0.568
Δ International activities	67	0.381	0.501	-0.593	1.908
Δ Financial center exposure	67	2.450	13.41	-0.748	109.4
Δ Periphery exposure	67	0.628	1.575	-0.913	12.01
Δ Deposit funding	67	0.0809	0.343	-0.356	1.678
Δ Short term funding	67	8.571	64.21	-0.622	526.1
Δ Foreign assets - pre crisis	67	0.458	0.647	-0.624	3.126
Δ Size - pre crisis	67	0.0507	0.232	-0.334	1.645
Δ Leverage	67	0.00774	0.371	-0.295	2.871
Δ Non-interest income	67	-2.526	22.14	-180.1	10.38

Table 3: Descriptive statistics: Crisis bank characteristics for panel estimations

This table reports the descriptive statistics for the data applied in panel regression equations (3) and (4). For this, data enter on a quarterly basis. The dependent variables - deleveraging in foreign assets, total size, foreign assets vis-à-vis non financial centers and financial centers, and in the share of foreign assets - are calculated as quarterly growth rates. The indices for the macroeconomic conditions are the four-quarter growth rates of weighted GDP of the foreign economies, or of the home and foreign economies together respectively. The national GDP growth rates are weighted according to their relevance in total business just before the collapse of Lehman Brothers 2008Q2. The other exogeneous variables are either ratios or expressed relative to total assets. The log is taken from the variable size. Exceptions are the ratio of non-interest income in relation to total income, and return on capital, where, for the sake of smoothing and seasonal adjustment, the means over four quarters are taken. The crisis period comprises 2008Q3 to 2012Q4, while the pre-crisis period lasts from 2002Q2 to 2008Q2 - due to the calculation of growth rates, one quarter "is lost" in the estimations.

	N	mean	sd	min	max
Crisis period					
Δ Foreign assets	1,206	3,854	133,827	-1	4.647e+06
Δ Size	1,206	-0.00153	0.0586	-0.433	0.644
Δ Foreign assets: Non-fin. centers	1,206	1,733	60,165	-1	2.089e+06
Δ Foreign assets: Fin. centers	1,205	0.0133	0.501	-1	13.93
Δ Foreign to total assets	1,197	2,361	81,698	-1	2.827e+06
Tier 1 to RWA	1,206	0.112	0.0633	confidential*	confidential*
Liquidity	1,206	0.0560	0.0517	confidential*	confidential*
Loans to deposits	1,206	14.90	34.86	confidential*	confidential*
Securities	1,206	0.250	0.120	confidential*	confidential*
International activities	1,206	0.204	0.203	confidential*	confidential*
Affiliate relevance	1,206	0.0665	0.129	confidential*	confidential*
Financial center exposure	1,206	0.0798	0.0978	confidential*	confidential*
Peripheral exposure	1,206	0.0490	0.0604	confidential*	confidential*
Deposit funding	1,206	0.480	0.397	confidential*	confidential*
Short term funding	1,206	0.112	0.121	confidential*	confidential*
Size	1,206	76.79	167.3	confidential*	confidential*
Leverage	1,206	28.44	18.48	confidential*	confidential*
Non-interest income	1,206	0.768	2.370	confidential*	confidential*
Return on cap	1,206	0.000707	0.00129	confidential*	confidential*
Δ Foreign economies	1,206	0.0200	0.0781	-0.155	0.195
Δ All economies	1,206	0.00312	0.0659	-0.553	0.388
Pre-crisis period					
Δ Foreign assets	1,699	0.0582	0.591	-0.739	22.44
Δ Foreign assets: Non-fin. centers	1,699	0.0659	0.799	-0.874	30.10
Δ Foreign assets: Fin. centers	1,699	0.272	5.777	-0.972	233.9
Δ Size	1,699	0.00391	0.0429	-0.277	0.390
Δ Foreign to total assets	1,699	0.0538	0.606	-0.681	23.29
Tier 1 to RWA	1,671	0.0872	0.0645	confidential*	confidential*
Liquidity	1,674	0.0535	0.0491	confidential*	confidential*
Loans to deposits	1,674	15.74	41.36	confidential*	confidential*
Securities	1,674	0.241	0.121	confidential*	confidential*
International activities	1,674	0.166	0.181	confidential*	confidential*
Affiliate relevance	1,674	0.0782	0.149	confidential*	confidential*
Financial center exposure	1,674	0.0753	0.103	confidential*	confidential*
Periphery exposure	1,674	0.0392	0.0418	confidential*	confidential*
Deposit funding	1,674	0.505	0.417	confidential*	confidential*
Short term funding	1,674	0.120	0.149	confidential*	confidential*
Size	1,674	84.24	177.6	confidential*	confidential*
Leverage	1,674	30.63	17.38	confidential*	confidential*
Non-interest income	1,668	0.0986	24.35	confidential*	confidential*
Return on cap	1,671	0.000813	0.00109	confidential*	confidential*
Δ Foreign economies	1,675	-0.0228	0.0670	-0.194	0.185
Δ All economies	1,675	0.00557	0.0411	-0.188	0.285

* Not to be published due to confidentiality rules (as minima and maxima are single observations).

Table 4: Results: OLS regressions with time-collapsed data - Impact of pre-crisis bank characteristics on banks during the crisis

The relevance of pre-crisis variables for banks' behavior in the crisis is estimated by OLS (see regression equation (1)). In our "time-collapsing" approach, we describe for every bank both its reaction in the crisis (2008Q3 to 2012Q4) and its pre-crisis structure (2002Q1 to 2008Q2) by one observation for each variable series. The deleveraging variables for the crisis period are calculated as growth rates (Δ) - for the sake of smoothing and seasonal adjustment, the average value of the last four quarters of the crisis period is set in relation to the one of the first four quarters. The variables for the pre-crisis period are generally taken at the end of Q2 2008, which means just before the collapse of Lehman Brothers. If they are no ratios, they are expressed relative to total assets and the log is taken from size. Exceptions are the Tier 1 to RWA capital ratio, the share of non-interest income to total income and return on capital, where the means over the pre-crisis period are taken.

	(1)	(2)	(3)	(4)	(5)
Dependent vars.:	Δ For. assets	Δ Size	Δ For. assets - Large for. as.	Δ Size - Large for. as.	Δ For. assets - Small for. as.
Tier 1 to RWA	-5.221	0.647	0.0638	3.293	-7.219
	(7.111)	(0.710)	(5.975)	(2.933)	(5.771)
Liquidity	1.521	1.088	4.445*	-0.197	-0.234
	(12.26)	(1.208)	(2.234)	(1.138)	(13.47)
Loans to deposits	0.00400	0.000181	0.00169	0.000622	0.953
	(0.0105)	(0.00104)	(0.00166)	(0.000826)	(1.023)
Securities	-8.103**	-1.486***	-0.215	-0.557	-2.433
	(3.310)	(0.342)	(0.957)	(0.488)	(3.907)
Internat. activities	-1.353	3.243***	3.359***	2.342**	-2.084
	(7.791)	(0.988)	(1.109)	(0.860)	(37.40)
Affiliate relevance	5.359	-1.048	-0.547	-0.118	365.5***
	(5.932)	(0.629)	(0.983)	(0.508)	(65.11)
Financial center exp.	-5.599	-3.729***	-5.082**	-2.610**	-75.45
	(12.33)	(1.355)	(1.891)	(1.097)	(48.51)
Periphery exp.	14.91	-0.207	-4.292**	-1.702	63.02
	(13.82)	(1.392)	(2.035)	(1.062)	(55.95)
Deposit funding	0.935	0.125	-0.104	0.224	0.840
	(1.510)	(0.149)	(0.526)	(0.263)	(2.922)
Short term funding	3.788	1.350**	-1.367	0.408	10.27
	(5.559)	(0.567)	(0.898)	(0.487)	(10.22)
Size	-0.487	-0.0959*	-0.0308	-0.0285	-0.171
	(0.524)	(0.0516)	(0.106)	(0.0564)	(0.762)
Leverage	0.0338	0.00181	0.00340	0.00262	0.0859
	(0.0211)	(0.00214)	(0.00309)	(0.00160)	(0.0588)
Non-interest income	-0.0656	-0.0400**	-0.0774	-0.0799	0.177
	(0.169)	(0.0169)	(0.0911)	(0.0474)	(0.148)
Return on cap	1,425**	142.2**	-144.1	230.6**	2,182***
	(625.8)	(63.76)	(178.2)	(92.09)	(689.8)
Δ For. economies	-6.489		3.486		5.600
	(4.933)		(2.226)		(4.267)
Δ All economies		6.389***		3.918**	
		(1.562)		(1.548)	
Constant	-1.970	1.406***	1.378	0.384	-1.326
	(3.326)	(0.336)	(1.083)	(0.412)	(4.075)
Observations	67	67	34	34	33
R-squared	0.298	0.682	0.730	0.840	0.897
adj. R-squared	0.0916	0.589	0.505	0.708	0.806
F-value	1.443	7.306	3.243	6.323	9.861

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5: Results: OLS regressions with time-collapsed data - Impact of pre-crisis bank characteristics on various components of banks' balance sheets

Again, equation (1) is estimated by OLS (see further information in the head of Table 4). To gain a deeper insight, we take the following components of the previous dependent variables: foreign assets from countries with no financial center, from countries with financial centers, domestic assets, and in addition the share of foreign assets.

Dependent vars.	(1) Non-finan cent. - Δ For. assets	(2) Non-finan cent. - Δ For. assets - Large for. as.	(3) Non-finan cent. - Δ For. assets - Small for. as.	(4) Finan cent. - Δ For. assets	(5) Finan cent. - Δ For. assets - Large for. as.	(6) Finan cent. - Δ For. assets - Small for. as.	(7) Δ Dom. assets	(8) Δ Dom. assets - Large for. as.	(9) Δ Dom. assets - Small for. as.	(10) Δ For. to tot. assets - Large for. as.
Tier 1 to RWA	-7.143	2.209	-7.219	-2.407	-2.527	-0.380	0.883	3.977	0.525	2.185
	(7.597)	(5.586)	(5.771)	(4.540)	(8.068)	(5.018)	(0.619)	(3.575)	(0.758)	(5.531)
Liquidity	-0.290	4.744**	-0.234	0.692	3.540	-10.72	0.673	0.189	1.851	4.357**
	(13.09)	(2.088)	(13.47)	(7.825)	(3.017)	(11.72)	(1.052)	(1.387)	(1.830)	(2.068)
Loans to deposits	0.00741	0.00149	0.953	0.000357	0.00247	1.798*	-0.000286	0.000793	0.0318	0.00228
	(0.0112)	(0.00155)	(1.023)	(0.00668)	(0.00224)	(0.890)	(0.000904)	(0.00101)	(0.143)	(0.00154)
Securities	-7.867**	-0.734	-2.433	-5.509**	-0.0732	-4.328	-1.243***	-0.312	-1.214**	0.585
	(3.535)	(0.895)	(3.907)	(2.113)	(1.293)	(3.397)	(0.298)	(0.595)	(0.544)	(0.886)
Internat. activities	-2.679	4.090***	-2.084	-1.098	2.182	-10.71	0.958	0.101	-1.501	3.211***
	(8.322)	(1.036)	(37.40)	(4.974)	(1.497)	(32.52)	(0.860)	(1.048)	(4.882)	(1.026)
Affiliate relevance	7.150	-0.836	365.5***	4.451	0.745	122.3**	-0.414	0.625	1.831	-0.724
	(6.337)	(0.919)	(65.11)	(3.787)	(1.327)	(56.62)	(0.548)	(0.619)	(10.13)	(0.910)
Financial center exp.	-2.753	-5.745***	-75.45	-4.352	-4.991*	-15.29	-1.439	-0.893	-3.076	-5.458***
	(13.17)	(1.768)	(48.51)	(7.872)	(2.554)	(42.18)	(1.180)	(1.337)	(6.646)	(1.751)
Periphery exp.	14.42	-5.230**	63.02	7.879	-1.500	38.54	1.569	0.479	11.64	-4.825**
	(14.77)	(1.903)	(55.95)	(8.825)	(2.748)	(48.65)	(1.212)	(1.294)	(7.322)	(1.884)
Deposit funding	1.320	-0.127	0.840	0.0926	0.329	2.686	0.216	0.609*	0.207	-0.303
	(1.613)	(0.492)	(2.922)	(0.964)	(0.711)	(2.540)	(0.129)	(0.321)	(0.385)	(0.487)
Short term funding	5.604	-0.954	10.27	0.0730	-1.494	3.718	1.813***	1.169*	2.134	-1.781**
	(5.939)	(0.839)	(10.22)	(3.549)	(1.212)	(8.891)	(0.494)	(0.594)	(1.312)	(0.831)
Size	-0.575	-0.0846	-0.171	-0.282	0.0459	-0.485	-0.0727	-0.0269	-0.0422	0.106
	(0.560)	(0.0992)	(0.762)	(0.335)	(0.143)	(0.663)	(0.0449)	(0.0688)	(0.0971)	(0.0982)
Leverage	0.0349	0.00474	0.0859	0.0296**	0.00653	0.129**	0.00194	0.00358*	-0.00859	0.000273
	(0.0225)	(0.00289)	(0.0588)	(0.0135)	(0.00418)	(0.0511)	(0.00187)	(0.00196)	(0.00771)	(0.00286)
Non-interest income	-0.0595	-0.0158	0.177	-0.0410	-0.195	0.143	-0.0345**	-0.106*	-0.0312	-0.0421
	(0.180)	(0.0852)	(0.148)	(0.108)	(0.123)	(0.129)	(0.0147)	(0.0578)	(0.0208)	(0.0843)
Return on cap	2.190***	-238.6	2,182***	512.9	49.60	1,350**	111.1*	260.9**	89.19	-307.3*
	(668.5)	(166.6)	(689.8)	(399.6)	(240.7)	(599.8)	(55.53)	(112.2)	(91.28)	(165.0)
Δ For. economies	-14.39***	3.146	5.600	-1.998	2.950	5.118				2.511
	(5.270)	(2.081)	(4.267)	(3.149)	(3.006)	(3.710)				(2.061)
Δ All economies							4.132***	2.094	5.048	
							(1.360)	(1.887)	(4.108)	
Constant	-5.700	1.235	-1.326	0.196	0.834	-3.253	0.814***	-0.210	1.100	0.592
Observations	67	34	33	67	34	33	67	34	33	34
adj. R-squared	0.256	0.552	0.806	0.0777	0.297	0.632	0.514	0.513	0.534	0.445
F-value	2.514	3.713	9.861	1.370	1.930	4.669	5.658	3.322	3.448	2.762

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 6: Results: OLS regressions with time-collapsed data - Impact of pre-crisis bank behavior on banks in the crisis

In equation (2), again OLS regressions with time-collapsed data are conducted. We now look at the relevance of the pre-crisis behavior of banks for their balance sheet shrinkages in the crisis. The pre-crisis period is in columns (1) to (4) from 2002Q1 to 2008Q2 and in columns (5) and (6) shortened to the time span from 2005Q1 to 2008Q2. Here, both the variables for the crisis and the pre-crisis period are calculated as growth rates (Δ) - for the sake of smoothing and seasonal adjustment, the average value of the last four quarters of the crisis period is set in relation to the one of the first four quarters.

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Vars.:	Δ For. assets	Δ Size	Δ For. assets	Δ Size	Δ For. assets - Short pre crisis.	Δ Size - Short pre crisis
Δ Tier 1 to RWA	1.368	0.331**	1.365	0.327**	0.743	0.0869
	(1.048)	(0.128)	(1.043)	(0.128)	(1.470)	(0.161)
Δ Liquidity	0.0923	-0.00765	0.0947	-0.00738	0.125	-0.0172
	(0.0683)	(0.00849)	(0.0680)	(0.00851)	(0.285)	(0.0311)
Δ Securities	-1.229**	-0.114	-1.237**	-0.111	-4.311***	-0.651***
	(0.602)	(0.0833)	(0.599)	(0.0835)	(1.193)	(0.140)
Δ International activities	0.422**	0.0603***	0.458**	0.0707***	4.721**	0.0998*
	(0.206)	(0.0208)	(0.199)	(0.0187)	(2.148)	(0.0595)
Δ Financial center exp.	-0.0178	8.64e-05	-0.0186*	-0.000107	-0.0718	-0.0200**
	(0.0108)	(0.00138)	(0.0107)	(0.00137)	(0.0799)	(0.00878)
Δ Periphery exp.	-0.117***	-0.00409***	-0.123***	-0.00471***	0.104	-0.00164
	(0.0256)	(0.00115)	(0.0242)	(0.00101)	(0.174)	(0.0189)
Δ Deposit funding	-0.395	0.0851*	-0.325	0.0981**	-0.497	0.106
	(0.379)	(0.0461)	(0.364)	(0.0447)	(0.878)	(0.100)
Δ Short term funding	-0.240	-0.0284	-0.222	-0.0249	-0.00160	0.000852*
	(0.307)	(0.0366)	(0.305)	(0.0366)	(0.00459)	(0.000507)
Δ Foreign assets	0.541***				-3.581*	
	(0.177)				(1.993)	
Δ Total assets		0.420***				-0.723**
		(0.140)				(0.346)
Δ Leverage	0.529	0.245	0.314	0.193	5.586*	1.334***
	(1.350)	(0.169)	(1.310)	(0.163)	(3.171)	(0.370)
Δ Non-interest income	0.000520	-0.000364	0.000617	-0.000375	-0.000682	-0.00319**
	(0.0166)	(0.00204)	(0.0165)	(0.00205)	(0.0136)	(0.00153)
Δ Return on cap	-309.9	-60.47			-337.1	-130.8**
	(432.3)	(53.69)			(495.0)	(51.82)
Δ Foreign economies	-2.083		-2.295		-6.039	
	(3.557)		(3.528)		(4.126)	
Δ All economies		3.168***		3.216***		2.151***
		(0.651)		(0.651)		(0.684)
Δ Foreign asset profitability			-0.561***			
			(0.174)			
Δ Total asset profitability				-0.458***		
				(0.136)		
Constant	-1.077	0.616***	-1.257	0.606***	-2.505	0.492***
	(1.527)	(0.156)	(1.499)	(0.157)	(1.804)	(0.164)
Observations	67	67	67	67	67	67
R-squared	0.548	0.689	0.543	0.682	0.415	0.681
adj. R-squared	0.437	0.613	0.442	0.611	0.272	0.603
F-value	4.939	9.034	5.357	9.638	2.893	8.696

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 7: Results: Panel regressions - Impact of bank characteristics during the crisis and pre-crisis period

This is the outcome of regression equation (3), a non-dynamic panel with bank and time fixed effects, based on quarterly data for the crisis period (2008Q3 to 2012Q4) and pre-crisis period (2002Q2 to 2008Q2). In general, the dependent and independent variables are quarter-on-quarter growth rates. However, the indices for the macroeconomic conditions - here, GDP development in all foreign countries, or in the home and foreign countries together respectively are four-quarter growth rates. Further exceptions are the share of non-interest income to total income and return on capital, where, for the sake of smoothing and seasonal adjustment, the means over the previous four quarters are taken. All exogenous variables enter the regressions with a lag.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Dependet vars.:	Δ For. assets	Non-fin. cent. - Δ For. assets	Finan. cent. - Δ For. assets	Δ Size	Δ For. to tot. assets	Δ For. assets - Pre crisis	Non-fin. cent. - Δ For. assets - Pre crisis	Fin. cent. - Δ For. assets - Pre crisis	Δ Size - Pre crisis	Δ For. to tot. assets - Pre crisis
Tier 1 to RWA	2.406e+06***	1.081e+06***	0.341	0.378***	1.464e+06***	2.152**	3.115***	-1.245	-0.142***	2.363***
	(22,228)	(9,993)	(1.044)	(0.0314)	(13,522)	(0.401)	(0.541)	(4.000)	(0.0266)	(0.412)
Liquidity	-977.0	-439.1	-0.229	-0.252***	6,118	1.911**	2.576**	46.99***	-0.286***	2.241***
	(51,362)	(23,091)	(0.709)	(0.0721)	(31,327)	(0.796)	(1.076)	(7.948)	(0.0528)	(0.820)
Loans to deposits	-28.65	-12.88	0.000371	0.000134	-11.92	-0.000290	-0.000324	-0.00441	6.15e-05	-0.000360
	(97.12)	(43.66)	(0.00134)	(0.000136)	(59.09)	(0.000853)	(0.00115)	(0.00851)	(5.65e-05)	(0.000878)
Securities	-125,786***	-56,550***	-0.819	-0.175***	-79,961***	-0.391	-0.498	0.950	0.0618*	-0.467
	(37,148)	(16,701)	(0.515)	(0.0521)	(22,643)	(0.495)	(0.669)	(4.946)	(0.0329)	(0.510)
International activities	23,816	10,706	1.234	-0.132	31,586	-0.519	-1.386	2.230	0.156**	-0.686
	(58,357)	(26,236)	(0.805)	(0.0824)	(35,967)	(0.943)	(1.273)	(9.408)	(0.0628)	(0.970)
Affiliate relevance	504,651***	226,878***	1.036	0.000101	302,868***	0.102	0.0973	-2.498	-0.184***	0.265
	(66,810)	(30,036)	(0.945)	(0.0940)	(40,651)	(0.857)	(1.158)	(8.554)	(0.0568)	(0.882)
Financial center exp.	89,207	40,107	-3.411***	0.211*	47,526	-0.242	1.578	-25.36**	-0.00452	-0.241
	(80,581)	(36,227)	(1.112)	(0.114)	(49,064)	(1.284)	(1.735)	(12.82)	(0.0852)	(1.322)
Periphery exp.	-247,762***	-111,387***	-1.643	0.559***	-168,617***	0.235	0.842	12.36	-0.373***	0.637
	(80,353)	(36,125)	(1.113)	(0.114)	(49,239)	(1.594)	(2.154)	(15.92)	(0.106)	(1.641)
Deposit funding	5,152	2,316	0.00896	0.0104	346.6	0.0850	-0.130	-0.778	0.134***	-0.0497
	(10,348)	(4,652)	(0.143)	(0.0146)	(6,398)	(0.414)	(0.560)	(4.134)	(0.0274)	(0.426)
Short term funding	-83,537**	-37,556**	0.313	0.0766	-50,865**	-0.129	-0.164	6.327	-0.0859**	-0.0131
	(33,294)	(14,968)	(0.461)	(0.0469)	(20,269)	(0.568)	(0.767)	(5.665)	(0.0377)	(0.584)
Size	-11,364	-5,109	0.0392	-0.107***	-9,845	-0.420**	-0.450*	3.009*	-0.0855***	-0.335*
	(12,339)	(5,547)	(0.170)	(0.0176)	(7,587)	(0.183)	(0.247)	(1.823)	(0.0121)	(0.188)
Leverage	1,745***	784.3***	0.000512	1.31e-05	1,065***	0.00312	0.00532	-0.0843**	-0.000299	0.00328
	(245.8)	(110.5)	(0.00347)	(0.000346)	(149.5)	(0.00408)	(0.00552)	(0.0408)	(0.000271)	(0.00420)
Non-interest income	-1,172**	-526.9**	-0.00109	0.000386	-743.6**	-3.95e-06	-6.74e-05	-5.57e-05	-1.06e-05	1.33e-05
	(518.0)	(232.9)	(0.00716)	(0.000728)	(315.2)	(0.000649)	(0.000877)	(0.00648)	(4.30e-05)	(0.000668)
Return on cap	-1.150e+06	-517,082	58.72**	0.774	-524.634	75.27***	96.33***	464.9**	5.787***	70.86***
	(1.741e+06)	(782,930)	(24.03)	(2.472)	(1.061e+06)	(19.66)	(26.55)	(196.2)	(1.303)	(20.23)
Δ Foreign economies	27,423	12,328	-0.122		22,630	0.464	1.112	3.000		0.535
	(38,063)	(17,112)	(0.525)		(23,739)	(0.724)	(0.979)	(7.231)		(0.746)
Δ All economies				-0.0505					0.0130	
				(0.0311)					(0.0307)	
Constant	-241,569***	-108,603***	0.0186	0.337***	-136,997***	1.087*	1.130	-8.759	0.234***	0.855
Observations	1,206	1,206	1,205	1,206	1,197	1,664	1,664	1,664	1,664	1,664
Number of banks	67	67	67	67	67	67	67	67	67	67
R-squared	0.930	0.930	0.043	0.254	0.931	0.071	0.0712	0.0451	0.186	0.069
Bank and Time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table 8: Results: Categorical panel regressions - Impact of bank characteristics in the crisis with banks grouped on pre-crisis features

In further panel regressions (equation 4), we again conduct a non-dynamic panel with bank and time fixed effects based on quarterly data to explain growth in foreign assets in the crisis (2008Q3 to 2012Q4) but, in addition, we group our bank sample according to pre-crisis features. The categories are relevance of foreign assets, growth of foreign assets and average return on assets in the pre-crisis period. We divide the sample for each category into three groups.

Dependent var.: Δ For. assets	(1)	(2)	(3)
Categories:	For. assets - Pre crisis	Δ For. assets - Pre crisis	Return on cap - Pre crisis
G1: Tier 1 to RWA	91,193	2.542e+06***	2.519e+06***
G2: Tier 1 to RWA	38,723	-1,444	154,779
G3: Tier 1 to RWA	2.440e+06***	3,451	-3,805
G1: Liquidity	-94,411	241,460***	-115,781*
G2: Liquidity	13,396	2,481	-51,421
G3: Liquidity	-18,982	274.3	-45,127
G1: Loans to deposits	-5,439	72.04	-0.749
G2: Loans to deposits	-36.63	-4.482	-20.99
G3: Loans to deposits	-204.1*	15.69	-1.094
G1: Securities	58,376	43,008*	-227,425***
G2: Securities	-57,692	4,445	-15,306
G3: Securities	-269,230***	2,553	36,801
G1: International activities	180,559	-261,747***	97,811*
G2: International activities	137,000	-3,560	106,628
G3: International activities	-231,106***	3,083	108,005
G1: Affiliate relevance	-149,982	780,700***	471,080***
G2: Affiliate relevance	82,703	-3,731	-6,860
G3: Affiliate relevance	1.068e+06***	2,822	36,402
G1: Financial center exp.	-370,341*	755,685***	-402,203***
G2: Financial center exp.	-187,279	8,131	-180,421
G3: Financial center exp.	204,981**	6,065	-204,574*
G1: Periphery exp.	-95,832	-159,303*	472,287***
G2: Periphery exp.	-473,690**	4,735	-357,520*
G3: Periphery exp.	296,665**	-3,287	-111,333
G1: Deposit funding	-13,196	32,749***	81,131***
G2: Deposit funding	-201.9	3,268	-560.1
G3: Deposit funding	-7,659	2,527	1,212
G1: Short term funding	-54,036	32,401	-38,764
G2: Short term funding	-43,383	-520.6	-14,699
G3: Short term funding	-74,302**	973.4	-55,053
G1: Size	33,184*	-55,907***	-21,468
G2: Size	31,463	2,156	20,560
G3: Size	-53,177***	604.8	24,819*
G1: Leverage	-529.9	426.9***	2,386***
G2: Leverage	-846.0	-33.41	-540.9
G3: Leverage	2,335***	-3.587	486.8
G1: Non-interest income	-619.2	-39.48	-1,468***
G2: Non-interest income	-437.1	27.00	-135.8
G3: Non-interest income	-1,983***	29.98	-2,248
G1: Return on cap	7.078e+06***	-6.799e+06***	4.754e+06**
G2: Return on cap	6.175e+06**	315,745	5.018e+06***
G3: Return on cap	-922,495	154,938	6.757e+06***
G1: Δ Foreign economies	22,600	-725.2	37,563
G2: Δ Foreign economies	33,706	9,672	8,581
G3: Δ Foreign economies	39,826	11,490	9,819
Constant	-80,725*	-72,337***	-127,117***
Observations	1,206	1,206	1,206
R-squared	0.958	0.992	0.972
Bank and Time FE	YES	YES	YES

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table 9: Panel regression results: Impact of bank characteristics during the crisis for various bank types

This is the outcome of regression equation (3) a non-dynamic panel with bank and time fixed effects based on quarterly data for the crisis (2008Q3 to 2012Q4). Now, the regressions are run for the different types of banks separately. In general, the dependent and independent variables are quarter-on-quarter growth rate. However, the index for the macroeconomic conditions - here, variation in GDP in all foreign countries is a four-quarter growth rates. Further exceptions are the share of non-interest income to total income and return on capital, where, for the sake of smoothing and seasonal adjustment, the means over the previous four quarters are taken. The exogenous variables enter the regressions with a lag.

	(1)	(2)	(3)	(4)	(5)
Bank groups	private	Landesbanken	savings	cooperatives	mortgage
Tier 1 to RWA	0.118	2.507e+06***	0.115	-0.706	-0.401
	(1.777)	(52,000)	(1.106)	(2.154)	(0.777)
Liquidity	0.145	137,822	-0.155	0.369	-1.137
	(0.795)	(211,423)	(0.739)	(1.084)	(0.706)
Loans to deposits	0.00188	-235.3	0.00722	0.00114	0.000660
	(0.00326)	(473.6)	(0.0624)	(0.00239)	(0.000495)
Securities	-0.231	-1.013e+06***	-0.531	0.0676	-1.070**
	(0.805)	(216,521)	(0.520)	(1.091)	(0.528)
International activities	0.455	-394,556*	-1.677	-2.552*	-1.788**
	(1.353)	(203,981)	(1.078)	(1.507)	(0.707)
Affiliate relevance	0.349	696,700**	1.021	0.399	4.703**
	(1.493)	(280,249)	(0.975)	(1.659)	(2.017)
Financial center exp.	-1.833	63,854	-5.990***	1.156	2.016**
	(1.563)	(339,434)	(2.214)	(2.364)	(0.956)
Periphery exp.	-0.724	839,964	6.377***	3.626*	-1.426
	(1.704)	(507,984)	(2.073)	(2.114)	(1.589)
Deposit funding	-0.00333	-200,672	-0.0272	-0.158	3.611**
	(0.252)	(634,176)	(0.159)	(0.146)	(1.408)
Short term funding	-0.00775	34,590	-0.578	1.043	0.637**
	(0.947)	(156,992)	(0.506)	(0.823)	(0.320)
Size	-0.498**	117,555	0.445	0.268	-0.478***
	(0.221)	(90,122)	(0.436)	(0.527)	(0.136)
Leverage	0.00140	-2,532	-0.00840	-0.0115	0.000197
	(0.00761)	(1,573)	(0.0140)	(0.0136)	(0.00145)
Non-interest income	0.00425	3,530	0.00135	-0.0196	-0.0118*
	(0.00845)	(3,570)	(0.00513)	(0.0487)	(0.00609)
Return on cap	36.07	9.363e+06	-9.083	36.01	-0.659
	(61.01)	(8.057e+06)	(19.25)	(70.95)	(23.29)
Δ Foreign economies	-0.781	230,468	-0.401	0.333	-1.826***
	(0.581)	(390,533)	(0.427)	(0.614)	(0.511)
Constant	1.856**	-483,282	-0.621	-0.365	2.135***
	(0.818)	(393,011)	(0.955)	(1.329)	(0.595)
Observations	216	162	486	180	162
Banks	12	9	27	10	9
R-squared	0.192	0.988	0.090	0.158	0.396
Bank FE	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1