Loan Growth and Riskiness of Banks

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First version: April 30, 2007; this version: July 10, 2009

Abstract

We investigate whether loan growth affects the riskiness of individual banks in 16 major countries. Using Bankscope data from more than 16,000 individual banks during 1997-2007, we test three hypotheses on the relation between abnormal loan growth and asset risk, bank profitability, and bank solvency. We find that loan growth leads to an increase in loan loss provisions during the subsequent three years, to a decrease in relative interest income, and to lower capital ratios. Further analyses show that loan growth also has a negative impact on the risk-adjusted interest income. These results suggest that loan growth represents an important driver of the riskiness of banks.

JEL classification: G20, G21

Keywords: Bank lending; Credit risk; Loan losses; Bank profitability; Bank solvency

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We wish to thank John H. Boyd, Peter Raupach, Klaus Schaeck, Haluk Ünal, Oliver Vins, Wolf Wagner, as well as participants at the 3rd FIRS Conference on Banking, Corporate Finance and Intermediation 2008 in Anchorage, the Southwestern Finance Association Meetings 2008 in Houston, the European Financial Management Association Meetings 2008 in Athens, the European Banking Symposium (ProBanker) 2008 in Milan, the 14th Annual Meeting of the German Finance Association in Dresden, the 11th Annual Meeting of the Swiss Society for Financial Market Research in Zurich, the 2nd Conference on Banking Regulation, Integration and Financial Stability at the Centre for European Economic Research (ZEW) in Mannheim, the research seminar at the FDIC and the University of Mannheim for useful comments and suggestions. In addition, we are grateful to Julia Hein and Jeanette Roth for their support on data issues. Martin Betzwieser provided excellent research assistance.

1. Introduction

The current financial crisis represents a drastic example of what can go wrong with respect to the interplay of growth and risk in bank lending. Specifically, the growth in subprime mortgage lending, fueled by low interest rates, booming housing markets, credit securitization, and lax credit standards, has led to unprecedented credit losses and serious consequences for the global economy, highlighting the importance of the growth-risk nexus in bank lending (e.g., Borio, 2008; Dell'Ariccia, Igan and Laeven, 2008; Demyanyk and van Hemert, 2008; Gorton, 2008).

In this paper, we take a more general perspective and intend to provide new evidence on the intertemporal relation between loan growth and the riskiness of individual banks. Can individual banks grow without becoming riskier subsequently? Is loan growth associated with higher or lower risk-adjusted profitability? What is the relation between loan growth and bank capital? There is little evidence on these questions at the individual bank-level (e.g., Laeven and Majnoni, 2003; Berger and Udell, 2004). Beyond macroeconomic forces and structural trends that affect all banks in a similar way there are many important reasons why individual banks increase their lending. For instance, banks may intend to seize new lending opportunities, expand to new geographic markets or gain market share with existing products and markets. Moreover, potential mechanisms to increase lending are lowering interest rates or relaxing collateral requirements, loosening credit standards, or a combination of both (e.g., Dell'Ariccia and Marquez, 2006; Ogura, 2006). In addition, some banks rely on internal growth but others follow an external growth strategy by means of mergers and acquisitions (M&A). Under the presumption that new loans are granted to borrowers that were previously rejected, that were previously unknown or non-existent, or that ask for too low loan rates or too little collateral relative to their credit quality, loan growth may have adverse effects on bank risk.

To address the questions raised above, we examine the link between loan growth and three fundamental dimensions: the default risk of the loan portfolio, the interest income from lending, and the capital structure. For each of the three dimensions we rely on different empirical measures to capture the credit risk associated with bank lending, the compensation for risk taking, and the overall fragility of banks. Based on Bankscope data from more than 16,000 individual banks in 16 major countries during the period 1997-2007, we test three hypotheses on the relation between abnormal loan growth and riskiness of banks under regular conditions.[1] Abnormal loan growth is defined as the difference between an individual bank's loan growth and the median loan growth of banks from the same country and year. First, we investigate if and how past abnormal loan growth affects loan losses of individual banks. Given the experience that borrowers do not immediately default after they have received a bank loan ("loan seasoning"; e.g., Berger and Udell, 2004), we expect that loan growth translates into an increase of loan loss provisions with a time lag of several years (Hypothesis 1). Second, we examine how abnormal loan growth influences the profitability of individual banks. If new loans are granted at lower rates, the average outstanding loan volume generates a lower relative interest income (Hypothesis 2). Third, we analyze the impact of abnormal loan growth on bank solvency. If banks fund loan growth mainly with new debt, the capital structure becomes more risky. We expect that loan growth leads to a decrease of the equity-to-total assets ratio (Hypothesis 3). The multivariate analyses of these hypotheses indicate that past abnormal loan growth is significantly positively related to loan losses and significantly negatively associated with bank profitability and solvency.

Our paper contributes in several ways. Most of the related studies analyze the link between economic cycles, loan growth, and loan losses at the aggregate level, focusing on the macro-economic determinants of loan growth. Our paper goes beyond these studies by

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[1] Regular conditions refer to a stable economic and legal environment with banking regulation and moderate macroeconomic cycles which are present in all countries included in our sample. The only exception is Japan which we include because of the size of its financial system. All our results based on the full sample remain robust if we exclude Japan.

analyzing the effects of abnormal loan growth on the riskiness of individual banks, controlling for country- and year-specific macroeconomic conditions, including effects from monetary and fiscal policy. Moreover, we focus on the intertemporal relation between loan growth and bank risk while most of the related studies consider the contemporaneous relation in the context of procyclicality. We also provide a comprehensive view on the riskiness of banks, analyzing three fundamental dimensions: credit risk associated with lending, income from lending, and bank solvency. Finally, our study is based on a large and international micro dataset, including the most important banking systems as well as different types of banks, to obtain comprehensive and robust results.

The remainder of this paper is organized as follows. In Section 2 we review the related literature and in Section 3 we describe the data. In Section 4 we report our main results and in Section 5 we present findings from further empirical checks. Section 6 concludes.

2. Related literature

Although the intertemporal relation between loan growth and bank risk, especially credit losses, has been studied at the macroeconomic level in several strands of the literature (e.g., booms and busts in credit markets, banking crises, procyclicality of bank regulation; e.g., Borio, Furfine, and Lowe, 2001; Keeton, 1999), research is rather silent about the cross-sectional differences in this link.

Early empirical studies based on U.S. micro data indicate that loan growth may lead to a subsequent increase of loan losses. Sinkey and Greenawalt (1991) analyze large U.S. banks during the period 1984-1987 and find that the average past loan growth is significantly positively related to the contemporaneous loan loss rate. Interestingly, there is substantial cross-sectional heterogeneity in this link that cannot be explained with macro-economic factors. Clair (1992) analyzes data on individual banks from Texas during the period 1976-1990 and detects a negative impact of loan growth on nonperforming loans and the loan charge-off rate for the first year after a bank's credit expansion, whereas for subsequent years, a positive relation is partly found. Berger and Udell (2004) examine the procyclicality of bank lending in the U.S. during 1980-2000. They find that credit standards are relaxed and more loans are granted as time passes by since a bank's last peak in loan losses. This result is evidence in favor of the "institutional memory hypothesis", i.e., the ability of loan officers to recognize potential loan problems fades out over time, lowering the credit standards and increasing the lending volume.

The determinants of loan losses have also been studied at the international level and in countries outside the U.S. Laeven and Majnoni (2003) analyze Bankscope data from 45 countries to shed light on factors influencing the loan loss provisioning and income smoothing of more than 1,000 large commercial banks during the period 1988-1999. It turns out that, on average, banks provision too little in good times of the cycle and are forced to overreact in bad times. They also detect a significantly negative contemporaneous relation between loan growth and loan losses, suggesting an imprudent provisioning behavior of banks. Similarly, Bikker and Metzemakers (2005) examine the contemporaneous relation between loan loss provisioning of individual commercial banks and the business cycle during the period 1991-2001. Based on Bankscope data from a subset of OECD countries they find a negative relation between GDP growth and loan loss provisioning, i.e., a procyclical effect. This relation is partially mitigated by a positive contemporaneous link between loan loss provisioning and loan growth, which is in contrast to the findings from Laeven and Majnoni (2003). The key difference to our analysis is that the previous two studies do not investigate the intertemporal relation between loan growth and bank risk.

The latter issue has been addressed in the following studies. Salas and Saurina (2002) analyze a large data set from Spanish commercial and savings banks from the period 1985-1997. They find that loan growth (branch growth) of savings banks is significantly positively associated with loan losses three (four) years ahead. Hess, Grimes and Holmes (2008) analyze determinants of credit losses at 32 Australasian banks during the period 1980-2005. It turns out that strong loan growth translates into higher credit losses with a lag of two to four years, which is similar to our findings despite of a very different dataset. Iannotta, Nocera and Sironi (2007) as well as Illueca, Norden and Udell (2008) document that bank ownership is an important determinant of lending behavior, risk taking and performance. Therefore, we subsequently control for bank specialization and bank type (e.g., savings banks, private commercial banks), which coincides in some countries with bank ownership. Finally, there are studies that analyze the relation between loan growth and banking crises in transition economies and developing countries (e.g., see Cottarelli, Dell'Ariccia and Vladkova-Hollar, 2005; Kraft and Jankov 2005) while we focus on regular conditions.

Summarizing, we extend the literature by focusing on the intertemporal, bank-specific linkages between loan growth and risk as well as by taking a multi-dimensional view on the riskiness of individual banks.

3. The data

We analyze yearly balance sheet and income statement data from Bankscope on more than 16,000 individual banks from 16 major countries during the period 1997-2007. Our sample includes banks from the U.S., Canada, Japan, and 13 European countries.[2] The banking systems of these countries, as measured by total banking assets in 2002, are among the 21 largest in the world, and we cover all of the 12 largest banking systems, as well as the important banking centers Luxembourg and Switzerland. Furthermore, the sum of the GDPs for 11 out of the 16 selected countries adds up to 94% of the cumulative GDP for the world's 15 largest economies in 2001. Analyzing a cross-section of the most important banking systems has the advantage to obtain comprehensive findings, which are robust to differences

[2] These countries are Belgium, Denmark, France, Germany, Italy, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and the United Kingdom.

in credit supply and demand, bank competition, and bank regulation. Emerging Asian markets, developing countries, and transition economies are excluded from our sample because our goal is to analyze loan growth under regular conditions. Since our focus is on bank lending to the private sector, we exclude investment banks, development banks, and other similar institutions. Moreover, since we use historical releases of the Bankscope data base the raw data represents an unbalanced panel, with some banks entering the sample after 1997 and others dropping out before 2007. Accounting standards are subject to changes over time, and in 451 cases, banks have switched from national to international financial reporting standards. To avoid structural breaks in our time series, the respective observation is dropped. Table 1 reports main characteristics of the data set.

(Insert Table 1 here)

Panel A displays the number of banks in our final data set and compares the sample composition to the total number of banks in each country published in OECD statistics. In most of the countries, a substantial fraction of the relevant banks in existence is covered by our data, amounting to an overall coverage of 67.7%. Note that the representativeness measured by the fraction of total assets covered is even higher because Bankscope claims to cover at least 90% of total banking assets per country.

Panel B summarizes the main variables employed in the subsequent empirical analyses, referring to bank-year observations. We measure loan growth ($LG_{i,t}$) as the percentage change in the amount of bank i's total customer loans from the year t – 1 to year t. Lending to other financial institutions is not included as this is a distinct line of business, implying a different risk-return structure. The mean (median) annual loan growth amounts to 11.3% (7.4%). Notice that the data set includes some extreme observations from banks which reduced their lending to customers by 28% during one year as well as banks that expanded total customer loans by 165%. We address the issue of extreme loan growth in Section 5.2 in more detail. The consequences of a bank's loan growth are not only determined by its absolute level, but depend crucially on the relative growth rate compared to its competitors under similar conditions, in the same country and year. Therefore, our main analysis are based on the abnormal loan growth rate ($ALG_{i,t}$), defined as the difference between bank i's loan growth rate and the growth rate of each country's aggregate loan amount, as reported in OECD and central bank statistics, in the year t: $ALG_{i,t} = LG_{i,t} - Aggregate(LG_{c,t})$.[3] This approach permits to control for the macroeconomic and competitive conditions in each country and year.

Loan losses ($LL_{i,t}$) are measured as the fraction of loan loss provisions established in the year t relative to total customer loans in year t – 1 (e.g., Laeven and Majnoni, 2003). Since borrowers rarely default during the first year after a new loan has been granted, to disentangle losses of existing loans from contemporaneous changes in total lending, and because of potential endogeneity problems, we take lag 1 of total customer loans in the denominator and not the contemporaneous variable. We are aware of two problems related to this measure of relative loan losses: First, loan loss provisions which have been established in one year may be canceled in subsequent years if the borrower recovers from financial distress, which causes a netting effect. Our data does not allow us to control for this effect, i.e., loan losses are systematically underestimated, which creates a conservative bias in our analysis. Second, as the allocation to loan loss reserves reduces the amount of total customer loans in the balance sheet, there may be compensating effects with our measure of loan growth. However, we do not expect any material distortions to be caused by this because loan loss provisions are relatively small (median of 0.36%) compared to typical rates of loan growth (median of 7.4%). Additionally, we use z-scores as a distance-to-default measure for banks as a robustness check in Section 5.1.

[3] All of our results remain unchanged if we subtract the median loan growth rate of all banks in the same country and year, i.e., the aggregate lending volume to non-banks, as an alternative benchmark.

The relative interest income ($RII_{i,t}$) is defined as the fraction of total interest income over total customer loans. Given that the income statement reflects first-year earnings from lending on a prorated basis, the annual interest income from new loans is likely to be smaller than the annual interest income of loans in the second year and so forth because new loans are granted gradually throughout all calendar months, and thus do not pay interest for a full first year. Therefore, we use the average of total customer loans from year t – 1 and year t as the denominator of $RII_{i,t}$.[4] The relative interest income, with a median of 9.11%, may be upward biased because of interest-related payments due to guarantees granted that are not part of total customer loans. For this reason, RII exhibits a maximum of 37.68%.

Bankscope provides all items from bank balance sheets and income statements in U.S. Dollar denomination, where numbers in other currencies are already converted. However, as the local market is still dominant for most banks' business, we reverse this conversion with the appropriate year-specific exchange rate and calculate loan growth rates, loan losses, and the relative interest income from numbers in local denomination.

The equity-to-total assets ratio ($EQASSETS_{i,t}$) represents the key measure of bank solvency, with values between 2.18% and 31.80% and a median of 8.58%. The equity ratio indicates a bank's ability to cover any kind of unexpected losses (due to lending or other activities). Therefore, banks are required to meet a minimum regulatory capital ratio of 8% under the Basel I and Basel II capital adequacy rules.[5] In fact, most of the banks hold a considerable capital buffer above the 8% ratio. We consider values for all variables below the 1%-quantile and above the 99%-quantile to be outliers, and exclude these observations from all analyses. In the remainder, we control for bank size (using the total amount of customer loans) and differentiate by bank specialization: bank holdings and holding companies

[4] We employ the total loan volume from year t-1 plus 50% of the volume of new loans granted during year t, implicitly assuming a uniform distribution of loan granting throughout the year.

[5] We use the accounting capital ratio as a proxy because Bankscope reports missing values for the regulatory Tier 1 and Tier 2 ratios in many countries and years.

(S_BHHC; 1,493 banks in 1999), commercial banks (S_COMM; 7,451 banks), cooperative banks (S_COOP; 2,098 banks), medium and long term credit banks (S_MLTC; 26 banks), real estate and mortgage banks (S_REMB; 95 banks), and savings banks (S_SAV; 1,473 banks). Finally, we apply a full set of interacted country-year dummies to capture the macroeconomic heterogeneity due to the cross-country composition of our data set.

4. Empirical analysis

4.1. Loan growth and loan losses

We now analyze the impact of past abnormal loan growth on contemporaneous loan losses. As stated in H1, we intend to test whether rapid loan growth in the past is associated with a gradual decrease of the average credit quality in a bank's loan portfolio. Therefore, we regress contemporaneous loan losses ($LL_{i,t}$, as defined above) on past abnormal loan growth ($ALG_{i,t-k}$), as indicated in the following model:

$$LOGLL_{i,t} = \alpha + \beta_1 \, LOGLL_{i,t-1} + \sum_{k=1}^{4}\left(\beta_{k+1} \, ALG_{i,t-k}\right) + \beta_6 \, SIZE_{i,t} + \beta_7 \, EQASSETS_{i,t}$$

$$+ \gamma \text{ specialization dummies} + \delta \text{ country-year-dummies} + \varepsilon_{i,t} \quad (1)$$

First, since almost all values of $LL_{i,t}$ are bigger than zero, we control for the lognormal distribution of loan losses by taking the natural logarithm of this variable ($LOGLL_{i,t}$), to obtain a $(-\infty,+\infty)$ range of possible values, and thus implicitly exclude net releases of loan loss reserves from our analysis ($LL_{i,t} \leq 0$; 2,564 observations). Since we regard these releases rather as a means of earnings management than as a valid proxy for of credit risk, we do not expect much information being lost by this restriction. As loan loss provisions highly depend on other determinants of credit risk besides loan growth, and are therefore related to past loan losses, we include the lagged dependent variable $LOGLL_{i,t-1}$, which controls for a bank's overall risk characteristics. The fact that most of the loan losses typically are not realized before the second year after the loan has been granted leads us to include lag 1-4 of abnormal loan growth ($ALG_{i,t-k}$) as explanatory variables ("loan seasoning"). If banks expand their total loan volume by granting credit to relatively low-quality borrowers, as implied in H1, we expect to find a positive relation between loan losses and higher lags of past loan growth.

As control variable for bank i's size ($SIZE_{i,t}$), we consider the logarithm of its total customer loans ($LOGTCL_{i,t}$), and to control for the level of capitalization, the equity-to-total assets ratio ($EQASSETS_{i,t}$) of the respective bank and year is included in our regressions. Furthermore, dummy variables for each bank type capture specialization effects. The macroeconomic conditions (economic growth, monetary policy, etc.) represent an important determinant of both loan supply and demand. However, as we focus on an individual bank's decision to expand or reduce lending, we control for the macroeconomic conditions by including a full set of interacted indicator dummy variables for countries and years (16*11 = 176 dummies).

We apply two different techniques to estimate the model: Ordinary least squares (OLS) regressions and a dynamic two-step system GMM panel estimator, as proposed by Blundell and Bond (1998) with Windmeijer's (2005) finite sample correction.[6] Given our unbalanced panel and the autoregressive regression model, we prefer the orthogonal deviations transformation of instruments, which makes them also exogenous to possible bank-level fixed effects. Standard errors are robust regarding potential problems from heteroskedasticity and clustering of observations within banks using the Huber-White correction in the OLS specification, and using the Windmeijer correction in our GMM models..

Table 2 displays the results from the baseline regressions. Model (1) is estimated using OLS, whereas columns (2) and (3) report the output from GMM estimates. In Model (2), we treat only the lagged dependent variable ($LOGLL_{i,t-1}$) as endogenous, so that "GMM-style"

[6] To be precise, the estimation method follows Roodman's (2007) "xtabond2" command for Stata.

instruments of deeper lags are created,[7] and in model (3), we extend this set of predetermined variables by lagged loan growth ($LG_{i,t-k}$) and the ratio of equity over assets ($EQASSETS_{i,t}$), which we hypothesize to depend on loan growth (H2). Two tests support our specification choice: The null of second-order autocorrelation (AR(2)) is rejected, and heteroskedasticity-consistent Hansen J-tests confirm the validity of our instrument set at least at the 5%-level.

(Insert Table 2 here)

As Hypothesis H1 suggests, our results from models (1) and (2) document a substantial, positive, and highly significant impact of ALG_{t-2} and ALG_{t-3} on contemporaneous loan losses. The coefficient of ALG_{t-4} is also significantly positive, however, Wald tests for differences between coefficients confirm that ALG_{t-2} and ALG_{t-3} exhibit the strongest effect. The evidence provided by model (3) is less clear, but it still confirms a significantly positive coefficient for ALG_{t-3}. Our results are consistent with Salas and Saurina (2002) who discover a positive impact of lag 3 of loan growth on total loan loss reserves at Spanish banks. However, since they measure loan losses differently, the magnitude of their results can not be directly compared to our findings. The coefficient for ALG_{t-3}, which amounts to approximately 0.2 in models (1) and (2), means that an abnormal loan growth of 18.7% (one standard deviation) in year t-3 leads to a relative increase of the ratio of relative loan losses by 3.8% (starting from the mean). The effect becomes stronger if we jointly consider the loan growth from all three previous years (instead of year t-3 only). Note that the negative influence of ALG_{t-1} is due to a technical effect since the total loan amount in t-1 is included in the numerator of ALG_{t-1} as well as in the denominator of LL_t. We cannot detect a significant impact of bank size (measured by total customer loans) or the equity-to-total assets ratio on

[7] We prefer the Blundell-Bond (1998) setting to adjusting a LSDV estimator for the autoregressive bias (Kiviet, 1995, Bruno, 2005) to have a consistent framework for the estimation of models (2) and (3).

relative loan losses, and with respect to bank specialization, our expectation is confirmed that real estate and mortgage banks, which mainly grant secured loans with relatively low default risk (of course, except the subprime mortgage lending segment), exhibit substantially lower loan losses. This effect is smaller in absolute values, but still significantly negative to the 1%-level, for cooperative and savings banks.[8]

There may be the concern that abnormal loan growth in the years t-k is serially correlated, leading to multicollinearity in the linear regression model. We address this problem in three different ways: First, past loan growth is treated as endogenous in model (3) of Table 2, meaning that "GMM-style" instruments are used, and we obtain – though less significantly – the same key findings. Second, we analyze two-way linkages between loan growth and loan losses using a Vector Autoregressive Model (Section 5.3, Table 8), and the positive link between loan growth and past loan losses is also confirmed. Third, we estimate models with polynomially distributed lags following Almon (1965). Assuming either a quadratic or a cubic functional form for the time lag between past loan growth on loan losses, both specifications show a significantly positive peak in coefficients for ALG_{t-2} and ALG_{t-3}, so that our previous findings are confirmed as well. Summarizing, we find clear support for Hypothesis H1 discovering a positive and highly significant relation between past abnormal loan growth and contemporaneous loan losses at the individual bank-level, meaning that new loans exhibit a higher risk of default.

4.2. Loan growth and interest income

Subsequently, we examine whether new loans that have been granted in order to abnormally expand a bank's credit portfolio are priced at a lower rate than loans granted by banks that intend to maintain their current credit exposure, as suggested by Hypothesis H2.

[8] In Section 4.5 we run separate regression models by bank specialization and obtain similar findings on the influence of past abnormal loan growth on loan losses (except for savings banks).

Note that a risk-based loan pricing policy, combined with the positive relation between past loan growth and loan losses detected in Section 4.1, would require banks to charge higher rates for these additional loans compared to the existing credit portfolio.[9] However, the competition for borrowers may induce banks to underprice the loan rates of competing banks in order to attract new customers (e.g., Ogura, 2006).

We use the following regression model to explain the change in relative gross interest income of each bank ($\Delta RII_{i,t}$) by the contemporaneous abnormal loan growth ($ALG_{i,t}$) and a set of control variables:

$$\Delta RII_{i,t} = \alpha + \beta_1\, ALG_{i,t} + \beta_2\, SIZE_{i,t} + \beta_3\, EQASSETS_{i,t} + \gamma \text{ specialization dummies} + \delta \text{ country-year-dummies} + \varepsilon_{i,t} \quad (2)$$

The relative interest income of bank i in the year t ($RII_{i,t}$ as defined in Section 3) is highly correlated with RII_{t-1} since income from all active loans that have been granted before t–1 are included in both variables. Therefore, it is crucial to take the first difference of this variable ($\Delta RII_{i,t} = RII_{i,t} - RII_{i,t-1}$) to measure the incremental changes in relative interest income, the variable we are actually interested in. Note that $\Delta RII_{i,t}$ only measures the change in average interest income from the entire loan portfolio, i.e., it is impossible to extract the fraction of the interest income that stems from newly granted loans. The contemporaneous abnormal loan growth ($ALG_{i,t}$) represents the main explanatory variable, and according to Hypothesis H2, we expect the relative interest income to decrease for rapidly growing banks, and thus a negative impact of $ALG_{i,t}$ on $\Delta RII_{i,t}$. In contrast to the intertemporal relation between loan growth and loan losses analyzed in Section 4.2, we hypothesize that abnormal loan growth immediately translates into lower relative interest income, so that we do not have to consider lagged values of $ALG_{i,t}$. Again, we control for bank i's size ($SIZE_{i,t}$) by including the natural

[9] We investigate the relation between loan growth and the risk-adjusted relative interest income in Section 4.3.

logarithm of its total customer loans, and for its capitalization, we proxy with the equity-to-total assets ratio ($EQASSETS_{i,t}$). Since the relative interest income also depends on the macroeconomic conditions, especially the level and term structure of interest rates, we include a full set of interacted indicator dummy variables for countries and years as controls. Furthermore, to deal with bank-specific effects, dummy variables for each bank type are included in our baseline models (OLS regressions), and alternatively, and we use bank-level fixed effects to capture cross-sectional heterogeneity. All standard errors are robust regarding potential distortions from heteroskedasticity and clustering of observations within banks using the Huber-White correction. Table 3 displays the regression results.

(Insert Table 3 here)

We detect a negative and highly significant impact of $ALG_{i,t}$ on $\Delta RII_{i,t}$, which represents evidence in favor of Hypothesis H2 claiming that loan growth leads to a reduction in the relative interest income. Interestingly, this link is non-linear and more pronounced if we omit extreme values of abnormal loan growth. While model (1) in Table 3 displays our OLS regression results for the full sample, the OLS model (2) and the fixed-effects model (3) exclude observations where loan growth is more than 35.6% higher than the median in the respective country and year (95%-quantile of the ALG distribution). For this subsample, coefficients of $ALG_{i,t}$ are three times larger than in the full sample specification, indicating that very high loan growth does not involve lower relative interest income. These high abnormal growth rates may result from external bank growth through mergers or acquisitions, an issue that we analyze in Section 5.2. Moreover, the economic significance of the link detected is high: Coefficients of approximately –1.5 in models (2) and (3) predict the relative interest income to decline by 0.28% if a bank implements a loan growth rate of 18.4% (one standard deviation) above the median. Among the controls, the significantly positive coefficient for bank size in models (1) and (2) indicates that large banks exhibit a trend to increase loan rates compared to smaller banks, and the same is true for relatively low-capitalized institutions. In summary, with the exception of very high loan growth rates, our analysis provides evidence in favor of Hypothesis H2, i.e., loan growth leads to a decrease in the relative interest income of banks.

4.3. The impact of loan growth on the ratio of loan losses and interest rate margin

So far, we have analyzed the effects of loan growth on loan losses (Section 4.1) and interest income (Section 4.2) separately. We now continue the analysis with a joint test of Hypotheses H1 and H2. The main issue is to analyze if and how high growth rates relate to loan losses after controlling for a possibly higher net interest result. If this is not the case, loan growth does not compromise a bank's solvency because risk-adjusted loan pricing and consequent loan monitoring ensure a "healthy" growth strategy. However, if loan growth is significantly and negatively related to measures of risk-adjusted income, we can conclude that banks are growing by accepting lower-quality borrowers, granting new loans at relatively low rates, or even both. Problems for bank solvency may be most severe in the last case.

We examine the loss-income ratio ($LOSSINC_{i,t}$), defined as the ratio of absolute loan loss provisions over net interest income from previous years. This ratio allows for a joint test of the influence of loan growth on loan losses and interest income. More specifically, we consider two definitions of the ratio in Model (1) and (2) that differ by the time horizon over which the input variables are measured. In Model (1), $LOSSINC_{i,t}$ is based on the net interest income in the four preceding years and calculated as follows:

$$LOSSINC_{i,t} = \frac{LL_t}{\sum_{k=1}^{4} \left(\text{Interest Income - Interest Expense}\right)_{t\text{-}k}}. \qquad (3)$$

Alternatively, since previous findings indicate that loan growth leads to a peak in loan losses two or three years later, the denominator of the ratio used in Model (2) is calculated only over the years t-2 and t-3. The key explanatory variable is bank i's abnormal loan growth ($ALG_{i,t}$), measured over the same time horizon as the dependent variable (Model (1): four preceding years, Model (2): years t–2 and t–3). We are aware of the problem that due to the time lag between the numerator, denominator, and the measure of loan growth, effects may also partially be driven by changes in the funding structure or funding costs, although we do not see a systematic bias that could fundamentally drive our results. We control for individual bank size ($SIZE_{i,t}$) using the natural logarithm of total customer loans, and for capitalization with the equity-to-total assets ratio ($EQASSETS_{i,t}$). Additionally, we include indicator dummy variables for each bank specialization, and a full set of interacted country-year variables serves as macroeconomic control. Table 4 displays results from OLS regressions.

(Insert Table 4 here)

It is striking that in both specifications, average abnormal loan growth in the past ($ALG_{i,t-k}$) exhibits a highly significant and positive coefficient. These results suggest that higher loan growth leads to an increase of loan loss provisions per unit of net interest income. Thus, rapidly growing banks are not able to obtain a sufficient compensation for the additional risks taken. Control variables indicate that in general, larger banks exhibit a more favorable loss-income ratio, which is also the case for Bank Holdings, Cooperatives, and Savings Banks. Note that including the net interest income in the denominator of the ratio has the advantage that a bank's actual refinancing costs in each year are directly included. In other words, these additional tests provide support for the view that loan growth has a negative impact on the risk-adjusted interest income of banks (represented by the inverse of $LOSSINC_{i,t}$), meaning that higher loan losses resulting from high loan growth cannot be compensated by higher interest rate margins.

4.4. Loan growth and bank solvency

Our previous analyses reveal that past loan growth leads to an increase of contemporaneous loan losses and to a decrease of the relative interest income. Both findings indicate that loan growth increases the riskiness of banks. We now investigate if loan growth leads to an overall decline in bank solvency, as stated in Hypothesis H3. Bank solvency is measured by means of the equity-to-total assets ratio for each bank-year observation.

Before turning to the analysis, some additional explanations are in order. Potentially, one may think that loan growth always implies a decline of the equity-to-total assets ratio (as stated in Hypothesis H3). However, the following example shows that this is not the case. Consider a bank with total loans of 1,000 and no other assets, which exhibits an equity-to-total assets ratio of 10%, i.e., equity amounts to 100 and total debt is 900. Suppose that these loans yield, on average, an interest margin of 1%, net of funding costs, assuming no other earnings or expenses. Thus, during one year, total net earnings add up to 10, and if no dividends are paid (which is not unusual, for example, in case of savings banks) both liquid assets and equity rises to 110. This corresponds to an increase of the equity-to-total assets ratio from 10% to 10.89% (=110/1,010). However, this increase in equity allows the bank to extend lending by 10% to 1,100 (converting 10 units of liquid assets into loans and 90 additional units of debt) by the end of the same year, maintaining the equity-to-total assets ratio at the 10%-level (=110/1,100), even if the additional loans do not pay interest in their first year. These alternatives clearly show that loan growth is not necessarily associated with a decrease of the equity-to-total assets ratio. Higher growth rates can be funded by banks with higher net interest margins, other income types (e.g., fee, commission and trading income), or by means of recapitalizations. Therefore, loan growth does not necessarily lead to a decrease in capital ratios.

In the multivariate analysis, we regress changes in the equity-to-total assets ratio of each bank i in the year t ($\Delta EQASSETS_{i,t}$) on contemporaneous loan growth and several control variables using the following model:

$$\Delta EQASSETS_{i,t} = \alpha + \beta_1\, ALG_{i,t} + \beta_2\, SIZE_{i,t} + \gamma \text{ specialization dummies} + \delta \text{ country-year-dummies} + \varepsilon_{i,t} \quad (4)$$

We consider the first difference $\Delta EQASSETS_{i,t} = EQASSETS_{i,t} - EQASSETS_{i,t-1}$ since capital ratios in subsequent years are usually highly correlated, and we are only interested in the relation between changes in equity and loan growth. The main explanatory variable is the contemporaneous abnormal loan growth ($ALG_{i,t}$). According to Hypothesis H3, $\Delta EQASSETS_{i,t}$ is expected to be negative for banks exhibiting rapid loan growth since these banks may not be able to increase their capital proportionally. We also control for individual bank size ($SIZE_{i,t}$) by including the natural logarithm of the amount of total customer loans, and for further bank- specific effects in Model (1) using indicator dummy variables for each bank specialization, and in Model (2) with bank-level fixed effects instead. As macroeconomic control serves a full set of interacted dummy variables for countries and years. Finally, standard errors are robust regarding heteroskedasticity and clustering of observations within banks using the Huber-White correction. Table 5 summarizes the regression results.

(Insert Table 5 here)

Most important, we detect a negative impact of abnormal loan growth on $\Delta EQASSETS_{i,t}$, which is statistically significant at the 1%-level. In both model specifications, the coefficient exhibits a magnitude of approximately –2.2, meaning that an "abnormal" increase of lending by one standard deviation (18.4%) is associated with a decrease of the equity ratio by 0.40%. In summary, we find a statistically and economically significant negative relation between abnormal loan growth and bank capitalization, which represents evidence in favor of Hypothesis H3.

4.5. Differentiation by region, bank specialization, size, and capitalization

All results presented above are based on the full sample of more than 16,000 banks from 16 countries. However, the linkages may differ by country, region, size, specialization, and capitalization. Therefore, we now test the Hypotheses H1–H3 in more detail, using again the regression models (1) – (3). The qualitative results are summarized in Table 6 (detailed results are availabe from the authors on request).

(Insert Table 6 here)

The differentiation by country and region reveals that H1 is confirmed in many large countries (France, Germany, Spain, USA) and counter-evidence is only found for Belgium. Differentiating by regions leads to even clearer results: H1 is confirmed in the most important banking systems of North America and Central Europe. Support for H2 and H3 is found in 6 out of our 7 regions. With regard to bank size, our hypotheses are corroborated in all three size categories but they are most pronounced for smaller banks (details not reported here). One explanation is that larger banks benefit from a more sophisticated risk management that mitigates adverse effects from loan growth. In addition, there are no substantial differences across bank specialization. Finally, the hypotheses are also confirmed across terciles of bank capitalization. The unreported estimation results indicate that the positive impact of past loan growth on relative loan losses (H1) is strongest for banks with a capitalization in the mid tercile while it is less pronounced (but still significant) for weak or strong banks. Moreover, findings on H2 and H3 are highest for strong banks. The latter are able to grow by setting relatively low loan spreads, taking advantage of their higher capital buffers that allow a temporary cutback in interest income. Furthermore, regulatory or economic restrictions may not allow weak banks a further decrease of their poor capitalization, thus the relation proposed in H3 is less significant. A further explanation is that strong banks may possess superior management skills to obtain a sufficient compensation for risk (e.g., loan pricing policy) or to avoid future loan losses (e.g., loan exposure and credit portfolio management). This reasoning implies that loan growth is especially dangerous for weak banks because their (low) capital buffer is also more sensitive to loan growth. Consequently, monitoring the loan growth of weak institutions may be valuable for banking supervisors and deposit insurers.

5. Further empirical checks

5.1 Loan growth and banks' distance-to-default

Loan loss provisions, our primary measure of bank risk that we have analyzed so far, are a proxy for credit risk, which allows us to demonstrate the intertemporal relation between abnormal loan growth and future loan losses. However, a bank's decision to expand the amount of loans granted may also affect other aspects of bank risk, which translate into lower solvency as well. Thus, we consider a well-established alternative measure of bank risk: the z-score $z = \frac{\text{Mean}\,(EQASSETS + ROA)}{\text{Std. Dev.}\,(ROA)}$ (Roy, 1952; Boyd, Graham, and Hewitt, 1993). This ratio represents the average capitalization (EQASSETS) + return on assets (ROA) during the five preceding years over the 5-year standard deviation of the return on assets and can be understood as a measure of bank stability, indicating the distance to default. Banks with a lower z-score would be considered more risky. Regressing z-scores on average loan growth in the last 5 years (controlling for a bank's size, capitalization, specialization, country and years) indicates a highly significant negative relation, confirming our previous findings that abnormally growing banks are more risky (H1) and less stable (H3), which is not compensated by higher profitability (ROA, H2).

5.2. Internal versus external growth of banks

We now extend our previous analysis by considering the type of loan growth. On the one hand, a bank may increase the loan volume because of new lending opportunities such as new lending segments or geographic expansion (internal growth). On the other hand, the loan portfolio may increase as a consequence of a takeover or bank merger (external growth). Since the propositions in Hypotheses H1–H3 are implicitly based on the idea of internal growth, we now address potential distortions from the M&A activity in the banking industry. Unfortunately, our data does not include bank- and year-specific information on M&A transactions so that we are unable to directly control for this effect. Instead, we construct an indicator variable $MERGE_{i,t}$ that takes the value 1 if bank i's total equity increases by more than 40.0%, which corresponds to the 95%-quantile of the equity growth rate distribution. Otherwise, the value of $MERGE_{i,t}$ is 0.[10] After specific accounting operations, the equity of two merging companies is usually pooled and consolidated, so that an increase by more than 40.0% within one year is very unlikely to result from either retained profits or a regular increase in capital (e.g., seasoned equity offering).

In the remainder, we repeat the tests of hypotheses H1-H3, but include the indicator variables $MERGE_{i,t}$, which we interact with the respective value of abnormal loan growth. For

[10] Alternatively, we define MERGE based on the 95%-quantile of loan growth and obtain similar results. We also considered a dummy variable that takes a value of 1 if a bank has extreme equity or loan growth in one year (otherwise 0) and sum up this variable over all years for each bank which allows us to distinguish between banks which were involved in M&A at least once or never. We then re-estimate regression models 1-3 to test H1-H3 for the both sub-samples of banks. This approach leads to results similar to the reported ones.

lagged values of $ALG_{i,t-k}$, we take the corresponding lagged merger dummy ($MERGE_{i,t-k}$). Estimation results are displayed in Table 7.

(Insert Table 7 here)

First, the analysis of the influence of past abnormal loan growth on contemporaneous loan losses leads to interesting results (Panel A). The interaction term $ALG_{i,t-1}$ X $MERGE_{i,t-1}$ exhibits a significantly negative and large coefficient. Consequently, M&A activity is predicted to lead to lower loan losses in the short run. The impact of the other lagged interaction terms is less surprising: Coefficients are negative, and summed up with the (positive) coefficients of $ALG_{i,t-1}$, $ALG_{i,t-2}$,…, the net influence of past external loan growth through M&A activity is significantly weaker than that in the case of internal growth. The overall coefficients of loan growth are –0.262 for the first lag, 0.096 for the second, 0.075 for the third, and –0.007 for the fourth. Accordingly, there still exists a moderate positive impact which, as we expected, is relatively weak for banks that grow through M&A. In other words, our previous findings on H1 are not biased by M&A transactions in the banking industry.

Second, as stated by H2, the impact of contemporaneous loan growth on relative gross interest income ($\Delta RII_{i,t}$) is analyzed in Panel B. Similar to Panel A, we find a strong compensating effect between $ALG_{i,t}$ (significantly negative) and $ALG_{i,t}$ X $MERGE_{i,t}$ (significantly positive), resulting in a net coefficient of 1.11. In contrast to the results described in Section 4.2, we now observe a positive impact of loan growth through M&A on relative interest income, meaning that acquired banks exhibit, on average, higher loan rates than acquirers. This effect is likely to drive our finding from Section 4.2 that extremely high loan growth (above the 95%-quantile) is not associated with lower relative interest income.

Third, Panel C reports the corresponding results for the impact of loan growth on bank solvency as stated in Hypothesis H3. We also find a compensating effect between $ALG_{i,t}$ and

$ALG_{i,t}$ X $MERGE_{i,t}$ with a net coefficient of 1.06, meaning there is a small, positive impact of external loan growth on bank solvency.[11] We would expect this finding for the case that a bank acquires / merges with an even better capitalized institution, resulting in a higher increase of equity relative to total loans and total assets.

In light of these results, we conclude that all of the relations uncovered in previous analyses are downward biased because of banks with high external growth rates. These persist even when we control for external growth in the manner described above. However, banks relying on external growth strategies through M&A experience by far weaker detrimental consequences regarding loan losses, income and solvency. Most importantly, if we exclude banks involved in M&A activities, our results for H1-H3 become even stronger.

5.3. Two-way linkages between loan growth and loan losses

So far we have examined the one-way relation between past loan growth and contemporaneous loan losses. Subsequently, we study whether our findings remain robust if we explicitly consider intertemporal two-way linkages between loan growth and loan losses. On the one hand, we have shown that loan growth is associated with an increase in future loan losses. On the other hand, banks facing big loan losses may be forced to reduce future loan growth for several reasons (shareholder activism, reputation, accounting policies, risk of bank runs, banking regulation, etc.). For example, Keeton (1999) analyzes aggregate time-series of loan growth and loan losses for the U.S. and finds that there are important two-way linkages. In addition, Berger and Udell (2004) also examine the relation between peaks in loan losses, credit standards and loan growth.

Specifically, we estimate a modified two-equation vector autoregressive model (VAR) with changes in contemporaneous loan loss provisions and abnormal loan growth as

[11] Indirectly, the tests of our three hypotheses suggest that acquirers benefit from synergies since the target banks tend to be less risky, more profitable and better capitalized in relative terms. Although "distress mergers" represent an alternative M&A motive, especially a preemptive mergers between smaller and unlisted banks, we do not find systematic evidence on this in our sample.

endogenous variables. The right-hand side variables (identical in both equations) are the cumulative relative loan losses over the period t-4 to t-1, the cumulative abnormal loan growth from t-4 to t-1, a bank size proxy, bank specialization dummies, and a full set of interacted country-year dummies.[12] Table 8 reports the results.

(Insert Table 8 here)

First and most important, our previous findings on the relation between loan growth and future loan losses (Hypothesis H1) remain robust if we include lags of loan losses. Second, lagged loan losses have indeed a significantly negative impact on contemporaneous loan growth. As discussed above, an increase in loan losses may force a bank to reduce loan growth in the future. Third, it turns out that contemporaneous loan losses can be better explained than contemporaneous loan growth in terms of goodness of fit (R^2). In other words, the impact of loan growth on future loan losses, as stated in Hypothesis H1 and analyzed in Section 4.1, is stronger than the inverse relation, underlining the economic relevance of the hypothesis. Finally, as expected, both loan growth and loan losses exhibit positive serial correlation. Summarizing, previous results are confirmed although we find two-linkages (which is consistent with results from studies analyzing aggregate data) between loan growth and loan losses.

6. Conclusions

This study provides new comprehensive evidence on the intertemporal relation between abnormal loan growth and the riskiness of individual banks. Using Bankscope data on more

[12] We have also estimated a VAR model including lags 1, 2, 3, and 4 of loan growth and loan losses and obtain very similar results. However, relative loan loss provisions exhibit strong serial correlation which leads to a multicollinearity problem. As a solution, we consider cumulative variables. Cumulative loan growth is calculated as the product of the annual growth factors minus one (geometric growth) while cumulative relative loan loss provisions are calculated as the sum of the annual loan loss provisions.

than 16,000 individual banks from 16 major countries during 1997-2007, we test three hypotheses on the relation between past abnormal loan growth and loan losses, bank profitability, and bank solvency, controling for year- and country-specific effects.

First, with respect to H1 we find that past abnormal loan growth has a positive and highly significant influence on subsequent loan losses with a lag of two to four years. This evidence is based on a large cross-country sample of individual banks and consistent with findings on the aggregate link between loan growth and loan losses in single countries. Second, with respect to H2, we detect that abnormal loan growth leads to a decline in the relative interest income of banks. This finding holds for most countries and supports the view that new loans are granted at rates that do not compensate for the associated default risk. Third, the test of H3 reveals that abnormal loan growth is significantly negatively related to bank solvency. In 14 out of 16 countries, higher abnormal loan growth leads to lower capital ratios, indicating a decrease of bank solvency.

In further analyses, we provide evidence that our baseline results are considerably stronger if we exclude bank-year observations that are influenced by M&A activities. Simultaneous tests of H1 and H2 yield that loan growth leads to a deterioration in a bank's risk-return structure. Although we find intertemporal two-way linkages between abnormal loan growth and losses, the positive relation between past abnormal loan growth and contemporaneous losses remains robust and turns out to be economically more important than the inverse relation. In additional tests of robustness, we have considered gross loan growth instead of abnormal loan growth and obtain highly similar results.

This paper has several important implications. Banks should carefully check whether the additional income generated by an increase in lending represents an adequate compensation for the additional risk taking. Bank supervisors and deposit insurers may benefit from monitoring a set of indvidual bank loan growth indicators to obtain early warning signals about the riskiness of banks. Further research may extend our study in analyzing the effects of bank growth on bank risk, distinguishing between on-balance sheet activities (interest income) and off-balance sheet activities (non-interest income). Moreover, it would be interesting to study whether banks' credit ratings and market-based credit risk indicators derived from stock prices, bond spreads, and credit default swap spreads of large banks (e.g., Bongini, Laeven and Majnoni, 2002; Gropp, Vesala and Vulpes, 2006; Lown and Morgan, 2006) are complementary to accounting-based, dynamic bank activity measures like loan growth. Finally, in light of the current financial crisis the intertemporal relation between loan growth, risk taking and credit risk transfer activities of banks such as credit securitization and credit derivatives need to be investigated in more detail.

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Table 1

Summary statistics

Panel A: Bankscope and OECD statistics (1999)

Country	No. of banks in data set	No. of banks (OECD)	Fraction of banks covered in data set
Belgium	39	75	52.00%
Canada	38	53	71.70%
Denmark	78	97	80.41%
France	261	521	50.10%
Germany	1,745	2,816	61.97%
Italy	550	876	62.79%
Japan	618	2,559*	24.15%
Luxembourg	38	213	17.84%
Netherlands	25	84	29.76%
Norway	26	152	17.11%
Portugal	24	203	11.82%
Spain	92	290	31.72%
Sweden	22	124	17.74%
Switzerland	137	334	41.02%
United Kingdom	100	420	23.81%
United States	8,843	9,855	89.73%
Total	12,636	18,672	67.67%

*Data from the year 2001

Panel B: Descriptive statistics of main variables

Variable	Notation	No. of obs	Mean	Median	St. dev.	Min	Max
Relative loan losses (in %)	LL	80,493	0.552	0.364	0.654	-0.583	5.987
Loan growth (%)	LG	80,493	11.333	7.447	18.917	-27.619	164.810
Abnormal loan growth (%)	ALG	80,493	4.383	0.773	18.697	-49.817	162.037
Relative interest income (in %)	RII	80,493	9.663	9.140	3.417	2.952	37.680
Equity-to-total assets (in %)	EQASSETS	101,153	9.106	8.583	3.836	2.177	31.798
Total assets (in bill. USD)	TA	101,153	5.990	0.241	59.310	0.002	3,785.291
Total customer Loans (in bill. USD)	SIZE	101,153	3.167	0.155	27.602	0.000	1,664.458

Table 2

Regression results for loan loss provisions

The dependent variable is the natural logarithm of the ratio of loan losses in t ($LOGLL_t$), defined as the fraction of total loan loss provisions in year t over the total amount of customer loans in t-1. Explanatory variables are, besides the lagged dependent variable ($LOGLL_{t-1}$), the lags 1-4 of abnormal loan growth (ALG_{t-k}) as a decimal number. We control for bank-specific effects using the logarithm of total customer loans ($SIZE_{i,t}$), the equity-to-total assets ratio ($EQASSETS_{i,t}$), and indicator dummy variables for each bank specialization: Commercial banks form the reference group, whereas Bank Holdings and Holding Companies are denoted by S_BHHC=1, Cooperative Banks by S_COOP=1, Medium and Long Term Credit Banks by S_MLTC=1, Real Estate / Mortgage Banks by S_REMB=1 and Savings Banks by S_SAV=1. We indirectly control for macroeconomic conditions by including a full set of interacted indicator dummy variables for countries and years. Model (1) is estimated using OLS, whereas columns (2) and (3) report coefficients stemming from a dynamic two-step system GMM panel estimator as proposed by Blundell and Bond (1998) with Windmeijer's (2005) finite sample correction. In model (2), we treat only the lagged dependent variable ($LOGLL_{i,t-1}$) as endogenous, so that "GMM-style" instruments of deeper lags are created, and in model (3), we extend this set of predetermined variables by lagged loan growth ($LG_{i,t-k}$) and the ratio of equity over assets ($EQASSETS_{i,t}$). All p-values are calculated from Huber-White robust standard errors, controlling for clustering at individual banks. ***, **, * indicate that coefficients are statistically significant at the 1%, 5%, and 10%-level.

Dep. Var.: $LOGLL_{i,t}$	(1)		(2)		(3)	
Explanatory Var.	Coeff.	p-val.	Coeff.	p-val.	Coeff.	p-val.
$LOGLL_{i,t-1}$	0.5952689***	0.000	0.3154541***	0.000	0.3730345***	0.000
$ALG_{i,t-1}$	-0.0661250*	0.099	-0.0187893	0.639	0.0016438	0.987
$ALG_{i,t-2}$	0.1334442***	0.000	0.1599735***	0.000	0.1694745**	0.050
$ALG_{i,t-3}$	0.1718842***	0.000	0.2212582***	0.000	0.1413185**	0.021
$ALG_{i,t-4}$	0.0831182***	0.005	0.1299775***	0.000	0.0097224	0.844
$SIZE_{i,t}$	-0.0030756	0.501	0.0017987	0.767	0.0079307	0.312
$EQASSETS_{i,t}$	-0.0005725	0.813	-0.0012716	0.682	0.0135304	0.426
S_BHHC_i	-0.0110288	0.509	-0.0154458	0.469	-0.0203468	0.396
S_COOP_i	-0.1634589***	0.000	-0.2809620***	0.000	-0.2617862***	0.000
S_MLTC_i	-0.2203780	0.175	-0.3501081	0.135	-0.3891607*	0.072
S_REMB_i	-0.6222215***	0.000	-1.081469***	0.000	-0.9792085***	0.000
S_SAV_i	-0.1357489***	0.000	-0.2760103***	0.000	-0.2527641***	0.000
+ interacted country-year dummy variables	yes		yes		yes	
Constant	-0.3015454***	0.000	-0.5611711***	0.000	-0.6625528***	0.001
No. of observations	21,540		21,540		21,540	
No. of banks	9,136		9,136		9,136	
Adjusted R^2	0.519					
Test for AR(1): Prob > z			0.000		0.000	
Test for AR(2): Prob > z			0.093		0.103	
Hansen test: Prob > χ^2			0.093		0.057	
Endogenous variables ("GMM-style" instruments)			$LOGLL_{i,t-1}$		$LOGLL_{i,t-1}$ $ALG_{i,t-k}$ $EQASSETS_{i,t}$	

Table 3

Regression results for the relative gross interest income

The dependent variable is the absolute change from the year t-1 to t of bank i's relative gross interest income ($RII_{i,t}$), defined as the fraction of total interest income in t over the average of total customer loans in t-1 and t). Explanatory variables are the contemporaneous abnormal loan growth ($ALG_{i,t}$) as a decimal number, the logarithm of total customer loans ($SIZE_{i,t}$), and the equity-to-total assets ratio ($EQASSETS_{i,t}$). We control for further bank-specific effects using indicator dummy variables for each bank specialization: Commercial banks form the reference group, whereas Bank Holdings and Holding Companies are denoted by S_BHHC=1, Cooperative Banks by S_COOP=1, Medium and Long Term Credit Banks by S_MLTC=1, Real Estate and Mortgage Banks by S_REMB=1, and Savings Banks by S_SAV=1. In model (3), these dummies are replaced by bank-level fixed effects. We indirectly control for macroeconomic conditions by including a full set of interacted indicator dummy variables for countries and years. P-values are calculated from Huber-White robust standard errors, controlling for clustering at individual banks. ***, **, * indicate that coefficients are statistically significant at the 1%, 5%, and 10%-level.

Dep. Var.: $\Delta RII_{i,t}$	(1)		(2)		(3)	
Explanatory Var.	Coeff.	p-val.	Coeff.	p-val.	Coeff.	p-val.
$ALG_{i,t}$	-0.5237363***	0.000	-1.521392***	0.000	-1.453826***	0.000
$SIZE_{i,t}$	0.0211182***	0.000	0.0175967***	0.000	-0.0756320	0.122
$EQASSETS_{i,t}$	-0.0196846***	0.000	-0.0250655***	0.000	-0.0661148***	0.000
S_BHHC_i	-0.0364131***	0.002	-0.0235081**	0.044		
S_COOP_i	0.1444130***	0.000	0.0881359***	0.000		
S_MLTC_i	0.6012450***	0.000	0.5699348***	0.000		
S_REMB_i	0.3394505***	0.000	0.3322081***	0.000		
S_SAV_i	0.0914218***	0.000	0.0832776***	0.000		
+ bank-level fixed effects					yes	
+ interacted country-year dummy variables	yes		yes		yes	
Constant	-1.507643***	0.000	-1.400089***	0.000	-0.2287340	0.417
No of observations	62,098		59,646		59,646	
No of banks	14,726		14,574		14,574	
Adj. R^2 (fixed effects: within)	0.356		0.397		0.426	
Subsample	full sample		$ALG_{i,t}$ < 35.6%		$ALG_{i,t}$ < 35.6%	

Table 4

Regression results for the ratio of loan losses and the net interest income

The dependent variable ($LOSSINC_{i,t}$) is the ratio of contemporaneous loan losses and the average net interest income in the past. Model (1) considers all four years t-1, t-2, t-3, and t-4, whereas model (2) focuses on the years t-2 and t-3. Explanatory variables are the average abnormal loan growth rate ($Avg(ALG_i)$) as a decimal number, calculated over the corresponding time period, the logarithm of total customer loans ($SIZE_{i,t}$), and the equity-to-total assets ratio ($EQASSETS_{i,t}$). We control for further bank-specific effects using indicator dummy variables for each bank specialization: Commercial banks form the reference group, whereas Bank Holdings and Holding Companies are denoted by S_BHHC=1, Cooperative Banks by S_COOP=1, Medium and Long Term Credit Banks by S_MLTC=1, Real Estate and Mortgage Banks by S_REMB=1, and Savings Banks by S_SAV=1. We indirectly control for macroeconomic conditions by including a full set of interacted indicator dummy variables for countries and years. P-values are calculated from Huber-White robust standard errors, controlling for clustering at individual banks. ***, **, * indicate that coefficients are statistically significant at the 1%, 5%, and 10%-level.

Dep. Var.: $LOSSINC_{i,t}$ (calculation period)	(1) (t-1, t-2, t-3, t-4)		(2) (t-2, t-3)	
Explanatory Var.	Coeff.	p-val.	Coeff.	p-val.
$Avg(ALG_i)$ in t-1, t-2, t-3, t-4	0.1018744***	0.000		
$Avg(ALG_t)$ in t-2, t-3			0.0542047***	0.000
$SIZE_{i,t}$	-0.0500236***	0.000	-0.0567978***	0.000
$EQASSETS_{i,t}$	0.0016170**	0.042	0.0012598	0.126
S_BHHC_i	-0.0124467***	0.000	-0.0107236***	0.000
S_COOP_i	-0.0143548*	0.062	-0.0121054*	0.082
S_MLTC_i	0.0033628	0.874	0.0037775	0.867
S_REMB_i	-0.0011019	0.913	-0.0036536	0.734
S_SAV_i	-0.0257023***	0.000	-0.0289053***	0.000
+ interacted country-year dummy variables	yes		yes	
Constant	0.3805318***	0.000	0.4368883***	0.000
No of observations	22,559		33,642	
No of banks	9,384		11,063	
Adj. R^2	0.170		0.152	

Table 5

Regression results for the equity-to-total assets ratio

The dependent variable is the absolute change from t-1 to t of bank i's equity-to-total assets ratio ($\Delta EQASSETS_{i,t}$). Explanatory variables are the contemporaneous abnormal loan growth ($ALG_{i,t}$) as a decimal number and the logarithm of total customer loans ($SIZE_{i,t}$). We control for further bank-specific effects using indicator dummy variables for each bank specialization: Commercial banks form the reference group, whereas Bank Holdings and Holding Companies are denoted by S_BHHC=1, Cooperative Banks by S_COOP=1, Medium and Long Term Credit Banks by S_MLTC=1, Real Estate and Mortgage Banks by S_REMB=1, and Savings Banks by S_SAV=1. In model (2), these dummy variables are replaced by bank-level fixed effects. We indirectly control for macroeconomic conditions by including a full set of interacted indicator dummy variables for countries and years. P-values are calculated from Huber-White robust standard errors, controlling for clustering at individual banks. ***, **, * indicate that coefficients are statistically significant at the 1%, 5%, and 10%-level.

Dep. Var.: $\Delta EQASSETS_{i,t}$	(1)		(2)	
Explanatory Var.	Coeff.	p-val.	Coeff.	p-val.
$ALG_{i,t}$	-2.213505***	0.000	-2.149049***	0.000
$SIZE_{i,t}$	0.0744316***	0.000	0.6866952***	0.000
S_BHHC	-0.0914360***	0.000		
S_COOP	0.1504493***	0.000		
S_MLTC	-0.1187245	0.361		
S_REMB	-0.2561712***	0.000		
S_SAV	0.0073623	0.680		
+ bank-level fixed effects			yes	
+ interacted country-year dummy variables	yes		yes	
Constant	-0.0654916***	0.004	-3.577146***	0.000
No of observations	78,912		78,800	
No of banks	16,245		16,247	
Adj. R^2 (fixed effects: within)	0.100		0.080	

Table 6

Summary of results by country, region, bank size, specialization, and capitalization

This table differentiates the results for hypotheses H1-H3 by country, region, bank size, specialization, and capitalization. For each of the subsamples, the baseline regression models are used to check whether the findings for hypotheses H1-H3 prove true. + stands for a confirmation of the hypothesis (at least at the 5%-level), ~ indicates ambiguous evidence (the null cannot be rejected), and – means that contrarian evidence is found.

Classification category	H1	H2	H3
Countries			
Belgium	–	~	+
Canada	~	~	+
Denmark	+	+	+
France	+	~	+
Germany	+	+	+
Italy	~	+	+
Japan	~	+	~
Luxembourg	+	+	~
Netherlands	~	~	+
Norway	~	~	+
Portugal	~	~	~
Spain	+	~	+
Sweden	~	~	+
Switzerland	~	~	+
United Kingdom	~	+	+
USA	+	+	+
Regions			
Northern America (Canada, USA)	+	+	+
United Kingdom	~	+	+
Japan	~	+	~
Belgium, France, Luxembourg, and the Netherlands	+	~	+
Germany and Switzerland	+	+	+
Northern Europe (Denmark, Norway, Sweden)	~	+	+
Southern Europe (Italy, Portugal, Spain,)	~	+	+
Bank size (75-95-100% quantile of total customer loans)			
Small banks	+	+	+
Medium banks	~	+	+
Large banks	+	~	+
Bank specialization			
Bank Holding and Holding Company	+	+	+
Commercial bank	+	+	+
Cooperative bank	+	+	+
Medium and Long Term Credit Bank Real Estate / Mortgage Bank	~	+	+
Savings Bank	~	+	+
Bank capitalization (terciles)			
Low (weak banks)	+	+	+
Medium	+	+	+
High (strong banks)	~	+	+

Table 7

Interaction effects from mergers and acquisitions in the banking industry

This table reports results for hypotheses H1-H3 taking into account the mergers and acquisitions activity of banks. M&A effects are considered by an interacted indicator variable $MERGE_{i,t}$ (= 1 if a bank's total equity increases by more than 40.0%, which corresponds to the 95% percentile of the equity growth rate distribution). All regressions also include dummy variables for bank specializations and interacted countries/years (not reported here). P-values are calculated from Huber-White robust standard errors, controlling for clustering at individual banks. ***, **, * indicate that coefficients are statistically significant at the 1%; 5%, and 10%-level.

Panel A: Loan growth and loan losses (H1)

Dep. Var.	$LOGLL_{i,t}$	
Explanatory Var.	Coeff.	p-val.
$LOGLL_{i,t-1}$	0.5954992***	0.000
$ALG_{i,t-1}$	0.1000962*	0.074
$ALG_{i,t-1}$ X $MERGE_{i,t-4}$	-0.3621817***	0.000
$ALG_{i,t-2}$	0.1029457*	0.070
$ALG_{i,t-2}$ X $MERGE_{i,t-4}$	-0.0067092	0.923
$ALG_{i,t-3}$	0.2791565***	0.000
$ALG_{i,t-3}$ X $MERGE_{i,t-4}$	-0.2037789***	0.001
$ALG_{i,t-4}$	0.1192328***	0.003
$ALG_{i,t-4}$ X $MERGE_{i,t-4}$	-0.1262412**	0.027
$SIZE_{i,t}$	-0.0024234	0.603
$EQASSETS_{i,t}$	0.0011460	0.645
+ specialization dummy variables	yes	
+ interacted country-year dummies	Yes	
Constant	-0.3221741***	0.000
No. of observations	21,230	
No. of banks	8,959	
Adj. R^2	0.519	

Panel B: Loan growth and interest income (H2)

Dep. Var.	$\Delta RII_{i,t}$	
Explanatory Var.	Coeff.	p-val.
$ALG_{i,t-1}$	-1.715719***	0.000
$ALG_{i,t-1}$ X $MERGE_{i,t-4}$	2.826737***	0.000
$SIZE_{i,t}$	0.0155375***	0.000
$EQASSETS_{i,t}$	-0.0272306***	0.000
+ specialization dummy variables	yes	
+ interacted country-year dummies	yes	
Constant	-1.403906***	0.000
No. of observations	62,097	
No. of banks	14,726	
Adj. R^2	0.387	

Panel C: Loan growth and bank solvency (H3)

Dep. Var.	$\Delta EQASSETS_{i,t}$	
Explanatory Var.	Coeff.	p-val.
$ALG_{i,t-1}$	-4.289703***	0.000
$ALG_{i,t-1}$ X $MERGE_{i,t-4}$	5.340658***	0.000
$SIZE_{i,t}$	0.0619825***	0.000
+ specialization dummy variables	yes	
+ interacted country-year dummies	yes	
Constant	-0.0063448	0.765
No. of observations	78,911	
No. of banks	16,245	
Adj. R^2	0.220	

Table 8

Modified VAR model for loan losses and loan growth

The dependent variables are the natural logarithm of bank i's relative loan losses in t ($LOGLL_{i,t}$), defined as the fraction of total loan loss provisions in t over the total amount of customer loans in t-1, and the abnormal loan growth in t. Explanatory variables are the cumulative abnormal loan growth ($CUM\_ALG_{i,t-1}$) as a decimal number in t-1 and the natural logarithm of cumulative loan losses ($CUM\_LOGLL_{i,t-1}$) in t-1. Cumulative variables span the years from t-1 to t-4. We control for bank size ($SIZE_{i,t}$) using the logarithm of total customer loans, for capitalization with the equity-to-total assets ratio ($EQASSETS_{i,t}$), and apply indicator dummy variables for each bank specialization: Commercial banks form the reference group, whereas Bank Holdings and Holding Companies are denoted by S_BHHC=1, Cooperative Banks by S_COOP=1, Medium and Long Term Credit Banks by S_MLTC=1, Real Estate / Mortgage Banks by S_REMB=1, and Savings Banks by S_SAV=1. We also include a full set of interacted country and year dummies. P-values are calculated from Huber-White robust standard errors, controlling for clustering at individual banks. ***, **, * indicate that coefficients are statistically significant at the 1%, 5%, and 10%-level.

Dep. Var.:	(1) $LOGLL_{i,t}$		(2) $ALG_{i,t}$	
Explanatory Var.	Coeff.	p-val.	Coeff.	p-val.
$CUM\_ALG_{i,t-1}$	0.0213848**	0.040	0.0530052***	0.000
$CUM\_LOGLL_{i,t-1}$	0.6521295***	0.000	-0.0058643***	0.000
$SIZE_{i,t}$	-0.0027188	0.608	0.0136059***	0.000
$EQASSETS_{i,t}$	0.0015306	0.568	-0.0014489***	0.001
S_BHHC_i	-0.0177748	0.378	-0.0070190**	0.028
S_COOP_i	-0.1574264***	0.000	0.0187918***	0.000
S_MLTC_i	-0.2474698	0.200	-0.0502684 **	0.034
S_REMB_i	-0.4770529***	0.000	-0.0402637***	0.000
S_SAV_i	-0.0931875***	0.000	-0.0079062*	0.051
+ interacted country-year dummies	yes		yes	
Constant	-1.128564***	0.000	-0.0789364***	0.000
No. of observations	21,794		22,443	
No. of banks	9,223		9,343	
Adj. R^2	0.477		0.137	