Bank Ownership and Stability: Evidence from Germany

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Abstract: Using a unique bank-level panel dataset over the period 1995 to 2007, this paper assesses the stability of German banks with different ownership structures. Using three different measures of bank stability – the *z-score*, a standard measure of distance from insolvency, *non-performing loans,* and *distress probabilities* derived from hazard models – we find consistent evidence that privately-owned banks are less stable than government-owned savings banks and cooperative banks. Furthermore, cooperative banks are farther away from insolvency than government-owned savings banks, but are more likely to become distressed than savings banks. We also find evidence for the Too-Big-To-Fail phenomenon, as larger privately-owned banks hold less risk-weighted capital than their smaller peers, thus moving closer to insolvency, but face lower distress probability. We cannot find such behavior for cooperative or savings banks.

Keywords: Bank ownership; bank stability; bank failure; Germany
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Non-technical summary

Theory gives conflicting predictions on which ownership type is most conducive to stability. This paper uses a unique dataset on German banks of different ownership types to assess the relationship between bank ownership and stability. Germany offers a unique "laboratory" to explore bank stability across different ownership types, as the banking system consists of three broadly equally sized segments, privately-owned banks, government-owned savings banks, and cooperative banks. We use annual data over the period 1995 to 2007 and relate different measures of bank stability to ownership dummies and an array of other bank characteristics. We also explore differences in the relationship between stability and bank size across different ownership types.

Our findings suggest that cooperative banks are the most stable financial institutions in Germany, as measured by the z-score, i.e. the distance to insolvency, followed by savings banks and private banks. Decomposing the z-score, we find that privately-owned banks are more profitable and better capitalized than both savings and cooperative banks, which, however, is more than compensated by the higher volatility in profits. Using a measure of lending risk, the NPL-score, yields similar results, although there is no significant and consistent difference between cooperative and savings banks in lending risk. The findings confirm the stability-enhancing impact of cooperative banks due to their focus on capital endowment protection and consumer surplus maximization as well as their disperse shareholdings.

When using a measure of distress probability, however, we find that savings banks are more stable than cooperative banks, with private banks again facing the highest distress risk. While cooperative banks are thus farthest away from insolvency, due to the low volatility of their profits, they face higher distress risk than savings banks, suggesting skewness in the underlying distribution of profits and capital ratios.

Considering the effect of several other bank characteristics, including bank size, on bank stability, we find tentative evidence for the Too-Big-to-Fail phenomenon. Specifically, when using the z-score, larger private banks are less stable than small private banks, due to lower capital ratios, while this relationship is reversed for savings and cooperative banks, due to lower volatility. When using the distress probability score, on the other hand, we find that both private and savings banks are less likely to become distressed as they grow larger. Further, there is a negative relationship between bank size and lending risk for private banks. Taken together, we interpret this as evidence in favor to Too-Big-To-Fail policies, especially in the case of private banks; the latter reduce capital ratios as they grow larger, counting on government support in case of fragility.

Nichttechnische Zusammenfassung

Die Finanzmarkttheorie gibt widersprüchliche Erklärungsansätze vor, welche Eigentümerstruktur am besten geeignet ist die Stabilität des Bankensystems zu fördern. Die vorliegende Studie basiert auf einem Mikro-Panel mit bankenaufsichtlichen Daten zu Instituten, die dem dreigliedrigen deutschen Bankensystem angehören. Mit den Gruppen Privatbanken, staatliche Sparkassen und Kreditgenossenschaften bietet Deutschland ein einzigartiges "Laborumfeld" zur Untersuchung von Bankenstabilität zwischen verschiedenen Eigentümergruppen. Wir basieren unsere Untersuchung auf Jahresdaten für den Zeitraum 1995 bis 2007 und erklären verschiedene Stabilitätsmaße durch Bankengruppen-Dummys sowie weitere Bankcharakteristika. Darüber hinaus untersuchen wir die Unterschiede in der Beziehung zwischen Bankenstabilität und Institutsgröße über verschiedene Eigentümergruppen hinweg.

Unsere Ergebnisse deuten darauf hin, dass Kreditgenossenschaften die stabilsten Banken in Deutschland sind, sofern man den z-Score – und damit den Abstand eines Instituts zur Insolvenz – als Stabilitätsmaß heranzieht. Es folgen Sparkassen und schließlich Privatbanken. Bei Analyse der z-Score-Bestandteile kommen wir zu dem Ergebnis, dass Privatbanken profitabler und besser kapitalisiert sind als Sparkassen und Kreditgenossenschaften. Dieser Vorteil wird jedoch durch die höhere Volatilität der Gewinne wieder mehr als kompensiert. Bei Verwendung eines Kreditrisikomaßes, des (logit-transformierten) Anteils der notleidenden Kredite, erhalten wir ähnliche Ergebnisse, wenngleich es keine signifikanten Unterschiede des Kreditrisikos zwischen Kreditgenossenschaften und Sparkassen gibt. Unsere Ergebnisse bestätigen den stabilitätserhöhenden Einfluss von Kreditgenossenschaften aufgrund ihrer Ausrichtung auf Kapitalakkumulation und auf die wirtschaftlichen Förderung ihrer Mitglieder sowie ihrer granularen Eigentümerstruktur.

Das Stabilitätsmaß “distress probability”, d. h. die Wahrscheinlichkeit, dass eine Bank in Schieflage gerät, hingegen zeigt Sparkassen stabiler als Kreditgenossenschaften, wobei auch hier die Privatbanken das höchste Risiko aufweisen. Aufgrund der geringen Volatilität ihrer Gewinne sind Kreditgenossenschaften damit am Weitesten von einer Insolvenz entfernt, wenngleich sie ein höheres Risiko einer Schieflage als die Sparkassen aufweisen. Dies deutet auf eine dementsprechend andere Verteilung der dem z-Score zugrunde liegenden Gewinne und Kapitalquoten hin.

Die Untersuchung des Einflusses verschiedener anderer Bankcharakteristika (einschließlich der Bankengröße) auf Finanzstabilität lässt auf ein “to-big-to-fail”-Phänomen schließen. Insbesondere beim z-Score zeigt sich bei größeren Banken (aufgrund kleinerer Kapitalquoten) eine geringere Stabilität, während sich dieses Ergebnis für Sparkassen und Kreditgenossenschaften (aufgrund deren geringeren Volatilität) umdreht. Andererseits zeigt sich bei Verwendung (logit-transformierter) “distress probabilities” mit zunehmender Größe eine kleinere Wahrscheinlichkeit für eine Schieflage sowohl von Privatbanken als auch von Sparkassen. Zudem besteht bei Privatbanken eine negative Beziehung zwischen Bankgröße und Kreditrisiko. Insgesamt interpretieren wir diese Ergebnisse als Hinweis auf eine “too-big-to-fail”-Politik von Banken, insbesondere von Privatbanken. Letztere weisen mit zunehmender Größe kleinere Kapitalquoten auf, was wir dahingehend deuten, dass sie im Notfall auf staatliche Unterstützung vertrauen.

1. Introduction

Since the onset of the financial crisis bank stability has been yet again at the top of policy makers' agenda across advanced and developing countries. Concerns about the stability of banks of different sizes and ownership have dominated the public debate around the world over the past two years. While some point to the failure of private banks as evidence for the fragility of short-term and profit-oriented banking, others point to governance failures and distorted business models in state-owned banks that came to light during the crisis, such as in Germany and elsewhere. A third bank group that has seemingly been least affected by the current crisis are cooperative banks, i.e. financial institutions owned by their members, given their business models and very limited exposures to structured finance products. Beyond this crisis, however, there are more fundamental questions about the relative stability of banks of different ownership types. This is an important question for researchers and policy makers alike who care about the stability of the overall banking system.

Theory gives conflicting predictions on which ownership type is most conducive to stability. While government ownership of banks can reduce risk-taking by banks as high returns might not be the primary concern, it can also increase bank fragility given weaker banking skills, weak governance structures, unstable business models, and overall misaligned incentives in government-owned banks, resulting in lower efficiency and lower profitability thus leading to fragility. Cooperative banks might be less fragile than other banks as they have a stable deposit and customer basis, focus on capital preservation and do not maximize profits but customer surplus which could serve as a potential cushion in weaker periods; further, disperse membership and dominance by managers in risk-taking decisions might reduce incentives for risk taking and thus fragility. Finally, the stability of privately-owned banks depends on shareholder concentration, among other factors; more concentrated ownership might reduce agency problems between managers and owners, as the latter are better able to

monitor and discipline the former, and lead to more risk taking. Besides bank-specific factors, the risk-taking approach and thus stability of banks of all ownership types depends very much on the financial safety net and macroeconomic conditions.

This paper uses a unique dataset on German banks of different ownership types (excluding the five large private banks, Landesbanken and two cooperative central banks) to assess the relationship between bank ownership and stability. Previous research has derived findings either from comparing countries with different bank ownership patterns or comparing two of the three ownership types within a country. While in the former case, unobserved country effects might confound the relationship between bank ownership and fragility, in the latter case differences in the financial safety net and institutional and governance framework faced by banks of different ownership types might confound the relationship between bank ownership and stability. Germany offers a unique "laboratory" to explore bank stability across different ownership types, as the banking system consists of three broadly equally sized segments, privately-owned banks, government-owned savings banks, and cooperative banks. At the same time, these banks face the same institutional and macroeconomic framework and similar financial safety net arrangements. We use annual data over the period 1995 to 2007 and relate different measures of bank stability to ownership dummies and an array of other bank characteristics. We also explore differences in the relationship between stability and bank size across different ownership types.

To understand the link from ownership type to bank stability, one has to consider the objective function of shareholders and the potential principal-agent problems between shareholders and management. While shareholders of privately-owned banks focus on profit-maximization, owners of government-owned banks might have other – political and profit-reducing – objectives. Political capture can lead to commercially unsustainable lending decisions and fragility (La Porta et al., 2002; Cole, 2009; Dinc, 2005; Khwaja and Mian, 2005). The idea underlying the cooperative bank movement is that of preserving an

endowment of capital for future generations of members while maximizing consumer surplus for current members, which potentially should result in more prudent risk taking and lower volatility (Fonteyne, 2007).

Theory predicts that banks with large dominating shareholders – with easy control over management – tend to take more aggressive risks than manager-dominated banks with small disperse shareholdings, as diversified owners have stronger incentives to take aggressive risks than non-shareholding managers with bank-specific human capital and private control benefits (Jensen and Meckling, 1976; Galai and Masulis, 1976; Esty, 1998). While German savings banks have typically one dominating shareholder – the local or regional government – with a potentially relatively easy influence on management, accountability of management might be difficult to enforce, with bureaucrats taking non-commercial, politicized lending decisions. Further, regional and local governments are typically less diversified in their risk exposure, which might further reduce their risk appetite. Cooperative banks, on the other hand, have a disperse membership, which might make influence of individual members on management more difficult and thus result in lower risk taking. If members come from very similar socio-economic background, however, it might be easier for them to monitor and control management. In international comparison, the ownership of German private banks is relatively disperse, with limited influence of large shareholders on management (Laeven and Levine, 2008), suggesting fewer incentives to risk taking. On the other hand, privately-owned financial institutions are more clearly focused on risk taking than cooperative or state-owned financial institutions. Given the confounding influences of ownership structure and owner objectives across the three German banking groups, theory does not provide us with unambiguous predictions.

The existing evidence has provided ambiguous evidence on the relative stability of banks with different ownership patterns. Cross-country evidence has consistently pointed to a higher share of government ownership resulting in higher banking fragility and crisis

probability (La Porta et al., 2002; Barth, Caprio and Levine, 2004). Ianotta, Nocera and Sironi (2007) find for a sample of large European banks that government-owned banks are least stable, followed by privately-owned banks, while cooperative banks are the most stable banking group. Garcia Marco and Robles Fernandez (2008), however, find that Spanish commercial banks are less stable than Spanish savings banks. Similarly, Cihak and Hesse (2007) find for a sample of OECD countries that cooperative banks are more stable than commercial banks.[1] Saunders et al. (1990) and Laeven and Levine (2008) confirm predictions of the theory that banks with large dominating shareholders take larger risks than manager-dominated banks with small shareholdings. Unlike the existing literature, our paper considers bank stability across three different ownership types within the same country, holding constant the institutional and macroeconomic framework faced by banks.

Our findings suggest that cooperative banks are the most stable financial institutions in Germany, as measured by the z-score, i.e. the distance to insolvency, followed by savings banks and private banks. Decomposing the z-score, we find that cooperative banks have typically lower profitability and lower capital-asset ratios, while they also have substantially lower volatility of profits. It is this lower volatility that drives the overall higher distance of cooperative banks from insolvency. Using a measure of lending risk, the NPL-score, yields similar results, although there is no significant and consistent difference between cooperative and savings banks in lending risk. When using a measure of distress probability, however, we find that savings banks are more stable than cooperative banks, with private banks again facing the highest distress risk. While cooperative banks are thus farthest away from insolvency, due to the low volatility of their profits, they face higher distress risk than savings banks, suggesting skewness in the underlying distribution of profits and capital buffers.

While focusing on the relationship between ownership type and insolvency risk, we consider the effect of several other bank characteristics, including bank size, on bank stability,

[1] This is consistent with findings from both Chaddad and Cook (2004) and Hansmann (1996) that in the U.S. mutual financial institutions are more stable than demutualized institutions.

with some interesting findings. One the one hand, the literature on the relationship between bank size and stability has found ambiguous results for banks in the U.S (Boyd and Runkle, 1993; Calomiris and Mason, 2000; Chong, 1991; Hughes and Mester, 1998, among others). De Nicolo (2000), on the other hand, finds a positive and significant relationship between bank size and the probability of failure for banks in the U.S., Japan and several European countries. Apart from the intrinsic relationship between bank size and stability, larger banks might also be less likely to fail as they are considered to be too important to fail (e.g. Mishkin, 1999). For Germany, we find that the relationship between bank size and stability varies across the different ownership types. Specifically, when using the z-score, larger private banks are less stable than small private banks, due to lower capital, while this relationship is reversed for savings and cooperative banks, due to lower volatility. When using the distress probability score, on the other hand, we find that both private and savings banks are less likely to become distressed as they grow larger. Further, there is a negative relationship between bank size and lending risk for private banks. Taken together, we interpret this as evidence in favor to Too-Big-To-Fail policies, especially in the case of private banks.

This paper makes several important contributions to the literature on bank ownership and stability. First, we compare banks of three different ownership groups holding constant the institutional and regulatory framework, thus controlling for confounding factors. Second, we consider three alternative and complementary measures of bank stability, the z-score as measure of the distance from insolvency, the NPL-score as indicator of lending risk, and the probability of distress score (PD-score) as measure of the actual insolvency risk, or the tail risk of a bank. We also improve on the computation of both z-score and PD-score compared to the literature, utilizing detailed financial statement data, e.g. undisclosed reserves, that have not been made available so far. Finally, we contribute to the literature on bank size and stability by comparing the relationship between bank size and stability across different

ownership types. This allows us to explore the mechanisms through which the size of banks impacts bank stability.

This paper, however, has also its limitations. First, our findings do not have welfare implications, as we focus exclusively on the stability of banks, and not on efficiency of different banking groups, the optimal degree of risk taking or the extent to which banks contribute to growth through their intermediation and other activities. Our findings, however, do provide important insights for regulators and supervisors in charge of banks of different ownership types. Second, while our findings provide insights into the risk-taking activities and stability of banks of different ownership in the same institutional setting, these findings might not hold in different institutional environments and in countries where banks of different ownership face different financial safety nets. Third, financial systems in many advanced economies have been under very severe stress in recent months with massive government interventions, e.g. capital injections and guaranteeing of bank liabilities. The paper is not able to account for the dynamics of the current financial turbulences.

The remainder of this paper is organized as follows. Section 2 briefly presents the main features of the German banking system in terms of ownership patterns. Section 3 discusses our data and present descriptive statistics and correlations. Section 4 presents our main results, while section 5 provides robustness tests. Section 6 concludes.

2. The German Banking System

The German banking system consists of three large groups, characterized by their different ownership type. The largest group, savings banks and their central institutions (Landesbanken), consists of financial institutions owned by governments on city-, county- or state-level, constituting around 37% of the total assets of the banking system. The savings bank segment, excluding Landesbanken, is highly fractionalized, with a total of 446 banks and average total assets of 2,292 million Euros. Savings banks are restricted to the area of the

city or county that owns them; therefore there is little if any competition among them. The private bank segment is heavily concentrated, with the five largest banks representing more than 80% of total assets of all private banks.[2] While these five and other private banks are active in all German states, there are also a large number of regionally concentrated private banks. Finally, there are still a small number of private bankers who are liable for the banks' losses not only with their paid-in capital, but also with their personal assets.[3] The German private bank industry thus shows a relatively inhomogeneous structure, with average total assets of 21,024 million Euros, but ranging from 0.7 million Euros to 1,886,768 million Euros. The third and smallest segment of the German banking system are the cooperative banks, similarly fractionalized as the savings banks as they are limited to specific geographic areas and do not compete against each other. The average assets of cooperative banks, excluding their central institutions, are 500 million Euros, ranging from 12 million to 37,070 million Euros.[4]

Most of the savings banks were founded in the 18th and 19th century to provide a safe outlet for the savings of the lower and middle classes. While geographically restricted, they are linked to Landesbanken that provide banking services that the local banks are not able to provide, such as international banking and securities business. Similarly, cooperative banks also operate in geographically restricted areas. These credit cooperatives were founded in the 19th century to serve rural areas, but also small and medium entrepreneurs in urban areas.[5] Originally restricted to serving only their members, they have opened up in recent decades. While members had initially mutual and indefinite liability for their cooperative, their liability has since been restricted and in most cases does not exceed the paid-in capital. As the savings

[2] These are Deutsche Bank, Dresdner Bank, Bayerische Hypo- und Vereinsbank, Commerzbank and Postbank.
[3] Many of these "private bankers", however, have been taken over by one of the large banks and, although operating under their original name, are not private banks anymore.
[4] The remainder of the German banking system is made up by mortgage banks, building and loan associations and banks with special functions.
[5] See Bonus and Schmidt (1990) for an excellent description of the cooperative-banking group in Germany.

banks, the cooperative banks have access to the services provided by two national apex institutions.

Each of the three segments of the German banking system has its own deposit insurance scheme that goes above and beyond the statutory minimum deposit insurance of 20,000 Euros per depositor that was increased to 100,000 Euros recently because of the financial crisis. The schemes of savings and cooperative banks guarantee the institutions themselves rather than the depositors, thus providing full coverage for all liability holders. In the case of private banks, the privately-funded and managed deposit insurance scheme guarantees deposits of up to 30% of paid-in capital.[6] For each of the three segments, the banking association and the deposit insurance fund play an active role in the resolution of failing banks, which is mostly undertaken in the form of mergers of the failing with a strong institution or joint recapitalization of the failing institution by the respective deposit insurance fund. Given this structure of the financial safety nets, there is little incentive for depositors and other liability holders to exercise market discipline vis-à-vis banks.[7]

In summary, the three banking groups have similar importance within the German banking sector, similar business models, and face similar financial safety net frameworks. The main difference concerns the ownership structure of the different banks, with most private banks being shareholding companies, savings banks owned by local and regional governments and cooperative banks being owned by their members. In our empirical analysis, we will control for other differences across banks of the three segments, most critically, for the size of institutions.

[6] Since the scheme is privately managed and funded, membership is voluntary and there are a few privately owned financial institutions that do not participate in the scheme, either because they are not interested or because they have not been accepted. See Beck (2002) for a more detailed discussion.
[7] There seems to be a certain degree of inter-bank market discipline. See Beck (2002).

3. Data and Methodology

We employ a unique bank level dataset with a sample of 3,810 banks for the years 1995 through 2007, which is the result of combining five different databases which are available at the Deutsche Bundesbank: Specifically, we use BAKIS to construct bank-specific variables; the Bundesbank distress database to derive bank probabilities of distress (PDs); the Bundesbank borrowers' statistics for information on sectoral loan concentration of banks; the Bundesbank credit register to construct the measure for the regional market concentration and, finally, data from the Federal Statistical Office and the Bank of International Settlements (BIS) to construct macroeconomic variables. BAKIS is the Information System on bank-specific data which is jointly operated by the Deutsche Bundesbank and BaFin (German Federal Banking Supervisory Office) and which contains bank financial statements for all German banks. The information on bank PDs is taken from the Bundesbank distress database, a unique data set collected by the Deutsche Bundesbank on a variety of distress events experienced by banks between 1994 and 2007. The Bundesbank borrowers' statistics contain information on the break down of domestic banks' lending to enterprises and households in Germany by economic sector on a quarterly basis and allow us to construct the Herfindahl-index to proxy the sectoral loan concentration at the individual bank level. The Deutsche Bundesbank's credit register contains the individual exposures of German banks to firms. Specifically, it contains information on banks' exposures to a firm, if either the sum of the exposures to firms in a borrower unit or the exposure to the individual firm exceeds the threshold of 1.5 million Euros.[8] We use the information on regional lending from the credit register in order to construct the Herfindahl-index for the regional market concentration and then use a weighted average across states where a bank is active. Finally, we take the information on macroeconomic variables such as insolvency rate at the Bundesland level, real

[8] For a more detailed definition, see Section 14 of the Banking Act (Deutsche Bundesbank, 2001). If exposures of 1.5 million Euros or above existed during the reporting period but are partly or fully repaid, the remaining exposure is reported even if the amount is zero. We take the actual amounts of the exposures into consideration.

one-year interest rate from the Federal Statistical Office. The information on the Real Asset Price Index comes from the Bank of International Settlements (BIS).

Our sample includes 655 savings banks, 2,923 cooperative banks and 232 private banks. The sample thus consists of 77% cooperative bank-year, 17% savings bank-year and 6% private bank-year observations. We do not include the large five private banks, the large state-level savings banks (Landesbanken) and the two apex institutions for the cooperative banking segment, as they have very different business lines in comparison to the rest of the respective banking groups. In case of mergers, we treat the original two banks and the resulting banks as three separate financial institutions (for description see appendix A).

Following the literature, we focus on three indicators of financial stability, the z-score as measure of distance from insolvency, the NPL-score as indicator of lending risk, and the probability of distress score (PD-score) as measure of actual insolvency risk. A number of outliers are eliminated (see appendix B).[9] We will discuss each measure in turn.

The z-score is a measure of bank stability and indicates the distance from insolvency, combining accounting measures of profitability[10], leverage and volatility. Specifically, if we define insolvency as a state where losses surmount equity ($E<-\pi$) (where E is equity and π is profits), A as total assets, $ROA=\pi/A$ as return on assets and $CAR = E/A$ as capital-asset ratio, the probability of insolvency can be expressed as prob($-ROA<CAR$). If profits are assumed to follow a normal distribution, it can be shown that $z = (ROA+CAR)/SD(ROA)$ is the inverse of the probability of insolvency. Specifically, z indicates the number of standard deviation that a bank's return on assets has to drop below its expected value before equity is depleted

[9] For z-score, NPL-score and bank size, we drop observations smaller than the 2nd percentile and larger than 98th percentile of the distribution within each banking group, while the PD-score does not contain outliers. We truncate the variables risky assets, RWA growth, cost efficiency and income diversification as follows: the observations smaller than the 2nd percentile of the distribution are set to the value of the 2nd percentile and the observations larger than 98th percentile of the distribution are set to the value of the 98th percentile.

[10] For our measure of profitability we use a bank's *operative result* instead of the *annual net profit* ("Jahresüberschuss"). This is due to the fact that German banks can build up undisclosed hidden reserves pursuant to section 340(f) of the German commercial code, which are already accounted for in the *annual net profit*. Furthermore, there seems to be evidence that German banks use these 340(f)-reserves for smoothing their *annual net profits* and, therefore, this measure of profitability would be artificial to some extent.

and the bank is insolvent (see Roy, 1952, Hannan and Henwick, 1988, Boyd, Graham and Hewitt, 1993 and De Nicolo, 2000). Thus, a higher z-score indicates that the bank is more stable. In our regression analysis, we also consider the different components of the z-score, i.e. the return on assets, capital-asset ratio and the standard deviation of the return on assets.

Benefiting from the detailed data we have available, we make several adjustments and improvements to the way the literature has traditionally computed the z-score. First, we use risk-weighted rather than total assets, when calculating the capital-asset ratio, return on assets and its standard deviation, thus taking into account risk differences in banks' balance sheets. Second, we include disclosed and undisclosed[11] reserves when calculating equity, as German banks typically resort to these reserves when in trouble.

While the z-score has been widely used in the financial and non-financial literature, it might underestimate banking risk for several reasons. First, it measures risk in a single period of time and does not capture the probability of a sequence of negative profits. We therefore use the stock of non-performing loans as alternative fragility indicator. Second, it considers only the first and second moment of the distribution of profits and ignores the potential skewness of the distribution (De Nicolo, 2000). We therefore also use the PD-score as alternative indicator of bank fragility, which focuses on the tail risk of banks. A third concern is the reliance of the z-score on accounting data whose quality might vary across banks. This, however, is less of a concern in our case as we focus on banks within one country that are all subject to the same accounting standards.[12]

The z-score varies between 0.8 and 80.5 across our sample, with a mean of 27.7 and standard deviation of 13.8. Figure 1 shows the kernel density plots (based on the Gaussian kernel) for the distribution of the z-score for all three banking groups, which reveals an

[11] While these reserves do not have to be disclosed on the publicly available balance sheets, they have to be disclosed to the bank regulators, including the Bundesbank.

[12] As an alternative method, other authors have relied on stock market data to compute bank risk as a put option on the value of the bank's assets (Laeven, 2002, and Hovakimian, Kane and Laeven, 2003). This is not possible in our case, however, as German savings and cooperative banks are not listed on stock exchanges.

asymmetric distribution for all groups with fat tails for lower z-scores, and clearly indicate a lower stability of private banks in contrast to savings and cooperative banks. The average z-score shows a u-shaped distribution over our sample period, falling until 2001 (with a minimum of 24.8) and then increasing again to a maximum of 31.7 in 2007. The risk-weighted CAR (capital asset ratio) varies between 8.4% and 402.4%, with an average of 14.4%, and the risk-weighted ROA between -45.8% and 39.1%, with an average of 1.2%. The SD (standard deviation) of risk-weighted ROA varies between 0.17 and 25.86, with a mean of 0.76. Comparing the average z-score across the three banking groups, we find that cooperative banks have the highest z-score, followed by savings banks and private banks (Table 1). Specifically, cooperative banks show an average z-score of 30.1, savings banks of 23.9, and private banks of 17.0. Considering the different components we see that in the numerator this difference is driven more by differences in capitalization than by differences in profitability. The risk-weighted CAR averages 27.6% for private banks, 13.4% for savings banks and 13.3% for cooperative banks. The risk-weighted ROA averages 1.67% for private banks, 1.32% for savings banks and 1.13% for cooperative banks. But even larger are the differences in the denominator, the volatility of the risk-weighted profits, which is 3.88 for private banks, 0.67 for savings banks and 0.54 for cooperative banks.

The non-performing loan (NPL) ratio is defined as the ratio of classified loans to total loans (excluding interbank loans). Unlike the other two stability measures, however, it is only available after 1997, thus our sample period is one year shorter than for the other two stability indicators. The NPL ratio varies between 0.2% and 54.9%, with mean of 6.6% and standard deviation of 4.5%. The variation of the average NPL ratio over the years is quite low with minima of 6.0% in 1998 and 2007 and a maximum of 7.5% in 2004. Private banks have the highest average NPL ratio (10.0%), followed by savings (6.4%) and cooperative banks (6.3%). Since the NPL ratio is limited by zero, we apply a logistical transformation to create the linear variable NPL-score, for which kernel density plots are shown in Figure 2. In

contrast to the z-score, the distribution is for all banking groups rather symmetric with slim tails. Again, we find indication for lower stability of private banks.

To compute the PD-score, we utilize a panel logit model with a dummy variable as dependent variable that indicates whether a bank has (i) faced compulsory notifications about events that may jeopardize the existence of the bank as a going concern (ii) suffered severe losses of capital and extreme declines in return on equity, (iii) benefited from capital injections from the deposit insurance scheme, (iv) been subject to a distress merger, or (v) been closed by the bank supervisory agency. In contrast to previous studies this data set consists of a more precise distress definition as well as on a longer time period for which distress data is available (for a detailed description of the Bundesbank distress database see Appendix C.) As explanatory variables we include a standard CAMEL-vector together with a macroeconomic indicator. We run two separate specifications for (1) savings and cooperative banks and (2) private banks and compute distress probabilities based on the models. We apply a logistic transformation to the estimated distress probabilities to create the linear variable PD-score, which we use as dependent variable in a second step. The PD-score varies between -16.2 and 3.3, with an average of -4.8 and a standard deviation of 2.0. Kernel density plots (Figure 3) show a rather symmetric distribution of the PD-score for all three banking groups with a clear ranking when banking group stability is concerned: savings banks (highest), credit cooperatives (intermediate), and private banks (lowest stability). Between 1997 and 2003 the mean PD-score per year varies only slightly around -4.4, but from 2004 to 2007 it steadily decreases up to -6.4, thus mimicking the movement in the z-score. The PD-score averages -5.8 for savings banks, -4.7 for cooperative banks, and -2.8 for private banks. Thus according to the PD-score it is the savings banks that face the lowest probability of distress rather than the cooperative banks, which simple comparisons suggest are farthest away from insolvency as measured by the z-score.

While the z-score is a linear measure of distance from insolvency, the PD-score focuses on tail of the distribution, the probability of actual distress. Not surprisingly, the two measures are correlated, but not perfectly, with a correlation coefficient of -22.2%, significant at the 1% level. The correlation between z-score and NPL-score is -17.2%, while the correlation between PD-score and NPL-score is 28.0%, both significant at the 1% level. The significant but imperfect correlation of NPL-score with the other stability measure suggests that lending risk is only one source of risk for banks.

In order to assess the relationship of ownership and other bank characteristics with bank stability, we utilize regressions of the following form:

$$Score_{i,t} = \alpha + \beta B_{i,t-1} + \gamma M_{i,t} + \delta_1 S_i + \delta_2 C_i + \varepsilon_{i,t} \qquad (1)$$

where Score is the z-score, the NPL-score, or the PD-score, B is a vector of lagged bank characteristics varying across banks and over time, M is a vector of contemporaneous macroeconomic variables varying over time, S is a dummy for savings banks, C is a dummy for cooperative banks and ε is the white-noise error term. Our focus is on the coefficients on S and C as well as the difference between the two. In a second step, we interact B and M with dummy variables for private, savings and cooperative banks to assess whether the relationship between the different bank characteristics and bank stability varies across different bank ownership types. We run the regression with random effects, since fixed effects estimation would not allow us to test for differences between banking groups. The regressions of the SD of risk-weighted ROA, i.e. the denominator of the z-score, are run with simple OLS regressions, as there is only one observation per bank. Further, the macroeconomic variables M are not included.

The vector B comprises (i) bank size, measured as logs of total assets, (ii) the riskiness of a bank's balance sheet, measured by the ratio of risk-weighted assets to total assets, with higher values thus indicating higher risk taking, (iii) the growth rate of risk-weighted assets, deflated by the BIP deflator, (iv) a cost inefficiency measure, computed as overhead costs

divided by net revenue, (v) a measure of income diversification, which is defined as one minus the square of net interest income divided by total net revenue and the square of net non-interest income divided by total net revenue, (vi) the Herfindahl-index of sectoral loan concentration, calculated across six sectors[13] and (vii) a measure of market concentration, computed as the average across bank concentration in each state where the bank is active weighted by the loan exposure of the bank in each state.[14] The vector M consists of three time-varying macro-indicators. Specifically, we include (i) the firm insolvency ratio (insolvent firms as a fraction of total firms), computed on the state-level and averaged for each bank across all states where the bank is active weighted by the loan exposure of the bank in each state, (ii) the one-year real interest rate (one-year government bond rate minus growth rate of consumer price index), and (iii) the growth rate of the BIS Aggregate Asset Price Index for Germany. The definition and measurement of the variables is summarized in Table 2.

Bank size is an important determinant of bank stability, and its relationship has been fairly ambiguous in the academic literature (e.g. Boyd and Runkle, 1993; Calomiris and Mason, 2000) while De Nicolo (2000) finds a negative and significant relationship. Furthermore, a higher amount of risky assets is expected to be associated with higher bank failure and too rapid expansion of loan portfolio can lean to greater risk taking by banks (Pain (2003), Davis (1993), Borio and Lowe (2002)). In addition, a measure for cost inefficieny is included, and more efficient banks tend to be more stable (e.g. Cihak and Hesse, 2007). Similarly, Wheelock and Wilson (2000) show that banks' productive inefficiency leads to a

[13] The Herfindahl-index of sectoral loan concentration comprises of six sectors: (1) manufacturing; (2) wholesale and retail trade; repair of motor-vehicles, motor-cycles and personal and household goods; (3) other services; (4) agriculture, hunting and forestry, fishing and fish farming; electricity, gas and water supply; mining and quarrying; construction; transport, storage and communication; (5) housing loans to households; (6) other household loans.

[14] In the case of private banks, we calculate the weights from the credit register of the Bundesbank, which allows us to calculate the share of loans over 1.5 million Euros by each bank that go to each state. In the case of savings and cooperative banks which are not available in the credit register, we take the value for the state where they are located. Therefore, the market concentration measure might be slightly distorted for savings and cooperative banks.

higher probability of bank failure. Our definition for income diversification follows Stiroh and Rumble(2006). Stiroh (2004) finds that diversification to noninterest income is related to lower profits and higher risks in the U.S. banking industry. Also DeYoung and Rice (2004) find that on average increases in noninterest income are associated with poorer risk-return tadeoffs.

We also include measures for concentration- very common in the academic literature-, both at the sectoral loan and regional level. The one measure is on sectoral loan concentration and the other is on market concentration. The theoretical and empirical literature has not identified a robust relationship between sectoral loan concentration and stability (Winton, 1999; Archaya et al., 2006); Hayden et al., 2008). Specifically, theory suggests opposing effects of sectoral loan concentration – on the one hand, it might increase the quality of screening and monitoring, drawing on specialized skills, thus foster stability; on the other hand, high concentration might expose the banks more to sectoral shocks and thus increase the risk of fragility (Winton, 1999). Further, sectoral diversification might lead to lower monitoring effort in riskier banks as the downsides of diversification accumulate to debt but not equity holders (Archaya et al., 2006). On market concentration, results could go either way a priori with, for instance, Beck et al (2005) finding that market concentration is associated with more financial stability. In contrast, research by Boyd and de Nicolo (2005) as well as Schaeck et al (2009) suggests that more competitive systems are conducive to more bank stability. In addition, Hoggarth, Milne, and Wood (1998) find that a less competitive German banking system appears to be more stable in their comparison of German and UK banks.

Also, standard macroeconomic variables such as interest rates, asset price growth and a regional insolvency rate are incorporated into the analysis. Similar variables have also been used by other studies (Pain (2003), Salas and Saurina (2002), Borio and Lowe (2002), Fernandez de Lis, Pages and Saurina (2000), Davis (1993)). Higher interest rates as a proxy

for the cost of capital should lead to relative less bank stability while higher asset price growth and lower firm insolvency, both capturing the overall business climate, are expected to reduce banks' failure risk.

Table 3A provides descriptive statistics of all variables that enter our estimations. Bank size (which we include as natural logarithm in our regressions) varies between 2 million and 27.6 billion Euros with an average of 638.2 million Euros. The ratio of risk-weighted to total assets varies between 7.6% and 102.7%, while the growth rate in risk-weighted assets ranges from -66% to 147.4%. The cost inefficiency ratio varies between 20.2% and 284.0%. Income diversification ranges from 1.6% to 50%, while sectoral loan portfolio concentration varies between 16.7% and 100% and the Herfindahl-index of regional concentration between 2.0% and 13.5%. The insolvency rate varies between 0.5% and 3.1%, the real asset price increase between -10.6% and 7.0% and the one-year real interest rate between 0.6% and 3.3%.

The correlations in Table 3B suggest that larger banks, banks with less risky asset portfolios and banks with faster growth in risk-weighted assets have lower z-scores (are thus closer to insolvency), but also face lower distress probabilities, except for banks with faster growth in risk-weighted assets. Banks with less risky asset portfolios and banks with faster growth in risk-weighted assets have lower NPL-scores, whereas larger banks tend to have higher NPL-scores. Higher cost inefficiency, higher sectoral loan diversification and higher regional concentration are correlated with lower z-scores and higher distress probabilities, whereas higher income diversification is only positively and significantly correlated with the PD-score, but not with the z-score. Income diversification and regional concentration are positively and significantly correlated with the NPL-score, while sectoral loans concentration is negatively and significantly correlated with the NPL-score. The correlation of the variable cost inefficiency with the NPL-score is insignificant. Lower insolvency rate and higher asset price inflation are associated with higher bank stability, as measured by the z-score, the NPL-

score and – except for the insolvency rate – the PD-score. Lower real interest rates are also correlated with higher bank stability, as measured by the z-score and the PD-score but not if measured by the NPL-score. We also find interesting correlations between some bank characteristics and the bank ownership dummies. Bank size, for example, is positively correlated with the private and savings bank dummies. The significant correlations between different bank characteristics and the ownership dummies underline the importance of multivariate analysis. The sometimes contradictory correlations of bank characteristics with the z-score, the NPL-score and the PD-score also underline the importance to broaden the concept of bank stability and utilize alternative indicators.

4. Main results

The results in column 1 of Table 4 suggest that cooperative banks are more stable than both savings and private banks, while savings banks are also more stable than private banks. The dummy variables for both savings and cooperative banks enter positively and significantly at the 1% level and the difference between the two dummies is significant at the 1% level as well. The difference is also economically significant; cooperative banks are on average able to withstand a fall in profits that is at least 17 standard deviations higher than private banks and 10 standard deviations higher than savings banks. This difference is even higher than in the simple comparison discussed above (Table 1), i.e. when not controlling for other bank characteristics. This result thus suggests that even after controlling for an array of other bank characteristics that vary with ownership type, cooperative banks are significantly farther away from insolvency than both savings and private banks.

The results in columns 2 through 4 of Table 4 suggest that the higher distance of cooperative banks from insolvency is driven by the substantially lower volatility of their risk-weighted profits. Here we regress the three components of the z-score (risk-weighted CAR, risk-weighted ROA, and SD of risk-weighted ROA) on ownership dummies and other bank

characteristics. We find that private banks have significantly higher capital levels than both savings and cooperative banks, while there is no significant difference between savings and cooperative banks (column 2). Cooperative and savings banks have significantly lower levels of profitability than private banks, with no significant difference between the two groups (column 3). Finally, cooperative banks have significantly lower volatility in their profit levels than savings and private banks, while savings banks also have lower volatility than private banks (column 4). So, while cooperative banks have both lower capital and profitability than private banks, which both reduces the relative distance to insolvency, their relatively lower volatility more than compensates for this, resulting in an overall higher distance from insolvency.

Column 5 of Table 4 shows that savings and cooperative banks have a lower NPL-score than private banks, but there is no significant difference between the two banking groups. While the overall risk is therefore lower in cooperative banks, these results suggest that the lending risk is similar between savings and cooperative banks.

Column 6 of Table 4 shows that savings and cooperative banks have a lower probability of distress score (PD-score) than private banks, while savings banks have a lower distress probability than cooperative banks. While the finding on the private banks is thus consistent with the previously reported z-score regressions, we find that savings banks are more stable than cooperative banks, the reverse result than when considering z-scores. While cooperative banks are thus overall farther away from insolvency than savings banks, they face a higher likelihood of becoming distressed, which might be explained by a higher tail risk for these institutions. This interpretation is also confirmed by the distress frequencies among the three banking groups over the period 1994 to 2006 for which data are available in the Bundesbank's distress database. While for private banks the share of distressed events is

9.5%, it is only 1.5% for savings banks and 4.4% for cooperative banks.[15] This finding from descriptive statistics, on itself, seems to be evidence for a lower stability of the private banking sector in Germany. The economic effect of the bank dummies is similar to the simple comparison in Table 1 suggested, i.e. the difference between the three banking groups holds even when controlling for other bank characteristics.

Turning to the other bank characteristics, we find that bank size is positively and significantly correlated with the z-score, but not significantly with any of the components. While bank size is not significantly correlated with the NPL-score, larger banks face a significantly lower distress probability. Overall, large banks seem to be more stable. Banks with riskier asset structure have lower z-scores, higher NPL-score and higher PD-scores. They have lower levels of capitalization and profitability, but also lower volatility in profits. Banks with faster risk-weighted asset growth have significantly lower z-scores, explained by lower levels of capitalization, but also significantly lower NPL-scores.[16] Cost inefficiency is negatively and significantly associated with the z-score, positively and significantly with risk-weighted CAR and with the SD of risk-weighted ROA, but negatively with the risk-weighted ROA. Less efficient banks are also more likely to experience distress, but are not more likely to suffer from lending risk. Banks that better diversify their income sources have higher z-scores, driven by lower profit volatility, as well as lower NPL-scores and PD-scores. Sectoral loan concentration is not significantly associated with the z-score, as both capitalization and volatility of profits have a positive association with loan concentration. Sectoral loan concentration is negatively associated with NPL-score and PD-score. Banks that face more concentrated markets have higher z-scores – due to higher profits and in spite of lower capitalization – and lower PD-scores, but higher NPL-scores.

[15] The share of distressed events is measured by the number of bank-year observations which are classified as "distressed" according to the Bundesbank distress database (see Appendix C) as a fraction of all bank-year observations for a specific banking group.

[16] We do not include this variable in the PD-score regression, as it is already included as an explanatory variable in the first stage.

Turning to macroeconomic variables, higher insolvency rates are associated with lower z-scores, lower levels of capitalization, higher NPL-scores and higher PD-scores. Higher real asset price growth is associated with higher z-scores, higher levels of capitalization and profits, lower lending risk and lower distress probability. The one-year real interest rate, finally, is negatively associated with z-scores, the risk-weighted CAR, the risk-weighted ROA and with the NPL-score.[17]

In summary, the Table 4 findings suggest that private banks are consistently less stable than both cooperative and savings banks. The significantly higher volatility of profits of private banks dominates the effect of higher capital and higher profits. The lower stability of private banks is also due to higher lending risk. Private banks also face a higher probability of distress, thus a higher tail risk. This is consistent with privately-owned financial institutions focusing on higher return activities, even if it implies higher risks. The higher stability of cooperative banks vis-à-vis savings banks is again driven by the lower volatility of returns for cooperative banks confirming the stability-enhancing impact of the focus on capital endowment protection and consumer surplus maximization as well as of the disperse shareholdings. Compared to cooperative banks, the stability-reducing potential of political interference into savings banks seems to combine with the stability-reducing effect of a large dominant shareholder. However, the difference between savings and cooperative banks is not driven by differences in lending risk, but risks in other business areas that explain the higher profit volatility of savings banks. Finally, cooperative banks seem to face a higher tail risk of actual distress than savings banks, in spite of being – on average – farther away from insolvency. Comparing the relative importance in explaining stability across banks and over

[17] We do not include the interest rate in the PD regression, as it is already included in the first-stage. Also, we do not include the macroeconomic variables in the SD of risk-weighted ROA regression, as these are cross-sectional regressions.

time by utilizing standardized coefficients, we find that the bank ownership dummies are the most important factors explaining bank stability across all regressions in Table 4.[18]

Table 5 shows that the relationship between some bank characteristics and stability varies significantly across different bank ownership types. Here we present results of bank characteristics interacted with the dummies for private, savings and cooperative banks.

While bank size is negatively associated with bank stability for private banks, it is positively associated with z-scores for savings and cooperative banks. Similar differences can be observed across the components of the z-score. On the one hand, while bank size is negatively associated with the capitalization of private banks, it is positively and significantly associated with the risk-weighted CAR of cooperative banks and insignificantly with savings banks' capitalization levels. On the other hand, a larger bank size results in lower profits for both cooperative and savings banks, but not for private banks. Banks of all three ownership types see lower volatility as their bank size increases, with the effect being strongest for private banks. The effect of the negative capitalization-size relationship, however, outweighs the negative relationship between volatility and size in the case of private banks, while the negative relationship between volatility and size outweighs the negative relationship between profits and size in the case of savings and cooperative banks. Larger private banks have lower NPL-scores, while larger cooperative banks have higher NPL-scores. Finally, bank size is associated with lower distress risk for private and savings, but not cooperative banks.

The finding of a negative relation of private banks' size with risk-weighted capitalization, but also with lending risk and distress probability suggests that larger private banks might benefit from the Too-Big-To-Fail phenomenon, extensively documented in the literature, and thus take on more risk relative to their capital than smaller private banks. On the other hand, larger savings and cooperative seem to be more stable, mainly because they experience lower volatility in their returns. It is important to note that the negative

[18] These standardized coefficients are obtained after standardizing all variables to have a mean of zero and a standard deviation of one.

relationship between bank size and volatility holds after controlling for income diversification and loan concentration, thus capturing other benefits of bank size for stability, such as scale economies resulting in better risk management. Further, the positive relationship between bank size and stability is not driven by lower lending risk, as the relationship between bank size and lending risk is insignificant for savings banks and even positive for cooperative banks.

Some of the other variables also show different coefficients across different ownership groups. Higher amounts of risky assets are positively and significantly associated with cooperative banks' lending risk, but negatively and significantly with savings banks' lending risk. Growth in risk-weighted assets is positively and significantly associated with savings banks' SD of risk-weighted ROA, but negatively and significantly with cooperative banks' SD of risk-weighted ROA. More efficient private banks have lower levels of capitalization, while more efficient cooperative banks have higher levels. While more efficient private banks face lower profit volatility, more efficient savings and cooperative banks face higher volatility. While sectoral loan concentration is positively associated with the z-scores and capitalization levels of private and savings banks, it is negatively associated with the z-scores and capitalization levels of cooperative banks. Savings banks that operate in more concentrated markets face lower volatility, while cooperative banks in more concentrated markets face higher volatility. Private banks operating in more concentrated markets face lower lending risk, while savings banks and cooperative banks face higher lending risk. Higher real asset growth is associated with a higher distress probability for private, but lower distress probability for savings and cooperative banks. Finally, higher interest rates lead to higher lending risk for private, but lower lending risk for cooperative and savings banks.

5. Robustness tests

We used an array of sensitivity analyses to test the robustness of our findings, especially the "stability-ranking" of banks of different ownership types and the different relationships of bank size with stability across the different ownership groups.

Tables 6 and 7 show the robustness of our results to a more stringent outlier adjustment. Specifically, here we apply a 5% outlier cut-off rather than the 2% applied in the baseline regressions of Tables 4 and 5, which results in a sample of 3,404 banks and 18,790 bank-year observations. The results in Table 6 show that cooperative banks are farther away from insolvency and have lower levels of capitalization than both savings and private banks, while savings banks have the lowest default probability. There is no significant difference between savings and cooperative banks in profitability and lending risk. Unlike in the Table 4 regressions, we find a negative and significant relationship of bank size with risk-weighted CAR, risk-weighted ROA and the volatility of profits. The Table 7 results confirm the negative relationship between bank size and z-score for private banks, and a positive relationship for cooperative and savings banks, driven by a significantly negative relationship between private banks' size and risk-weighted CAR and by a significantly negative relationship between the bank size of cooperative and savings banks and their volatility of profits. Similarly, we confirm the negative (positive) relationship between private (cooperative) banks' size and lending risk.

Tables 8 and 9 show the robustness of our general findings to a somewhat different outlier adjustment. Rather than applying a percentage rule in truncating the sample and dropping outliers, we truncate (and drop in the case of z-scores) all observations that are more than two standard deviations above the mean for the respective banking group. This yields a sample of 3,954 banks and 21,830 bank-year observations, so more than in our baseline regressions. The Table 8 results confirm some of our previous findings, but contradict others. Specifically, we find that cooperative banks have significantly higher z-scores than both

savings and private banks; while savings banks have significantly lower NPL-scores and PD-scores than both cooperative and private banks. While savings banks have significantly higher z-scores and lower levels of capitalization than private banks and cooperative banks have significantly lower NPL scores and lower PD scores than private banks, there is no significant difference between the three banking groups in profitability. The Table 9 results confirm the negative relationship between bank size and private banks' z-scores, driven by the lower capitalization level and the positive relationship between savings and cooperative banks' z-scores, driven by lower profit volatility. Similarly, we confirm that large private banks have lower NPL scores, while larger cooperative banks have higher NPL scores.

Moreover, Table 10 shows the robustness to utilizing a fixed-effects specification for the interaction term regressions of Table 5, using our baseline sample of 2% outlier correction. Here we replace the bank ownership dummies with bank fixed effects. We thus exploit within-bank variation over time rather than cross-bank variation. Not surprisingly, the significance levels of many of our coefficients declines. However, we still find that the relationship between bank size and z-score is negative for private banks and positive for cooperative banks, while it is insignificant for savings banks. The negative relationship between capitalization and private banks' size turns insignificant; on the other hand, we find a positive (negative) and significant relationship between savings and cooperative banks' capitalization level (profitability). Only private banks' size is negatively and significantly associated with NPL scores while all banking groups' size is negatively and significantly associated with the PD score.

We also tested for the difference in z-score, NPL-score and PD-score between different banking groups at different percentiles of bank size. The differences between private, savings and cooperative banks vary with bank size, but the ranking of the banking groups does not change if consider z-score and PD-score. Independent of their size, cooperative banks are more stable than private banks and savings banks have lower z-scores

but also lower PD-scores than cooperative banks. However, at the 25th and the 50th percentile of bank size cooperative banks have significantly lower NPL-scores than savings banks. At the 75th percentile we do not find any significant differences between banking groups when considering NPL-score.

Additionally, we used the log rather than level of z-score and confirm our findings. While the log transformation of the z-score reduces the differences between the different banking groups, our main results on the relative stability of the different banking groups are confirmed.

6. Conclusions

This paper assessed the relative stability of German banks of different ownership types. We find that cooperative banks are farthest away from insolvency, while savings banks are the least likely to fail. Private banks are the ownership group that is closest to insolvency, has the highest lending risk and is most likely to fail. Larger privately-owned banks are less stable, as they have less capital relative to their risk, suggesting Too-Big-To-Fail problems, while larger cooperative and savings banks are actually more stable. These results are robust to controlling for a large number of other bank characteristics and macroeconomic variables. The differences between the three banking groups that we found in simple descriptive statistics are confirmed both in significance and in size when we undertake multivariate regression analysis. We confirm our findings with different samples and different estimation techniques.

Our findings are consistent with findings by Cihak and Hesse (2007) who show that cooperative banks are more stable than banks of other ownership types across a sample of European countries. However, our results also show that cooperative banks are subject to a certain degree of tail risk in form of a higher distress probability than savings banks. There is no consistent evidence on whether savings or cooperative banks face lower lending risk, as

measured by the NPL-score. Our findings provide empirical support for the notion of Too-Big-To-Fail for private banks, as they reduce their capital levels as they grow larger, which explains the closer proximity to insolvency, but also lower distress probability. On the other hand, the higher stability of cooperative and savings banks as they grow larger, seems to be driven by lower volatility in profits and in spite of higher lending risk and lower profitability. Our findings also underline the importance of applying different stability indicators, as they might yield different findings, depending on whether they focus on specific risks, such as lending risks, or on different moments of the distribution. In addition to ownership and bank size, many other bank characteristics are related to bank stability either positively or negatively, depending on the ownership groups, but also varying across different stability measures.

On a final note, we would like to stress the relative nature of our stability comparison across ownership types. Although private banks in Germany are less stable than cooperative and savings banks in Germany, they are stable in international comparison, as shown by Beck and Laeven (2008).

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Table 1: Decomposition of Z-Score, NPL-Score and PD-Score and Tests of Equality of Means

	Z-Score	Equity to RWA	RORWA	Standard Deviation of RORWA	NPL-Score	PD-Score
All banks	27.721	14.363	1.213	0.763	-2.860	-4.809
Private banks (P)	16.996	27.582	1.667	3.881	-2.664	-2.837
Savings banks (S)	23.914	13.441	1.324	0.673	-2.826	-5.799
Cooperative banks (C)	30.095	13.344	1.129	0.536	-2.891	-4.663
			Mean-comparison tests			
S vs. P	**-6.919*** **	**14.141*** **	**0.343*** **	**3.208*** **	**0.162*** **	**2.962*** **
Equility of means	**(0.000)**	**(0.000)**	**(0.002)**	**(0.000)**	**(0.000)**	**(0.000)**
C vs. P	**-13.100*** **	**14.238*** **	**0.538*** **	**3.345*** **	**0.226*** **	**1.826*** **
Equility of means	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**
C vs. S	**-6.181*** **	**0.097* **	**0.195*** **	**0.137*** **	**0.064*** **	**-1.136*** **
Equility of means	**(0.000)**	**(0.054)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**

The null hypothesis of equality of means in tested with the mean-comparison test (in Stata ttest). P-values in parentheses.
*, ** and *** indicate rejection of the null hypothesis at the 10, 5 and 1% significance levels respectively.

Table 2: Definition of the Variables and Data Sources

Proxy for Variables	Variable Name	Description	Source
		Financial Stability Indicators	
Insolvency Risk	**Z-Score**	Bank Capital, Reserves, and Return to Risk-weighted Assets	BAKIS
	PD-Score	Logit-transformed PDs Derived from Hazard Rate Models	Bundesbank Distress Database / BAKIS
	NPL-Score	Logit-transformed Ratio of Classified Loans to Total Loans (Excluding Interbank Loans)	BAKIS
Capitalization	**Capital-to-RWA Ratio**	Bank Capital to Risk-weighted Assets	BAKIS
Profitability	**RORWA**	Return (operative result) to Risk-weighted Assets	BAKIS
Profitability Risk	**Standard Deviation of RORWA**		BAKIS
		Bank-specific Variables	
Business Growth	**RWA Growth**	Growth of Risk-weighted Assets	BAKIS
Heterogeneity Across Banks in Size, Asset Structure, and Efficiency	**Bank Size**	Ln of Total Assets in Mio. EUR	BAKIS
	Risky Assets	Risk-weighted Assets to Total Assets	BAKIS
	Cost Inefficiency	Cost-Income Ratio: General Administrative Expenses to Raw Result	BAKIS
Diversification	**Income Diversification**	One Minus the Square of Net Interest Income Divided by Total Net Revenue Plus the Square of Net Non-interest Income Divided by Total Net Revenue	BAKIS
	Sectoral Loan Concentration	HHI of Sectoral Loan Concentration	Borrowers Statistics
Regional Competition	**Regional Market Concentration**	Average Across Bank Concentration in Each State (Weighted by the Loan Exposure of the Bank in Each State)	Credit Register
Distress	**Distress Indicator**	Dummy that Takes on 1 when a Bank is Distressed in a Certain Year	Bundesbank Distress Database

Table 2 (continued)

Proxy for Variables	Variable Name	Description	Source
		Macroeconomic Variables	
Business Climate	**Insolvency Rate, Bundesland Level**	Insolvent Firms as a Fraction of Total Firms on the State-level (Weighted by the Loan Exposure of the Bank in Each State)	Federal Statistical Office / Credit Register
	Real Asset Price Growth	Growth Rate of the BIS Aggregate Asset Price Index for Germany	Bank of International Settlements
Cost of Capital	**Real One-Year Interest Rate**	One-Year Government Bond Rate Minus CPI Growth Rate	Federal Statistical Office

* BAKIS is the Deutsche Bundesbank's Prudential Database

Table 3A: Descriptive Statistics

Variable	Mean	Standard Deviation	25th Quantile	Median	75th Quantile	Min	Max
Z-Score	27.72	13.76	18.01	24.40	34.13	0.80	80.47
Capital to RWA Ratio	14.36	13.22	11.08	12.67	15.04	8.43	402.42
RORWA	1.21	2.20	0.69	1.15	1.66	-45.79	39.06
Standard Deviation of RORWA	0.76	1.69	0.37	0.53	0.76	0.17	25.86
NPL-Score	-2.86	0.73	-3.28	-2.81	-2.38	-6.10	0.20
PD-Score	-4.81	2.04	-5.98	-4.64	-3.50	-16.21	3.26
Bank Size	5.50	1.34	4.47	5.41	6.46	0.66	10.16
Risky Assets	60.89	11.70	54.43	61.76	68.37	7.58	102.66
RWA Growth	3.20	9.76	-1.20	2.59	6.74	-66.02	147.35
Cost Inefficiency	64.77	13.00	58.76	64.34	69.84	20.18	283.97
Income Diversification	32.28	7.31	27.95	32.36	36.88	1.56	49.98
Sectoral Loan Concentration	25.37	11.66	19.80	21.93	25.98	16.74	100.00
Regional Market Concentration	5.26	1.65	4.11	5.19	6.38	2.01	13.46
Insolvency Rate, Bundesland Level	1.00	0.39	0.74	0.87	1.11	0.50	3.07
Real Asset Price Growth	1.48	6.84	1.35	5.15	6.63	-10.65	6.99
Real One-Year Interest Rate	1.89	0.76	1.58	1.86	2.55	0.57	3.27
Private Banks Dummy	0.07	0.26	0	0	0	0	1
Savings Banks Dummy	0.24	0.42	0	0	0	0	1
Cooperative Banks Dummy	0.69	0.46	0	1	1	0	1

Table 3B: Correlation Coefficients

	Z-Score	Capital to RWA Ratio	RORWA	Standard Deviation of RORWA	NPL-Score	PD-Score	Bank Size (t-1)	Risky Assets (t-1)	RWA Growth (t-1)	Cost Inefficiency (t-1)	Income Diversification (t-1)	Sectoral Loan Concentration (t-1)	Regional Market Concentration (t-1)	Insolvency Rate, Bundesland Level	Real Asset Price Growth	Real Ome-Year Interest Rate	Savings Banks Dummy (t-1)	Cooperative Banks Dummy (t-1)	Private Banks Dummy (t-1)
Z-Score	1																		
Capital to RWA Ratio	-0.0089	1																	
RORWA	**0.0480***	0.0075	1																
SD of RORWA	**-0.2840***	**0.6807***	**-0.1035***	1															
NPL-Score	**-0.1715***	0.0047	**-0.1155***	0.041	1														
PD-Score	**-0.2220***	**-0.0507***	**-0.1613***	**0.1382***	**0.2804***	1													
Bank Size (t-1)	**-0.0750***	**-0.0376***	0.0071	-0.0142	**0.1144***	**-0.0604***	1												
Risky Assets (t-1)	**0.1027***	**-0.3011***	**-0.1473***	**-0.3157***	**0.0673***	**0.1126***	**-0.1008***	1											
RWA Growth (t-1)	**-0.0892***	**-0.0325***	0.0003	**0.2529***	**-0.1865***	-0.0141	**-0.0334***	**-0.0347***	1										
Cost Inefficiency (t-1)	**-0.0469***	**0.2027***	**-0.4065***	**0.4450***	0.0129	**0.2960***	**-0.1857***	**-0.0703***	-0.0096	1									
Income Div. (t-1)	0.0171	0.0085	**-0.0910***	-0.0525	**0.0513***	**0.1819***	**0.0652***	**0.0835***	**-0.0947***	**0.2574***	1								
Sec. Loan Conc. (t-1)	**-0.1288***	**0.3086***	**0.0911***	**0.4456***	**-0.0693***	**0.1031***	**-0.0241***	**-0.1116***	**0.1857***	**0.0388***	**-0.1053***	1							
Reg. Market Conc. (t-1)	**-0.0764***	-0.0067	0.0213	0.0304	**0.0682***	**0.1567***	**0.0459***	**-0.0421***	**-0.0363***	**0.0654***	**0.1534***	0.0096	1						
Ins. Rate	**-0.1275***	**0.0404***	-0.0047		**0.1637***	-0.0017	**0.1712***	**-0.2207***	**-0.0448***	**0.0553***	**0.1112***	-0.0036	**-0.1494***	1					
Real Asset Price Growth	**0.0796***	0.0015	**0.0589***		**-0.0674***	**-0.0936***	**-0.0700***	**-0.0513***	**0.0513***	**-0.1196***	**-0.0987***	-0.0035	**-0.0437***	**-0.2859***	1				
Real One-Year Interest Rate	**-0.0650***	**-0.0555***	0.0048		**-0.1187***	**0.0661***	**-0.0950***	**-0.0700***	**0.1607***	**-0.0639***	**-0.0450***	0.0057	0.0046	**-0.2866***	**0.3042***	1			
Sav. Banks Dum. (t-1)	**-0.1536***	**-0.0388***	**0.0281***	-0.0243	**0.0268***	**-0.2758***	**0.6091***	**-0.2008***	0.0095	**-0.2072***	**-0.1222***	**-0.1775***	**-0.0259***	**0.1511***	**-0.0266***	-0.0056	1		
Coop. Banks Dum. (t-1)	**0.2599***	**-0.1163***	**-0.0573***	**-0.2439***	**-0.0622***	**0.1048***	**-0.6348***	**0.2000***	**-0.0949***	**0.1271***	**0.0542***	**-0.1350***	**-0.0263***	**-0.1523***	**0.0365***	0.0094	**-0.8369***	1	
Priv. Banks Dum. (t-1)	**-0.2138***	**0.2744***	**0.0567***	**0.4694***	**0.0704***	**0.2694***	**0.1329***	**-0.0271***	**0.1556***	**0.1152***	**0.1054***	**0.5390***	**0.0906***	**0.0237***	-0.0216	-0.0076	**-0.1524***	**-0.4135***	1

* Significant at least at the 10% level.

Table 4: Stability Across Different Banking Groups

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable	**Z-Score**	**Capital to RWA Ratio**	**RORWA**	**Standard Deviation of RORWA**	**NPL-Score**	**PD-Score**
Estimation Technique	**RE**	**RE**	**RE**	**OLS**	**RE**	**RE**
Bank-Specific Variables						
Savings Banks Dummy (S) (t-1)	**7.095*** **	**-12.263*** **	**-1.027** **	**-1.603*** **	**-0.374*** **	**-3.098*** **
	(1.177)	**(4.101)**	**(0.470)**	**(0.307)**	**(0.100)**	**(0.132)**
Cooperative Banks Dummy (C) (t-1)	**17.408*** **	**-14.515*** **	**-0.858** **	**-2.015*** **	**-0.375*** **	**-2.244*** **
	(1.123)	**(4.861)**	**(0.437)**	**(0.307)**	**(0.096)**	**(0.107)**
Bank Size (t-1)	**1.192*** **	-0.797	-0.109	-0.054	0.012	**-0.152*** **
	(0.373)	(0.833)	(0.069)	(0.035)	(0.017)	**(0.028)**
Risky Assets (t-1)	**-0.184*** **	**-0.269*** **	**-0.035*** **	**-0.024*** **	**0.006*** **	**0.006** **
	(0.013)	**(0.051)**	**(0.005)**	**(0.005)**	**(0.001)**	**(0.003)**
RWA Growth (t-1)	**-0.057*** **	**-0.141*** **	-0.005	0.009	**-0.009*** **	
	(0.007)	**(0.025)**	(0.009)	(0.013)	**(0.001)**	
Cost Inefficiency (t-1)	**-0.009** **	**0.163** **	**-0.066*** **	**0.050*** **	0.001	**0.013*** **
	(0.005)	**(0.075)**	**(0.014)**	**(0.009)**	(0.001)	**(0.001)**
Income Diversification (t-1)	**0.169*** **	0.043	0.002	**-0.025** **	**-0.008*** **	**-0.029*** **
	(0.012)	(0.034)	(0.006)	**(0.010)**	**(0.002)**	**(0.003)**
Sectoral Loan Concentration (t-1)	0.008	**0.239** **	-0.006	**0.028*** **	**-0.008*** **	**-0.012*** **
	(0.016)	**(0.113)**	(0.011)	**(0.007)**	**(0.002)**	**(0.003)**
Regional Market Concentration (t-1)	**0.153*** **	**-0.156* **	**0.034** **	-0.008	**0.026*** **	**-0.035** **
	(0.056)	**(0.095)**	**(0.016)**	(0.016)	**(0.006)**	**(0.017)**
Macroeconomic Variables						
Insolvency Rate, Bundesland Level	**-0.803*** **	**-1.708** **	-0.030		**0.225*** **	**0.213*** **
	(0.204)	**(0.781)**	(0.100)		**(0.024)**	**(0.062)**
Real Asset Price Growth	**0.131*** **	**0.049*** **	**0.006** **		**-0.001** **	**-0.033*** **
	(0.005)	**(0.011)**	**(0.003)**		**(0.001)**	**(0.001)**
Real One-Year Interest Rate	**-1.597*** **	**-0.849*** **	**-0.123*** **		**-0.027*** **	
	(0.048)	**(0.107)**	**(0.034)**		**(0.008)**	
Constant	**18.534*** **	**34.789*** **	**9.187*** **	1.182	**-2.852*** **	**-1.484*** **
	(2.520)	**(11.124)**	**(1.412)**	(0.816)	**(0.210)**	**(0.340)**
R-squared-within	0.266	0.153	0.096		0.091	0.118
R-squared				0.435		
Number of banks	3810	3810	3810	3810	3389	3643
Observations	21154	21154	21154	3810	16980	19716
Test on equality for mean values						
C vs. S	**10.313*** **	-2.252	0.169	**-0.412*** **	-0.002	**0.854*** **
	(0.914)	(1.391)	(0.167)	**(0.098)**	(0.045)	**(0.105)**

A 2% outlier correction is adopted for the baseline model here. All the regressions are based on Random Effects (RE) except column 4, where the standard deviation of RORWA is estimated with OLS. Standard errors in parentheses; * Significant at the 10% level, ** Significant at the 5% level, *** Significant at the 1% level.

Table 5: Stability Across Different Banking Groups Including Interaction Terms

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable	**Z-Score**	**Capital to RWA Ratio**	**RORWA**	**Standard Deviation of RORWA**	**NPL-Score**	**PD-Score**
Estimation Technique	**RE**	**RE**	**RE**	**OLS**	**RE**	**RE**
Private Banks						
P*Bank Size (t-1)	**-1.476****	**-5.330****	-0.137	**-0.598*****	**-0.189*****	**-0.230*****
	(0.611)	**(2.263)**	(0.305)	**(0.166)**	**(0.057)**	**(0.039)**
P*Risky Assets (t-1)	**-0.163*****	**-0.672*****	**-0.061*****	**-0.078*****	**0.007***	-0.003
	(0.028)	**(0.148)**	**(0.018)**	**(0.017)**	**(0.004)**	(0.002)
P*RWA Growth (t-1)	**-0.030*****	**-0.189*****	-0.003	-0.001	**-0.008*****	
	(0.009)	**(0.039)**	(0.013)	(0.017)	**(0.002)**	
P*Cost Inefficiency (t-1)	-0.002	**0.202****	**-0.087*****	**0.047*****	0.001	**0.009*****
	(0.006)	**(0.088)**	**(0.018)**	**(0.012)**	(0.002)	**(0.001)**
P*Income Diversification (t-1)	0.022	0.005	-0.021	**-0.067****	**-0.009****	**0.006****
	(0.026)	(0.091)	(0.023)	**(0.030)**	**(0.005)**	**(0.003)**
P*Sectoral Loan Concentration (t-1)	**0.052****	**0.484****	-0.010	**0.050*****	-0.001	**-0.004****
	(0.021)	**(0.204)**	(0.021)	**(0.013)**	(0.004)	**(0.002)**
P*Regional Market Concentration (t-1)	0.066	-0.950	0.124	-0.066	**-0.081****	-0.029
	(0.164)	(0.643)	(0.178)	(0.171)	**(0.033)**	(0.022)
P*Insolvency Rate, Bundesland Level	-0.038	**-10.821****	-0.325		**0.242***	**0.169*****
	(0.725)	**(5.347)**	(1.005)		**(0.143)**	**(0.065)**
P*Real Asset Price Growth	**0.046****	-0.110	0.003		**-0.006***	**0.005****
	(0.022)	(0.096)	(0.022)		**(0.003)**	**(0.002)**
P*Real One-Year Interest Rate	**-0.431***	**-2.384****	0.468		**0.088***	
	(0.230)	**(1.074)**	(0.351)		**(0.051)**	
Savings Banks						
Savings Banks Dummy (S) (t-1)	-9.574	**-72.496*****	**-5.411***	**-6.374****	**-1.283***	-0.211
	(6.556)	**(22.947)**	**(3.275)**	**(2.746)**	**(0.718)**	(0.843)
S*Bank Size (t-1)	**1.829*****	0.109	**-0.085*****	**-0.055*****	0.026	**-0.218****
	(0.668)	(0.130)	**(0.022)**	**(0.011)**	(0.026)	**(0.099)**
S*Risky Assets (t-1)	**-0.188*****	**-0.122*****	**-0.041*****	**-0.014*****	**-0.003***	0.004
	(0.021)	**(0.009)**	**(0.002)**	**(0.001)**	**(0.002)**	(0.007)
S*RWA Growth (t-1)	**-0.107*****	**-0.088*****	**0.008*****	**0.010*****	**-0.009*****	
	(0.007)	**(0.004)**	**(0.002)**	**(0.003)**	**(0.001)**	
S*Cost Inefficiency (t-1)	-0.003	-0.006	**-0.022*****	**-0.009*****	-0.001	**0.008***
	(0.010)	(0.006)	**(0.002)**	**(0.002)**	(0.001)	**(0.005)**
S*Income Diversification (t-1)	**0.051*****	**0.070*****	**-0.017*****	0.005	**-0.007*****	**-0.038*****
	(0.020)	**(0.011)**	**(0.004)**	(0.003)	**(0.002)**	**(0.009)**
S*Sectoral Loan Concentration (t-1)	**0.177*****	**0.151*****	**-0.008***	0.002	-0.003	**-0.093*****
	(0.034)	**(0.019)**	**(0.004)**	(0.003)	(0.003)	**(0.016)**
S*Regional Market Concentration (t-1)	-0.115	-0.017	**0.019***	**-0.016****	**0.019****	0.012
	(0.079)	(0.039)	**(0.011)**	**(0.006)**	**(0.009)**	(0.034)
S*Insolvency Rate, Bundesland Level	**-2.339*****	**-0.974*****	**-0.166*****		**0.262*****	**0.344*****
	(0.295)	**(0.165)**	**(0.048)**		**(0.035)**	**(0.119)**
S*Real Asset Price Growth	**0.099*****	**0.033*****	**0.024*****		0.001	**-0.027*****
	(0.006)	**(0.003)**	**(0.002)**		(0.001)	**(0.003)**
S*Real One-Year Interest Rate	**-1.412*****	**-0.600*****	**-0.252*****		**-0.026****	
	(0.070)	**(0.040)**	**(0.014)**		**(0.010)**	

Table 5 (continued)

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable	**Z-Score**	**Capital to RWA Ratio**	**RORWA**	**Standard Deviation of RORWA**	**NPL-Score**	**PD-Score**
Estimation Technique	**RE**	**RE**	**RE**	**OLS**	**RE**	**RE**
Cooperative Banks						
Cooperative Banks Dummy (C) (t-1)	-6.198	**-70.833*** **	**-7.608** **	**-7.492*** **	**-1.968*** **	**-4.060*** **
	(5.517)	**(22.935)**	**(3.268)**	**(2.743)**	**(0.700)**	**(0.574)**
C*Bank Size (t-1)	**3.894*** **	**0.123** **	**-0.107*** **	**-0.033*** **	**0.073*** **	-0.035
	(0.385)	**(0.060)**	**(0.010)**	**(0.005)**	**(0.015)**	(0.036)
C*Risky Assets (t-1)	**-0.223*** **	**-0.116*** **	**-0.021*** **	**-0.007*** **	**0.007*** **	**0.018*** **
	(0.015)	**(0.006)**	**(0.001)**	**(0.001)**	**(0.001)**	**(0.004)**
C*RWA Growth (t-1)	**-0.124*** **	**-0.071*** **	**-0.002** **	**-0.006*** **	**-0.012*** **	
	(0.006)	**(0.003)**	**(0.001)**	**(0.001)**	**(0.001)**	
C*Cost Inefficiency (t-1)	**-0.048*** **	**-0.020*** **	**-0.022*** **	**-0.002** **	0.001	**0.025*** **
	(0.006)	**(0.003)**	**(0.001)**	**(0.001)**	(0.001)	**(0.002)**
C*Income Diversification (t-1)	**0.226*** **	**0.131*** **	-0.001	0.001	**-0.008*** **	**-0.039*** **
	(0.014)	**(0.006)**	(0.001)	(0.001)	**(0.002)**	**(0.004)**
C*Sectoral Loan Concentration (t-1)	**-0.061*** **	**-0.020** **	**0.008*** **	**0.002** **	**-0.012*** **	0.000
	(0.019)	**(0.008)**	**(0.001)**	**(0.001)**	**(0.002)**	(0.005)
C*Regional Market Concentration (t-1)	**0.161** **	0.047	**0.016*** **	**0.019*** **	**0.036*** **	-0.027
	(0.068)	(0.031)	**(0.005)**	**(0.003)**	**(0.006)**	(0.021)
C*Insolvency Rate, Bundesland Level	**-0.558** **	-0.111	-0.020		**0.221*** **	**0.193** **
	(0.264)	(0.120)	(0.029)		**(0.029)**	**(0.081)**
C*Real Asset Price Growth	**0.137*** **	**0.056*** **	**0.012*** **		**-0.002*** **	**-0.037*** **
	(0.005)	**(0.002)**	**(0.001)**		**(0.001)**	**(0.002)**
C*Real One-Year Interest Rate	**-1.650*** **	**-0.725*** **	**-0.171*** **		**-0.035*** **	
	(0.057)	**(0.027)**	**(0.008)**		**(0.009)**	
Constant	**33.426*** **	**89.354*** **	**12.141*** **	**8.602*** **	**-1.522** **	**-1.803*** **
	(5.156)	**(22.928)**	**(3.266)**	**(2.741)**	**(0.682)**	**(0.396)**
R-squared-within	0.332	0.235	0.127		0.109	0.152
R-squared				0.575		
Number of banks	3810	3810	3810	3810	3389	3643
Observations	21154	21154	21154	3810	16980	19716
Test on equality for mean values						
S vs. P	**7.965*** **	**-18.024*** **	-0.220	**-3.208*** **	**-0.150* **	**-2.888*** **
	(1.047)	**(2.914)**	(0.309)	**(0.288)**	**(0.085)**	**(0.091)**
C vs. P	**15.249*** **	**-18.271*** **	-0.408	**-3.345*** **	**-0.191** **	**-1.745*** **
	(1.011)	**(2.913)**	(0.308)	**(0.288)**	**(0.084)**	**(0.054)**
C vs. S	**7.283*** **	**-0.247** **	**-0.188*** **	**-0.137*** **	-0.041	**1.142*** **
	(0.517)	**(0.102)**	**(0.020)**	**(0.010)**	(0.025)	**(0.087)**

A 2% outlier correction is adopted for the baseline model here. All the regressions are based on Random Effects (RE) except column 4, where the standard deviation of RORWA is estimated with OLS. Standard errors in parentheses; * Significant at the 10% level, ** Significant at the 5% level, *** Significant at the 1% level.

Table 6: Stability Across Different Banking Groups - Robustness with 5% Outlier Correction

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable	**Z-Score**	**Capital to RWA Ratio**	**RORWA**	**Standard Deviation of RORWA**	**NPL-Score**	**PD-Score**
Estimation Technique	**RE**	**RE**	**RE**	**OLS**	**RE**	**RE**
Bank-Specific Variables						
Savings Banks Dummy (S) (t-1)	**7.591*** **	**-10.523*** **	**-0.633** **	**-1.171*** **	**-0.279*** **	**-2.956*** **
	(1.177)	**(2.246)**	**(0.255)**	**(0.147)**	**(0.090)**	**(0.140)**
Cooperative Banks Dummy (C) (t-1)	**16.767*** **	**-13.731*** **	**-0.581** **	**-1.426*** **	**-0.283*** **	**-2.131*** **
	(1.132)	**(2.663)**	**(0.242)**	**(0.150)**	**(0.090)**	**(0.115)**
Bank Size (t-1)	**0.633***	**-1.462*** **	**-0.080** **	**-0.048** **	0.004	**-0.167*** **
	(0.372)	**(0.508)**	**(0.036)**	**(0.019)**	(0.018)	**(0.033)**
Risky Assets (t-1)	**-0.177*** **	**-0.204*** **	**-0.028*** **	**-0.017*** **	**0.004*** **	0.003
	(0.014)	**(0.033)**	**(0.003)**	**(0.002)**	**(0.001)**	(0.003)
RWA Growth (t-1)	**-0.081*** **	**-0.136*** **	-0.001	**-0.011***	**-0.008*** **	
	(0.008)	**(0.023)**	(0.004)	**(0.006)**	**(0.001)**	
Cost Inefficiency (t-1)	-0.009	**0.093** **	**-0.044*** **	**0.017*** **	-0.001	**0.016*** **
	(0.007)	**(0.038)**	**(0.007)**	**(0.004)**	(0.001)	**(0.001)**
Income Diversification (t-1)	**0.163*** **	**0.059*** **	-0.000	**-0.008***	**-0.010*** **	**-0.033*** **
	(0.013)	**(0.022)**	(0.004)	**(0.005)**	**(0.002)**	**(0.003)**
Sectoral Loan Concentration (t-1)	0.014	**0.167*** **	0.004	**0.016*** **	**-0.004** **	**-0.008*** **
	(0.017)	**(0.059)**	(0.006)	**(0.003)**	**(0.002)**	**(0.003)**
Regional Market Concentration (t-1)	**0.122** **	-0.051	**0.029*** **	-0.008	**0.026*** **	**-0.031***
	(0.056)	(0.053)	**(0.009)**	(0.007)	**(0.005)**	**(0.018)**
Macroeconomic Variables						
Insolvency Rate, Bundesland Level	**-0.719*** **	**-0.806** **	-0.019		**0.208*** **	**0.222*** **
	(0.194)	**(0.381)**	(0.053)		**(0.023)**	**(0.064)**
Real Asset Price Growth	**0.125*** **	**0.043*** **	**0.010*** **		**-0.002*** **	**-0.033*** **
	(0.005)	**(0.010)**	**(0.001)**		**(0.001)**	**(0.001)**
Real One-Year Interest Rate	**-1.544*** **	**-0.688*** **	**-0.139*** **		**-0.028*** **	
	(0.049)	**(0.084)**	**(0.015)**		**(0.007)**	
Constant	**22.196*** **	**37.335*** **	**6.801*** **	**2.029*** **	**-2.636*** **	**-1.488*** **
	(2.497)	**(5.720)**	**(0.687)**	**(0.374)**	**(0.206)**	**(0.369)**
R-squared-within	0.274	0.147	0.099		0.088	0.120
R-squared				0.496		
Number of banks	3404	3404	3404	3404	2948	3260
Observations	18790	18790	18790	3404	14334	17580
Test on equality for mean values						
C vs. S	**9.175*** **	**-3.207*** **	0.052	**-0.255*** **	-0.004	**0.825*** **
	(0.882)	**(1.029)**	(0.088)	**(0.049)**	(0.045)	**(0.116)**

All the regressions are based on Random Effects (RE) except column 4, where the standard deviation of RORWA is estimated with OLS. Standard errors in parentheses; * Significant at the 10% level, ** Significant at the 5% level, *** Significant at the 1% level.

Table 7: Stability Across Different Banking Groups Including Interaction Terms - Robustness with 5% Outlier Correction

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable	**Z-Score**	**Capital to RWA Ratio**	**RORWA**	**Standard Deviation of RORWA**	**NPL-Score**	**PD-Score**
Estimation Technique	**RE**	**RE**	**RE**	**OLS**	**RE**	**RE**
Private Banks						
P*Bank Size (t-1)	**-2.471*** **	**-6.440*** **	-0.011	**-0.309*** **	**-0.237*** **	**-0.225*** **
	(0.597)	**(1.359)**	(0.153)	**(0.086)**	**(0.056)**	**(0.040)**
P*Risky Assets (t-1)	**-0.151*** **	**-0.443*** **	**-0.037*** **	**-0.041*** **	0.003	-0.002
	(0.029)	**(0.098)**	**(0.009)**	**(0.006)**	(0.004)	(0.002)
P*RWA Growth (t-1)	**-0.050*** **	**-0.185*** **	0.001	**-0.020** **	**-0.006*** **	
	(0.011)	**(0.038)**	(0.006)	**(0.008)**	**(0.002)**	
P*Cost Inefficiency (t-1)	-0.001	**0.135** **	**-0.061*** **	**0.018*** **	-0.002	**0.012*** **
	(0.009)	**(0.054)**	**(0.010)**	**(0.006)**	(0.002)	**(0.001)**
P*Income Diversification (t-1)	0.001	-0.028	-0.002	-0.016	**-0.011*** **	0.002
	(0.025)	(0.070)	(0.012)	(0.012)	**(0.004)**	(0.002)
P*Sectoral Loan Concentration (t-1)	**0.060*** **	**0.318*** **	0.005	**0.025*** **	0.001	-0.003
	(0.021)	**(0.096)**	(0.010)	**(0.006)**	(0.003)	(0.002)
P*Regional Market Concentration (t-1)	0.079	-0.116	0.045	-0.053	**-0.052* **	-0.020
	(0.157)	(0.491)	(0.082)	(0.076)	**(0.031)**	(0.018)
P*Insolvency Rate, Bundesland Level	0.313	-4.757	-0.093		0.149	**0.157*** **
	(0.623)	(3.041)	(0.497)		(0.138)	**(0.058)**
P*Real Asset Price Growth	**0.044** **	-0.071	**0.022* **		**-0.007** **	**0.004** **
	(0.022)	(0.078)	**(0.013)**		**(0.003)**	**(0.002)**
P*Real One-Year Interest Rate	-0.326	**-1.399* **	0.113		**0.073* **	
	(0.239)	**(0.764)**	(0.143)		**(0.044)**	
Savings Banks						
Savings Banks Dummy (S) (t-1)	**-11.679* **	**-63.637*** **	-1.033	**-3.266*** **	**-1.662** **	0.222
	(6.528)	**(14.192)**	(1.812)	**(1.170)**	**(0.687)**	(0.955)
S*Bank Size (t-1)	**1.296** **	0.106	**-0.126*** **	**-0.031*** **	-0.014	**-0.216* **
	(0.652)	(0.133)	**(0.025)**	**(0.011)**	(0.029)	**(0.123)**
S*Risky Assets (t-1)	**-0.178*** **	**-0.113*** **	**-0.036*** **	**-0.010*** **	**-0.004** **	-0.001
	(0.021)	**(0.008)**	**(0.002)**	**(0.001)**	**(0.002)**	(0.007)
S*RWA Growth (t-1)	**-0.113*** **	**-0.086*** **	**0.009*** **	0.005	**-0.010*** **	
	(0.008)	**(0.005)**	**(0.002)**	(0.003)	**(0.001)**	
S*Cost Inefficiency (t-1)	-0.002	-0.005	**-0.019*** **	**-0.007*** **	0.000	**0.010** **
	(0.011)	(0.006)	**(0.002)**	**(0.002)**	(0.001)	**(0.005)**
S*Income Diversification (t-1)	**0.049** **	**0.066*** **	**-0.020*** **	0.002	**-0.008*** **	**-0.044*** **
	(0.020)	**(0.010)**	**(0.004)**	(0.003)	**(0.002)**	**(0.010)**
S*Sectoral Loan Concentration (t-1)	**0.155*** **	**0.116*** **	**-0.008** **	0.003	-0.002	**-0.089*** **
	(0.034)	**(0.016)**	**(0.004)**	(0.003)	(0.003)	**(0.016)**
S*Regional Market Concentration (t-1)	-0.083	-0.026	**0.029*** **	**-0.020*** **	**0.015* **	0.022
	(0.081)	(0.038)	**(0.011)**	**(0.006)**	**(0.009)**	(0.035)
S*Insolvency Rate, Bundesland Level	**-2.018*** **	**-0.626*** **	**-0.150*** **		**0.241*** **	**0.350*** **
	(0.322)	**(0.156)**	**(0.046)**		**(0.034)**	**(0.126)**
S*Real Asset Price Growth	**0.099*** **	**0.033*** **	**0.022*** **		-0.000	**-0.029*** **
	(0.006)	**(0.003)**	**(0.001)**		(0.001)	**(0.003)**
S*Real One-Year Interest Rate	**-1.359*** **	**-0.522*** **	**-0.236*** **		**-0.022** **	
	(0.074)	**(0.038)**	**(0.014)**		**(0.010)**	

Table 7 (continued)

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable	**Z-Score**	**Capital to RWA Ratio**	**RORWA**	**Standard Deviation of RORWA**	**NPL-Score**	**PD-Score**
Estimation Technique	**RE**	**RE**	**RE**	**OLS**	**RE**	**RE**
Cooperative Banks						
Cooperative Banks Dummy (C) (t-1)	**-11.038****	**-62.463*****	**-3.330***	**-3.904*****	**-2.469*****	**-3.456*****
	(5.554)	**(14.170)**	**(1.800)**	**(1.162)**	**(0.660)**	**(0.578)**
C*Bank Size (t-1)	**3.646*****	0.066	**-0.105*****	**-0.035*****	**0.088*****	-0.038
	(0.347)	(0.059)	**(0.010)**	**(0.004)**	**(0.015)**	(0.045)
C*Risky Assets (t-1)	**-0.218*****	**-0.104*****	**-0.020*****	**-0.006*****	**0.005*****	**0.014*****
	(0.016)	**(0.006)**	**(0.001)**	**(0.000)**	**(0.002)**	**(0.005)**
C*RWA Growth (t-1)	**-0.135*****	**-0.071*****	-0.002	**-0.007*****	**-0.011*****	
	(0.006)	**(0.003)**	(0.001)	**(0.001)**	**(0.001)**	
C*Cost Inefficiency (t-1)	**-0.037*****	**-0.016*****	**-0.020*****	**-0.004*****	-0.001	**0.024*****
	(0.007)	**(0.003)**	**(0.001)**	**(0.001)**	(0.001)	**(0.003)**
C*Income Diversification (t-1)	**0.228*****	**0.126*****	-0.002	**0.002*****	**-0.011*****	**-0.042*****
	(0.015)	**(0.006)**	(0.001)	**(0.001)**	**(0.002)**	**(0.004)**
C*Sectoral Loan Concentration (t-1)	**-0.049****	**-0.020****	**0.008*****	**0.001****	**-0.007*****	0.007
	(0.021)	**(0.008)**	**(0.001)**	**(0.001)**	**(0.002)**	(0.006)
C*Regional Market Concentration (t-1)	0.107	0.021	**0.021*****	**0.014*****	**0.034*****	-0.023
	(0.067)	(0.028)	**(0.005)**	**(0.002)**	**(0.006)**	(0.022)
C*Insolvency Rate, Bundesland Level	**-0.641*****	-0.113	0.015		**0.203*****	**0.219*****
	(0.233)	(0.102)	(0.027)		**(0.029)**	**(0.082)**
C*Real Asset Price Growth	**0.133*****	**0.051*****	**0.011*****		**-0.002*****	**-0.036*****
	(0.005)	**(0.002)**	**(0.001)**		**(0.001)**	**(0.002)**
C*Real One-Year Interest Rate	**-1.648*****	**-0.669*****	**-0.155*****		**-0.037*****	
	(0.057)	**(0.025)**	**(0.008)**		**(0.008)**	
Constant	**39.220*****	**80.295*****	**7.569*****	**5.075*****	-0.843	**-2.061*****
	(5.213)	**(14.160)**	**(1.796)**	**(1.160)**	(0.641)	**(0.343)**
R-squared-within	0.343	0.233	0.133		0.114	0.154
R-squared				0.6154		
Number of banks	3404	3404	3404	3404	2948	3260
Observations	18790	18790	18790	3404	14334	17580
Test on equality for mean values						
S vs. P	**8.038*****	**-15.001*****	**-0.365****	**-1.803*****	**-0.138***	**-2.846*****
	(1.014)	**1.838**	**(0.170)**	**(0.127)**	**(0.078)**	**(0.097)**
C vs. P	**15.256*****	**-15.314*****	**-0.556*****	**-1.938*****	**-0.177****	**-1.692*****
	(0.987)	**(1.837)**	**(0.170)**	**(0.127)**	**(0.077)**	**(0.057)**
C vs. S	**7.218*****	**-0.312*****	**-0.192*****	**-0.135*****	**-0.039***	**1.154*****
	(0.451)	**(0.094)**	**(0.019)**	**(0.009)**	**(0.023)**	**(0.092)**

All the regressions are based on Random Effects (RE) except column 4, where the standard deviation of RORWA is estimated with OLS. Standard errors in parentheses; * Significant at the 10% level, ** Significant at the 5% level, *** Significant at the 1% level.

Table 8: Stability Across Different Banking Groups - Robustness with Mean +/- 2 Standard Deviations Outlier Correction

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable	**Z-Score**	**Capital to RWA Ratio**	**RORWA**	**Standard Deviation of RORWA**	**NPL-Score**	**PD-Score**
Estimation Technique	**RE**	**RE**	**RE**	**OLS**	**RE**	**RE**
Bank-Specific Variables						
Savings Banks Dummy (S) (t-1)	**9.183*** **	**-11.105*** **	-0.844	**-1.755*** **	**-0.320*** **	**-3.082*** **
	(1.289)	**(3.870)**	(0.586)	**(0.327)**	**(0.098)**	**(0.136)**
Cooperative Banks Dummy (C) (t-1)	**23.196*** **	**-12.003** **	-0.563	**-2.104*** **	**-0.234** **	**-2.249*** **
	(1.535)	**(4.669)**	(0.576)	**(0.319)**	**(0.096)**	**(0.113)**
Bank Size (t-1)	**1.291** **	-0.478	-0.043	-0.037	**0.041** **	**-0.151*** **
	(0.619)	(0.744)	(0.081)	(0.033)	**(0.016)**	**(0.028)**
Risky Assets (t-1)	**-0.199*** **	**-0.314*** **	**-0.042*** **	**-0.022*** **	**0.006*** **	**0.008*** **
	(0.014)	**(0.073)**	**(0.008)**	**(0.005)**	**(0.001)**	**(0.003)**
RWA Growth (t-1)	-0.001	-0.002	0.000	**0.005*** **	-0.000	
	(0.001)	(0.004)	(0.000)	**(0.001)**	(0.000)	
Cost Inefficiency (t-1)	**-0.007* **	**0.101* **	**-0.053*** **	**0.049*** **	0.001	**0.009*** **
	(0.004)	**(0.052)**	**(0.011)**	**(0.007)**	(0.001)	**(0.001)**
Income Diversification (t-1)	**0.178*** **	**0.080*** **	0.000	**-0.031*** **	**-0.009*** **	**-0.026*** **
	(0.016)	**(0.025)**	(0.008)	**(0.009)**	**(0.002)**	**(0.003)**
Sectoral Loan Concentration (t-1)	0.004	**0.255** **	-0.007	**0.031*** **	**-0.006*** **	**-0.010*** **
	(0.017)	**(0.116)**	(0.014)	**(0.008)**	**(0.002)**	**(0.003)**
Regional Market Concentration (t-1)	**0.214*** **	-0.110	0.022	0.002	**0.030*** **	**-0.032* **
	(0.060)	(0.088)	(0.023)	(0.018)	**(0.005)**	**(0.017)**
Macroeconomic Variables						
Insolvency Rate, Bundesland Level	**-0.364* **	-1.019	-0.117		**0.250*** **	**0.231*** **
	(0.201)	(0.739)	(0.116)		**(0.024)**	**(0.062)**
Real Asset Price Growth	**0.134*** **	**0.041*** **	**0.009*** **		**-0.001* **	**-0.033*** **
	(0.005)	**(0.014)**	**(0.003)**		**(0.001)**	**(0.001)**
Real One-Year Interest Rate	**-1.623*** **	**-1.010*** **	**-0.137*** **		**-0.039*** **	
	(0.053)	**(0.124)**	**(0.039)**		**(0.007)**	
Constant	**16.768*** **	**35.015*** **	**8.354*** **	1.297	**-3.104*** **	**-1.464*** **
	(4.220)	**(10.077)**	**(1.477)**	(0.806)	**(0.205)**	**(0.347)**
R-squared-within	0.226	0.093	0.078		0.068	0.112
R-squared				0.466		
Number of banks	3954	3954	3954	3954	3464	3779
Observations	21830	21830	21830	3954	17214	20309
Test on equality for mean values						
C vs. S	**14.012*** **	-0.898	0.282	**-0.349*** **	**0.086** **	**0.833*** **
	(1.581)	(1.374)	(0.183)	**(0.084)**	**(0.043)**	**(0.105)**

All the regressions are based on Random Effects (RE) except column 4, where the standard deviation of RORWA is estimated with OLS. Standard errors in parentheses; * Significant at the 10% level, ** Significant at the 5% level, *** Significant at the 1% level.

Table 9: Stability Across Different Banking Groups Including Interaction Terms - Robustness with Mean +/- 2 Standard Deviations Outlier Correction

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable	**Z-Score**	**Capital to RWA Ratio**	**RORWA**	**Standard Deviation of RORWA**	**NPL-Score**	**PD-Score**
Estimation Technique	**RE**	**RE**	**RE**	**OLS**	**RE**	**RE**
Private Banks						
P*Bank Size (t-1)	**-1.444****	**-5.541*****	0.083	**-0.666*****	**-0.176*****	**-0.228*****
	(0.590)	**(2.110)**	(0.403)	**(0.187)**	**(0.057)**	**(0.039)**
P*Risky Assets (t-1)	**-0.177*****	**-0.858*****	**-0.073*****	**-0.080*****	0.006	-0.003
	(0.026)	**(0.217)**	**(0.025)**	**(0.017)**	(0.004)	(0.002)
P*RWA Growth (t-1)	0.000	0.002	-0.000	**0.004*****	-0.000	
	(0.001)	(0.004)	(0.000)	**(0.001)**	(0.000)	
P*Cost Inefficiency (t-1)	-0.003	**0.105***	**-0.065*****	**0.042*****	0.000	**0.006*****
	(0.003)	**(0.061)**	**(0.014)**	**(0.010)**	(0.001)	**(0.001)**
P*Income Diversification (t-1)	0.020	0.062	-0.031	**-0.081****	**-0.010****	**0.007****
	(0.025)	(0.095)	(0.032)	**(0.033)**	**(0.005)**	**(0.003)**
P*Sectoral Loan Concentration (t-1)	**0.056*****	**0.499****	-0.018	**0.054*****	-0.002	-0.002
	(0.021)	**(0.204)**	(0.028)	**(0.015)**	(0.004)	(0.002)
P*Regional Market Concentration (t-1)	0.141	-0.731	0.034	0.040	**-0.069****	-0.027
	(0.161)	(0.623)	(0.275)	(0.206)	**(0.033)**	(0.019)
P*Insolvency Rate, Bundesland Level	0.310	-9.446	-0.186		**0.253***	**0.173*****
	(0.761)	(6.237)	(1.269)		**(0.151)**	**(0.065)**
P*Real Asset Price Growth	**0.049****	-0.135	0.019		-0.005	**0.004***
	(0.023)	(0.115)	(0.032)		(0.003)	**(0.002)**
P*Real One-Year Interest Rate	**-0.473****	**-2.995****	0.601		0.084	
	(0.228)	**(1.398)**	(0.490)		(0.052)	
Savings Banks						
Savings Banks Dummy (S) (t-1)	-6.553	**-84.417*****	-4.141	**-7.478*****	**-1.216***	-0.438
	(7.668)	**(22.348)**	(4.032)	**(2.884)**	**(0.716)**	(0.829)
S*Bank Size (t-1)	**1.803***	0.091	**-0.074*****	**-0.055*****	0.021	**-0.262*****
	(0.986)	(0.111)	**(0.023)**	**(0.012)**	(0.025)	**(0.100)**
S*Risky Assets (t-1)	**-0.213*****	**-0.124*****	**-0.040*****	**-0.011*****	**-0.003***	0.006
	(0.023)	**(0.008)**	**(0.002)**	**(0.001)**	**(0.002)**	(0.007)
S*RWA Growth (t-1)	**-0.095*****	**-0.078*****	**0.008*****	**0.011*****	**-0.009*****	
	(0.008)	**(0.004)**	**(0.002)**	**(0.003)**	**(0.001)**	
S*Cost Inefficiency (t-1)	-0.008	**-0.009***	**-0.021*****	**-0.004****	-0.000	**0.011****
	(0.010)	**(0.005)**	**(0.002)**	**(0.002)**	(0.001)	**(0.005)**
S*Income Diversification (t-1)	**0.043****	**0.061*****	**-0.016*****	0.004	**-0.008*****	**-0.036*****
	(0.020)	**(0.010)**	**(0.004)**	(0.003)	**(0.002)**	**(0.009)**
S*Sectoral Loan Concentration (t-1)	**0.180*****	**0.128*****	-0.006	0.001	-0.004	**-0.093*****
	(0.033)	**(0.017)**	(0.004)	(0.003)	(0.004)	**(0.017)**
S*Regional Market Concentration (t-1)	-0.065	-0.004	**0.024****	**-0.018*****	**0.016***	0.012
	(0.078)	(0.036)	**(0.011)**	**(0.007)**	**(0.009)**	(0.034)
S*Insolvency Rate, Bundesland Level	**-1.570*****	**-0.490*****	**-0.195*****		**0.262*****	**0.356*****
	(0.306)	**(0.145)**	**(0.048)**		**(0.034)**	**(0.117)**
S*Real Asset Price Growth	**0.104*****	**0.036*****	**0.026*****		0.001	**-0.027*****
	(0.006)	**(0.003)**	**(0.002)**		(0.001)	**(0.003)**
S*Real One-Year Interest Rate	**-1.364*****	**-0.533*****	**-0.252*****		**-0.029*****	
	(0.074)	**(0.036)**	**(0.014)**		**(0.010)**	

Table 9 (continued)

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable	**Z-Score**	**Capital to RWA Ratio**	**RORWA**	**Standard Deviation of RORWA**	**NPL-Score**	**PD-Score**
Estimation Technique	**RE**	**RE**	**RE**	**OLS**	**RE**	**RE**
Cooperative Banks						
Cooperative Banks Dummy (C) (t-1)	-4.314	**-82.764*** **	-6.224	**-8.364*** **	**-2.096*** **	**-4.097*** **
	(9.267)	**(22.338)**	(4.027)	**(2.881)**	**(0.695)**	**(0.543)**
C*Bank Size (t-1)	**4.810*** **	-0.047	**-0.087*** **	**-0.036*** **	**0.095*** **	-0.026
	(1.475)	(0.053)	**(0.011)**	**(0.006)**	**(0.014)**	(0.037)
C*Risky Assets (t-1)	**-0.243*** **	**-0.110*** **	**-0.024*** **	**-0.006*** **	**0.006*** **	**0.019*** **
	(0.016)	**(0.005)**	**(0.001)**	**(0.001)**	**(0.002)**	**(0.004)**
C*RWA Growth (t-1)	**-0.118*** **	**-0.070*** **	**-0.003** **	**-0.004*** **	**-0.011*** **	
	(0.006)	**(0.003)**	**(0.001)**	**(0.001)**	**(0.001)**	
C*Cost Inefficiency (t-1)	**-0.042*** **	**-0.013*** **	**-0.017*** **	0.001	**0.001* **	**0.020*** **
	(0.011)	**(0.003)**	**(0.001)**	(0.001)	**(0.001)**	**(0.002)**
C*Income Diversification (t-1)	**0.230*** **	**0.117*** **	-0.002	-0.001	**-0.011*** **	**-0.037*** **
	(0.030)	**(0.006)**	(0.002)	(0.001)	**(0.002)**	**(0.004)**
C*Sectoral Loan Concentration (t-1)	**-0.072*** **	**-0.014* **	**0.009*** **	**0.001* **	**-0.009*** **	0.002
	(0.024)	**(0.008)**	**(0.001)**	**(0.001)**	**(0.002)**	(0.005)
C*Regional Market Concentration (t-1)	**0.185** **	0.035	**0.011* **	**0.023*** **	**0.040*** **	-0.022
	(0.075)	(0.027)	**(0.006)**	**(0.004)**	**(0.006)**	(0.021)
C*Insolvency Rate, Bundesland Level	**-0.543** **	-0.120	**-0.083** **		**0.237*** **	**0.221*** **
	(0.273)	(0.104)	**(0.033)**		**(0.028)**	**(0.080)**
C*Real Asset Price Growth	**0.133*** **	**0.053*** **	**0.014*** **		**-0.003*** **	**-0.036*** **
	(0.006)	**(0.002)**	**(0.001)**		**(0.001)**	**(0.002)**
C*Real One-Year Interest Rate	**-1.605*** **	**-0.703*** **	**-0.182*** **		**-0.030*** **	
	(0.065)	**(0.024)**	**(0.009)**		**(0.008)**	
Constant	**32.684*** **	**101.636*** **	**10.591*** **	**9.303*** **	**-1.475** **	**-1.676*** **
	(4.889)	**(22.332)**	**(4.024)**	**(2.880)**	**(0.680)**	**(0.360)**
R-squared-within	0.299	0.169	0.104		0.107	0.145
R-squared				0.5899		
Number of banks	3954	3954	3954	3954	3464	3779
Observations	21830	21830	21830	3954	17214	20309
Test on equality for mean values						
S vs. P	**9.780*** **	**-17.424*** **	0.144	**-3.599*** **	**-0.155* **	**-2.904*** **
	(1.130)	**(2.642)**	(0.414)	**(0.311)**	**(0.084)**	**(0.092)**
C vs. P	**20.323*** **	**-17.588*** **	-0.032	**-3.700*** **	**-0.179** **	**-1.799*** **
	(1.279)	**(2.641)**	(0.414)	**(0.311)**	**(0.082)**	**(0.057)**
C vs. S	**10.543*** **	**-0.164* **	**-0.176*** **	**-0.101*** **	-0.025	**1.105*** **
	(0.979)	**(0.092)**	**(0.021)**	**(0.011)**	(0.024)	**(0.086)**

All the regressions are based on Random Effects (RE) except column 4, where the standard deviation of RORWA is estimated with OLS. Standard errors in parentheses; * Significant at the 10% level, ** Significant at the 5% level, *** Significant at the 1% level.

Table 10: Stability Across Different Banking Groups Including Interaction Terms - Robustness Fixed Effects Regressions

	(1)	(2)	(3)	(4)	(5)
Dependent Variable	**Z-Score**	**Capital to RWA Ratio**	**RORWA**	**NPL-Score**	**PD-Score**
Estimation Technique	**FE**	**FE**	**FE**	**FE**	**FE**
Private Banks					
P*Bank Size (t-1)	**-1.922*** **	-3.741	0.837	**-0.503*** **	**-0.410*** **
	(0.678)	(3.482)	(1.439)	**(0.114)**	**(0.092)**
P*Risky Assets (t-1)	**-0.179*** **	**-0.568*** **	-0.041	0.001	-0.003
	(0.029)	**(0.187)**	(0.044)	(0.005)	(0.003)
P*RWA Growth (t-1)	**-0.031*** **	**-0.181*** **	0.000	**-0.008*** **	
	(0.009)	**(0.038)**	(0.015)	**(0.002)**	
P*Cost Inefficiency (t-1)	-0.001	**0.216** **	**-0.064*** **	0.001	**0.008*** **
	(0.007)	**(0.093)**	**(0.021)**	(0.002)	**(0.001)**
P*Income Diversification (t-1)	0.022	-0.004	-0.021	-0.009	**0.006* **
	(0.027)	(0.094)	(0.029)	(0.005)	**(0.003)**
P*Sectoral Loan Concentration (t-1)	**0.058*** **	**0.440* **	**-0.088* **	-0.005	-0.004
	(0.021)	**(0.262)**	**(0.053)**	(0.005)	(0.003)
P*Regional Market Concentration (t-1)	0.078	-0.493	0.067	**-0.128*** **	-0.032
	(0.167)	(0.717)	(0.145)	**(0.037)**	(0.023)
P*Insolvency Rate, Bundesland Level	0.097	**-11.512** **	0.788	**0.245* **	**0.178*** **
	(0.721)	**(5.408)**	(0.958)	**(0.145)**	**(0.066)**
P*Real Asset Price Growth	**0.045** **	-0.113	0.022	**-0.006* **	**0.004** **
	(0.022)	(0.096)	(0.023)	**(0.003)**	**(0.002)**
P*Real One-Year Interest Rate	**-0.454** **	**-2.227** **	0.596	0.057	
	(0.228)	**(1.022)**	(0.396)	(0.049)	
Savings Banks					
S*Bank Size (t-1)	1.427	**1.657*** **	**-1.753*** **	-0.142	**-1.791*** **
	(1.084)	**(0.560)**	**(0.175)**	(0.154)	**(0.417)**
S*Risky Assets (t-1)	**-0.204*** **	**-0.099*** **	**-0.041*** **	**0.005* **	-0.005
	(0.023)	**(0.012)**	**(0.004)**	**(0.003)**	(0.010)
S*RWA Growth (t-1)	**-0.107*** **	**-0.083*** **	0.002	**-0.009*** **	
	(0.007)	**(0.004)**	(0.002)	**(0.001)**	
S*Cost Inefficiency (t-1)	-0.005	0.000	**-0.008*** **	0.001	0.003
	(0.010)	(0.006)	**(0.002)**	(0.001)	(0.005)
S*Income Diversification (t-1)	**0.058*** **	**0.049*** **	**-0.009* **	**-0.008*** **	**-0.024** **
	(0.021)	**(0.012)**	**(0.005)**	**(0.003)**	**(0.010)**
S*Sectoral Loan Concentration (t-1)	**0.191*** **	**0.137*** **	0.005	**-0.007* **	**-0.081*** **
	(0.034)	**(0.020)**	(0.006)	**(0.004)**	**(0.018)**
S*Regional Market Concentration (t-1)	-0.100	**-0.074* **	**0.032** **	0.014	0.010
	(0.079)	**(0.041)**	**(0.016)**	(0.010)	(0.035)
S*Insolvency Rate, Bundesland Level	**-2.080*** **	**-1.623*** **	-0.059	**0.200*** **	**0.764*** **
	(0.321)	**(0.209)**	(0.075)	**(0.044)**	**(0.141)**
S*Real Asset Price Growth	**0.098*** **	**0.033*** **	**0.023*** **	0.001	**-0.029*** **
	(0.006)	**(0.003)**	**(0.002)**	(0.001)	**(0.003)**
S*Real One-Year Interest Rate	**-1.402*** **	**-0.621*** **	**-0.266*** **	**-0.030*** **	
	(0.071)	**(0.041)**	**(0.016)**	**(0.010)**	

Table 10 (continued)

	(1)	(2)	(3)	(4)	(5)
Dependent Variable	**Z-Score**	**Capital to RWA Ratio**	**RORWA**	**NPL-Score**	**PD-Score**
Estimation Technique	**FE**	**FE**	**FE**	**FE**	**FE**
Cooperative Banks					
C*Bank Size (t-1)	**7.096*** **	**4.687*** **	**-1.422*** **	-0.086	**-2.692*** **
	(0.854)	**(0.446)**	**(0.108)**	(0.104)	**(0.291)**
C*Risky Assets (t-1)	**-0.253*** **	**-0.127*** **	**-0.020*** **	**0.006*** **	**0.027*** **
	(0.015)	**(0.008)**	**(0.002)**	**(0.002)**	**(0.006)**
C*RWA Growth (t-1)	**-0.120*** **	**-0.060*** **	**-0.006*** **	**-0.011*** **	
	(0.006)	**(0.003)**	**(0.001)**	**(0.001)**	
C*Cost Inefficiency (t-1)	**-0.048*** **	**-0.015*** **	**-0.010*** **	0.000	**0.017*** **
	(0.006)	**(0.003)**	**(0.001)**	(0.001)	**(0.003)**
C*Income Diversification (t-1)	**0.213*** **	**0.123*** **	**-0.006*** **	**-0.012*** **	**-0.035*** **
	(0.015)	**(0.008)**	**(0.002)**	**(0.002)**	**(0.005)**
C*Sectoral Loan Concentration (t-1)	**-0.053*** **	**-0.031*** **	**0.008*** **	-0.003	**0.018*** **
	(0.020)	**(0.010)**	**(0.003)**	(0.003)	**(0.007)**
C*Regional Market Concentration (t-1)	**0.218*** **	**0.063* **	**0.032*** **	**0.039*** **	**-0.069*** **
	(0.068)	**(0.033)**	**(0.008)**	**(0.008)**	**(0.024)**
C*Insolvency Rate, Bundesland Level	-0.480	**-0.460*** **	**0.129*** **	**0.181*** **	**0.302*** **
	(0.296)	**(0.163)**	**(0.044)**	**(0.034)**	**(0.096)**
C*Real Asset Price Growth	**0.138*** **	**0.058*** **	**0.015*** **	**-0.003*** **	**-0.042*** **
	(0.006)	**(0.002)**	**(0.001)**	**(0.001)**	**(0.002)**
C*Real One-Year Interest Rate	**-1.609*** **	**-0.691*** **	**-0.162*** **	**-0.051*** **	
	(0.056)	**(0.027)**	**(0.009)**	**(0.008)**	
Constant	**16.125*** **	**4.552* **	**11.395*** **	**-2.222*** **	**6.453*** **
	(3.095)	**(2.560)**	**(0.823)**	**(0.419)**	**(1.131)**
R-squared-within	0.337	0.240	0.153	0.121	0.201
Number of banks	3810	3810	3810	3389	3643
Observations	21154	21154	21154	16980	19716

A 2% outlier correction is applied here. All the regressions are based on Fixed Effects (FE). Standard errors in parentheses; * Significant at the 10% level, ** Significant at the 5% level, *** Significant at the 1% level.

Figure 1: Kernel density estimates for z-score

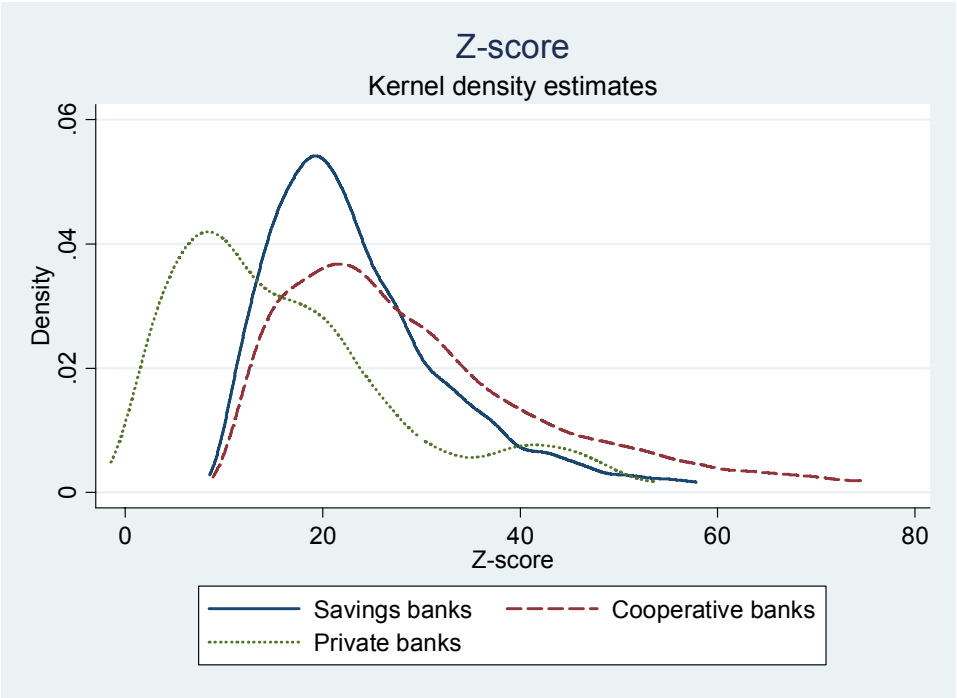


Figure 2: Kernel density estimates for NPL-score

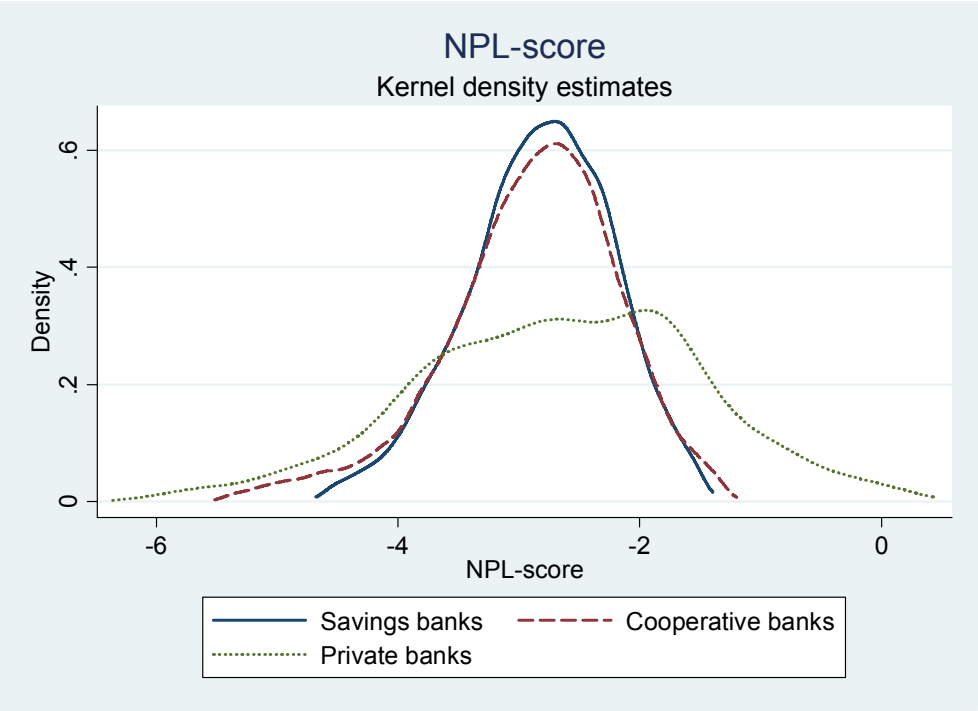
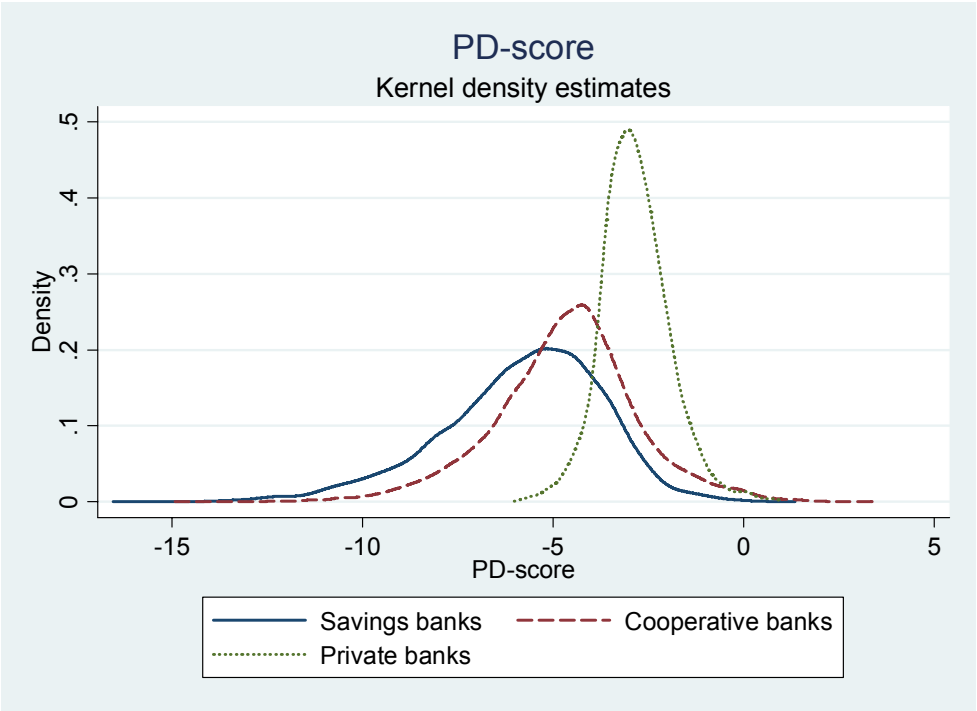


Figure 3: Kernel density estimates for PD-score



Appendix

A: Treatment of Bank Mergers

More than one hundred bank mergers took place during the sample period. An exclusion of banks that were involved in mergers would thus lead to a considerable loss of information. Alternatively, one can consider the merged bank to be one institution during the entire time period. In this case, we need to aggregate the merging banks into one institution before the actual merger takes place. However, data breaks in this procedure are unavoidable since the aggregated data before the merger and the data of the merged bank do typically not correspond well.

Given the difficulties involved in the aforementioned approaches, we choose to separate the pre-merger banks from the merged bank. In the end, we have three banks, which are treated independently. We repeat this procedure as often as a merger takes place. Each time a newly merged bank receives a new identification number, we drop the target banks in that year (or quarter).

B: The Treatment of Outliers

By constructing of the dependent and the explanatory variables we eliminate series of outliers. By constructing of the z-score we proceed as follows:

- We first truncate the RORWA. Specifically, we set the observations smaller than the 2nd percentile of the distribution to the value of the 2nd percentile and we set the observations larger than the 98th percentile of the distribution to the value of the 98th percentile within each banking group.
- In a second step, we calculate the standard deviation of the RORWA. We set lower and upper bounds for the observations smaller than the 2nd percentile of the distribution and larger than the 98th percentile of the distribution within each banking group. To set the

lower and the upper bounds we focus only on banks with more than 5 bank-year observations.

- In a third step we truncate the variable capital. We set the observations smaller than the 2nd percentile of the distribution to the values of the 2nd percentile and we set the observations larger than the 98th percentile of the distribution to the values of the 98th percentile within each banking group.
- In a fourth step we calculate the z-score. By calculating the z-score we set observations smaller than the 2nd percentile and larger than the 98th percentile of the distribution to missing values within each banking group.

We eliminate outliers for the NPL-score in a similar way as for the z-score. We set observations smaller than the 2nd percentile and larger the 98th percentile of the distribution to missing values within each banking group.

The elimination of outliers for the PD-score is not necessarily, since the explanatory variables entering the first stage estimation of PD score are truncated within each banking group. Within the banking groups savings banks and cooperative banks the explanatory variables are truncated at the 0.3th percentile and at the 99.5th percentile. Within the banking group private banks the explanatory variables are truncated at the 1st percentile and at the 98.5th percentile.

Among the explanatory variables for the variable bank size we apply the same procedure as for the z-score and for the NPL-score. Other variables such as risky assets, RWA growth, cost efficiency and income diversification are truncated with the values of the 2nd percentile for the observations smaller than the 2nd percentile and with the values of the 98th percentile for the observations larger than the 98th percentile.

C: Estimating PD scores

A hazard model based on a logistic link function transforms a set of bank-specific covariates together with a macroeconomic indicator observed in year t-1 into the probability of distress (PD). The right hand side of the regression equation is oriented on the so-called CAMEL taxonomy: Capitalization, Asset quality, Management, Earnings, and Liquidity. On the left hand side we use a unique data set collected by the Deutsche Bundesbank, which consists of a variety of distress events experienced by banks between 1994 and 2006. In contrast to previous studies[19] this data set consists of a more precise distress definition[20] as well as on a longer time period for which distress data is now available. Distress events consist of

- compulsory notifications by banks about events that may jeopardize the existence of the bank as a going concern according to §29(3) of the German Banking act ("KWG"),
- notifications by banks of losses amounting to 25 percent of liable capital according to §24(1)5 KWG or a severe decline in the bank's return on equity,
- capital injections from the deposit insurance scheme,
- takeovers classified by the Bundesbank as restructuring mergers, and
- enforced closures of banks initiated by the BaFin, which happened in Germany only for a few private banks but not for savings and cooperative banks.

The hazard model is based on the following logistic link function, which is estimated as population-averaged panel logit model.

[19] See Porath (2006), Kick and Koetter (2007), De Graeve, Kick and Koetter (2008), etc.

[20] In this data set banks are allowed to face repeated distress events between 1994 and 2006. I.e. in contrast to the data set on which several previous studies are based upon, banks are allowed to face repeated distress events (like capital injections) in the sample period without being removed from the data set.

$$PD_{it} = \frac{e^{\beta X_{it-1} + \pi m_{t-1}}}{1 + e^{\beta X_{it-1} + \pi m_{t-1}}}$$

Here, PD_{it} denotes the probability that bank *i* will be distressed in year *t*. It is estimated from a set of covariates X_{it-1} observed for bank *i* in period *t-1* to which a macroeconomic variable m_{t-1} is added[21], where β and π are parameters to be estimated. Based on the logistic link function the hazard model transforms this set of covariates into bank-specific PDs on which the further financial stability analysis is based upon.[22]

As the group of private banks is extremely heterogeneous in bank characteristics, and different from savings and cooperative banks, two different bank rating models are estimated: one for savings and cooperative banks, and one for private banks. Regressions statistics are reported in Table C.1 and C.2.

Especially for savings and cooperative banks it turns out that the discriminatory power of the panel logit model, measured by the Area Under the Receiver Operating Characteristics Curve (AUR), is extremely high at 91.1%.[23] Coefficient estimates for the CAMEL vector and the business climate index are in line with both expectations and previous results in the literature and most of them are significant on the 1%-level. Better capitalization and bank reserves, higher profitability, large asset growth, and a more favorable business climate reduce the likelihood of distress. In turn, a high reduction of bank reserves, a large share of non-performing loans, and avoided write-offs on a bank's assets ("hidden liabilities") imply a higher probability of distress. The management's ability to avoid brokerage business and generate income in the less risky

[21] Porath (2006) has shown that the incorporation of macroeconomic variables significantly improves the performance of such a bank rating model.

[22] See De Graeve, Kick and Koetter (2008).

[23] In the context of bank rating models AUR values measure the ability of the model to discriminate between distress and non-distress events for a range of cut-off probabilities from zero to one. According to Hosmer and Lemshow (2000) values above 80% can be regarded as excellent.

interest business[24] is reflected by a (highly significant) positive coefficient for the *Share of brokerage business*. Moreover, a high liquidity ratio can be considered an indicator for management inefficiencies in the exploitation of (profitable) business opportunities.[25] Finally, the number of supervisory measures and weak incidents (like letters of warning by supervisors) reveal some weaknesses of an institution and, hence, imply a higher probability of distress.

The rating of private banks is based on a similar CAMEL vector like for the savings and cooperative banks. Because of the strong heterogeneity of private banks, the discriminatory power (AUR) of the panel logit regression is with almost 82% still very good, but lower than for the previous model. In this specification *Write-offs* proxy the asset quality in the bank portfolios slightly better than *Non-performing loans* used before, and *Cost-income-ratio* account for management efficiency. Finally, the *Interest rate* is a direct cost factor in the banking industry and, for private banks, it reflects the macroeconomic development better than the *Business climate index* used for the PD estimation of savings and cooperative banks.

[24] De Jonghe (2008) points out that "interest income is less risky than all other revenue streams."

[25] For savings and cooperative banks the *Share of brokerage business* and also *Liquidity* are highly correlated with the usual *Cost-income-ratios*. Hence, the latter are removed from this regression.

Table C.1: Regression statistics for savings and cooperative banks

Variable	
Equity ratio	-0.3008***
	(0.0336)
Undisclosed bank reserves	-1.3961***
	(0.2260)
Disclosed bank reserves	-1.5974***
	(0.1619)
Dummy reserves reduction	0.8580***
	(0.1106)
Non-performing loans	0.1249***
	(0.0092)
Dummy hidden liabilities	0.6047***
	(0.1063)
Share of brokerage business	0.0720***
	(0.0176)
Return on equity (ROE)	-0.0299***
	(0.0047)
Growth of (deflated) total assets	-0.0131
	(0.0100)
Liquidity	0.0200*
	(0.0107)
Supervisory measures	0.1448**
	(0.0619)
BCI	-0.0111***
	(0.0020)
Constant	-1.4951***
	(0.2834)
Observations	**26221**
Number of banks	**4243**
AUR	**0.9113**

Equity ratio = Tier 1-capital/ risk-weighted assets ◆ **Undisclosed bank reserves** = Undisclosed 340 f-bank reserves/ total capital ◆ **Disclosed bank reserves** = Disclosed 340 f-bank reserves/ total capital ◆ **Non-performing loans** = Non-performing loans/ customer loans ◆ **Hidden liabilities** = Avoided write-offs on the bank's assets ◆ **Share of brokerage business** = Brokerage income and expenses/ total income and expenses ◆ **ROE** = Operating results/ equity ◆ **Liquidity** = (Cash + overnight IB loans)/ total assets ◆ **Supervisory measures** = No. of supervisory measures and weak incidents over one year ◆ **BCI** = Growth rate of business climate index All ratios in percent/ standard errors in parentheses / *** p<0.01, ** p<0.05, * p<0.1

Table C.2: Regression statistics for private banks

Variable	
Bank reserves	-0.4295**
	(0.2175)
Write-offs	0.0326
	(0.0220)
Dummy hidden liabilities	0.6496***
	(0.1908)
Cost-income-ratio (CIR)	0.0296***
	(0.0043)
Return on equity (ROE)	-0.0294***
	(0.0034)
Supervisory measures	0.3721***
	(0.1035)
Interest rate	0.2114***
	(0.0660)
Constant	-4.7241***
	(0.4395)
Observations	**2583**
Number of banks	**388**
AUR	**0.8185**

Bank reserves = Total bank reserves/ total capital ◆ **Write-offs =** Write-offs and provisions/ customer loans ◆ **CIR =** General administrative expenditures/ revenues ◆ **ROE =** Operating results/ equity ◆ **Supervisory measures and incidents =** No. of supervisory measures and weak incidents over 2 years ◆ **Interest rate** = government bond rate (10 years). All ratios in percent/ standard errors in parentheses / *** p<0.01, ** p<0.05, * p<0.1