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EVIDENCE FROM A NATURAL EXPERIMENT

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Abstract

In 2001, government guarantees for savings banks in Germany were removed following a law suit. We use this natural experiment to examine the effect of government guarantees on bank risk taking, using a large data set of matched bank/borrower information. The results suggest that banks whose government guarantee was removed reduced credit risk by cutting off the riskiest borrowers from credit. At the same time, the banks also increased interest rates on their remaining borrowers. The effects are economically large: the Z-Score of average borrowers increased by 7.5% and the average loan size declined by 17.2%. Remaining borrowers paid 46 basis points higher interest rates, despite their higher quality. Using a difference-in-differences approach we show that the effect is larger for banks that ex ante benefited more from the guarantee and that none of these effects are present in a control group of German banks to whom the guarantee was not applicable. Furthermore, savings banks adjusted their liabilities away from risk-sensitive debt instruments after the removal of the guarantee, while we do not observe this for the control group. We also document in an event study that yield spreads of savings banks' bonds increased significantly right after the announcement of the decision to remove guarantees, while the yield spread of a sample of bonds issued by the control group remained unchanged. The results suggest that public guarantees may be associated with substantial moral hazard effects.

JEL Classification: G21, G28, G32
Key words: banking, public guarantees, credit risk, moral hazard, market discipline

Non-technical summary

Public guarantees in the wake of the financial crisis of 2007/2008 have been widespread. Most countries either nationalized banks, provided blanked guarantees for the banking system or both. Evidence on the likely effect of such intervention on bank risk taking is scarce, as in most cases guarantees are granted in the midst of a crisis, in which case the effects of the guarantees on the portfolio risk of banks are confounded by the effects of the crisis itself on portfolio risk of banks. To disentangle the two is very difficult in such a setting. In this paper we do not consider the introduction of government guarantees, but rather their removal. Further, the removal was not prompted by a financial event, but exogenously imposed by a court decision. The period under consideration in this paper, 1996 to 2006, was a period without major financial system incidence for the banks in our sample and hence is particularly well suited to identify the effects of behavioral changes in response to changes in the safety net.

In 2001, government guarantees for savings banks in Germany were removed following a law suit. We use this natural experiment to empirically identify the effect of government guarantees on bank risk taking, using a large data set of matched bank/borrower information. The results suggest that banks whose government guarantee was removed reduced credit risk by cutting off the riskiest borrowers from credit. At the same time, the banks also increased interest rates on their remaining borrowers and reduced the average loan size. The effects are economically large: the Z-Score of average borrowers increased by 7.5% and the average loan size declined by 17.2%. Remaining borrowers paid 46 basis points higher interest rates, despite their higher quality. Using a difference-in-differences approach we show that the effect is larger for banks that ex ante benefited more from the guarantee. We proxy for banks that benefited more by distinguishing between ex ante riskier and ex ante safer savings banks. We also show that in a control group of German banks to whom the guarantee was not applicable credit risk increased in the period subsequent to the removal of the guarantee. This is consistent with a deterioration in overall borrower quality in Germany during the period. Furthermore, savings banks adjusted their liabilities away from risk-sensitive debt instruments and towards insured deposits and equity after the removal of the guarantee, while we do not observe this for the control group. We also document in an event study that yield spreads of savings banks' bonds increased significantly right after the announcement of the decision to

remove guarantees, while the yield spread of a sample of bonds issued by the control group remained unchanged.

Finally, given the richness of our dataset, we can distinguish whether banks reduced credit risk by tightening lending standards for new borrowers ("screening") or by better monitoring of existing borrowers. We find that the credit quality of both existing and new borrowers improves, but the improvements are significantly larger in the case of new borrowers. This finding is consistent with a tightening of lending standards after the removal of guarantees.

Overall, the results suggest that public guarantees may be associated with substantial moral hazard effects. The unique identification scheme permits us to establish a causal relationship between public guarantees and banks' risk taking. The findings of this paper have important policy implications: The results suggest that a credible removal of guarantees will be essential in reducing the risk of potential future financial instability. They also support recent initiatives to impose capital surcharges on the largest banking institutions, which may benefit either from an explicit or an implicit guarantee. Higher capital in these banks may help offset the incentives provided by the public guarantees imposed during the crisis.

1 Introduction

In this paper we empirically analyze the impact of public guarantees on the risk taking of banks in the context of a natural experiment. Until the year 2000 the German savings banks were protected by a federal government guarantee.[1] In July 2001 the European Union, based on the outcome of a lawsuit at the European Court of Justice, ordered that the guarantees be discontinued, as they were deemed to be in violation of European anti-subsidy rules.[2] Using a unique panel data set consisting of matched balance sheet information for all German savings banks and their commercial loan customers for 1996 to 2006, we estimate the effect the removal had on credit risk, loan volumes, and interest rates of savings banks. Taking advantage of this natural experiment we are able to identify the effect of government guarantees on banks' credit portfolio choices and risk taking.

We find that the removal of government guarantees resulted in a significant reduction in banks' exposure to credit risk. Exposure to credit risk decreased significantly more in banks, for which the value of guarantees was higher ex ante. Savings banks shifted their portfolios towards safer borrowers by dropping existing borrowers with higher credit risk and by tightening their lending standards for new borrowers. Loan sizes were reduced. Despite the reduction in credit risk, savings banks increased interest rates on the remaining customers. Using a control group of banks that was unaffected by the removal, we find in a difference-in-differences estimation that these effects do not exist for the control group.[3] We then check whether the reduction in credit risk can be related to an increase in market discipline after the removal of the guarantee. We show that savings banks shifted their liabilities away from risk-sensitive debt. Further, interest yields of savings bank bonds increased around the time of the announcement of the removal in July of 2001, while the

[1] We provide more detail on the institutional structure of German savings banks in Section 2.

[2] Several major newspapers commented on the court decision. See for example Financial Times "Solution to Five-year Battle Welcomed by Private Sector" and Wall Street Journal "Germany to End State Guarantees for Public Banks", both on 18 July, 2001.

[3] Indeed, we tend to find an increase in borrower credit risk in the years after the removal of guarantees for the control group, due to the recession in Germany in 2002/2003 (Figure 2). Hence, in an environment of deteriorating quality of loan applicants, the quality of those that were granted a loan by savings banks improved significantly. Consistent with this, the market share of savings banks in the lending business to non-financials fell from 22% to 21% after the removal (Figure 3).

yields of bonds of a control group does not change. Taken together we feel we can establish a causal relationship between the removal of guarantees and the reduction in risk taking of savings banks, consistent with significant moral hazard effects of public guarantees.

Public guarantees in the wake of the financial crisis of 2007/2008 have been widespread. Most countries either nationalized banks (e.g., U.S.: Indy Mac, Fannie Mae, Freddy Mac; UK: Bradford Bingley, Northern Rock, RBS, HBOS, Lloyds; Germany: IKB, Hypo Real Estate; Belgium/Netherlands: Dexia, Fortis), provided blanked guarantees for the banking system (e.g., Germany, Italy) or both. Evidence on the likely effect of such intervention on bank risk taking is scarce, as in most cases guarantees are granted in the midst of a crisis, in which case the effects of the guarantees on the portfolio risk of banks are confounded by the effects of the crisis itself on portfolio risk of banks. To disentangle the two is very difficult in such a setting. In this paper we do not consider the introduction of government guarantees, but rather their removal. Further, the removal was not prompted by a financial event, but exogenously imposed by a court decision. The period under consideration in this paper, 1996 to 2006, was a period without major financial system incidence in Germany and hence is particularly well suited to identify the effects of behavioral changes in response to changes in the safety net.[4]

Theory would tell us that there are two effects of public guarantees on bank risk taking that work in opposite directions. On the one hand, government guarantees may reduce market discipline because creditors anticipate their bank's bail-out and therefore have lower incentives to monitor the bank's risk-taking or to demand risk premia for higher observed risk-taking (Flannery, 1998; Sironi, 2003; Gropp et al., 2006). This tends to increase the protected banks' risk-taking. The effect is similar to the well-known moral hazard effect discussed in the deposit insurance literature (Merton, 1977; Ruckes, 2004). If depositors are protected by a guarantee, they will punish their bank less for risk-taking, reducing market discipline. On the other hand, government guarantees also affect banks'

[4]This is not to say that there were no financial incidents at all; rather the effects of the Russian default (1998), LTCM (1998), or the 9/11 terrorist attacks in 2001 on German savings banks were very mild (Hackethal and Schmidt, 2005).

risk-taking through their effect on banks' margins and charter values. Keeley (1990) was the first to argue that higher charter values decrease the incentives for risk-taking, because the threat of losing future rents acts as a deterrent. Government bail-out guarantees result in higher charter values for protected banks who benefit from lower refinancing costs. Hence, government guarantees may alternatively be viewed as an implicit subsidy to the banks and through their future value decrease bank risk taking.

Ultimately, as argued by Cordella and Yeyati (2003) and by Hakenes and Schnabel (2010), the net effect of government bail-out guarantees on the risk-taking of banks is ambiguous and depends on the relative importance of the two channels. Which dominates is an empirical matter.[5]

Empirically, the literature tends to conclude that banks increase their risk-taking in the presence of government guarantees, but the evidence is far from unambiguous. For example, Hovakimian and Kane (2000) show evidence for higher risk-taking of banks in the presence of deposit insurance. Large banks – which may be perceived to be "too big to fail" – have been shown to follow riskier strategies than smaller banks (Boyd and Runkle, 1993; Boyd and Gertler, 1994; Gropp et al., 2010). The findings on the relationship between bank size and failure probabilities are mixed. De Nicoló (2001) and De Nicoló et al. (2004) document higher probabilities of failure for larger banks. In contrast, De Nicoló and Loukoianova (2007) find that public banks do not appear to follow riskier strategies than private banks. Finally, Sapienza (2004) shows that public banks charge lower interest rates for given riskiness of loans, which is consistent with the results presented in this paper.

The evidence on the effect of government bail-out guarantees on overall banking system stability is also mixed. Demirgüç-Kunt and Detragiache (2002) present evidence for a destabilizing effect of deposit insurance. Similarly, some papers find a negative relationship between bank stability and government ownership (Caprio and Martínez Pería,

[5]The presence of government guarantees may not only affect the risk-taking of protected banks, but also – through competition – that of the protected banks' competitors (Gropp et al., 2010).

2000) or bank concentration (De Nicoló et al., 2004). However, there also exist papers that are consistent with no or even a stabilizing effect of government guarantees. Barth et al. (2004) show that government ownership has no robust impact on bank fragility, once one controls for banking regulation and supervisory practices. Beck et al. (2006) find that systemic banking crises are less likely in countries with more concentrated banking sectors.

Most of these papers rely on cross-country or cross-sectional variation in public guarantees to identify their effect. In contrast, in this paper we are able to take advantage of a unique natural experiment within one country for a homogeneous set of relatively small banks. We view the small size of the banks in our sample (mean total assets of Euro 1.8 billion, see Section 6) as an advantage. If public guarantees were removed for a set of very large banks, these banks may remain "too big to fail" and therefore still be subject to an implicit government guarantee, rather than an explicit one (Gropp et al., 2010). Further, we use the link between banks and their customers in the data to obtain a precise measure of bank risk taking.

The reminder of the paper is organized as follows. Section two gives some institutional background on German savings banks and describes the events surrounding the removal of public guarantees. A description of the data set and some descriptive statistics can be found in Section three. Section four presents our empirical strategy and Section five and six present the baseline results. Section seven gives a number of extensions and robustness checks. Section eight concludes.

2 Institutional background

The German banking market is almost evenly split between three sets of banks: the savings bank sector (the focus of this paper), the cooperatives bank sector ("Volks- und Raiffeisenbanken"), and commercial banks.[6] It is characterized by a low level of concentration with

[6]For an in depth description of the German banking market see Hackethal (2004).

452 savings banks, more than 1,000 credit cooperatives (many of them extremely small), and around 300 privately owned commercial banks.

Taken as a group, savings banks in Germany have more than Euro 1 trillion in total assets and 22,000 branches. German savings banks focus on traditional banking business with virtually no off-balance sheet operations. Their main financing source are customer deposits, which they transform into loans to households and small and medium sized enterprises.[7] Savings banks are owned by the local government of the community they operate in. One important difference between commercial banks and savings banks is that savings banks in Germany are obliged by law to serve the "common good" of their community by providing households and local firms with easy access to credit. They do not compete with each other, as a regional separation applies: each savings bank uniquely serves its local market (similar to the geographic banking restrictions that existed up to the 1990s in the U.S.). Each savings bank is affiliated with one federal state bank ("Landesbank") and each federal state bank is affiliated with a state ("Bundesland") or group of states. The affiliated savings banks own each a part of their federal state bank. The federal state banks act as regional clearing houses for liquidity and facilitate the transfer of liquidity from savings banks with excess liquidity to those with liquidity shortfalls. In addition, the federal state banks secure market funding through the issuance of bonds. Federal state banks are largely internationally operating wholesale and investment banks (they are not allowed to lend to individuals, for example) and hence follow a fundamentally different business model from savings banks (Hau and Thum, 2009; Puri et al., 2010). They are not included in this paper.

Despite their obligation to serve the "common good", the saving banks in our sample are on average relatively profitable: average pre-tax ROE is 12.8%. The average cost to income ratio is 82.1%. Despite the differences in governance, savings banks appear very similar to private commercial banks of comparable size in continental Europe. Pre-

[7] Savings banks also issue some covered bonds and certificates of deposits that have characteristics similar to subordinated debt (Hackethal, 2004). We use yield data on these bonds in Section 6.3 below.

tax ROE of commercial banks is 12.1% in continental Europe and 13.1% in the UK (317 banks, 1996-2004, data is from Bankscope). Similarly, cost to income ratios are 80.1% in continental Europe and 66.8% in the UK. Overall, they look like a fairly typical and moderately inefficient small commercial bank in continental Europe.

Until the year 2000, the entire savings bank sector was protected by government guarantees ("Gewaehrtraegerhaftung"). As savings banks compete with commercial banks for retail and commercial customers, commercial banks in Germany alleged that the government guarantees resulted in a significant competitive advantage for savings banks. Prompted by these allegations, the European Union filed a lawsuit against the government guarantees at the European Court of Justice in 2000. The subsequent decision on July 17, 2001 resulted in the removal of guarantees for savings banks and federal state banks in two steps: during a transition period from July 18, 2001 to July 18, 2005, newly contracted obligations (such as bonds or commercial paper) continue to be secured by government guarantees if their maturity is shorter than December 31, 2015. In a second step, starting from July 18, 2005 all newly contracted obligations will no longer be covered. Obligations contracted before July 18, 2001 are grandfathered. This implies that our sample largely covers the transition period between the full existence of the guarantees (until 2001) and their complete removal (2005). Hence, we check the extent to which the expectation of their complete removal affected bank behavior.[8]

3 Data

3.1 Main data sources

We use a proprietary data set provided by the German Savings Banks Association for the years 1996 to 2006 which symmetrically spans the removal of government guarantees in

[8]Technically, the "Gewaehrtraegerhaftung" and the "Anstaltslast" were abolished. The "Anstaltslast" describes the obligation of the government to provide all state-owned enterprises with "sufficient resources to carry out their tasks". In that sense the savings banks considered in this paper could technically not become insolvent before 2001. In the change in legislation of 2001 it explicitly stipulates that federal state banks and savings banks from then on have the "ability to become insolvent".

2001. The data set provides annual balance sheets and income statements of all commercial loan customers of all 452 German savings banks affiliated with the German Savings Banks Association.[9] It includes data of 87,702 customers after excluding missing values and requiring at least two consecutive observations in order to be able to use lagged variables in the empirical analysis. In total there are 230,562 observations in the data set. Hence, there are around 2.6 annual observations per customer on average. The borrowers are largely small and medium sized enterprises with an average of Euro 1.6 million in total assets. They strongly rely on bank loans as the mean loan ratio, i.e. total loan volume divided by total assets is equal to 51%.

To control for savings bank characteristics, we also use annual balance sheets for the 452 savings banks. The savings bank data is also from the German Savings Banks Association. By using this proprietary data set, the sample size is much larger than by using public sources. In order to ensure some degree of anonymity of customers, the matching of borrowers to savings banks is possible only aggregated in groups of 5-12 savings banks. In total, there are 65 savings bank groups. Hence, while we have precise information on the individual customer, we only know that the customer banked with any one of the group. We thus link the customer characteristics to the average of the group of savings banks, rather than to an individual savings bank.

In addition to the detailed borrower/bank matched data set, we also use a bank level data set that includes the savings banks and as a control group all other banks in Germany for which we could obtain data in Bankscope. In particular, we include bank holding companies, commercial banks, cooperative banks, and medium and long term credit banks.[10]

[9] There are seven savings banks that are not full members in the savings banks association. They are not covered in the data set.

[10] Refer to Section 6 for a further description of the bank level data set.

3.1.1 Dependent variables

Table 1 provides the definitions and data sources of all variables we use. As a measure for the credit risk at the borrower level we use the Z-Score (Altman, 1968) calibrated to the German banking market (Engelmann et al., 2003):[11]

$$Z\ Score = 0.717 * Working\ capital/Assets + 0.847 * Retained\ earnings/Assets +$$
$$3.107 * Net\ profits/Assets + 0.420 * Net\ worth/Liabilities + 0.998 * Sales/Assets$$

A higher *Z Score* indicates a lower risk associated with the borrower. It is important to emphasize that we calculate the Z-Score based on borrower data. We do not rely on internal credit risk indicators of the savings banks themselves. The internal assessment may be problematic, as savings banks may have incentives to review their internal ratings of borrowers after the removal of government guarantees.

Loan size are the borrower's liabilities towards the savings bank. As savings banks are prohibited from competing with each other, borrowers in a certain region are able to obtain loans only from the local savings bank. In case a borrower has several loans outstanding at the reporting date, our proxy for loan size is the total loan volume outstanding to the customer.

We approximate borrower level interest rates from the borrowers' balance sheets as interest expenses over total loan volume. The loan volume of borrowers may, however, also contain loans from the savings banks' competitors. Hence, we only include data from commercial borrowers with more than 50% share of total loan volumes from savings banks.[12] *Interest rate spread* is then calculated as the difference between the savings banks loan interest rate and the risk-free rate. We use the annual return of five-year German government bonds as the risk-free rate (taken from the German central bank)

[11] We replace *EBIT* by *Net profits* due to better data availability.
[12] Results remain qualitatively the same if we use an alternative cutoff value of 100% (Section 5.1).

since the term to maturity of the average loan is between four and five years (information taken from savings banks' balance sheets).

3.1.2 Independent variables

In the baseline analysis, the central variable of interest is *NoStateG* which is a dummy variable distinguishing between the period when savings banks enjoyed a public guarantee (1996 to 2000) and the period when they did not (2001 to 2006). We set the post 2001 period equal to one.[13] Hence, the dummy divides the period of observation into two parts of almost equal size and measures whether bank behavior changed after the removal of public guarantees in 2001.

As we can link borrowers to groups of savings banks, we use a number of bank group level variables to control for bank group level heterogeneity. For example, we use the savings bank groups' total assets, *Total bank assets*, to control for a variety of theories related to bank size. Demsetz and Strahan (1997), among others, emphasize that larger banks can more easily diversify. In our setting, this implies that larger banks are able to lend to individually riskier borrowers without increasing overall portfolio risk. In the specification with *Z Score* as the dependent variable, diversification would imply a negative coefficient for *Total bank assets*. Similarly, Acharya et al. (2006), using a data set of individual loan customers, show that diversification tends to result in higher risk at the individual loan level. They argue that this increase in risk at the individual loan level stems from a decline in monitoring by larger banks. Monitoring declines, because agency problems within banks (between management and loan officers) may increase with bank size (Stein, 2002; Goetz, 2010).

At the same time, large banks may enjoy economies of scale in lending (Berger and Mester, 1997). In a competitive environment, these cost savings may be passed on

[13] Although the final court decision was in July 2001, we use the 2001 data for the post removal sample as we mainly have year-end financial statements data.

to borrowers in the form of lower interest rates. Hence, this would suggest a negative coefficient of *Total bank assets* in the *Interest rate spread* specification. Finally, Berger et al. (2005) show that larger banks tend to lend to larger borrowers. If larger borrowers ultimately obtain larger loans, we would expect a positive coefficient of *Total bank assets* in the *Loan size* specification.

Downgrade is the number of numerical notches, the federal state bank a savings bank belongs to, is downgraded after the removal of guarantees. As savings banks in part own the federal state banks, a revaluation of their equity stake after the removal of guarantees may affect their lending behavior and/or their willingness to take risk. We control for the regional level of competition (Boyd and De Nicoló, 2005), *Direct competition*, by using the ratio of branches of direct competitors (commercial banks and cooperative banks) to savings banks branches per group of savings banks and year. The data comes from the Bundesbank.[14] In line with Keeley (1990) and Dick (2006), we expect that banks lend more aggressively in more competitive markets (higher risk, larger loan size and lower interest rates). Further, *Number mergers* contains the number of mergers within a group of savings banks per year and controls for potential effects that merged banks tend to weaken bank/firm relationships, which may affect loan conditions (Di Patti and Gobbi, 2007).[15]

GDP per capita is the level of GDP per capita per group of savings banks and controls for demand effects as well as for differences in regional economic development. We further control for relative changes in business climate, Δ *Ifo index*, by using the annual change in the Ifo index which is published on the national level by the Ifo Institute for Economic Research. *Indebtedness* is the average debt per capita of the community that the savings bank is located in. With this variable we attempt to control for differences in the financial strength of the savings banks' owners.[16] Both variables come from the federal

[14] The data covers the year 1996-2004. Thus, as the data ends too early, we assume that competition remained unchanged in 2005/2006 and use the 2004 data in these two years.

[15] However, Berger et al. (1998) provide evidence that reduced small business lending is offset by the reactions of other banks.

[16] Recall that all savings banks are at least in part owned by the local community it operates in.

statistical office of Germany ("Destatis"). In addition, we employ *Risk-free interest rate*, which is the average daily risk-free interest rate at the national level (Bundesbank data), in order to control for the relationship between interest rates and credit risk. We also use 16 sectoral dummies following the two-digit classification of industries by the federal statistical office of Germany.

3.2 Descriptive statistics

Table 2 provides descriptive statistics for the variables that we use. The first three variables will serve as dependent variables in the regressions below. The average Z-Score is 2.5 with a 5% percentile of 0.2 and a 95% percentile of 6.1. On average, borrowers have loans from savings banks of Euro 530,000 outstanding. The median amount outstanding is Euro 215,000. The average interest rate spread is 6.7% with a standard deviation of 19.7%.

Total bank assets per group of savings banks are Euro 15.3 billion on average. The 5% percentile is Euro 5.5 million while the 95% percentile is Euro 39.2 billion.[17] On average, federal state banks were downgraded by two and a half rating notches after the removal of state guarantees, which gives a first glimpse of the impact of the removal of public guarantees on the assessment of rating agencies (note that the overwhelming majority of savings banks are not rated by major rating agencies). The number of direct competitors is less than one on average, indicating a rather low level of competition. On average, the savings bank groups were involved in 24% of the years with a merger. The GDP per capita is Euro 25,200 on average and the relative change in business climate (Ifo-index) is one point (the Ifo-index was 100 points in the year 2000). Local communities the savings banks were operating in were indebted by Euro 1,040 per capita on average and average daily interest rates were 3% on an annual basis during our sample period.

As a first cut at how the removal of government guarantees affected the banks' risk taking, we compare the means of the dependent variables with and without the guaran-

[17] To account for outliers, we winsorize the first four variables on the 0.5%/99.5% level.

tees in place. The average Z-Score increased by 0.20 from 2.36 in 1996/2000 to 2.56 in 2001/2006 (i.e. by 8.5%), which is significant at the 1% level. Hence, we observe a shift towards an improvement in the average borrower quality after guarantees were removed. Figure 1 further illustrates this point. It shows that savings banks reduced lending to commercial customers with a Z-Score between 1.0 and 3.0 in favor for less risky clients with a higher Z-Score (3.5 and above). It appears that the savings banks tried to reduce largely the proportion of very risky borrowers in their portfolios. Savings banks also reduced loan sizes to individual borrowers by Euro 78,000 or 13.4% and charged higher interest rates spreads. On average, savings banks increased interest rate margins by 112 basis points or 18.8%. Both differences in means are significant at the 1 percent level.

4 Empirical strategy

We are interested in the effect of government guarantees on bank behavior. Recall the two main predictions that we take from the literature. First, if the moral hazard effect of guarantees dominates, we would expect banks to reduce their risk taking after the removal of the guarantees (Flannery, 1998; Sironi, 2003; Gropp et al., 2006). Second, if the charter value effect, that is the implicit subsidy, dominates, we would expect savings banks to increase their risk taking (Keeley, 1990). Changing risk taking due to the removal of government guarantees would then be reflected in decreasing (moral hazard effect) or increasing (charter value effect) lending to riskier borrowers. The predictions for interest rates charged are ambiguous. If the moral hazard effect dominates, we would expect interest rates charged not to decline on the pool of borrowers left after the removal of guarantees, consistent with findings that public firms tend to charge lower interest rates for a given level of riskiness (Sapienza, 2004). If the charter value effect dominates, we would expect interest rates not to increase after the removal. We think the ability to control for the level of interest rates charged is a strength of the paper, because it permits

us to control for changes in risk premia charged by banks when examining changes in the risk of borrowers. If any change in the riskiness of banks' customers was associated with a corresponding change in risk premia charged, it would be difficult to draw firm conclusions on the overall risk incurred by banks.

The removal of the guarantees took place in 2001, in the middle of our observation period. One major advantage of our data set is that the removal was exogenously imposed by a court decision and thus creates a unique natural experiment. We first consider whether we can detect any differences in the Z-Scores, loan sizes, and interest rates charged to borrowers before and after 2001, controlling for bank group characteristics and local economic conditions, and thus identify the effect of the removal by the time series variation only. In particular, we use the three dependent variables on the borrower level i at time t: $Z\ Score(i,t)$, $Loan\ size(i,t)$, and $Interest\ rate\ spread(i,t)$. To account for the simultaneity of the risk, loan size, and interest rate decisions by banks we use a seemingly unrelated regression (SUR) model:

$$\begin{aligned} Z\ Score(i,t) &= \alpha_1 + \beta_1\ NoStateG(t) + \gamma_{11}\ X_1(g,t) + \gamma_{21}\ X_2(i,t) + \gamma_{31}\ X_3(t) + \varepsilon_1(i,t) \\ Loan\ size(i,t) &= \alpha_2 + \beta_2\ NoStateG(t) + \gamma_{12}\ X_1(g,t) + \gamma_{22}\ X_2(i,t) + \gamma_{32}\ X_3(t) + \varepsilon_2(i,t) \\ Interest\ rate\ spread(i,t) &= \alpha_3 + \beta_3\ NoStateG(t) + \gamma_{13}\ X_1(g,t) + \gamma_{23}\ X_2(i,t) + \gamma_{33}\ X_3(t) + \varepsilon_3(i,t) \end{aligned} \quad (1)$$

where the variable of interest is $NoStateG(t)$. It is a dummy variable distinguishing between 1996 to 2000 (equals zero) and 2001 to 2006 (equals one). The vector $X_1(g,t)$ includes bank group level variables, g, such as savings bank assets at the group level, the downgrade severity of the corresponding federal state bank, local banking competition, local savings bank merger history, local GDP per capita, and the debt per capita per group of savings banks. $X_2(i,t)$ includes a full set of two-digit industry dummies which are on the borrower level i. $X_3(t)$ is a vector of variables that vary only in the time series, such as the change in the business climate and the annual average of daily risk-free interest

rates. The SUR model allows for a correlated error structure across the error terms of the three equations. We estimate all specifications with cluster robust standard errors at the savings bank group level, thus allowing for unobserved correlation between observations from the same savings bank group (Froot, 1989).

We explore different ways to deal with simultaneity of our dependent variables in unreported robustness checks. One, we lag the independent variables $Z\ Score(i, t-1)$, $Loan\ size(i, t-1)$, and $Interest\ rate\ spread(i, t-1)$ by one year, include two of them as further independent variables (Acharya et al., 2006), and run three independent bank group fixed effects regressions as well as three pooled OLS regressions. Second, we omit these independent variables from the regressions and run three independent pooled OLS regressions. All results reported below are robust to these alternative specifications.[18]

5 Results

5.1 Baseline results

While we found the univariate results in Section 3.2 encouraging, it is possible, for instance, that the effects are due to regional differences across local markets. Hence, in Table 3 we present the baseline results for the three dependent variables $Z\ Score$, $Loan\ size$, and $Interest\ rate\ spread$ using specification (1), controlling for a host of local market characteristics. The variable of interest is $NoStateG$, which takes the value one for the period after the removal of government guarantees (2001 to 2006) and zero before.

Table 3 shows the results from specification (1). We find that the $NoStateG$ coefficient is positive (lower risk) and significant at any significance level in the first column. The commercial loan customers of savings banks exhibited lower risk in the period after the removal of the government guarantee. The coefficient is 0.176 and thus almost as large as in the comparison of unconditional means. The average borrower has an 7.5% higher

[18] These results and those of the following robustness checks are available from the authors upon request.

Z-Score after the removal of government guarantees than before. This difference indicates not only a statistically significant but also an economically relevant reduction in credit risk.

In the second column we show that *NoStateG* also enters significantly (1% level) in the regression for loan size. We find that savings banks significantly reduced loan sizes after the removal of government guarantees. The average reduction is economically large at Euro 100,000 or 17.2%. Further, we find that interest rate spreads charged (column 3) were significantly increased (at the 1% level). However, the average increase is 46 basis points or 7.7%, smaller than the 112 basis points in the univariate analysis, suggesting that regional differences matter for interest rate spreads charged. Both findings corroborate our main finding: Savings banks significantly reduced their risk taking after the government guarantees were removed.

Most control variables conform to expectations. If the savings banks' communities were more indebted, credit risk was higher. Borrowers tend to be less risky and are charged higher interest rate spreads in regions with higher GDP per capita. We find a positive relationship between changes in the business climate and Z-Score and a negative relationship with the interest rate spread, and with the loan size. Higher competition yields riskier lending, which is consistent with the charter value effect (Keeley, 1990), but is unrelated to loan size and interest rate spread. Low overall levels of interest rates in the economy result in safer borrowers, smaller loans and higher interest rate spreads. Larger banks tend to originate larger loans even though this coefficient does not enter significantly. However, bank size is not related to the level of credit risk and interest rate spreads. We further find evidence that savings banks in regions where the federal state bank was downgraded more severely had a lower level of credit risk and charged a lower interest rate spread.

We next discuss the results of a series of additional tests to illustrate the robustness of our findings. One, using savings bank group fixed effects leaves the results qualitatively

unchanged. In particular, the coefficient on *NoStateG* still enters significantly (at the 1% level) in all three regressions with the credit risk, the loan size, and the interest rate spread as dependent variables. Results thus seem to be robust to controlling for time-invariant saving bank group heterogeneity.

Second, it seems plausible that savings banks may have expected the law suit to go against them and wanted to extend as many risky loans under the old regime. If so, this may imply that they increased their lending to risky borrowers after the law suit was filed in April 2000 and stopped after the law suit was decided in July 2001. We thus perform a robustness check with the years 2000 and 2001 dropped. The number of observations decreases from 230,562 to 168,006. Unreported results regarding the *NoStateG* coefficient remain qualitatively unchanged. Our findings hence do not seem to be driven by savings banks increasing risk levels shortly before the court decision in combination with a decline in risk levels in 2001.

Third, we vary the sample selection criteria. In the baseline, we include a commercial borrowers in the data set if more than 50% of the total loan volume comes from savings banks. As a robustness check, we include a firm as a customer only if all bank loans come from savings banks. When doing this, the number of observations declines to 103,407. Again, the *NoStateG* coefficients enter significantly in the SUR regression for all three dependent variables.

Fourth, we decompose the Z-Score and analyze the five components separately for the time before and after the removal of the public guarantees. It is possible that the change in the Z-Score after 2001 was dominated by the change in only one or two of its components, raising the possibility that at least part of our findings is spurious. We find that four of the five components move into the direction of less risk. Further the difference between the respective component before and after the removal is significant at least at the 10% level for all four. Only one component, the first liquidity factor, has a negative sign (moving towards higher risk). We are thus confident that the regressions are not picking

up spurious movements in only one component of the Z-Score. Furthermore, we check the leverage, defined as total liabilities over total assets, of the savings banks' commercial borrowers. We find that the customers on average reduced leverage after the removal of public guarantees, in line with a reduction of credit supply from savings banks. Overall, the results turn out to be robust to different regression setup, different sample selection criteria, omitting 2000/2001 from the analysis, and decomposing the Z-Score measure of credit risk.

While we feel reasonably confident that the results above indeed are driven by the removal of guarantees, their identification relies only on time series variation in the behavior of savings banks. It is possible that all banks reduced their risk taking after 2001. If this were the case, the effect of the removal of government guarantees would be confounded by a general time series trend. In the next section we examine this by difference-in-differences estimation, using different control groups. At this stage, however, it seems useful to briefly examine the overall economic developments in Germany around the removal. As shown in Figure 2, Germany experienced a recession in 2002/2003. This suggests an overall decline in the quality of the pool of potential borrowers. Despite this decline in the quality in the pool of potential borrowers, we find an improvement in the quality of the accepted borrowers for the savings banks.

We further find that the savings banks' market share in lending to commercial borrowers decreased after the removal of the public guarantees. Figure 3 suggests that savings banks' market share was relatively stable at around 22% before 1999. Then we observe an increase of around 1.5% in the years 1999 and 2000. That might have been an anticipation of the forthcoming regulatory change. In the years 2001 and (to a lesser extend) 2002, we observe a drop to around 20% and after that a stable market share of around 21%. The removal of state guarantees thus corresponds to a lower market share of savings banks. The chart suggests that savings banks changed their lending behavior in 2002-2006 more than their competitors, which were not affected by the removal of public

guarantees.

Both trends are consistent with the idea that savings banks reduced risk taking in 2002 to 2006, but may also be consistent with a "flight to safety" in the face of a recession unrelated to changes in public guarantees. In order to address this concern, we show the results for attempts at identifying the effect of public guarantees in the cross-section as well as the time series.

5.2 Higher ex ante value of guarantees

In this section we identify the effect of the removal of government guarantees using a difference-in-differences approach. We would expect that the effects on the behavior of savings banks should be larger if the value of the government guarantees to the savings banks was larger ex ante. We identify the value of ex ante guarantees on the basis of risk taking before the removal of the guarantee. If the guarantee resulted in moral hazard effects, their removal should result in a stronger reaction for those banks that incurred greater risk with the guarantee in place. If the charter value effect dominates, we would not necessarily expect a difference in the reaction of ex ante riskier and ex ante safer banks.[19] We measure the ex ante riskiness of the savings bank as the average Z-Score of their borrowers before the removal of government guarantees. To identify the difference in reaction we define two groups of savings banks: $HighRisk$ is a dummy variable equal to one if savings banks have below average Z-Score before 2001 and zero otherwise, while $LowRisk$ is a dummy variable equal to one if savings banks have above average Z-Score and zero otherwise. The key identifying assumption for this difference-in-differences approach to yield causal effects is that customers of both groups of savings banks exhibited the same trend in the absence of treatment ("parallel trends assumption", see e.g. Angrist and Pischke, 2009). In our setting, this implies that the first difference of the Z-score, loan sizes and interest rate spreads charged of low risk and high risk savings banks between

[19] Reasons for the cross-sectional variation in risk taking among savings banks in the presence of guarantees could be for example managerial preferences as in Bertrand and Schoar (2003).

1996 and 2000 are not significantly different from one another. We test this accordingly and find that the assumption is satisfied.

Table 4 presents the univariate results. We observe a stronger increase in the average Z-Score after the removal of government guarantees for ex ante riskier banks (0.29) compared to ex ante less risky banks (0.08). The difference-in-differences is 0.21 (significant at the 1% level). In addition, the decrease of the average loan volume was stronger for riskier (Euro 106,000) than for safer banks (Euro 59,000). The difference-in-differences is negative but not significant. The average interest rate spread was raised more strongly (132 basis points compared to 80 basis points). The resulting difference-in-differences (52 basis points) is statistically significant at the 10% level.

In line with the univariate analysis, we estimate the following equation for $Z\ Score(i,t)$ $Loan\ size(i,t)$, and $Interest\ rate\ spread(i,t)$ simultaneously using a SUR model as before:

$$Y(i,t) = \alpha + \beta_1\ NoStateGxHighRisk(g,t) + \beta_2\ NoStateGxLowRisk(g,t) + \beta_3\ StateGxLowRisk(g,t) + \gamma_1\ X_1(g,t) + \gamma_2\ X_2(i,t) + \gamma_3\ X_3(t) + \varepsilon(i,t). \quad (2)$$

where $Y(i,t)$ represents the three dependent variables at the borrower level i. The key variables are the three interaction terms. We are interested in the change in lending behavior before ($StateG$) and after ($NoStateG$) the removal of government guarantees for the savings bank groups with lower ($LowRisk$) and higher ($HighRisk$) ex ante riskiness. We thus base our inference on β_1 - (β_2 - β_3). All control variables are defined as in equation (1).

The results in Table 5 show that the reduction in risk, the reduction in loan size, and the increase in interest rate spreads were all larger for savings banks which carried a higher credit risk before the removal of state guarantees. The difference-in-differences terms enter significantly for credit risk (at the 1% level) and interest rate spread (at the 5% level) while the difference-in-differences is negative but insignificant for loan size. Ex

ante riskier banks appear to have reduced their risk taking more after the removal of guarantees relative to ex ante safer banks.

6 Control group of banks unaffected by the removal and market discipline

In this section we identify the effect of the removal of guarantees using a second difference-in-differences approach. We use a control group of German non savings banks that were not affected by the removal of government guarantees (the treatment) in order to control for changes over time that are common to all banks in Germany. As in Section 5.2, the central assumption for the difference-in-differences estimation to yield causal effects is the parallel trends assumption: savings banks (the treated group of banks) and the control group of banks (the untreated group of banks) should exhibit a common trend in the absence of treatment. Again, unreported results indicate that the assumption is satisfied.[20]

6.1 Data

We start with a brief description of the control data set. The control group includes all non-savings banks available for Germany in Bankscope, including bank holding companies, commercial banks, cooperative banks, and medium and long term credit banks. The control sample ultimately consists of 877 banks in 1995 - 2006 after excluding observations with missing values for the variables used in the empirical analysis. Unfortunately, for the control group we cannot link banks to their customers, which implies that we have to calculate indicators of risk at the bank level (see below). We combine the control group with the 452 savings banks (treatment group) to generate a data set with 1,329 banks for 1995 - 2006.

[20] Note that we cannot formally test for the parallel trend assumption for the bank level Z-Score and return on asset volatility, as for both we need several years to calculate return on asset volatilities and therefore do not have several non-treatment years to compare trends.

On average the size of the control group banks and the savings banks tends to be similar with the average savings bank at Euro 1.8 billion total assets and the average control group bank at Euro 2.2 billion in total assets. However, the size variation is much smaller for savings banks, as the largest savings bank is just below Euro 30 billion of total assets, while the largest bank in the control sample has more than Euro 500 billion of total assets.[21]

6.2 Risk taking

We first check whether the borrower level baseline findings regarding the change in risk taking after the removal of public guarantees hold at the bank level. We concentrate on the bank level Z-Score which measures the distance from insolvency for a particular bank (Laeven and Levine, 2009). As before, a higher Z-Score indicates a lower default risk. The bank level Z-Score is defined as $(ROAA + CAR)/\sigma(ROAA)$ where $\sigma(ROAA)$ is the standard deviation of the average return of assets, E stands for equity, and A for total assets.[22] The latter two are used to calculate the capital assets ratio $(E/A = CAR)$. $ROAA$ and CAR are both averages for the six years before and the six years after the removal, respectively. $\sigma(ROAA)$ is calculated using the six years before and six years after the removal, respectively. We require available data for the years 1995 to 2006 for all variables and thus have two observations for each bank in our sample.[23]

The first column of panel A of Table 6 reports the bank level Z-Score before (1995-2000) and after (2001-2006) the removal of public guarantees for savings banks. We use the natural logarithm of the bank level Z-Score because it is highly skewed (Laeven and Levine, 2009). The Z-score is 3.18 before the removal and 3.68 after the removal. The difference is significant at any significance level and confirms the borrower level results

[21] Recall that the descriptive statistics reported earlier referred to saving bank groups (necessitated by the maintenance of confidentiality of customers when matching them to savings banks), while the statistics here refer to individual savings banks.

[22] We winsorize the raw data on the 0.5%/99.5% level.

[23] We require at least three observations in each subperiod. All results remain qualitatively unchanged if we use different sample selection criteria.

that savings banks reduced credit risk after the removal of government guarantees. This result remains qualitatively unchanged if we run a regression using the same controls averaged over the two periods (before/after) used in Section 5.1. The forth column of the table shows the bank level Z-Score of the control sample. In the control group the bank level Z-score decreases from 4.26 before to 3.62 after the removal. In contrast to the savings banks, the control sample increased risk levels after the removal of government guarantees. Savings bank behave fundamentally different from the control group after the removal of the guarantees. It is important to emphasize that these results suggest that after the removal of guarantees bank level Z-scores of savings banks and the control group converged, suggesting similar risk taking across the two sets of banks after the removal of guarantees.

As an alternative to the bank level Z-Score, Panel A of Table 6 also shows the change in the standard deviation of return of average assets, $\sigma(ROAA)$. Column 2 shows a $\sigma(ROAA)$ for the savings banks of 0.23% before and 0.16% after the removal. In contrast, the fifth column shows the $\sigma(ROAA)$ for the control sample. For the control sample, we observe a significant increase from 0.14% to 0.29% after the removal.[24]

If savings banks reduced the extension of credit to risky borrowers, we should be able to detect this in overall loan volumes of banks. Hence, we compare the total loan volume before and after the removal of public guarantees for the savings and the control group. Column 3 shows a slight decrease from Euro 0.54 to Euro 0.51 billion for the savings banks. The difference is not significant. Column 6 shows in the control group loan volume increased from Euro 0.60 to Euro 0.75 billion. Again, the difference is not statistically significant.

We are concerned that these differences may at least in part be driven by unobserved bank level heterogeneity. Hence, we combine the samples of savings banks with the control group and run the following bank fixed effects difference-in-differences regression:

[24] Results have the same direction and are also highly significant if we use the standard deviation of the average return of equity instead.

$$Y(k,t) = A(k) + \beta_1\ NoStateG(t) + \beta_2\ NoStateGxSB(k,t) + \varepsilon(k,t) \quad (3)$$

where $Y(k,t)$ represents one of the dependent variables *Banking Z Score*, $\sigma(ROAA)$, and *Loan volume*. $A(k)$ are the bank fixed effects (k denotes the bank level). The variable of interest, $NoStateGxSB$, equals one for savings banks after the removal of government guarantees (2001-2006) and zero otherwise. Panel B of Table 6 shows the results. We find that $NoStateGxSB$ enters significantly positive in the bank level Z-Score regression in column 1 (at the 1% level). Savings banks reduced their risk taking relative to the control group after the removal of public guarantees. Column 2 results confirm that savings banks significantly reduced earnings volatility compared to the control group (at the 1% level). Finally, in column 3 we show that savings banks significantly decreased the loan volume in contrast to non savings banks (at the 1% level). This finding is in line with the declining market share of savings banks depicted in Figure 3.

The results indicate that the control group increased their risk taking after the public guarantees for savings banks were removed. This stands in stark contrast to the savings banks, which reduced risk taking and lowered loan volumes. Taken together with the earlier finding that savings banks that ex ante benefited more from the public guarantee reduced their risk taking more, the finding further lends support to a causal relationship between the removal of guarantees and the reduction in risk taking of savings banks.

6.3 Market discipline

In the previous section, we document the economically significant reduction in risk taking of savings banks after the removal of guarantees. This section investigates whether we can find direct evidence that savings banks in doing so reacted to tightening market discipline. We examine whether savings banks adjusted their liabilities consistent with stronger monitoring by risk-sensitive debt holders and we check whether interest rate

spreads of savings bank bonds reacted around the time of the announcement that the guarantees were removed.

If market discipline had indeed influenced savings banks to reduce risk taking after the removal, we would expect the following patterns in liabilities of savings banks. One, savings banks increased their capital, as investors pushed savings banks towards more capital as a cushion against future losses. Second, they increased reliance on deposits, because deposits were still covered by deposit insurance even after the removal of guarantees. Third, we would expect to observe reduced reliance on risk-sensitive (non-deposit) debt, because the remuneration on this source of financing can be expected to react particularly strongly to the removal of guarantees.

We analyze the changes in the structure of liabilities using the same sample of bank level observations for savings banks and the control group as in the previous section. We examine the capital to assets ratio (CAR), the deposit ratio, and the ratio of risk-sensitive debt. Denoting customer deposits as D, the deposits ratio equals D/A. The risk-sensitive debt ratio is defined as $(A - E - D)/A$. Panel A of Table 7 presents the univariate results. Column 1 shows that the CAR increased from 4.3% before the removal to 5.2% after the removal for savings banks. The change is significant at the 1% level. The control group, however, also increased capital from 5.7% before to 6.4% after the removal (column 4). This change is also significant at the 1% level. Hence at the univariate level, we cannot attribute the change in capital to the removal of public guarantees. Further we find that savings banks increased the deposit funding from 60.0% to 62.8% (column 2, significant at the 1% level) while there is no change for the control group (column 5). Similarly, column 3 shows that savings banks significantly decreased reliance on risk-sensitive debt by 3.8% to 32.0% (at the 1% level)), while for the control group there is no change during the same time period (column 6).

As before, we next control for unobserved bank level heterogeneity by including bank fixed effects in a set of regressions combining savings banks and the control group

(Panel B of Table 7). We find results consistent with a significant adjustment of liabilities by savings banks towards equity and insured deposits and away from risk-sensitive debt. This adjustment is significantly stronger than in the control group. The difference-in-differences terms are significant at least at the 5% level in all three regressions.

We next check whether the removal of public guarantees of savings banks is reflected in bond yield spreads of outstanding savings bank bonds around the time of the announcement of the removal on July 17, 2001. If so, this would be direct evidence that market participants adjusted their default expectations regarding savings banks in response to the removal of public guarantees. Again we make use of a difference-in-differences set up by comparing changes in savings bank bonds yield spreads to changes in yield spreads of the bonds issued by the control group of banks. We use yield spread data of traded unsecured debt around the final removal decision which took place on July 17, 2001, for all savings bank bonds available in Bloomberg or Datastream. For bonds issued by the control group we impose that the bonds issued are larger than Euro 50 million. We calculate yield-to-maturities (YTM) over the risk-free YTM as yield spreads. The risk-free YTM was obtained from the Bundesbank. We first collect daily YTM data and require all bonds to have non-missing values in the 12 weeks before and the 12 weeks after the announcement of the removal on July 17, 2001. The relatively wide event window is the result of the need to keep a reasonable sample size in light of relatively infrequent trading of many savings bank bonds and sparse data for 2001 in our data sources. Ultimately we were able to obtain data on 81 bonds issued by 29 savings banks and 112 bonds issued by 18 banks of the control sample. We then compute the average weekly yield spread using the daily data. Column 1 of Table 8 shows the yield spread changes for the bonds issued by savings banks. The average weekly spread increased from 45 to 51 basis points. This increase is significant at the 5% level. In contrast, the yield spreads of the bonds issued by the control group decreased from 108 to 106 basis points during the same period. The difference is insignificant. The results from the event study are consistent with an upward

revision of default probabilities of savings banks by market participants.[25]

Overall, we find evidence – both from financial statement and bond market data – that market discipline played a role in explaining the decreased risk taking by German savings banks after the removal of public guarantees.

7 Further results

7.1 Introduction of risk based regulation and prompt corrective action

We want to be sure that the effects we describe above are indeed due to the removal of guarantees and not due to subsequent changes in the regulatory framework. Each savings bank in Germany is required to contribute to a regional support fund. In December 2003 (two years after the removal of guarantees) it was announced that the contributions to the fund would be changed from flat contributions to risk based contributions based on the portfolio risk of each savings bank. The volume of the fund was also increased. Finally a risk monitoring system was introduced and intervention rights of the fund were strengthened. The fund can ask savings banks to provide further details on its exposures, it may set up meetings with the board of directors and management of the savings bank and a restructuring of the affected savings bank can be imposed. The reforms, which became effective in 2006, can be viewed as introducing a form of prompt corrective action. Interestingly, these reforms of the fund were motivated by the removal of the public guarantees.[26]

While the implementation of these reforms took place in 2006, the last year of our sample period, we want to make sure that the changes in bank behavior were not due to the expectation of these regulatory changes becoming effective. It is possible that by dividing the time period into 1996 to 2000 and 2001 to 2006, we mistakenly attributed effects

[25] All results are robust to using daily data instead of weekly data and different event window definitions.

[26] See for example Sparkassenzeitung (Werner, 2005): "With the removal of the public guarantees...the support fund takes on greater importance due to a change in risk perception of savings banks" (translation from German by the authors).

that occurred due to the announcement of the introduction of changes in the regulatory framework in December 2003 to the removal of public guarantees. Hence, in the results reported in Table 9, we divide the sample into three sub-periods:

- 1996/2000: Government guarantees are in place ($StateG$)
- 2001/2003: Guarantees no longer in place, no risk based regulation
- 2004/2006: Guarantees no longer in place, risk based regulation announced ($IntroRW$)

Dividing the sample in this way highlights that we can identify the effect of the removal of government guarantees by considering the change in risk taking in 2001/2003 relative to 1996/2000 ($StateG$). However, we cannot unambiguously attribute any further effects (the coefficient $IntroRW$ for the 2004/2006 period) to either the removal of guarantees or the introduction of regulation, as this period will reflect a combination of both effects. Still, it seems interesting in its own right to check whether after 2003 there were additional effects on bank risk taking. Hence, we estimate the SUR model

$$Y(i,t) = \alpha + \beta_1\ StateG(t) + \beta_2\ IntroRW(t) + \gamma_1\ X_1(g,t) + \gamma_2\ X_2(i,t) + \gamma_3\ X_3(t) + \varepsilon(i,t) \qquad (4)$$

where $Y(i,t)$ again represents the three dependent variables on the borrower level, $Z\ Score(i,t)$, $Loan\ size(i,t)$, and $Interest\ rate\ spread(i,t)$. The first variable of interest in the results for this exercise is $StateG$. The results in Table 9 show that savings banks reduced their risk taking in 2001/2003 as $StateG$ is negative in the first column. We further find that the borrowers' loan sizes (column 2) were reduced and the interest rate spreads charged (column 3) were increased significantly. All three coefficients are significant at the 1% level. The effect of the removal of government guarantees on risk taking is robust to controlling for the subsequent introduction of risk based regulation and prompt corrective action.

The results also suggest that savings banks reduced their risk taking further in 2004/2006 ($IntroRW$ is positive and significant at the 1% level), although we do not find a significant effect for loan size and interest rate spreads. Overall, we would interpret the evidence as suggestive that risk based regulation reduced risk taking further, although we cannot fully distinguish the effect from a potential late adjustment to the removal of government guarantees.

7.2 Screening versus monitoring

Our matched bank/borrower data set provides a direct possibility to investigate whether banks changed their screening or their monitoring policies or both. In order to disentangle screening from monitoring, we create two sub samples of our borrower level data set. One includes only new and the second only existing borrowers. Figure 4 shows how we define the two sub samples. It illustrates five exemplary borrowers of a given bank. We first exclude all observations for 1995 (denoted in Figure 4 with B), because for 1995 we are unable to distinguish whether the observations refers to an existing or a new borrower. That is the case for borrower 2 and 3 in Figure 4. Second, if we observe a borrower in 1995 and 1996 or a subsequent year, we define this observation as "existing" (E). Third, if we observe a borrower for the first time in 1996 or any subsequent year, we classify the borrower as "new", denoted with N in Figure 4. Subsequent observations of this same borrower would then be included in the set of existing borrowers. To disentangle screening and monitoring effects, we further exclude existing borrower observations for borrowers for which we do not have observations before and after the removal of public guarantees. Thus, we drop existing observations that are marked by 'e' in the figure, i.e. for borrowers 1, 4 and 5.

In order to examine whether the adjustment in credit quality of the banks primarily came about through changes in screening or changes in monitoring, we compare the changes in Z-Scores for these two sub samples. The results are presented in Table 10. We

observe a change towards higher Z-Scores (corresponding to a reduction in risk) both for new and for existing borrowers after the removal of the guarantees. The average credit quality of new and of existing borrowers is higher for each annual observation after the removal of guarantees than for any observation before removal. This further strengthens our earlier findings. However, the increase is stronger for new (0.49) than for existing borrowers (0.13). The difference between the differences of 0.37 is statistically significant at the 1% level. Overall, we find that banks both dropped riskier existing borrowers (monitoring) and tightened lending standards for new borrowers (screening), with a stronger emphasis on tightening standards for new borrowers.

8 Conclusion

The results in this paper show that government guarantees are associated with strong moral hazard effects. The approach taken in the paper permits a unique identification of the causal effect of government guarantees on bank risk taking. One, the removal of guarantees was exogenously imposed on the sample banks. The change in the safety net that we examine was unrelated to a financial incident, but rather based on a European court decision. Second, the banks in the sample are small and, therefore, unlikely to be "too big to fail". Hence, we can exclude the possibility that explicit government guarantees were simply replaced by implicit guarantees, which may have similar effects on bank risk taking and also be associated with moral hazard (Gropp et al., 2010). Third, the data permit a link between the balance sheet information of the banks and the balance sheet information of their commercial loan customers. Savings banks largely operate along traditional banking lines with little off-balance sheet operations. Hence, we are able to measure their risk taking comprehensively by examining the Z-Score of their commercial loan customers.

We find that the removal of government guarantees not only significantly decreased

the risk taking of banks, but we also show that after the removal of guarantees, banks reduced average loan size and overall lending volume. At the same time, banks increased interest rates for loans on the remaining borrowers. The effects are economically substantial: Z-Scores increased on average by 7.5%, loan sizes declined by 17.2%, and interest rate spreads increased by 46 basis points. We find that these effects tend to be significantly larger for banks, where it is likely that the ex ante value of guarantees was higher.

Using a control group of non savings banks that was unaffected by the removal we find that, compared to savings banks, these banks increased their risk taking and their loan volume after the guarantees for savings banks were removed. Furthermore, we find evidence for market discipline since savings banks changed their refinancing structure towards a higher ratio of (insured) deposits and a lower ratio of risk-sensitive debt instruments after the removal while we do not observe these changes for the control group. Yield spreads of savings banks' bonds increased upon the announcement of the decision to remove the guarantee, while the yield spread of bonds issued by the control group remained unchanged.

In light of the extensive public guarantees extended in the wake of the recent financial crisis, the findings of this paper have important policy implications: The results suggest that a credible removal of guarantees will be essential in reducing the risk of potential future financial instability. They also support recent initiatives to impose capital surcharges on the largest banking institutions, which may benefit either from an explicit or an implicit guarantee (e.g. Swiss TBTF Commission of Experts, 2010). Higher capital in these banks may help offset the incentives provided by the public guarantees imposed during the crisis.

References

Acharya, V. V., I. Hasan, and A. Saunders (2006): "Should Banks Be Diversified? Evidence from Individual Bank Loan Portfolios," *Journal of Business*, 79, 1355 – 1412.

Altman, E. I. (1968): "Financial Ratios, Discriminant Analysis and the Prediction of Corporate Bankruptcy," *Journal of Finance*, 23, 589 – 609.

Angrist, J. and J.-S. Pischke (2009): *Mostly Harmless Econometrics*, Princeton University Press.

Barth, J. R., G. Caprio Jr., and R. Levine (2004): "Bank Regulation and Supervision: What Works Best?" *Journal of Financial Intermediation*, 13, 205 – 248.

Beck, T., A. Demirgüç-Kunt, and R. Levine (2006): "Bank Concentration, Competition, and Crises: First Results," *Journal of Banking and Finance*, 30, 1581 – 1603.

Berger, A. N. and L. J. Mester (1997): "Inside the Black Box: What Explains Differences in the Efficiencies of Financial Institutions?" *Journal of Banking and Finance*, 21, 895 – 947.

Berger, A. N., N. H. Miller, M. A. Petersen, R. G. Rajan, and J. C. Stein (2005): "Does Function Follow Organizational Form? Evidence From the Lending Practices of Large and Small Banks," *Journal of Financial Economics*, 76, 237 – 269.

Berger, A. N., A. Saunders, J. M. Scalise, and G. F. Udell (1998): "The Effects of Bank Mergers and Acquisitions on Small Business Lending," *Journal of Financial Economics*, 50, 187 – 229.

Bertrand, M. and A. Schoar (2003): "Managing with Style: The Effect of Managers on Firm Policies," *Quarterly Journal of Economics*, 118, 1169 – 1208.

Boyd, J. H. and G. De Nicoló (2005): "The Theory of Bank Risk Taking and Competition Revisited," *Journal of Finance*, 60, 1329 – 1343.

Boyd, J. H. and M. Gertler (1994): "The Role of Large Banks in the Recent U.S. Banking Crisis," *Federal Reserve Bank of Minneapolis Quarterly Review*, 18, 2 – 21.

Boyd, J. H. and D. E. Runkle (1993): "Size and Performance of Banking Firms: Testing the Predictions of Theory," *Journal of Monetary Economics*, 31, 47 – 67.

Caprio, G. and M. S. Martínez Pería (2000): "Avoiding Disaster: Policies to Reduce the Risk of Banking Crises," in *Monetary Policy and Exchange Rate Regimes: Options for the Middle East*, ed. by E. Cardoso and A. Galal, The Egyptian Center for Economic Studies, Cairo, Egypt.

Cordella, T. and E. L. Yeyati (2003): "Bank Bailouts: Moral Hazard vs. Value Effect," *Journal of Financial Intermediation*, 12, 300 – 330.

De Nicoló, G. (2001): "Size, Charter Value and Risk in Banking: An International Perspective," in *The Financial Safety Net: Costs, Benefits and Implications for Regulation, Proceedings of the 37th Annual Conference on Bank Structure and Competition*, Federal Reserve of Chicago, 197 – 215.

De Nicoló, G., P. Bartholomew, J. Zaman, and M. Zephirin (2004): "Bank Consolidation, Internationalization, and Conglomeration: Trends and Implications for Financial Risk," *Financial Markets, Institutions and Instruments*, 13, 173 – 217.

De Nicoló, G. and E. Loukoianova (2007): "Bank Ownership, Market Structure and Risk," *International Monetary Fund Working Paper No. 07/215.*

Demirgüç-Kunt, A. and E. Detragiache (2002): "Does Deposit Insurance Increase Banking System Stability? An Empirical Investigation," *Journal of Monetary Economics*, 49, 1373 – 1406.

Demsetz, R. S. and P. E. Strahan (1997): "Diversification, Size, and Risk at Bank Holding Companies," *Journal of Money, Credit and Banking*, 29, 300 – 313.

Di Patti, E. B. and G. Gobbi (2007): "Winners or Losers? The Effects of Banking Consolidation on Corporate Borrowers," *Journal of Finance*, 62, 669 – 695.

Dick, A. A. (2006): "Nationwide Branching and Its Impact on Market Structure, Quality, and Bank Performance," *Journal of Business*, 79, 567 – 592.

Engelmann, B., E. Hayden, and D. Tasche (2003): "Testing Rating Accuracy," *Risk*, January, 82 – 86.

Flannery, M. J. (1998): "Using Market Information in Prudential Bank Supervision: A Review of the U.S. Empirical Evidence," *Journal of Money, Credit and Banking*, 30, 273 – 305.

Froot, K. A. (1989): "Consistent Covariance Matrix Estimation with Cross-Sectional Dependence and Heteroskedasticity in Financial Data," *Journal of Financial and Quantitative Analysis*, 24, 333 – 355.

Goetz, M. (2010): "Bank Organization, Market Structure and Risk Taking: Theory and Evidence From U.S. Commercial Banks," *Working Paper, Brown University.*

Gropp, R., H. Hakenes, and I. Schnabel (2010): "Competition, Risk-Shifting, and Public Bail-out Policies," *Review of Financial Studies*, Forthcoming.

Gropp, R., J. Vesala, and G. Vulpes (2006): "Equity and Bond Market Signals as Leading Indicators of Bank Fragility," *Journal of Money, Credit and Banking*, 38, 399 – 428.

Hackethal, A. (2004): "German Banks and Banking Structure," in *The German Financial System*, ed. by J. P. Krahnen and R. H. Schmidt, Oxford University Press, 71 – 105.

Hackethal, A. and R. H. Schmidt (2005): "Structural Change in the German Banking System?" *Goethe University Working Paper Finance and Accounting No. 147.*

Hakenes, H. and I. Schnabel (2010): "Banks Without Parachutes: Competitive Effects of Government Bail-out Policies," *Journal of Financial Stability*, 6, 156–168.

Hau, H. and M. Thum (2009): "Subprime Crisis and Board (In-)competence: Private versus Public Banks in Germany," *Economic Policy*, 24, 701 – 752.

Hovakimian, A. and E. J. Kane (2000): "Effectiveness of Capital Regulation at U.S. Commercial Banks, 1985 to 1994," *Journal of Finance*, 55, 451 – 468.

Keeley, M. C. (1990): "Deposit Insurance, Risk, and Market Power in Banking," *American Economic Review*, 80, 1183 – 1200.

Laeven, L. and R. Levine (2009): "Bank Governance, Regulation and Risk Taking," *Journal of Financial Economics*, 93, 259 – 275.

Merton, R. C. (1977): "An Analytic Derivation of the Cost of Deposit Insurance and Loan Guarantees: An Application of Modern Option Pricing Theory," *Journal of Banking and Finance*, 1, 3 – 11.

Puri, M., J. Rocholl, and S. Steffen (2010): "Global Retail Lending in the Aftermath of the US Financial Crisis: Distinguishing between Supply and Demand Effects," *Journal of Financial Economics*, forthcoming.

Ruckes, M. (2004): "Bank Competition and Credit Standards," *Review of Financial Studies*, 17, 1073 – 1102.

Sapienza, P. (2004): "The Effects of Government Ownership on Bank Lending," *Journal of Financial Economics*, 72, 357 – 384.

Sironi, A. (2003): "Testing for Market Discipline in the European Banking Industry: Evidence From Subordinated Debt Issues," *Journal of Money, Credit and Banking*, 35, 443 – 472.

Stein, J. C. (2002): "Information Production and Capital Allocation: Decentralized versus Hierarchical Firms," *Journal of Finance*, 57, 1891 – 1921.

Swiss TBTF Commission of Experts (2010): "Final report of the Commission of Experts for limiting the economic risks posed by large companies," Zurich, Switzerland.

Werner, K. (2005): "Weiterentwicklung des Haftungsverbundes der Sparkassen-Finanzgruppe (Further Development of the Savings Banks' Support Fund)," *Infodienst des Sparkassen- und Giroverbandes Rheinland-Pfalz*, Januar, 5.

FIGURE 1: Distribution of Z-Scores before and after the removal of public guarantees

The figure shows the distribution of the Z-Score before (1996-2000) and after (2001-2006) the removal of government guarantees. The Z-Score is defined in Table 1. We use univariate kernel density estimation to derive the figure.

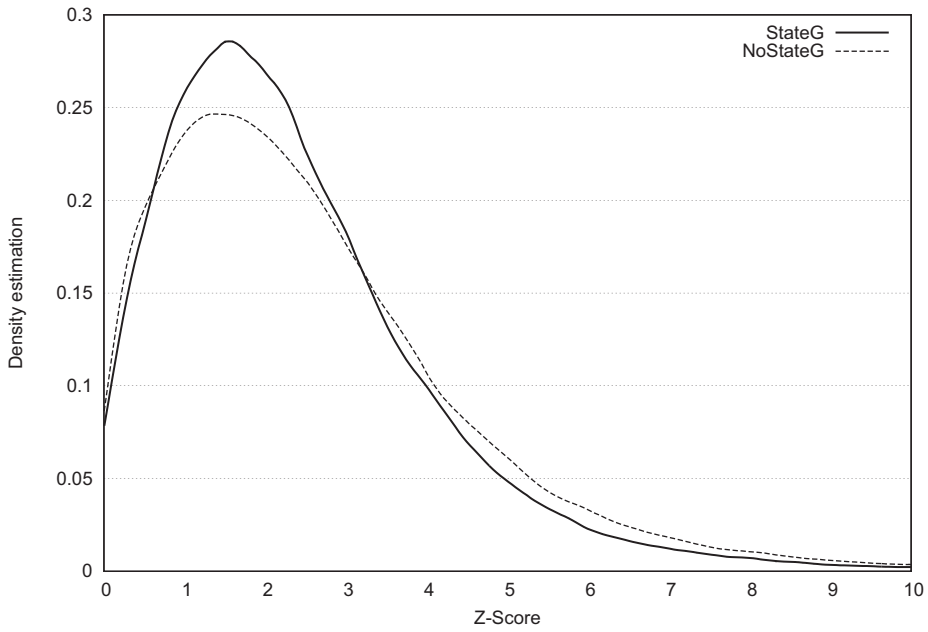

FIGURE 2: Economic developments in Germany

The figure shows annual GDP growth in Germany during our sample period. Data are taken from the federal statistical office of Germany (Destatis).

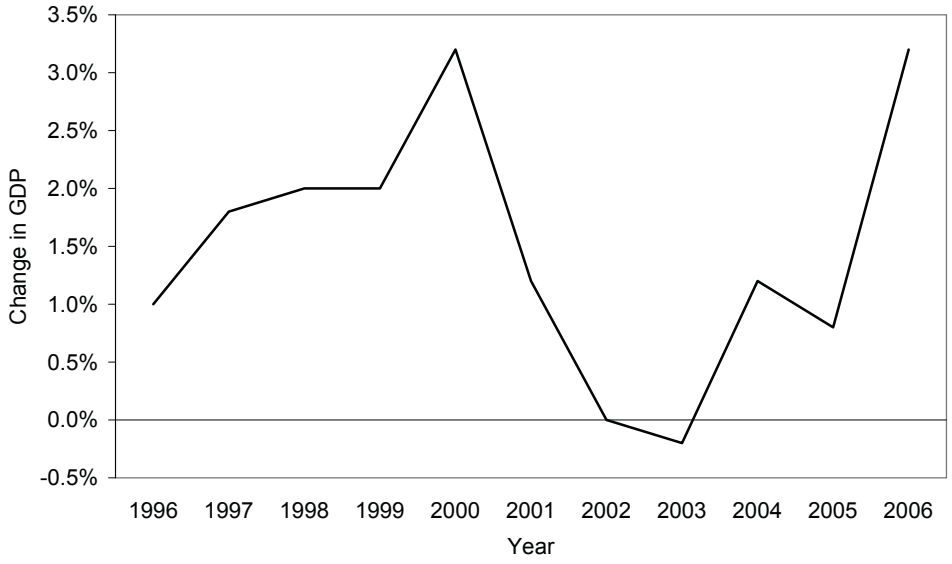

FIGURE 3: Market share of savings banks in Germany

The figure shows the annual loan volume of savings banks as a percentage of the total loan volume to commercial customers in Germany ("market share"). Data are from the Bundesbank and the German Savings Banks Association.

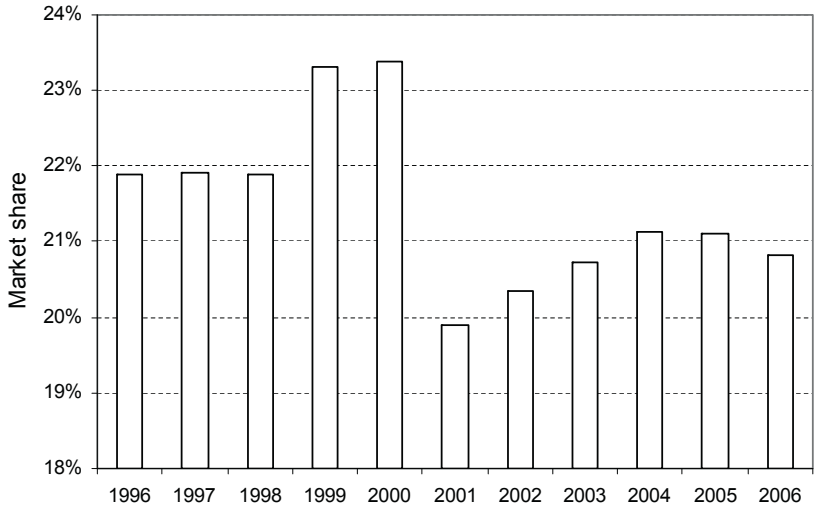

FIGURE 4: Sample selection - Screening versus monitoring

The figure shows how we define the two sub samples of new and existing borrowers used for Table 10. It illustrates five exemplary borrowers of a given bank. All observations for 1995, denoted by B, are excluded. If we observe a borrower in 1995 and 1996 or a subsequent year, we define this observation as "existing" (E). If we observe a borrower for the first time in 1996 or any subsequent year, we classify the borrower as "new", denoted with N. Subsequent observations of this borrower are classified as existing borrower (E). We only include those existing borrowers for which we have observations before and after the removal of public guarantees in 2001. Those borrower-year observations are denoted "E" (borrowers 2 and 3). Observations of existing borrowers 1, 4, and 5 are denoted "e" and are excluded from our analysis.

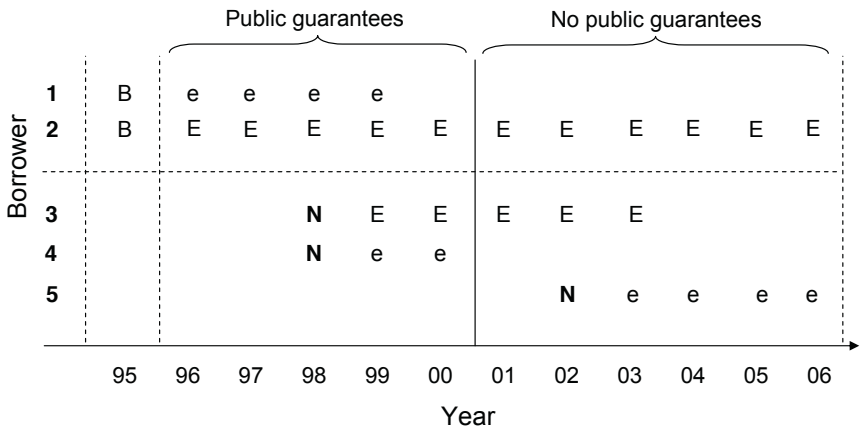

TABLE 1: Definition of dependent and independent variables

The table gives the definitions of all variables used in the empirical analysis. EBIL stands for the proprietary data set of borrowers' balance sheets and income statements. Destatis is the federal statistical office of Germany and Ifo Institute stands for the Ifo Institute for Economic Research.

Variable name	Description	Definition/Source
Dependent variables		
Z Score	Altman's Z-Score calibrated to the German banking market (approximation of the credit risk of each individual loan customer), defined by $Z\ Score = 0.717 * Working\ capital/Assets + 0.847 * Retained\ earnings/Assets + 3.107 * Net\ profits/Assets + 0.420 * Net\ worth/Liabilities + 0.998 * Sales/Assets$	EBIL, Engelmann et al., 2003
Loan size	Commercial borrowers liabilities towards the savings bank	EBIL
Interest rate spread	Interest rate spread of commercial borrower (approximated by interest expenses over total loan volumes minus the annual return of five-year German government bonds as the risk-free rate) for customers with at least 50% of credit volumes from savings banks	EBIL, Bundesbank
Independent variables		
Total bank assets	Aggregated total assets of groups of savings banks	Savings banks
Downgrade	Downgrade of federal state bank in numerical rating notches which was due to the removal of state guarantees	S&P's, Moody's
Direct competition	Branches of direct competitors (commercial banks and cooperative banks) to savings banks branches per group of savings banks	Bundesbank
Number mergers	Number of mergers within a group of savings banks per year	Savings banks
GDP per capita	Level of local GDP per capita per group of savings banks	Destatis
Δ Ifo index	Relative change in business climate (Ifo-index) in Germany	Ifo Institute
Indebtedness	Debt per capita of the community that the savings bank is located in	Destatis
Risk-free interest rate	Average daily risk-free interest rate at the national level	Bundesbank
Industry	Two-digit industry classification of commercial borrower	EBIL
Dummy and interaction variables		
StateG	Dummy variable for removal of government guarantees (before removal of state guarantees)	1 for years 1996 - 2000
NoStateG	Dummy variable for removal of government guarantees (after removal of state guarantees)	1 for years 2001 - 2006
StateGxLowRisk	Dummy variable for interaction of removal of government guarantees with ex ante riskiness of the savings bank group, measured as the average Z-Score for the years 1996-2000	1 for 1996-2000 if ex ante risk $\leq$ median
NoStateGxLowRisk		1 for 2001-2006 if ex ante risk $\leq$ median
NoStateGxHighRisk		1 for 2001-2006 if ex ante risk $>$ median
IntroRW	Dummy variable for introduction of risk weighted provisions to the savings banks' group-wide reserve funds	1 for 2004-06
NoStateGxSB	Dummy variable for interaction of removal of government guarantees with the type of bank being a savings bank	1 for years 2001 - 2006 if bank type = savings bank

TABLE 2: Descriptive statistics

This table shows descriptive statistics of the variables used in the empirical analysis. The definitions of variables are given in Table 1. We provide the number of observations, means, standard deviations, and the 5%, 25%, 50%, 75%, and 95% percentiles.

Variable	Unit	N	Mean	SD	5p	25p	50p	75p	95p
Z Score	-	230,562	2.49	2.12	0.18	1.13	2.11	3.38	6.11
Loan size	EUR mn	230,562	0.530	1.025	0.022	0.092	0.215	0.501	2.064
Interest rate spread	Percent	230,562	6.68	19.65	0.12	2.11	3.53	5.93	17.17
Total bank assets	EUR bn	230,562	15.31	11.69	5.46	9.04	11.59	16.37	39.16
Downgrade	Notches	230,562	2.54	0.95	1.50	2.00	2.00	4.00	4.00
Direct competition	-	230,562	0.90	0.25	0.48	0.75	0.88	1.03	1.36
Number mergers	-	230,562	0.24	0.58	0.00	0.00	0.00	0.00	1.00
GDP per capita	EUR thousands	230,562	25.24	6.39	16.32	21.61	25.00	27.59	39.93
Δ Ifo index	-	230,562	1.00	4.53	-7.80	-2.58	0.58	3.64	9.93
Indebtedness	EUR thousands	230,562	1.04	0.38	0.62	0.82	0.96	1.17	1.83
Risk-free interest rate	Percent	230,562	2.95	0.75	2.05	2.32	2.84	3.28	4.37

TABLE 3: Impact of the removal of government guarantees - Multivariate analysis

The table shows the result of a seemingly unrelated regression (SUR) model which simultaneously estimates the impact of the removal of government guarantees on credit risk (*Z Score*), loan size, and interest rate spreads on the borrower level. *NoStateG* equals 0 before 2001 and 1 for the years of 2001 - 2006. The control variables are savings bank assets on the group level, *Total bank assets*, the downgrade of the federal state bank, *Downgrade*, the debt per capita per group of savings banks, *Indebtedness*, the absolute level of local GDP per capita, *GDP per capita*, the relative change of the business climate in Germany, Δ *Ifo index*, the branches of direct competitors (commercial banks and cooperative banks) to savings banks branches per group of savings banks, *Direct competition*, the number of mergers within the group of savings banks per year, *Number mergers*, and the average daily interest rate in basis points, *Risk-free interest rate*. All specifications include two-digit industry dummies (coefficients omitted from the table). Standard errors are clustered at the savings banks' group level. *,**,*** indicate significance at the 10%, 5% and 1% level, respectively.

Independent variables	Z Score	Loan size	Interest rate spread
NoStateG	0.176***	-0.100***	0.460***
Total bank assets	0.001	0.001	0.003
Downgrade	0.050**	0.01	-0.307**
Indebtedness	-0.204***	-0.035	0.146
GDP per capita	0.016***	0.003	0.102***
Δ Ifo index	0.013***	-0.002*	-0.042***
Direct competition	-0.295***	0.042	-0.457
Number mergers	-0.003	-0.009	-0.103
Risk-free interest rate	-0.022**	0.022***	-0.701***
Intercept	1.855***	0.234***	4.302***
Observations	230,562	230,562	230,562
$Adj.R^2$	0.104	0.080	0.015

TABLE 4: Ex ante value of guarantees - Univariate analysis

The table shows the results of a univariate analysis of the impact of the removal of government guarantees on credit risk (*Z Score*), loan sizes (in millions of Euros), and interest rate spreads (in percent). The sample includes 230,562 observations of commercial borrowers. Government guarantees were in place in 1996-2000, and government guarantees were not in place in 2001-06. High/low ex ante risk stands for savings banks below/above average Z-Score prior to removal of guarantees. The differences in column 3 show a comparison before and after the removal of government guarantees. In column 3, *,**,*** indicate significance at the 10%, 5%, and 1% level, respectively, using univariate OLS with standard errors clustered at the savings bank group level.

Variable		Before the removal	After the removal	Difference
Z Score	Overall	2.36	2.56	0.20***
	Low ex ante risk	2.57	2.65	0.08**
	High ex ante risk	2.17	2.46	0.29***
Loan size	Overall	0.582	0.504	-0.078***
	Low ex ante risk	0.602	0.543	-0.059
	High ex ante risk	0.565	0.459	-0.106***
Interest rate spread	Overall	5.94	7.06	1.12***
	Low ex ante risk	6.53	7.34	0.81***
	High ex ante risk	5.43	6.75	1.32***

TABLE 5: Ex ante value of guarantees - Multivariate analysis

The table contains the difference-in-differences result of a SUR model regression which analyzes the impact of removal of government guarantees in dependence on the ex ante value of guarantees for the following variables: credit risk (*Z Score*), loan size, and interest rate spread on the borrower level. We approximate the ex ante value of guarantees by the ex ante risk taking of savings banks. The control variables are defined as in Table 3. Wald tests for the difference-in-differences terms are reported at the bottom of the table. All specifications include two-digit industry dummies (not reported). Standard errors are clustered at the savings banks' group level. *,**,*** indicate significance at the 10%, 5% and 1% level, respectively.

Independent variables	Z Score	Loan size	Interest rate spread
(1) NoStateGxHighRisk	0.282***	-0.120***	0.740***
(2) NoStateGxLowRisk	0.406***	-0.056	0.827**
(3) StateGxLowRisk	0.322***	0.016	0.638**
Total bank assets	0.001	0.001	0.003
Downgrade	0.050**	0.010	-0.306**
Indebtedness	-0.146**	-0.017	0.218
GDP per capita	0.011**	0.002	0.094***
Δ Ifo index	0.013***	-0.001	-0.041***
Direct competition	-0.178**	0.074	-0.296
Number mergers	0.005	-0.009	-0.088
Risk-free interest rate	-0.025**	0.022***	-0.707***
Intercept	1.660***	0.206***	3.967***
Difference (1)	0.282***	-0.120***	0.740***
Difference (2)-(3)	0.084**	-0.072*	0.189
Difference-in-differences (1)-[(2)-(3)]	0.198***	-0.048	0.552**
Observations	230,562	230,562	230,562
$Adj.R^2$	0.106	0.081	0.015

TABLE 6: Control group of banks unaffected by the removal - Risk taking

Panel A shows the average Banking Z-Score, the standard deviation of the average return of assets ($ROAA$), and the average total loan volume before (1995-2000) and after (2001-2006) the removal of public guarantees. The first to third column show results for German savings banks. We use data directly provided by the German savings banks. The fourth to sixth column provide results for a control group of banks unaffected by the removal. This group consists of German bank holding companies, commercial banks, cooperative banks, and medium and long term credit banks for which we use data from Bankscope. We require available data for the years 1995 to 2006 for the total loan volume, $ROAA$, equity (E), and total assets (A). The latter two are used to calculate the capital assets ratio ($E/A = CAR$). The Banking Z-Score is calculated according to Laeven and Levine (2009), i.e. it equals $(ROAA + CAR)/\sigma(ROAA)$. A higher Banking Z-Score indicates a lower default risk. *Loan volume*, $ROAA$, and CAR are averages for the six years before respectively after the removal. The standard deviation of the return of average assets, $\sigma(ROAA)$, is calculated using the six years before respectively after the removal. We use the natural logarithm of the Banking Z-Score. The third last line provides the p-values using univariate OLS regressions with Huber-White robust standard errors. Panel B uses the combined data of savings and non savings banks. It provides difference-in-differences regressions with the three different dependent variables of Panel A. Independent variables are $NoStateG$ that equals one for the period after the removal and zero otherwise and $NoStateGxSB$ that equals one for the period after the removal for savings banks and zero otherwise. We use bank fixed effects and Huber-White robust standard errors.

Panel A: Univariate results

	Savings banks			Non savings banks		
	Banking Z-Score	σ(ROAA)	Loan volume	Banking Z-Score	σ(ROAA)	Loan volume
Before the removal	3.18	0.0023	0.5373	4.26	0.0014	0.5955
After the removal	3.68	0.0016	0.5090	3.62	0.0029	0.7491
Difference	0.49	-0.0007	-0.0283	-0.64	0.0015	0.1536
P-value	(0.00)	(0.00)	(0.62)	(0.00)	(0.00)	(0.44)
Number of banks	452	452	452	877	877	877
Observations	904	904	904	1,754	1,754	1,754

Panel B: Difference-in-differences results

Independent variables	Banking Z-Score	σ(ROAA)	Loan volume
NoStateG	-0.64***	0.0015***	0.1536***
NoStateGxSB	1.13***	-0.0022***	-0.1818***
Intercept	3.90***	0.0017***	0.5757***
Bank fixed effects	Yes	Yes	Yes
Observations	2,658	2,658	2,658

TABLE 7: Market discipline - Refinancing structure

Panel A shows the average equity ratio, the average deposit ratio, and the average risk-sensitive debt ratio before (1995-2000) and after (2001-2006) the removal of public guarantees. Refer to Table 6 for the sample selection. The first to third column show results for German savings banks while the fourth to sixth column provide results for the control group. The capital assets ratio is abbreviated as CAR. Denoting (non-financial) customer deposits as D, the deposits ratio equals D/A. The risk-sensitive debt ratio equals (A - E - D)/A. The third last line provides the p-values using univariate OLS regressions with Huber-White robust standard errors. Panel B uses the combined data of savings and non savings banks. It provides difference-in-differences regressions with the three different dependent variables of Panel A. Independent variables are $NoStateG$ that equals one for the period after the removal and zero otherwise and $NoStateGxSB$ that equals one for the period after the removal for savings banks and zero otherwise. We use bank fixed effects and Huber-White robust standard errors.

Panel A: Univariate results

	Savings banks			Non savings banks		
	CAR	Deposit ratio	Risk-sensitive debt ratio	CAR	Deposit ratio	Risk-sensitive debt ratio
Before the removal	0.0428	0.5996	0.3576	0.0567	0.7119	0.2308
After the removal	0.0521	0.6281	0.3197	0.0642	0.7109	0.2248
Difference	0.0093	0.0285	-0.0379	0.0075	-0.0010	-0.0060
P-value	(0.00)	(0.00)	(0.00)	(0.00)	(0.89)	(0.39)
Number of banks	452	452	452	877	877	877
Observations	904	904	904	1,754	1,754	1,754

Panel B: Difference-in-differences results

Independent variables	CAR	Deposit ratio	Risk-sensitive debt ratio
NoStateG	0.0075***	-0.0010	-0.0060**
NoStateGxSB	0.0019**	0.0295***	-0.0319***
Intercept	0.0520***	0.6737***	0.2739***
Bank fixed effects	Yes	Yes	Yes
Observations	2,658	2,658	2,658

TABLE 8: Market discipline - Yield spread changes

The table compares the yield spreads before and after the removal of public guarantees. We define the week of the final removal decision, July 17, 2001, as event. We use yield-to-maturities (YTM) over the risk-free YTM as yield spreads. We employ Datastream and Bloomberg data for the bond YTM and Bundesbank data for the risk-free YTM. We first collect daily YTM data and require all bonds to have non-missing values in the 12 weeks before and the 12 weeks after the removal. We then compute the average weekly yield spread using the daily data. The first (second) line provides the average weekly yield spread in percent for the 12 weeks before (after) the removal. We test the yield spread differences by an univariate OLS regression with standard errors clustered at the issuer level. The third last line shows the respective p-value.

	Savings bank	Non savings bank
Before the removal	0.4463	1.0845
After the removal	0.5073	1.0595
Difference	0.0610	-0.0250
P-value	0.0220	0.7490
Number of bonds	81	112
Number of issuers	29	18

TABLE 9: The introduction of risk based regulation and prompt corrective action

The table contains the result of a SUR model regression which analyzes the introduction of risk weighted provisions for the group-wide reserve funds in the year 2004 on credit risk (*Z Score*), loan size, and interest rate spread on the borrower level. We use two dummy variables which indicate the periods 1996-2000 (*StateG*) and 2004-06 (*IntroRW*) and exclude as reference category the period 2001-03. The control variables are defined as in Table 3. All specifications include two-digit industry dummies (not reported). Standard errors are clustered at the savings banks' group level. *,**,*** indicate significance at the 10%, 5% and 1% level, respectively.

Independent variables	Z Score	Loan size	Interest rate spread
StateG	-0.125***	0.102***	-0.497***
IntroRW	0.151***	0.006	-0.112
Total bank assets	0.001	0.001	0.002
Downgrade	0.049**	0.01	-0.306**
Indebtedness	-0.198***	-0.035	0.142
GDP per capita	0.015***	0.003	0.103***
Δ Ifo index	0.008***	-0.002**	-0.038***
Direct competition	-0.256***	0.044	-0.486
Number mergers	0.009	-0.008	-0.112
Risk-free interest rate	0.01	0.023***	-0.725***
Intercept	1.847***	0.127	4.897***
Observations	230,562	230,562	230,562
$Adj.R^2$	0.104	0.080	0.015

TABLE 10: Screening versus monitoring

The table shows the average Z-Scores per year for newly approved borrowers (first column) and existing borrowers (second column). We require at least three observations per borrower and thus use a different sample compared to Tables 2 to 5 and 9. The sample selection process is illustrated in Figure 4. The results are broken down into two regimes. Panel A displays the years before while Panel B shows the years after the removal of government guarantees. We test the differences between the average Z-Scores before (1) and after the removal (2) by using an univariate OLS regression with standard errors clustered at the savings bank group level. The last line reports the p-value of the corresponding Wald test. *,**,*** indicate significance at the 10%, 5%, and 1% level, respectively.

	Average Z-Score	
Year	New borrowers	Existing borrowers
Panel A: Before the removal		
1996	2.94	2.85
1997	3.04	2.85
1998	3.07	2.83
1999	3.19	2.82
2000	3.21	2.84
(1) Average	3.09	2.83
Panel B: After the removal		
2001	3.33	2.90
2002	3.24	2.86
2003	3.39	2.90
2004	3.47	3.01
2005	3.75	3.08
2006	3.96	3.27
(2) Average	3.59	2.96
Difference (2) - (1)	0.49***	0.13***
t-statistic	(6.27)	(5.39)
Difference-in-differences	0.37***	
P-value, Wald test	(0.0001)	