Discussion Paper No. 03-66

How Do Banks Determine Capital? – Empirical Evidence for Germany

Volker Kleff and Martin Weber

Zentrum für Europäische
Wirtschaftsforschung GmbH

Centre for European
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Non-technical summary

Many banks in Germany are characterised by small capital ratios. On the one hand these banks can fund themselves through deposits at low costs, but on the other hand banking regulation forces them to maintain a certain minimum of capital. Although the capital ratios of these banks do not differ considerably, there might be some remarkable differences in their refinancing behaviour.

Banking regulation may have a stronger effect on undercapitalised or adequately capitalised banks than on well-capitalised banks. The former banks probably increase regulatory capital to a greater extent than the latter to avoid direct or indirect punishment by the regulator.

Traditional determinants found in the corporate finance literature may be relevant for banks as well. The higher the profitability, the more capital can be retained to increase capital. Furthermore, the larger the bank, the lower may be the capital ratio as these banks can refinance in the capital market more easily. Finally, larger banks may have more diversified portfolios and thus may need a lower capital buffer.

Based on bank-level data of nearly all German banks for the period 1992-2001, we examine the determinants of bank capital for the three pillars of the German banking market: savings banks, cooperative banks and *other banks*. We find the following patterns of bank behaviour:

- Portfolio risk has a significant and positive effect on capital for savings banks as these banks have less regulatory capital than *other banks* and are more likely to increase capital when increasing portfolio risk.

- Regulatory pressure influences the behaviour of all banking groups. Lower capitalised banks increase capital to a stronger extent than other banks.

- The size effect is much larger for other banks than for savings banks. This result is plausible, since even large savings banks have a very limited access to the capital market and cannot issue new equity.

- Profitability is a significant determinant of bank capital only in the case of savings banks, since these banks particularly rely on retained earnings.

Further analysis suggests that savings banks and cooperative banks are more reliant on subordinated debt to increase capital than other banks as their profitability is often insufficient to reach their target capital ratio.

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How Do Banks Determine Capital ?

– Empirical Evidence for Germany

Volker Kleff [a] and Martin Weber [b,c]

[a] Centre for European Economic Research (ZEW), Mannheim, Germany
[b] Department of Banking and Finance, University of Mannheim, L5,2, 68131 Mannheim, Germany
[c] Centre for Economic Policy Research (CEPR), London, United Kingdom

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Abstract: This paper examines how capital is determined by German banks. We analyse whether the determinants found in the previous empirical literature hold for the special German banking sector with its three characteristic banking groups of savings banks, cooperative banks and other banks. On the basis of a unique data set of nearly all German banks between 1992 and 2001 provided by the Deutsche Bundesbank, we apply the generalised method of moments (GMM) within a dynamic panel data framework. The results largely confirm the findings for other countries, but show considerable differences between the three German banking groups.

Keywords: Bank capital, portfolio risk, banking regulation, panel data, GMM

JEL classification code: G21, G32, C23

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Adress for correspondence: Volker Kleff, Centre for European Economic Research, P.O. Box 10 34 43, 68034 Mannheim, Germany, Phone: +49-621-1235-141, E-Mail: kleff@zew.de

1 Introduction

There is a large number of empirical papers on the determinants of corporate capital. Most of them do not consider banks, as they have a very different business. As a consequence, little is known about how banks determine their capital ratio. As we shall see, some papers examine the bank capital ratio, but usually they focus on the efficiency of banking regulation and analyse a very special determinant of bank capital, the portfolio risk.

Indeed, portfolio risk may be of great importance to bank capital. In July 1988 the Basle Committee on Banking Regulation and Supervisory Practices published its risk-based capital standard (Basle Accord), which took effect in the end of 1992. Since then, banks are obliged to hold a minimum regulatory capital ratio of 8 percent of all risk-weighted on-balance-sheet assets. The individual balance sheet assets are weighted according to four broad risk classes of 0, 20, 50 and 100 percent to obtain a measure of portfolio risk.

As a consequence, one could expect that portfolio risk and capital are positively related - at least for the banks that hold about as little regulatory capital as permissable, because they have to increase capital when increasing portfolio risk. Berger et al. (1995) show the potential impact of the Basle Accord on bank capital. The aggregate equity-to-asset-ratio for US-banks rose from 6.21 percent at the end of 1989 to 8.01 percent at the end of 1993. They suggest that much of the increase has to be attributed to banking regulation.[1] According to Haubrich and Wachtel (1993) US-banks also shifted their portfolio in favour of less risky government securities after bank regulators agreed to the introduction of risk-based capital requirements in 1988.[2] Aggarwal and Jacques (1997) finally state that most US-banks succeeded to fulfill the regulatory minimum: Less than one percent of all banks were categorised as undercapitalised in the end of 1992.

In this study we investigate whether the current Basle Accord affects the behaviour of German banks. Similar to the US, most German banks hold considerably more capital than necessary (see, for instance, Deutsche Bundesbank (2002b)). Thus they are not forced to keep that strict positive relationship between portfolio risk and capital. In this respect it remains unclear whether regulation results in a positive relationship between bank capital and portfolio risk for German banks. Results from US studies may not be applicable to German banks, as the latter's behaviour may differ considerably. Unlike the US, only a small fraction of German banks are joint-stock

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[1] Ashcraft (2001) argues that this effect was rather due to market forces than to banking regulation.

[2] However, Hancock and Wilcox (1994) cannot detect a strong effect on bank lending to businesses.

companies. That is why the argument that banks maximise their shareholder value is less convincing for German banks.

The German banking structure is characterised by its three banking groups of savings banks, cooperative banks and other banks. We enrich the literature by differentiating between these three banking groups in detail. Indeed, we find considerable differences between the behaviour of these banking groups. Results suggest that savings banks rely much stronger on retained earnings than other banks, as they have less alternatives to raise capital. Furthermore, we find a positive relationship between portfolio risk and capital for these banks. In case of other banks, no significant impact of profitability or portfolio risk on capital is found. However, we find a negative and significant effect of bank size on bank capital only for other banks. This finding is due to institutional characteristics. Additionally, results suggest a significant and positive impact of regulatory pressure on bank capital for other banks, but not for savings banks.

Furthermore, some additional determinants of bank capital are considered in this study, which were given little attention in previous literature. We examine whether the bank deposit ratio and the loan loss provisions have a significant impact on the bank capital ratio.

Finally, we apply a more appropriate econometric methodology. We estimated dynamic panel regressions using the generalised method of moments (GMM). By using GMM the endogeneity of all explanatory variables can be considered efficiently. In contrast, previous literature mostly uses simple two- or three-stage least squares regressions on the pooled data set or, when considering the panel-structure of the data set, simple random effects regressions.

The structure of this study is as follows. Section 2 presents some hypotheses to be examined. Furthermore, it gives an overview about potential determinants of bank capital. Section 3 summarises recent empirical work on the determinants of bank capital and Section 4 presents the data. Section 5 introduces the empirical methodology and the final specification of the model. Section 6 presents the results regarding the determinants of bank capital. In Section 7 the subordinated debt issue is examined in detail and Section 8 concludes.

2 Hypotheses

Risk-based capital requirements were proposed by the Basle Accord in 1988 for the first time. The reasoning behind the regulatory linking of capital with portfolio risk was the fear that banks could otherwise have an incentive to increase portfolio risk and thus to increase the probability of default, which would run counter to the regulator's intention of limiting the probability of default. Indeed, theories suggest that banks' choices of portfolio risk and capital are interrelated.

Hypothesis 1A (H1A): Bank capital and portfolio risk are negatively related because of deposit insurance.

A flat-rate deposit insurance can induce a bank to maximise its shareholder value by maximising both portfolio risk and leverage. Hence, this argument is valid for joint-stock companies, but hardly applies to German savings and cooperative banks in other legal forms. Merton (1977) and Pyle (1986) model the claim on the deposit insurer as a put option on the firm‘s value with the promised payment to the depositors being the strike price. Sharpe (1978), Kareken and Wallace (1978) and Dothan and Williams (1980) argue within a state-preference model and show that subsidised deposit insurance results in an incentive for value-maximising banks to increase both portfolio risk and leverage risk.[3] In this regard, deposit insurance could result in a negative relationship between capital and portfolio risk.

Hypothesis 1B (H1B): Bank capital and portfolio risk are positively related because of other factors.

Bankruptcy costs

Orgler and Taggart (1983) apply a modified version of the traditional trade-off theory to banks. They claim that besides taxes and bankruptcy costs, the special tax treatment of bank services and economies of scale in the production of these services have to be considered. As bankruptcy costs are dependent on both portfolio risk and leverage risk, banks will increase capital when they increase risk to avoid bankruptcy. In this case, banks have an own incentive to limit the probability of default.

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[3] Furlong and Keeley (1989) and Keeley and Furlong (1990) argue that under flat-rate deposit insurance and within both option and state-preference models, the incentive to increase portfolio risk and leverage decreases with the capital ratio. Thus, a more stringent capital regulation reduces the incentive to increase portfolio risk.

Financial risk and portfolio risk as substitutes

Very close to the argument above is the following. Within a mean-variance-framework it is also possible that risk averse bank managers wish to hold a certain optimal level of total risk as a sum of portfolio and leverage risk (see Kahane (1977), Koehn and Santomero (1980), Kim and Santomero (1988) and Rochet (1992)). In this case portfolio and leverage risk would be substitutes and capital and portfolio risk would be positively linked. A plausible rationale for this interrelationship of portfolio risk and leverage risk can be provided by agency theory. Bank managers, if they are not the owners of the bank, are especially afraid of a potential bankruptcy, because they would lose their job and their firm-specific human capital. That is why they should tend to decrease leverage when increasing risk (see Saunders et al. (1990)).

Regulatory costs

Up to now, banking regulation was neglected. A positive association between capital and risk could result from the costs of violating banking regulation. Buser et al. (1981) argue that banks have to balance the advantage of high portfolio risk against the explicit and implicit costs of regulation. Implicit costs of regulation may arise because of regulatory interference, which reduces the charter value of the bank.[4] As a result, banks hold capital levels slightly above the regulatory minimum. A positive relationship between risk and capital therefore could indicate that regulatory constraints are binding.

Hypothesis 2 (H2): The higher the banks' profitability, the higher is the bank capital ratio.

The banks' profitability determines the banks' ability to increase capital by accumulating profits. That is why a positive relationship between the banks' profitability and capital is to be presumed. Such a relationship would be consistent with the pekking-order theory of Myers and Majluf (1984). They claim that enterprises prefer funding by accumulating profits. Other possibilities to raise money by selling bonds or new shares are more expensive means of refinancing because of information asymmetries. Although information asymmetries may be lower in the case of banks, the pecking-order theory may hold even for banks.

It is expected that profitability is an especially important determinant for savings banks, as they cannot issue new shares on the capital market, but substantially rely

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[4] The charter value of a bank is the present value of the bank's prospective new investments. See, for example, Acharya (1996) for the importance of the charter value for a bank.

on retained earnings to increase capital. As argued by Dahl and Shrieves (1989), the magnitude of equity infusions make them an important instrument to increase the bank capital ratio.

Hypothesis 3 (H3): The bigger the bank, the lower is the bank capital ratio.

Larger banks could have an easier access to the capital market and could raise external capital more easily due to lower transaction costs. Thus they may have a greater financial flexibility and may need less excess regulatory capital than smaller banks. Moreover larger banks may have less investment opportunities and thus need less capital. In addition, they are more likely to have a more diversified portfolio and thus need less excess capital from the bank manager's point of view. According to Titman and Wessels (1988), fixed direct bankruptcy costs finally constitute a smaller portion of firm value when the firm is larger, lowering the importance of the bankruptcy costs. All these reasons may result in a negative relationship between size and bank capital.

This size effect is supposed to be smaller for savings and cooperative banks. As they usually are not listed on the stock exchange, they cannot issue new shares or cannot sell investments on the capital market to reduce liabilities, but must rely on retained earnings or issue of subordinate debt or hybrid capital. Furthermore, their business is limited to a certain local area, accordingly their portfolio may be less diversified. Finally bankruptcy costs are irrelevant for savings banks because of specific governmental guarantees (*Gewährträgerhaftung* and *Anstaltslast*) granted until July 2005.

3 Previous empirical findings

A number of empirical studies have examined the relationship between changes in the bank capital ratio and portfolio risk (see Basle Committee on Banking Supervision (1999) for an overview). They differ in the methodology used and in the time period and country observed. Shrieves and Dahl (1992) find a positive relationship between the capital ratio and portfolio risk for US banks during the period 1984 to 1986 using a simultaneous equations framework. Furthermore, they show that regulatory pressure induces banks to increase the capital ratio and to decrease portfolio risk. Rime (2001) applies the same methodology to Swiss Banks and confirms the positive relationship between the capital ratio and portfolio risk, but could not find that regulatory pressure can affect the level of portfolio risk. Likewise Bichsel and Blum (2002) find a positive relationship between the bank capital ratio and portfolio risk for Swiss banks from 1990 to 2002 in a similar two equation framework. Ediz et al. (1998) detect a positive relationship between the capital ratio and portfolio risk for British banks from 1989 to 1995, but cannot confirm that these banks increase their capital ratio by decreasing risk. They consider the panel structure of the data set by estimating random effects regressions, but ignore the endogeneity of portfolio risk. Nachane et al. (2000) adopt the model of Ediz et al. (1998) and apply it for India. Their results confirm the result that capital requirements make banks boost their capital ratio. No evidence was found that banks adjust their regulatory capital ratios by substituting from high-risk loans.

Jacques and Nigro (1997) use the simultaneous equations framework of Shrieves and Dahl and show that the introduction of risk-based capital ratios caused US banks to increase their capital ratios and to decrease portfolio risk in 1990 and 1991. Aggarwal and Jacques (2001) examine the behaviour of US banks in different prompt corrective action (*PCA*) zones established by the Federal Deposit Insurance Corporation Improvement Act (*FDICIA*) within the simultaneous-equation-framework. They find that both undercapitalised and adequately capitalised banks increased their capital ratios in 1992 and 1993.

All these findings from the literature would be consistent with our hypothesis *H1B*, claiming a positive relationship between capital and portfolio risk.

Nearly all of these studies, as they consider the banks' profitability as a potential determinant of the bank capital ratio, come to the conclusion that the capital ratio is positively influenced by profitability, but negatively influenced by bank size. These findings for US banks are consistent with our hypotheses *H2* and *H3* mentioned above.

4 Data

In contrast to the literature, we examine banks in Germany. Two data sets are analysed for that purpose. The first one is a unique data set provided by the Deutsche Bundesbank. The Bundesbank data set comprises yearly balance sheet and profit and loss account information of almost all German banks (no building and loan associations) reported to the Deutsche Bundesbank from 1992 to 2001.[5] The first two years, 1992 and 1993, are lost due to considering dynamics and first differencing. To run the dynamic panel regressions, continuous observations of each bank are needed. Therefore, we excluded these banks from the data set with six and less consecutive observations. A sample of 2,971 banks and 28,025 observations remains.

[5] We use the end-of-December data of the monthly *Bilanzstatistik* (BISTA), as the profit and loss accounts are reported yearly. Some cooperative banks and other banks could not be taken into account because of data restrictions.

As the German banking sector is very heterogeneous, we divide the whole sample into three subsamples. The first subsample comprises all German savings banks. These are statutory bodies which are publicly owned, whose activities are locally bounded and whose main object is to fulfill the public contract. The second subsample consists of nearly all German cooperative banks. Similar to the savings banks, their business is limited to a certain local area, but they are not subject to the public contract like savings banks. The third group is denoted *other banks*. On the one hand, these *other banks* consist of commercial banks, i.e. big banks, branches of foreign banks and (private) regional banks and other commercial banks. On the other hand the group of *other banks* comprises Land banks (Landesbanken), regional institutions of credit cooperatives, mortgage banks and banks with special functions (*Banken mit Sonderaufgaben*). A more detailed analysis is not possible, as the data set allows no further identification of each bank. Table 1a gives a synopsis of the banking groups in 2001.

Table 1a: Synopsis of the banking groups in 2001 (Deutsche Bundesbank 2002a)

	Number of banks		
- Savings banks		537	
- Cooperative banks			1,619
- *Other banks*			363
- Commercial banks		279	
- Big banks	4		
- Regional banks and other commercial banks	195		
- Branches of foreign banks	80		
- Land banks (*Landesbanken*)		12	
- Regional institutions of cooperative banks		1	
- Mortgage banks		28	
- Banks with special functions		14	
- Building and loan associations		29	
			2,519

The second data set we use is provided by the publishing house Hoppenstedt (see www.Hoppenstedt.de). The data set comprises published balance sheet and profit and loss account information of about 1,000 German banks. Smaller banks, particularly smaller cooperative banks, are missing in the Hoppenstedt data set. We examine bank behaviour for the reference period 1992-2001 and define the variables very similar to those from the Bundesbank data set.

As most German banks are not publicly listed and market values are not available for them, we examine book values instead of market values.

4.1 Bank capital

Two different definitions of capital are presented in this study to obtain a differentiated impression of how banks determine their capital ratios. The first one is a simple capital ratio defined as the ratio of equity capital to total assets (*CAP1*).[6] The second definition of capital refers to regulatory capital. *CAP2* is a proxy variable for Tier 1 + Tier 2 capital to total assets. It is defined as the ratio of paid-up equity capital including the fund for general bank risks, profit-sharing capital and subordinate debt, which in total are divided by total assets.[7] As we do not have any information about hidden reserves or revaluation reserves, *CAP2* is a little smaller than the actual sum of Tier 1 + Tier 2 to total assets. Additionally, we estimated our model with a third definition of capital. *CAP3* is a proxy variable for the ratio of Tier 1 capital to total assets. It comprises paid-up equity capital including the fund for general bank risks. We do not present the results for *CAP3* here as the definition of *CAP3* is very close to the definition of *CAP1* and the results are very similar.

4.2 Bank risk

Banks' portfolio risk (*RISK*) is measured by the ratio of risk-weighted on-balance-sheet assets to total assets.[8] We use the risk weights suggested by the Basle Committee on Banking Regulation in 1988, which are still obligatory until today. Within the Basle Accord framework the individual assets of a bank are weighted according to four broad risk classes of 0, 20, 50 and 100 percent. Recent literature has pointed to the fact that such a measure of portfolio risk is too rough to indicate the banks' probability of default. But here we are not interested in an accurate measure of the probability of default, but wish to explain banking behaviour in the regulatory context.

5 Partial-adjustment-framework and specification

We assume that banks consciously aim at a certain capital ratio (see Diamond et al. (2000) for the existence of an optimal bank capital ratio). The existence of capital regulation may give a strong hint that the capital ratio is at least partially influenced

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[6] Equity capital comprises subscribed capital, capital reserves, revenue reserves and stated loss in case of the Bundesbank data set. In case of the Hoppenstedt data set, equity capital comprises subscribed capital, capital reserves, revenue reserves and distributable profit.

[7] In contrast to German banking law (*Kreditwesengesetz)*, *CAP2* and *CAP3* comprise subscribed capital even in the case of savings banks. See the appendix for an exact definition of the variables.

[8] Other risk assets like off-balance-sheet engagements and derivatives as well as market risk could not be considered, because we do not have any information about these items.

by the bank. Thus we suggest that changes of the bank capital ratio result from discretionary adjustments and factors exogenous to the bank:

$$\Delta CAP_{j,t} = \Delta CAP^{d}_{j,t} + \varepsilon_{j,t} . \qquad (1)$$

$\Delta CAP_{j,t}$ are the observed changes in the capital ratio for bank *j* in period *t*. The discretionary changes in the capital ratio are denoted $\Delta CAP^{d}_{j,t}$. The error $\varepsilon_{j,t}$ denotes the exogenous factors influencing the bank capital ratio. An unanticipated shock to the national economy or an exogenously enforced increase of regulatory capital could be random factors influencing the bank capital ratio.

The discretionary changes in the capital ratio $\Delta CAP^{d}_{j,t}$ are modelled within a partial adjustment framework. Modelling the bank capital decision within a partial adjustment model is very common in the literature. Peltzman (1970), Mingo (1975) and Marcus (1981) were the first to apply such a model to analyse the bank capital decision, then many other empirical studies using the model in a simultaneous equation framework followed (see Section 3).

Banks are assumed to have a desired target capital ratio, but are not able to reach it instantaneously.[9] Within this framework, the discretionary changes in capital are proportional to the difference between the target values and the lagged values of capital:

$$\Delta CAP_{j,t} = \alpha \left[CAP^{*}_{j,t} - CAP_{j,t-1} \right] + \varepsilon_{j,t} . \qquad (2)$$

The coefficient α can be interpreted as the speed of adjustment. A high value of α indicates that the bank reaches its target capital ratio very quickly. $CAP^{*}_{j,t}$ denotes the target capital ratio for bank *j* in period *t*. Target capital is not directly observable and may differ cross-sectionally.

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[9] As the optimal or desired capital ratio and portfolio risk are not observable, it is assumed that the bank managers discretionary adjust the actual level of capital and risk towards the optimal level. This assumption can be explained by institutional inertia, high costs of rapid change, or a lack of information.

After rewriting equation (2) as follows:

$$CAP_{j,t} - CAP_{j,t-1} = \alpha\left[CAP^{*}_{j,t} - CAP_{j,t-1}\right] + \varepsilon_{j,t}\,. \quad (3)$$

we obtain our final regression equation:

$$CAP_{j,t} = (1-\alpha)CAP_{j,t-1} + \alpha CAP^{*}_{j,t} + \varepsilon_{j,t}\,. \qquad (4)$$

We estimate the model with all three definitions of capital to total assets (*CAP1*, *CAP2*, and *CAP3)* as left-hand-variables.[10]

5.1 Variables affecting target capital

As the target capital ratio $CAP^{*}_{j,t}$ is not directly observable, some proxy variables have to be found. We use some observable bank characteristics to describe $CAP^{*}_{j,t}$. In the following, the explanatory variables affecting the target capital ratio $CAP^{*}_{j,t}$ are presented.

Portfolio risk

As shown in the theoretical literature, capital and portfolio risk are interrelated (see hypotheses *H1A and H1B*). Regulation could have a decisive influence on the relationship between both variables. That is why portfolio risk (*RISK*) is expected to be a determinant of banks' target capital.

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[10] We also used other definitions of capital. Estimation of capital to risk-weighted assets resulted in a strong negative relationship between capital and risk. We assume that this strong negative relationship is caused by the construction of the variables: The denominator of the dependent variable capital to risk-weighted assets would be identical to the numerator of the regressor *RISK*.

Profitability

Corresponding to hypothesis *H2*, target capital may be influenced by banks' profitability. That is why *PROFIT* is included in the capital equation. *PROFIT* is defined as the ratio of net interest income plus net commission income to total assets.

Bank deposit ratio

Bank deposits are a very attractive means to fund the bank, because of the relatively lower interest rates to be paid compared to bonds or borrowing from banks. A decreasing bank deposit ratio makes banks' debt more expensive and reduces the current profit. This effect is controlled for by including *PROFIT* into the equation. But a decreasing (increasing) deposit ratio may signal even lower (higher) net interest profits in future years (see Gupta and Walker (1975)). Accordingly, lower (higher) future profits could mean increased (lower) pressure to extend the capital buffer. As a consequence, we expect a negative relationship between the capital ratio and the bank deposit ratio (*BDR*). We include *BDR* into our capital equation as it may have a significant influence on bank capital. The *BDR* is defined as the ratio of all liabilities to customers to total assets.

As both bank deposits and equity capital are components of the liabilities side of the bank balance sheet, it could be argued that a negative relationship between both variables alternatively could be the result of a simple automatism. But the automatism is not compelling. Most banks hold a considerable amount of liabilities to banks, which buffer fluctuations in the amount of liabilities to customers. Finally, we rule out the automatic effect of fluctations in the amount of deposits on total assets and thus on the ratio of capital to total assets by controlling for size.

Provisions

We also consider provisions for possible loan losses as well as write-downs and write-ups of and value adjustments to claims and securities. The ratio of these variables to total assets (*PROV*) may represent a proxy for the banks' financial health. We assume that banks with higher provisions have a lower capital target, as they are not able to increase their capital ratio significantly because the provisions reduce current profits. Thus we expect a negative impact of *PROV* on the capital ratio.

Regulatory pressure

As the theoretical literature suggests, banking regulation may have a direct effect on capital. A bank having a regulatory capital ratio close to the regulatory minimum may have an incentive to increase its regulatory capital ratio in order to prevent the capital ratio from falling below the regulatory minimum. Otherwise regulatory costs may arise. To capture this potential effect, we include a dummy variable *REG* into the equation, indicating the banks' regulatory pressure.[11] The dummy variable equals one if capital to risk-weighted-assets is lower than a certain threshold. These thresholds are calculated to include the quarter of banks with the lowest ratio of capital to risk-weighted assets. The threshold is 6.0 percent for the *CAP1*-equation and thus is two percentage points higher than the regulatory minimum of 4.0 percent for the Tier 1 capital ratio.[12] Simultaneously, this threshold coincides with the minimum Tier 1 capital ratio necessary to be classified as well-capitalised according to the Federal Deposit Insurance Corporation Improvement Act (FDICIA). For the *CAP2*-equation, the threshold of 7.0 percent lies below the regulatory minimum of 8.0 percent for Tier 1 + Tier 2 capital to risk-weighted assets, as *CAP2* does not contain all components of Tier 1 and Tier 2 capital.[13]

Merger

The German banking sector is characterised by many mergers and acquisitions in recent years, which could have a direct impact on the banks' capital ratio. We control for this effect by including the dummy variable *MERG* into the capital equation. The dummy variable is one if a bank has taken over another bank in the same year and zero otherwise.[14]

Size

Corresponding to hypothesis *H3*, size may have an influence on the target capital ratio. To capture size effects, the natural log of total assets (*SIZE*) is included in the capital equation.

Regulatory and macroeconomic shocks

Macroeconomic shocks must be taken into account, as changes in the volume or structure of loan demand can influence banks' observed capital. Also changes of the banking regulation may influence the dependent variable in a specific year. That is why time dummies are included in the capital equation.

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[11] We assume that *REG* indicates regulatory pressure, although we cannot exclude that it partly measures the banks' own incentive to prevent bancruptcy costs.

[12] We also experimented with other thresholds, but obtained very similar results.

[13] We do not have any information about the undisclosed reserves or revaluation reserves, which are components of Tier 2 capital.

[14] The dummy variable *MERG* was kindly provided by the Deutsche Bundesbank.

Table 1b: Number of observations and mean of variables by year (Bundesbank data set)

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	total
Obs.	2,733	2,963	2,966	2,971	2,971	2,971	2,971	2,728	2,480	2,271	28,025
sav. banks	500	590	590	590	590	590	590	578	561	535	5,714
coop. banks	1,954	2,089	2,089	2,089	2,089	2,089	2,089	1,899	1,675	1,512	19,574
other banks	279	284	287	292	292	292	292	251	244	224	2,737
CAP1	0.0491	0.0470	0.0488	0.0503	0.0508	0.0518	0.0532	0.0515	0.0538	0.0537	0.0509
CAP2	0.0502	0.0514	0.0549	0.0579	0.0595	0.0611	0.0625	0.0610	0.0637	0.0635	0.0584
CAP3	0.0491	0.0470	0.0489	0.0503	0.0509	0.0518	0.0532	0.0516	0.0540	0.0538	0.0509
CRWA1	0.1010	0.0995	0.1058	0.1071	0.1152	0.1120	0.1277	0.1118	0.1263	0.1245	0.1127
CRWA2	0.1027	0.1067	0.1165	0.1198	0.1295	0.1273	0.1429	0.1276	0.1422	0.1401	0.1251
CRWA3	0.1009	0.0995	0.1066	0.1072	0.1153	0.1121	0.1277	0.1120	0.1266	0.1247	0.1129
REG1	0.4274	0.3584	0.3240	0.2854	0.2545	0.2322	0.2383	0.2295	0.2101	0.2070	0.2787
REG2	0.6718	0.4222	0.3095	0.2158	0.1599	0.1434	0.1589	0.1393	0.1310	0.1233	0.2499
REG3	0.4274	0.3567	0.3233	0.2848	0.2535	0.2302	0.2370	0.2258	0.2060	0.1995	0.2766
RISK	0.6326	0.6055	0.6137	0.6152	0.6185	0.6258	0.6347	0.6330	0.6503	0.6456	0.6265
PROFIT	0.0370	0.0367	0.0379	0.0364	0.0356	0.0347	0.0332	0.0334	0.0345	0.0324	0.0353
BDR	0.7625	0.7533	0.7344	0.7207	0.7134	0.7045	0.6982	0.6870	0.6695	0.6813	0.7138
PROV	0.0004	0.0029	0.0058	0.0033	0.0033	0.0038	0.0032	0.0033	0.0047	0.0046	0.0035
SIZE	18.6817	18.8198	18.9099	18.9885	19.0622	19.1184	19.1800	19.3174	19.4548	19.5917	19.0965
SDEBT	0.0000	0.0028	0.0040	0.0053	0.0061	0.0066	0.0066	0.0068	0.0071	0.0072	0.0052
PCAP	0.0011	0.0016	0.0021	0.0023	0.0025	0.0027	0.0027	0.0027	0.0027	0.0024	0.0023
MERG	0.0000	0.0391	0.0435	0.0263	0.0266	0.0263	0.0417	0.0601	0.0742	0.0638	0.0391

Table 1c: Mean of variables by banking groups (Bundesbank data set)

	all banks	sav. banks	coop. banks	*other banks*
CAP1	0.0509	0.0384	0.0469	0.1057
CAP2	0.0584	0.0526	0.0520	0.1161
CAP3	0.0509	0.0385	0.0469	0.1056
REG1	0.2787	0.4499	0.2367	0.2210
REG2	0.2499	0.1986	0.2844	0.1103
REG3	0.2766	0.4478	0.2353	0.2141
RISK	0.6265	0.6075	0.6443	0.5393
PROFIT	0.3527	0.0323	0.0360	0.0363
BDR	0.7138	0.6795	0.7740	0.3544
PROV	0.0035	0.0041	0.0034	0.0029
SIZE	19.0965	20.5613	18.4739	20.4912
SDEBT	0.0052	0.0128	0.0028	0.0066
PCAP	0.0023	0.0013	0.0023	0.0039
MERG	0.0391	0.0257	0.0464	0.0150

Table 1b presents the means of these variables of the Bundesbank data set for each year of the reference period. On average, capital increases considerably in this time period, while portfolio risk increases marginally. Table 1c shows some descriptive statistics of the Bundesbank data set differentiating between the three banking groups. On average, *other banks* have a higher capital ratio than savings and cooperative banks. Another noteworthy fact is the high share of subordinate debt to total assets for savings banks. It seems that these banks compensate their lower equity capital ratio by issuing subordinate debt. We analyse this potential relationship in Section 7. Table 1d gives the correlations among the variables for the reference period. As in the study by Shrieves and Dahl (1992) for US-banks we find a negative correlation between portfolio risk and capital.

Table 1d: Correlations among the variables (Bundesbank data set)

	CAP1	CAP2	CAP3	RISK	PROFIT	BDR	PROV
CAP2	0.9770						
CAP3	0.9983	0.9787					
RISK	-0.0736	-0.0534	-0.0742				
PROFIT	0.3739	0.3532	0.3752	0.1394			
BDR	-0.3364	-0.3918	-0.3369	0.1238	0.0921		
PROV	-0.0287	-0.0047	-0.0292	0.1576	0.0628	-0.0114	
SIZE	-0.2093	-0.1330	-0.2081	-0.1284	-0.3020	-0.4503	0.0668

Some descriptive statistics of the Hoppenstedt data set are given in Tables 1e and 1f.

Table 1e: Number of observations and mean of variables by year (Hoppenstedt data set)

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	total
Obs.	925	997	1,012	1,024	1,023	1,030	1,021	1,023	965	876	9,896
sav. banks	385	433	448	455	456	451	446	441	419	368	4,302
coop. banks	261	290	293	293	295	308	316	320	295	284	2,955
other banks	279	274	271	276	272	271	259	262	251	224	2,639
CAP1	0.0501	0.0579	0.0589	0.0586	0.0588	0.0610	0.0609	0.0623	0.0610	0.0586	0.0589
CAP2	0.0664	0.0677	0.0702	0.0729	0.0743	0.0777	0.0776	0.0794	0.0783	0.0750	0.0740
CAP3	0.0646	0.0602	0.0603	0.0605	0.0606	0.0631	0.0628	0.0648	0.0638	0.0608	0.0621
CRWA1	0.1462	0.1407	0.1623	0.1488	0.1731	0.1638	0.1932	0.1648	0.1800	0.1649	0.1639
CRWA2	0.1811	0.1601	0.1796	0.1705	0.1962	0.1880	0.2169	0.1917	0.2065	0.1890	0.1880
CRWA3	0.1784	0.1491	0.1649	0.1520	0.1760	0.1672	0.1964	0.1705	0.1865	0.1696	0.1710
REG1	0.6281	0.4995	0.4852	0.4824	0.4966	0.4942	0.5260	0.4976	0.4694	0.4600	0.5035
REG2	0.6389	0.4162	0.3429	0.2822	0.2737	0.2650	0.2831	0.2483	0.2497	0.2432	0.3226
REG3	0.4757	0.4985	0.4842	0.4805	0.4946	0.4990	0.5299	0.4976	0.4694	0.4509	0.4888
RISK	0.6612	0.6708	0.6761	0.6815	0.6899	0.7019	0.7078	0.7096	0.7258	0.7256	0.6948
PROFIT	0.0355	0.0355	0.0341	0.0326	0.0328	0.0321	0.0324	0.0325	0.0883	0.0321	0.0386
BDR	0.6290	0.6457	0.6324	0.6198	0.6196	0.6147	0.6157	0.5996	0.5855	0.6046	0.6168
PROV	0.0014	0.0038	0.0066	0.0044	0.0042	0.0042	0.0033	0.0247	0.0245	0.0048	0.0059
SIZE	20.3869	20.4535	20.5433	20.6057	20.6829	20.7219	20.7717	20.8391	20.9300	21.0600	20.6967
SDEBT	0.0000	0.0052	0.0072	0.0094	0.0106	0.0112	0.0114	0.0115	0.0114	0.0112	0.0090
PCAP	0.0017	0.0022	0.0027	0.0030	0.0031	0.0033	0.0033	0.0031	0.0031	0.0029	0.0028
MERG	0.0022	0.0000	0.0119	0.0088	0.0137	0.0087	0.0264	0.0078	0.0093	0.0114	0.0101

Table 1f: Mean of variables by banking groups (Hoppenstedt data set)

	all banks	sav. banks	coop. banks	*other banks*
CAP1	0.0589	0.0412	0.0463	0.1018
CAP2	0.0740	0.0555	0.0561	0.1241
CAP3	0.0621	0.0408	0.0474	0.1133
REG1	0.5035	0.6813	0.3922	0.3384
REG2	0.3226	0.4014	0.3117	0.2061
REG3	0.4888	0.6953	0.3658	0.2899
RISK	0.6948	0.7235	0.7092	0.6319
PROFIT	0.0386	0.0320	0.0324	0.0564
BDR	0.6168	0.6872	0.7450	0.3586
PROV	0.0059	0.0044	0.0040	0.0106
SIZE	20.6967	20.9571	20.2359	20.7882
SDEBT	0.0090	0.0133	0.0045	0.0069
PCAP	0.0028	0.0014	0.0041	0.0038
MERG	0.0101	0.0081	0.0183	0.0042

For the final specification of our model, we decided to insert both the current and lagged values of the explanatory variables into the capital equation as specification tests (Sargan tests) recommend a more general specification. The final specification of the equation explaining the unobservable capital target is as follows:

$$\begin{aligned} CAP^{*}_{j,t} &= \sum_{p} \lambda_p X_t + \sum_{p} \gamma_p X_{t-1} + u_{j,t} \\ &= \lambda_1 RISK_{j,t} + \gamma_1 RISK_{j,t-1} + \lambda_2 PROFIT_{j,t} + \gamma_2 PROFIT_{j,t-1} \\ &\quad + \lambda_3 BDR_{j,t} + \gamma_3 BDR_{j,t-1} + \lambda_4 PROV_{j,t} + \gamma_4 PROV_{j,t-1} \\ &\quad + \gamma_5 REG_{j,t-1} + \lambda_5 MERG_t + \lambda_6 SIZE_{j,t} + u_{j,t} \end{aligned} \tag{5}$$

For bank size, only the current value is used in the regression. The effect of lagged size on the capital ratio is of minor importance here. Furthermore, including lagged size in the equation would result in a multicollinearity problem, as current size is very strongly correlated with lagged size, while the correlation is smaller in case of the other explanatory variables. In contrast, we only include the lagged value of the dummy variable *REG* into our equation. Regulatory pressure in the previous year can lead the bank to increase the capital ratio in the next year. However, including the current dummy variable instead of the lagged dummy variable in the equation would lead to a potential problem of simultaneity: a bank getting under regulatory pressure in period t is unlikely to have increased its capital ratio above average in period t.

The model to be estimated is given by equations (4-5). The coefficients of the regressors depict the dynamic short-term relationship between the bank capital ratio and its determinants. To examine the long-run relationship, the speed of adjustment α has to be taken into account. The long-run coefficients of the determinants can be obtained as follows:

$$
\begin{aligned}
CAP^{*}_{j,t} = & \left[\frac{\lambda_1+\gamma_1}{1-\alpha}\right] RISK^{*}_{j,t} + \left[\frac{\lambda_2+\gamma_2}{1-\alpha}\right] PROFIT^{*}_{j,t} + \\
& \left[\frac{\lambda_3+\gamma_3}{1-\alpha}\right] BDR^{*}_{j,t} + \left[\frac{\lambda_4+\gamma_4}{1-\alpha}\right] PROV^{*}_{j,t} + \\
& \left[\frac{\gamma_5}{1-\alpha}\right] REG^{*}_{j,t-1} + \left[\frac{\lambda_5}{1-\alpha}\right] MERG^{*}_{j,t} + \left[\frac{\lambda_6}{1-\alpha}\right] SIZE^{*}_{j,t}
\end{aligned} \tag{6}
$$

The coefficients of the explanatory variables marked with (*) denote the long-term relationship between the determinants and the target capital ratio $CAP^{*}_{j,t}$. The coefficients (λ_t, γ_t and α) are those calculated by using the dynamic estimation of equation (4) together with equation (5).

5.2 Considering the panel structure

In contrast to previous empirical studies by Shrieves and Dahl (1992), Jacques and Nigro (1997), Aggarwal and Jacques (2001) and Rime (2001), we consider the panel structure of the data set explicitly when estimating the model. Otherwise regarding the observations of an individual bank as independent from each other may result in biased coefficients. Indeed, the Breusch-Pagan test of poolability of the panel data indicates the inappropriateness of pooling the panel data. The Hausman test rejects the random effects assumption. That means that using fixed effects provides consistent estimators, while using random effects does not. We thus take account of the panel structure by adding fixed bank specific effects to equation (4). We assume that the $\varepsilon_{j,t}$ follow a one-way error component model:

$$\varepsilon_{j,t} = \mu_j + \nu_{j,t}\,. \tag{7}$$

The $\mu_{j,t}$ denote the fixed bank specific effects, the $\nu_{j,t}$ the residual error, where $\nu_{j,t} \sim IID(0,\sigma_\nu^2)$. Considering the panel structure of the data set within the fixed effects model results in some econometric problems. As there is a lagged dependent variable ($CAP_{j,t-1}$) on the right side of the equation (4), $CAP_{j,t-1}$ is correlated with the individual specific effects by construction. Accordingly, the estimation results are biased (see Nickell (1981)). A possible solution suggested by Anderson and Hsiao (1982) is to remove the individual specific effects by first differencing the equation. But the problem of correlation remains persistent. Now the differenced lagged dependent variable $\Delta CAP_{j,t-1}$ is correlated with the differenced error term. Instrumental-variable techniques can solve this problem. Anderson and Hsiao (1982) suggest to use $CAP_{j,t-2}$ as an instrument for $\Delta CAP_{j,t-1}$. While $CAP_{j,t-2}$ is correlated with $\Delta CAP_{j,t-1}$ by construction, it is not correlated with the differenced error, as long as the error term is not serially correlated. The estimator is consistent now, but not efficient, as not all available moment restrictions are used. Arellano und Bond (1991) suggest to use further lagged variables as instruments within a GMM-model. GMM enables to optimally exploit the orthogonality conditions between the lagged dependent variable and the disturbances.

An important advantage of GMM is the fact that it allows to consider explicitly the endogeneity not only of the lagged dependent variable but also of other right-hand variables. Thus the endogeneity of portfolio risk as a possibly important determinant of capital can be taken into account. As mentioned, theory suggests that portfolio risk and capital are interrelated, i.e. portfolio risk is endogenous in the capital equation. Additionally, Berger (1995) assumes that profitability is affected by capital. Thus *PROFIT* has to be endogenous as well in our capital equation. As we employ balance sheet and profit and loss account information, the endogeneity of further variables may be suspected. We performed Durbin-Wu-Hausman-tests to decide whether variables have to be taken as exogenous or endogenous. Additionally, the Sargan test gives some evidence whether the variables are better modelled as exogenous, predetermined or endogenous. These tests suggest to regard not only portfolio risk as endogenous, but all other explanatory variables as well.[15]

Potential pitfalls using GMM are the following. Firstly, the error term must not be serially correlated of order one. After first differencing, the error term must not be serially correlated of order two. Absence of second order correlation of the residuals in first differences is of crucial importance for the consistency of the GMM estimators. It is a necessary condition to use the regressors in levels lagged two periods (e.g. $CAP_{j,t-2}$) as instruments for the regressors in differences (e.g. $\Delta CAP_{j,t-1}$). Pre-

[15] We had to regard $MERG_t$ as exogenous, as we could not find suitable instruments for this dummy variable.

sence of second-order correlation would imply that these instruments are invalid, as they are correlated with the error term. The test statistic for the first and second order autocorrelation of residuals is asymptotically distributed as N(0,1) under the null hypothesis of no serial correlation. Secondly, suitable instruments for the whole set of endogenous or predetermined explanatory variables have to be found. Therefore, the validity of the over-identifying restrictions has to be tested. The Sargan test of over-identifying restrictions tests the validity of the set of instruments. It is used to check whether the whole set of instruments is correlated with the residuals. The test statistic of the Sargan test is asymptotically distributed as χ^2(df) under the null hypothesis of instruments' validity. If the over-identifying restrictions, that is the orthogonality conditions between the instruments and the residuals, are valid, the validity of the instrument set is confirmed. Violation of the Sargan test would shed doubt on the specification of the model.

Arellano and Bover (1995) argue that the GMM model in first differences described above (GMM-DIF) may suffer from weak instruments. As a consequence, poor estimation precision may result. They propose to use instruments in first differences for equations in levels in addition to using instruments in levels for equations in first differences. Blundell and Bond (1998) recommend using this extended linear GMM (GMM-SYS) when the coefficient of the lagged dependent variable is close to one. We estimated both GMM-DIF and GMM-SYS, but decided to stick with GMM-DIF as the Sargan test shed more doubt on the validity of the over-identifying restrictions in case of the extended set of instruments of GMM-SYS.

All calculations were conducted with Stata/SE 8.0 for Windows and DPD in OxPack for GiveWin 2.10. The test for second-order correlation nearly always confirms that the second lags of the regressors are not correlated with the error term. Thus the lagged dependent variable and other lagged explanatory variables can be instrumented by their lagged values from lag two. We use the two-step version of the GMM estimator to obtain the Sargan test statistics, as the one-step version of the Sargan test overrejects the validity of the set of instruments in presence of heteroskedasticity (see Arellano and Bond (1991)). As recommended by Arellano and Bond (1991), the autocorrelation tests for the residuals and the coefficient estimates are based on the one-step version.

6 Results

6.1 Preliminary evidence

Before estimating the dynamic model within the GMM-framework, we take a step back and estimate equation (4) together with equation (5) with the help of a simple fixed effects model to obtain a first impression of the determinants of the bank capital ratio. Here, all right-hand variables are treated as exogenous, none of them are instrumented. We ignore the Nickell-Bias and the potential endogeneity of right-hand variables. As a consequence, we may get coefficients that are potentially biased.

Table 2a: Simple fixed effects regression results for *CAP1*

	Results for CAP1 (to total assets)							
	all banks		savings banks		cooperative banks		*other banks*	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
$CAP1_{t-1}$	0.3493 ***	0.000	0.7755 ***	0.000	0.8115 ***	0.000	0.2479 ***	0.000
$RISK_t$	-0.0083 ***	0.000	0.0176 ***	0.000	0.0112 ***	0.000	-0.0416 **	0.015
$RISK_{t-1}$	0.0237 **	0.017	-0.0091 ***	0.000	-0.0147 ***	0.000	0.0194	0.270
$PROFIT_t$	0.6358 ***	0.000	0.1092 ***	0.000	0.2163 ***	0.000	0.5412 ***	0.000
$PROFIT_{t-1}$	-0.2384 ***	0.000	0.0135	0.275	0.0054	0.704	-0.1196 *	0.053
BDR_t	-0.1325 ***	0.000	0.0219 ***	0.000	-0.0083 ***	0.000	-0.2023 ***	0.000
BDR_{t-1}	0.0334 ***	0.000	-0.0291 ***	0.000	-0.0189 ***	0.000	0.1362 ***	0.000
$PROV_t$	0.1587 ***	0.000	-0.0171 **	0.038	-0.0029	0.749	0.4847 ***	0.000
$PROV_{t-1}$	0.1052 ***	0.000	-0.0857 ***	0.000	-0.0546 ***	0.000	0.1904 **	0.013
$REG1c_{t-1}$	-0.0050 ***	0.000	-0.0002 **	0.024	0.0003 **	0.039	0.0059	0.215
$MERG_t$	0.0065 ***	0.000	-0.0008 ***	0.000	0.0009 ***	0.000	0.0145 ***	0.000
$SIZE_t$	-0.0192 ***	0.000	0.0010 ***	0.000	-0.0008 ***	0.000	-0.0541 *	0.097
cons	0.4477 ***	0.000	-0.0153 ***	0.002	0.0408 ***	0.000	1.2075 ***	0.000
Observations	25,054		5,124		17,485		2,445	
Banks	2,971		590		2,089		292	
R^2 within	0.2838		0.7483		0.6978		0.3690	
R^2 between	0.6241		0.9395		0.9628		0.5706	
R^2 overall	0.553		0.9059		0.9031		0.5060	

Note: These are fixed effects regression results relating explanatory variables to *CAP1* for several samples of banks. All regressions include time dummies. *, **, *** indicates significance at the 0.10, 0.05, and 0.01 levels, respectively.

The regression results presented in Table 2a and 2b are differentiated on the one hand between several subsamples of banks, the savings banks, the cooperatives and the *other banks*, and on the other hand between both definitions of capital. For all definitions of the capital ratio, the results indicate that the speed of adjustment is much larger for *other banks* than for savings banks and cooperative banks, as the coefficient of $CAP_{j,t-1}$ is much lower for *other banks*. The fact that *other banks* can adjust capital to their target capital ratio more quickly can be explained by their easier access to the capital market. To reach their capital target quickly, they can issue new shares on the financial market or sell investments to reduce liabilities.

Table 2b: Simple fixed effects regression results for *CAP2*

	Results for CAP2 (to total assets)							
	all banks		savings banks		cooperatives		*other banks*	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
$CAP2_{t-1}$	0.3852 ***	0.000	0.6952 ***	0.000	0.7691 ***	0.000	0.2692 ***	0.000
$RISK_t$	0.0019	0.585	0.0219 ***	0.000	0.0136 ***	0.000	-0.0188	0.273
$RISK_{t-1}$	0.0215 ***	0.000	-0.0070 **	0.026	-0.0163 ***	0.000	0.0066	0.709
$PROFIT_t$	0.6678 ***	0.000	0.1362 ***	0.000	0.1966 ***	0.000	0.5861 ***	0.000
$PROFIT_{t-1}$	-0.2879 ***	0.000	0.0761 **	0.019	0.0184	0.261	-0.1525 **	0.015
BDR_t	-0.1320 ***	0.000	0.0154 ***	0.000	-0.0218 ***	0.000	-0.1942 ***	0.000
BDR_{t-1}	0.0357 ***	0.000	-0.0216 ***	0.000	-0.0097 ***	0.000	0.1356 ***	0.000
$PROV_t$	0.1908 ***	0.000	-0.0266	0.213	0.0269 **	0.010	0.5487 ***	0.000
$PROV_{t-1}$	0.1190 ***	0.000	-0.1034 ***	0.000	-0.0515 ***	0.000	0.2128 ***	0.006
$REG2c_{t-1}$	-0.0061 ***	0.000	0.0014 ***	0.000	0.0005 ***	0.000	-0.0072	0.122
$MERG_t$	0.0062 ***	0.000	-0.0010 **	0.020	0.0008 ***	0.000	0.0173 *	0.050
$SIZE_t$	-0.0202 ***	0.000	0.0007	0.272	-0.0023 ***	0.000	-0.0534 ***	0.000
cons	0.4647 ***	0.000	-0.0064	0.626	0.0737 ***	0.000	1.1922 ***	0.000
Observations	25,054		5,124		17,485		2,445	
Banks	2,971		590		2,089		292	
R^2 within	0.3178		0.7295		0.6875		0.3768	
R^2 between	0.5898		0.9252		0.9318		0.5572	
R^2 overall	0.5212		0.8369		0.8672		0.4911	

Note: These are fixed effects regression results relating explanatory variables to *CAP2* for several samples of banks. All regressions include time dummies. *, **, *** indicates significance at the 0.10, 0.05, and 0.01 levels, respectively.

Furthermore, the results indicate that portfolio risk (for savings and cooperative banks) and profitability positively influence the capital ratio. Thus we have first evidence that both *H1B* and *H2* are correct. For the *other banks* we do not obtain a significant and positive relationship between portfolio risk and the capital ratio. As *other banks* have a considerably higher capital ratio on average, they might not be forced to raise capital when increasing portfolio risk.

Even the results for the bank deposit ratio (*BDR*) vary for the different banking groups. We expected a negative relationship as banks should make a greater (smaller) effort to raise capital when their bank deposit ratio decreases (increases). Indeed, we find a negative and significant effect of *BDR* on the capital ratio for the cooperative and *other banks*.

Provisions (*PROV*) have a negative impact on the bank capital ratio for the savings and cooperative banks, but a positive one for the *other* banks. Probably this result is due to the latters' ability to issue new shares or to sell investments on the capital market even in a state of bad financial health.

The results for the dummy variable *REG* show a positive effect of regulatory pressure on the capital ratio for the cooperative banks, but mixed results for the savings banks. Although these results may be simply due to the potential specification error, they may indicate that savings banks have greater difficulties in increasing the capital ratio in case of regulatory pressure. Savings banks rely on retained earnings and issuing subordinate debt or hybrid capital to increase capital.

The merger dummy variable *MERG* is positive for cooperative banks and *other banks* but negative for savings banks. That result implies that merger have a positive effect on the capital ratio for cooperative banks and *other banks*. Increasing the capital ratio may have been a motivation behind the mergers for these banks. The negative effect for savings banks may be the consequence of financial distress prevention among savings banks. Well capitalised savings banks may merge with badly capitalised banks to relieve these banks from financial distress. As a recent example, the savings bank of Weinheim merged with the savings bank of Mannheim in the end of 2000, because the latter had been in financial distress.

Size has a negative impact on the capital ratio for cooperative banks and *other banks*. However, we find a significant and positive coefficient for savings banks in case of *CAP2*. Accordingly, our hypothesis *H3* is confirmed for the cooperative banks and *other banks*, but not for the savings banks. This result coincides with our expectations. We assumed that the negative size effect may be smaller for savings banks due to their specific institutional conditions.

6.2 GMM-Results

Tables 3a and 3b show the GMM-results for the dynamic short run model given by equations (4) and (5). Now, we explicitly consider the potential endogeneity of the explanatory variables. Again, it is differentiated on the one hand between savings banks, cooperative and *other banks*, and on the other hand between both definitions of capital.

We consciously interprete only the coefficients of the model for the savings banks and the *other banks*, as the specification tests for these subsamples do not shed any doubt on the specification of the model (exemption: *CAP2*-model for the savings banks). In these cases the test for no autocorrelation in residuals of order two is always insignificant. This is a necessary condition to get consistent GMM estimators. Furthermore, the Sargan test of over-identifying restrictions is always insignificant in these cases and signals the validity of the set of instruments.

Table 3a: Dynamic GMM-DIF-regression for *CAP1*

	Results for CAP1 (to total assets)							
	all banks		savings banks		cooperative banks		*other banks*	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
$CAP1_{t-1}$	0.2165 ***	0.006	0.6596 ***	0.000	0.6600 ***	0.000	0.1333 *	0.096
$RISK_t$	-0.0192	0.793	0.0180 ***	0.000	0.0606 **	0.032	-0.0045	0.961
$RISK_{t-1}$	0.0609	0.332	-0.0054	0.222	-0.0352 **	0.048	0.1020	0.111
$PROFIT_t$	0.1603	0.275	0.1147 **	0.017	-1.2582	0.368	0.0582	0.692
$PROFIT_{t-1}$	0.0562	0.601	0.0482	0.136	1.2128	0.218	-0.0005	0.996
BDR_t	-0.2521 ***	0.002	0.0302 ***	0.000	-0.1265 *	0.095	-0.3132 ***	0.000
BDR_{t-1}	0.2687 ***	0.000	-0.0312 ***	0.000	-0.0045	0.835	0.2101 ***	0.001
$PROV_t$	1.0144 **	0.021	-0.0192	0.572	-0.0362	0.294	1.0594 ***	0.005
$PROV_{t-1}$	0.1428	0.110	-0.0507 ***	0.001	0.0274	0.563	0.2443 *	0.078
$REG1c_{t-1}$	0.0010 *	0.096	0.0001	0.173	-0.0001	0.836	0.0061 **	0.034
$MERG_t$	0.0357 ***	0.000	-0.0004	0.719	0.0150 *	0.065	0.0247 *	0.078
$SIZE_t$	-0.0930 ***	0.000	0.0004	0.833	-0.0387 *	0.080	-0.1114 ***	0.000
cons	0.0035	0.197	0.0005 **	0.020	0.0017	0.286	0.0040	0.177
Observations	22,083		4,534		15,396		2,153	
Banks	2,971		590		2,089		292	
Sargan (df)	476(241)	0.00	256(241)	0.25	387(241)	0.00	261(241)	0.18
AR(1)	-4.33	0.00	-7.32	0.00	-1.54	0.12	-3.53	0.00
AR(2)	-0.89	0.37	-1.10	0.27	1.02	0.31	-1.11	0.27

Note: These are GMM regression results relating explanatory variables to *CAP1* for several samples of banks. Estimates are obtained using the Arellano and Bond (1991) method. All regressions include time dummies. Instruments begin with the third lag. P-values are calculated on the basis of standard errors robust to general cross-section and time-series heteroskedasticity. As recommended by Arellano and Bond, one-step results are presented, whereas the Sargan test refers to the two-step estimation results. AR(1) and AR(2) are the tests of first and second order autocorrelation in the residuals. *, **, *** indicates significance at the 0.10, 0.05, and 0.01 levels, respectively.

Table 3b: Dynamic GMM-DIF-regression for *CAP2*

	Results for CAP2 (to total assets)							
	all banks		savings banks		cooperative banks		*other banks*	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
$CAP2_{t-1}$	0.2078 ***	0.008	0.6231 ***	0.000	0.6427 ***	0.000	0.1221 *	0.087
$RISK_t$	-0.0032	0.964	0.0485 ***	0.000	0.0656 **	0.018	-0.0172	0.846
$RISK_{t-1}$	0.0550	0.374	-0.0180	0.124	-0.0324 *	0.084	0.0840	0.201
$PROFIT_t$	0.2085	0.170	0.5850 ***	0.000	-1.2697	0.374	0.1064	0.472
$PROFIT_{t-1}$	0.1116	0.360	-0.0382	0.639	1.1785	0.240	0.0247	0.825
BDR_t	-0.2312 ***	0.006	0.0110	0.392	-0.1427 **	0.046	-0.2829 ***	0.001
BDR_{t-1}	0.2627 ***	0.000	-0.0121	0.315	-0.0022	0.926	0.2103 ***	0.001
$PROV_t$	0.8762 **	0.048	-0.0901	0.273	0.0485	0.210	1.0477 ***	0.007
$PROV_{t-1}$	0.1919 **	0.033	0.0062	0.868	0.0383	0.664	0.2843 **	0.048
$REG2c_{t-1}$	0.0010	0.356	0.0011 ***	0.000	0.0005 *	0.079	0.0132 *	0.070
$MERG_t$	0.0362 ***	0.000	0.0009	0.709	0.0141 *	0.059	0.0305 *	0.058
$SIZE_t$	-0.0941 ***	0.000	0.0024	0.623	-0.0381 *	0.061	-0.1109 ***	0.000
cons	0.0045	0.111	-0.0038 ***	0.000	0.0008	0.604	0.0046	0.144
Observations	22,083		4,534		15,396		2,153	
Banks	2,971		590		2,089		292	
Sargan (df)	479(241)	0.00	345(241)	0.00	411(241)	0.00	250(241)	0.34
AR(1)	-4.07	0.00	-7.84	0.00	-1.72	0.09	-3.49	0.00
AR(2)	-0.74	0.46	-1.00	0.32	0.44	0.66	-0.94	0.35

Note: These are GMM regression results relating explanatory variables to *CAP2* for several samples of banks. Estimates are obtained using the Arellano and Bond (1991) method. All regressions include time dummies. Instruments begin with the third lag. P-values are calculated on the basis of standard errors robust to general cross-section and time-series heteroskedasticity. As recommended by Arellano and Bond, one-step results are presented, whereas the Sargan test refers to the two-step estimation results. AR(1) and AR(2) are the tests of first and second order autocorrelation in the residuals. *, **, *** indicates significance at the 0.10, 0.05, and 0.01 levels, respectively.

In contrast, the Sargan test is significant and sheds doubt on the specification in the case of the cooperative banks. Problems with the specification arise mainly in case of the larger samples of all cooperative banks and all banks. Obviously the size of the sample is an important factor leading to significant Sargan tests. The Sargan test confirms the validity of the set of instruments for the cooperative banks if 70 percent of all cooperative banks (the smaller ones) are dropped. As the Sargan tests for alternative smaller samples are insignificant, we maintain the specification of the model.

On the whole, the GMM-results are rather similar to those obtained with the fixed effects model, although there are some remarkable differences. As a point in common the lagged capital ratio has a positive and significant impact on the capital ratio, confirming the existence of dynamics in the model. The regression results for *CAP1* and *CAP2* indicate that there is a much faster adjustment of the capital ratio for *other banks* compared to savings banks. For *CAP1*, it is 0.87 in the case of *other banks* (1-0.1333) and 0.34 in the case of savings banks (1-0.6596). This result is due to the greater volatility of *CAP* in the case of *other banks* compared to savings banks. Here again, we can argue that *other banks* can adjust capital to their target capital more quickly as they can issue new shares on the financial market or can sell investments to reduce liabilities.

The results for the variable *RISK* indicate a positive relationship between portfolio risk and the capital ratio for savings banks, confirming our hypothesis *H1B*. No evidence for hypothesis *H1A* was found. That is why the deposit insurance has a minor importance not only for savings banks but even for *other banks*. The result additionally emphasises the importance of controlling for other (endogenous) explanatory variables, as the correlation between portfolio risk and the capital ratio is negative (see Table 1d). Contrary to the previous empirical literature we do not find a significant relationship between the capital ratio and portfolio risk for all banks. Nevertheless, the result is not implausible. As *other banks* have generally more excess capital than savings banks (see Table 1c), they are less likely to be subject to the regulatory constraint and may raise portfolio risk while decreasing the capital ratio.

As contrasted to the preliminary evidence, profitability has a positive and significant effect on capital only for savings banks, giving some evidence in support of the hypothesis *H2*. As expected, profitability is of greatest importance for the savings banks. These banks may be more dependent on internal profits than *other banks* to increase capital, as they have less alternatives to raise capital than *other banks*. The magnitude of the coefficient indicates that current *PROFIT* is an important determinant of capital for savings banks.

The results for the banks' deposit ratio (*BDR)* as a potential signal of future profits are mixed. We find no negative relationship between *BDR* and the capital ratio for savings banks but for *other banks*. For the latter banks a further explanation may hold: This banking group comprises German universal banks with a low capital ratio and a high deposit ratio as well as special banks with a high capital ratio and a small deposit ratio. Thus the negative coefficient for *other banks* may be just due to heterogeneity. Our expectation that banks make a greater (smaller) effort to raise capital when their deposit ratio decreases (increases) thus cannot be confirmed with certainty.

The results regarding the relationship between the ratio of provisions to total assets (*PROV*) and the capital ratio are mixed. There is some evidence of an overall negative relationship between *PROV* and the capital ratio for savings banks. That could mean that these banks cannot increase capital to a large extent if the amount of provisions in the previous year indicates bad financial health. Here again, the limited possibilities of the savings banks to increase capital may have led to that result. For *other banks*, we obtain a positive effect of provisions on the capital ratio. Possibly *other banks* issue new shares in bad financial health or sell investments to reduce liabilities. Dahl and Shrieves (1990) show for instance that undercapitalised banks were more likely to issue equity capital than adequately capitalised banks. That finding could be valid for banks with a large amount of provisions as well. Indeed, we can confirm the finding that *other banks* with *CAP1*<6 percent increase subscribed capital stronger than other banks, but we cannot find any significant impact of *PROV* on the ratio of subscribed capital to total assets. Issuing new shares in bad financial health thus does not appear to be important. Alternatively, highly profitable banks may retain their earnings to increase the capital ratio substantially in bad financial health. Indeed, interacting *PROV* with an additional dummy variable being unity for highly profitable banks shows that the positive relationship between *PROV* and the capital ratio for *other banks* is mainly due to highly profitable banks. That is why the *other banks'* rise of the capital ratio in bad financial health is mainly due to retained earnings.

The dummy variable *REG* for regulatory pressure gives some evidence that the behaviour of banks whose capital is close to the regulatory minimum behave in a different way than better capitalised banks. Unlike the preliminary evidence, we obtain significant and positive coefficients for savings banks and *other banks* in case of *CAP2*, but significant and positive coefficients only for *other banks* in case of *CAP1*. This fact suggests that savings banks under regulatory pressure try to leave the zone of regulatory pressure by issuing subordinate debt or hybrid capital.

The dummy variable *MERG* remains positive and significant for *other banks*, but becomes insignificant for savings banks. Possibly mergers among *other banks* are motivated by increasing the capital ratio.

The results for *SIZE* are in line with the preliminary evidence. They implicate an overall negative relationship between *SIZE* and the capital ratio, confirming our hypothesis *H3*. Accordingly the larger the bank, the lower is the bank capital target.

This negative relationship holds for *other banks* but does not for the savings banks. For these banks, some arguments in favour of a negative relationship between *SIZE* and the capital ratio do not hold. As described under hypothesis *H3*, the different institutional conditions of the savings banks may lead to the insignificant size effect for savings banks.

6.2.1 Long-term effects

So far we have considered only the results from short-term dynamics and have neglected the static long-term results according to equation (6). These are reported in Tables 3c and 3d on the basis of the estimation results presented in Tables 3a and 3b. The results are very similar to those obtained from the short-term dynamic capital structure model.

Table 3c: Static long-term effects on *CAP1* using GMM-DIF

	Results for CAP1 (to total assets)			
	all banks	savings banks	coop. banks	*other banks*
	Coefficient	Coefficient	Coefficient	Coefficient
$RISK_t$	0.0533	0.0371 ***	0.0748 **	0.1125
	(0.0381)	(0.0089)	(0.0296)	(0.0874)
$PROFIT_t$	0.2764	0.4785 ***	-0.1337	0.2251
	(0.2156)	(0.1510)	(1.2644)	(0.1859)
BDR_t	0.0211	-0.0029	-0.3854 ***	-0.1189
	(0.0620)	(0.0108)	(0.1032)	(0.0760)
$PROV_t$	1.4770 **	-0.2052 *	-0.0258	1.5042 ***
	(0.6612)	(0.1196)	(0.1372)	(0.5718)
$REG1c_{t-1}$	0.0013	0.0002	-0.0002	0.0070 **
	(0.0008)	(0.0002)	(0.0007)	(0.0032)
$MERG_t$	0.0456 ***	-0.0011	0.0440 ***	0.0286 *
	(0.0079)	(0.0031)	(0.0165)	(0.0163)
$SIZE_t$	-0.1187 ***	0.0012	-0.1137 **	-0.1286 ***
	(0.0213)	(0.0059)	(0.0463)	(0.0205)
Observations	22,083	4,534	15,396	2,153
Banks	2,971	590	2,089	292

Note: This Table refers to Table 3a and shows the long-run effects of the explanatory variables on *CAP1*. Asymptotic standard errors are in parentheses. *, **, *** indicates significance at the 0.10, 0.05, and 0.01 levels, respectively.

Table 3d: Static long-term effects on *CAP2* using GMM-DIF

	Results for CAP2 (to total assets)			
	all banks	savings banks	coop. banks	*other banks*
	Coefficient	Coefficient	Coefficient	Coefficient
$RISK_t$	0.0654 *	0.0810 ***	0.0928 ***	0.0761
	(0.0397)	(0.0212)	(0.0283)	(0.0816)
$PROFIT_t$	0.4041 *	1.4509 ***	-0.2552	0.1493
	(0.2208)	(0.3098)	(1.2275)	(0.1863)
BDR_t	0.0397	-0.0029	-0.4053 ***	-0.0827
	(0.0603)	(0.0255)	(0.1128)	(0.0714)
$PROV_t$	1.3483 **	-0.2228	0.2429	1.5173 ***
	(0.6401)	(0.2363)	(0.2181)	(0.5611)
$REG2c_{t-1}$	0.0013	0.0028 ***	0.0015 *	0.0151 *
	(0.0014)	(0.0007)	(0.0009)	(0.0084)
$MERG_t$	0.0457 ***	0.0024	0.0395 **	0.0347 *
	(0.0083)	(0.0065)	(0.0170)	(0.0185)
$SIZE_t$	-0.1188 ***	0.0063	-0.1067 **	-0.1263 ***
	(0.0219)	(0.0129)	(0.0465)	(0.0201)
Observations	22,083	4,534	15,396	2,153
Banks	2,971	590	2,089	292

Note: This Table refers to Table 3b and shows the long-run effects of the explanatory variables on *CAP2*. Asymptotic standard errors are in parentheses. *, **, *** indicates significance at the 0.10, 0.05, and 0.01 levels, respectively.

As in the short-term model, portfolio risk has a positive and significant long-term impact on the capital ratio for savings banks, as these banks usually have a small buffer of regulatory capital and are forced to increase capital with portfolio risk. Profitability has a positive and significant effect on capital only for savings banks. This result is plausible, since savings banks are particularly dependent on profits to raise capital.

The bank deposit ratio to total assets has no significant long-term effect on the capital ratio both for savings banks and *other banks*. Provisions have a negative long-term impact on the capital ratio for savings banks, as these banks have limited possibilities to increase capital in bad financial health. In contrast, provisions have a significant and positive effect on the capital ratio for *other banks*. As in the short-term model, the dummy variable *REG* signalling regulatory pressure is significant and positive for all banking groups in case of *CAP2*, but only for the *other banks* in case of *CAP1*. The merger variable *MERG* is significant and positive for the *other banks* but insignificant for the savings banks in the long term. The size of the bank has a significant and negative long-run impact on capital for *other banks*, but no long-run effect for savings banks.

6.2.2 Robustness check

First of all, we exclude those banks from the data set, which exhibit a very high regulatory capital ratio and thus may behave in another way than the "typical" German universal bank. We assume that a ratio of Tier 1 capital to risk-weighted assets (*CRWA3*) greater than 20 percent may indicate an appropriate threshold to define banks as outliers. We also tested for other thresholds, but found very similar results. Tables 4a to b (Tables 4c to d) present the short-term (long-term) results for the data set without these outliers. As a result, mainly *other banks* are dropped. The coefficients of the lagged dependent variable, CAP_{t-1}, become alike for the different banking groups. But even here, the speed of adjustment for savings banks is lower than for *other banks*. In contrast to Tables 3a to b, current *RISK* becomes significant and positive for *other banks*, indicating that banks with $CRWA3 \leq 0.2$ are exposed to capital regulation more strongly. Furthermore, the result suggests that *other banks* do not have an own incentive to increase capital with portfolio risk. Additionally, we obtain some evidence for a positive relationship between the bank deposit ratio and the capital ratio in case of this less heterogeneous subsample of *other banks*. The result suggests that these banks increase (decrease) their effort to raise the capital ratio, if a rise (decline) in the bank deposit ratio is suggesting higher (lower) future profits.

The merger variable turns insignificant for *other banks* when those banks with a high regulatory capital ratio are ignored. It suggests that banks with a lower capital ratio do not increase their capital ratio by mergers. The size effect remains negative and significant for *other banks*, but insignificant for savings banks.

Table 4a: Dynamic GMM-DIF-regression for *CAP1 without "outliers"*

	Results for CAP1 (to total assets)							
	all banks		savings banks		cooperative banks		*other banks*	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
$CAP1_{t-1}$	0.5969 ***	0.000	0.6596 ***	0.000	0.5946 ***	0.000	0.4239 ***	0.000
$RISK_t$	0.0589 ***	0.000	0.0180 ***	0.000	0.0292 ***	0.000	0.0606 ***	0.003
$RISK_{t-1}$	-0.0387 ***	0.000	-0.0054	0.222	-0.0180 ***	0.000	-0.0322 **	0.020
$PROFIT_t$	0.1070	0.160	0.1147 **	0.017	0.2867 ***	0.000	0.0273	0.803
$PROFIT_{t-1}$	-0.0360	0.515	0.0482	0.136	-0.1211 ***	0.002	-0.1521 *	0.098
BDR_t	0.0248 *	0.060	0.0302 ***	0.000	0.0091	0.263	0.0262 *	0.089
BDR_{t-1}	-0.0283 **	0.017	-0.0312 ***	0.000	-0.0097	0.147	-0.0088	0.475
$PROV_t$	0.2016 ***	0.001	-0.0192	0.572	0.0169	0.804	0.2463 *	0.065
$PROV_{t-1}$	-0.0595 ***	0.002	-0.0507 ***	0.001	-0.0469 **	0.012	-0.0604	0.155
$REG1c_{t-1}$	-0.0001	0.152	0.0001	0.173	-0.0001	0.449	0.0020 ***	0.002
$MERG_t$	0.0019	0.008	-0.0004	0.719	-0.0014 *	0.054	0.0023	0.378
$SIZE_t$	-0.0051 ***	0.002	0.0004	0.833	0.0046 **	0.025	-0.0114 ***	0.005
cons	0.0003	0.270	0.0005 **	0.020	0.0004	0.156	0.0009	0.259
Observations	21,261		4,534		15,344		1,383	
Banks	2,859		590		2,083		186	
Sargan (df)	430(241)	0.00	256(241)	0.25	423(241)	0.00	176(241)	1.00
AR(1)	-8.49	0.00	-7.32	0.00	-9.15	0.00	-3.69	0.00
AR(2)	-0.43	0.67	-1.10	0.27	-0.96	0.34	-0.19	0.85

Note: These are GMM regression results relating explanatory variables to *CAP1* for several samples of banks. Estimates are obtained using the Arellano and Bond (1991) method. All regressions include time dummies. Instruments begin with the third lag. P-values are calculated on the basis of standard errors robust to general cross-section and time-series heteroskedasticity. As recommended by Arellano and Bond, one-step results are presented, whereas the Sargan test refers to the two-step estimation results. AR(1) and AR(2) are the tests of first and second order autocorrelation in the residuals. *, **, *** indicates significance at the 0.10, 0.05, and 0.01 levels, respectively.

Table 4b: Dynamic GMM-DIF-regression for *CAP2 without "outliers"*

	Results for CAP2 (to total assets)							
	all banks		savings banks		cooperative banks		*other banks*	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
$CAP3_{t-1}$	0.3677 ***	0.000	0.6231 ***	0.000	0.4341 ***	0.000	0.4390	0.000
$RISK_t$	0.0658 ***	0.000	0.0485 ***	0.000	0.0279 ***	0.000	0.0679	0.001
$RISK_{t-1}$	-0.0175 **	0.033	-0.0180	0.124	-0.0122 ***	0.005	-0.0322	0.056
$PROFIT_t$	0.2228 **	0.025	0.5850 ***	0.000	0.3873 ***	0.005	0.0807	0.526
$PROFIT_{t-1}$	-0.1052	0.127	-0.0382	0.639	-0.1782 **	0.024	-0.1467	0.208
BDR_t	0.0195	0.104	0.0110	0.392	-0.0062	0.566	0.0158	0.324
BDR_{t-1}	-0.0306 **	0.018	-0.0121	0.315	0.0040	0.727	-0.0006	0.966
$PROV_t$	0.1340	0.100	-0.0901	0.273	0.0802	0.345	0.2434	0.092
$PROV_{t-1}$	-0.0594 **	0.020	0.0062	0.868	-0.0616 **	0.015	-0.1221	0.007
$REG2c_{t-1}$	0.0013 ***	0.000	0.0011 ***	0.000	0.0005 **	0.016	0.0032	0.008
$MERG_t$	0.0024 ***	0.002	0.0009	0.709	-0.0034 ***	0.002	0.0023	0.382
$SIZE_t$	-0.0069 ***	0.001	0.0024	0.623	0.0087 ***	0.005	-0.0104	0.006
cons	0.0001	0.710	-0.0038 ***	0.000	0.0000	0.912	-0.0002	0.869
Observations	21,261		4,534		15,344		1,383	
Banks	2,859		590		2,083		186	
Sargan (df)	465(241)	0.00	345(241)	0.00	410(421)	0.00	168(241)	1.00
AR(1)	-6.93	0.00	-7.84	0.00	-9.03	0.00	-4.12	0.00
AR(2)	-0.51	0.61	-1.00	0.32	-0.13	0.90	-0.30	0.76

Note: These are GMM regression results relating explanatory variables to *CAP2* for several samples of banks. Estimates are obtained using the Arellano and Bond (1991) method. All regressions include time dummies. Instruments begin with the third lag. P-values are calculated on the basis of standard errors robust to general cross-section and time-series heteroskedasticity. As recommended by Arellano and Bond, one-step results are presented, whereas the Sargan test refers to the two-step estimation results. AR(1) and AR(2) are the tests of first and second order autocorrelation in the residuals. *, **, *** indicates significance at the 0.10, 0.05, and 0.01 levels, respectively.

Table 4c: Static long-term effects on *CAP1* using GMM-DIF (without "*outliers*")

	Results for CAP1 (to total assets)			
	all banks	savings banks	coop. banks	*other banks*
	Coefficient	Coefficient	Coefficient	Coefficient
$RISK_t$	0.0502 ***	0.0371 ***	0.0275 ***	0.0493 *
	(0.0106)	(0.0089)	(0.0065)	(0.0278)
$PROFIT_t$	0.1763	0.4785 ***	0.4124 ***	-0.2166
	(0.1307)	(0.1510)	(0.0981)	(0.2158)
BDR_t	-0.0087	-0.0029	-0.0150	0.0301 *
	(0.0171)	(0.0108)	(0.0165)	(0.0180)
$PROV_t$	0.3526 ***	-0.2052 *	-0.0523	0.3228
	(0.1367)	(0.1196)	(0.1480)	(0.2849)
$REG1c_{t-1}$	-0.0003	0.0002	-0.0002	0.0035 ***
	(0.0002)	(0.0002)	(0.0002)	(0.0011)
$MERG_t$	0.0046 ***	-0.0011	-0.0035 *	0.0040
	(0.0016)	(0.0031)	(0.0018)	(0.0043)
$SIZE_t$	-0.0128 ***	0.0012	0.0051	-0.0198 ***
	(0.0037)	(0.0059)	(0.0051)	(0.0062)
Observations	21,261	4,534	15,344	1,383
Banks	2,859	590	2,083	186

Note: This Table refers to Table 4a and shows the long-run effects of the explanatory variables on *CAP1*. Asymptotic standard errors are in parentheses. *, **, *** indicates significance at the 0.10, 0.05, and 0.01 levels, respectively.

Table 4d: Static long-term effects on *CAP2* using GMM-DIF (without "*outliers*")

	Results for CAP2 (to total assets)			
	all banks	savings banks	coop. banks	*other banks*
	Coefficient	Coefficient	Coefficient	Coefficient
$RISK_t$	0.0763 ***	0.0810 ***	0.0277 **	0.0638 **
	(0.0113)	(0.0212)	(0.0110)	(0.0325)
$PROFIT_t$	0.1860	1.4509 ***	0.3695 ***	-0.1177
	(0.1149)	(0.3098)	(0.1303)	(0.2393)
BDR_t	-0.0176	-0.0029	-0.0040	0.0272
	(0.0139)	(0.0255)	(0.0147)	(0.0224)
$PROV_t$	0.1180	-0.2228	0.0329	0.2161
	(0.1145)	(0.2363)	(0.1271)	(0.2866)
$REG2c_{t-1}$	0.0020 ***	0.0028 ***	0.0009 **	0.0057 **
	(0.0004)	(0.0007)	(0.0004)	(0.0023)
$MERG_t$	0.0039 ***	0.0024	-0.0059 ***	0.0041
	(0.0013)	(0.0065)	(0.0020)	(0.0046)
$SIZE_t$	-0.0109 ***	0.0063	0.0154 ***	-0.0185 ***
	(0.0033)	(0.0129)	(0.0056)	(0.0062)
Observations	21,261	4,534	15,344	1,383
Banks	2,859	590	2,083	186

Note: This Table refers to Table 4b and shows the long-run effects of the explanatory variables on *CAP2*. Asymptotic standard errors are in parentheses. *, **, *** indicates significance at the 0.10, 0.05, and 0.01 levels, respectively.

6.2.3 Hoppenstedt data set

As the Sargan test still sheds some doubt on the validity of the specification for the cooperative banks, we re-examined the model with the help of the Hoppenstedt data set. The results of the short-term model are given in Tables 5a to b, the results of the long-term model in Tables 5c to d. Here, the Sargan test always confirms the validity of the set of instruments even for the cooperative banks. In addition, the results are similar to those drawn from the Bundesbank data set (Tables 4a to d). Thus our results from the Bundesbank data set are largely confirmed by the results on the basis of the Hoppenstedt data set. In the following we may interpret the coefficients for the cooperative banks. The coefficients of the lagged dependent variable nearly remain the same for cooperative banks compared to Tables 3 a to b. Although we do not find a positive and significant effect of current portfolio risk and current profitability on the capital ratio in the short-term model, we obtain it in the long-term-model. The dummy variable *REG* indicating regulatory pressure is insignificant for *CAP1* but significant and positive for *CAP2*. Possibly cooperative banks being badly capitalised issue subordinate and hybrid capital to increase their capital ratio. The size effect is significant and negative. This finding corresponds to our hypothesis *H3*.

Table 5a: Dynamic GMM-DIF-regression for *CAP1* (Hoppenstedt data set)

	Results for CAP1 (to total assets)											
	all banks			savings banks			cooperative banks			*other banks*		
	Coefficient		P-value	Coefficient		P-value	Coefficient		P-value	Coefficient		P-value
$CAP1_{t-1}$	0.2440	***	0.009	0.7077	***	0.000	0.6897	***	0.000	0.1573	*	0.078
$RISK_t$	-0.1157		0.242	0.0088	***	0.000	0.0191		0.293	-0.1352		0.241
$RISK_{t-1}$	0.0669		0.168	0.0001		0.950	0.0023		0.847	0.1711	***	0.004
$PROFIT_t$	1.4263	**	0.015	0.2944	***	0.000	-2.0469	**	0.016	0.8733	*	0.056
$PROFIT_{t-1}$	-0.0528	*	0.090	-0.0090		0.838	2.6502	***	0.001	-0.0550	**	0.044
BDR_t	-0.0912		0.295	0.0205	***	0.001	-0.1247	**	0.046	-0.0783		0.378
BDR_{t-1}	0.1374	***	0.004	-0.0409	***	0.000	0.0224		0.583	0.1172	**	0.024
$PROV_t$	-0.6319		0.111	-0.0993	***	0.001	0.2137		0.355	-0.8049		0.105
$PROV_{t-1}$	0.1272		0.394	-0.0184		0.221	-0.3381	**	0.015	-0.0245		0.872
$REG1c_{t-1}$	0.0016	*	0.085	0.0001		0.104	0.0001		0.697	0.0068	***	0.008
$MERG_t$	0.0418	***	0.003	-0.0019	*	0.085	0.0110	***	0.004	0.0787	**	0.017
$SIZE_t$	-0.0980	***	0.000	-0.0007		0.601	-0.0304	***	0.003	-0.1095	***	0.000
cons	0.0065	**	0.030	0.0003		0.288	0.0025	**	0.011	0.0010		0.851
Observations	6,927			3,298			2,079			1,550		
Banks	920			438			274			208		
Sargan (df)	291(241)		0.02	243(241)		0.45	230241)		0.69	191(241)		0.99
AR(1)	-2.60		0.01	-5.79		0.00	-2.33		0.02	-2.08		0.04
AR(2)	0.09		0.93	1.39		0.16	0.94		0.35	-0.17		0.87

Note: These are GMM regression results relating explanatory variables to *CAP1* for several samples of banks. Estimates are obtained using the Arellano and Bond (1991) method. All regressions include time dummies. Instruments begin with the third lag. P-values are calculated on the basis of standard errors robust to general cross-section and time-series heteroskedasticity. As recommended by Arellano and Bond, one-step results are presented, whereas the Sargan test refers to the two-step estimation results. AR(1) and AR(2) are the tests of first and second order autocorrelation in the residuals. *, **, *** indicates significance at the 0.10, 0.05, and 0.01 levels, respectively.

Table 5b: Dynamic GMM-DIF-regression for *CAP2* (Hoppenstedt data set)

	Results for CAP2 (to total assets)											
	all banks			savings banks			cooperative banks			*other banks*		
	Coefficient		P-value	Coefficient		P-value	Coefficient		P-value	Coefficient		P-value
$CAP2_{t-1}$	0.2357	**	0.014	0.5723	***	0.000	0.6771	***	0.000	0.1612	*	0.079
$RISK_t$	-0.0923		0.333	0.0226	***	0.000	0.0167		0.311	-0.1279		0.274
$RISK_{t-1}$	0.0653		0.161	0.0029		0.253	0.0048		0.679	0.1642	***	0.008
$PROFIT_t$	1.5130	***	0.003	0.8294	***	0.000	-1.9574	**	0.027	0.9676	**	0.011
$PROFIT_{t-1}$	-0.0520		0.106	-0.2332	**	0.026	2.4162	***	0.002	-0.0628	**	0.021
BDR_t	-0.0662		0.458	-0.0100		0.527	-0.1617	**	0.012	-0.0561		0.526
BDR_{t-1}	0.1384	***	0.004	-0.0081		0.576	0.0509		0.254	0.0944	*	0.056
$PROV_t$	-0.4673		0.257	0.0950		0.316	0.0523		0.812	-0.3745		0.481
$PROV_{t-1}$	0.1366		0.330	0.0261		0.491	-0.2845	*	0.085	0.0171		0.902
$REG2c_{t-1}$	0.0031	**	0.010	0.0015	***	0.000	0.0010	**	0.042	0.0068	**	0.015
$MERG_t$	0.0420	***	0.002	-0.0029		0.267	0.0141	***	0.002	0.0801	**	0.014
$SIZE_t$	-0.0972	***	0.000	0.0004		0.918	-0.0355	***	0.002	-0.1101	***	0.000
cons	0.0063	*	0.050	-0.0042	***	0.000	0.0016		0.188	0.0028		0.609
Observations	6,927			3,298			2,079			1,550		
Banks	920			438			274			208		
Sargan (df)	321(241)		0.00	271(241)		0.09	234(241)		0.62	214(241)		0.99
AR(1)	-2.45		0.01	-6.66		0.00	-2.61		0.01	-2.08		0.04
AR(2)	0.00		1.00	-1.89		0.06	0.63		0.53	-0.19		0.85

Note: These are GMM regression results relating explanatory variables to *CAP2* for several samples of banks. Estimates are obtained using the Arellano and Bond (1991) method. All regressions include time dummies. Instruments begin with the third lag. P-values are calculated on the basis of standard errors robust to general cross-section and time-series heteroskedasticity. As recommended by Arellano and Bond, one-step results are presented, whereas the Sargan test refers to the two-step estimation results. AR(1) and AR(2) are the tests of first and second order autocorrelation in the residuals. *, **, *** indicates significance at the 0.10, 0.05, and 0.01 levels, respectively.

Table 5c: Static long-term effects on *CAP1* using GMM-DIF (Hoppenstedt data set)

	Results for CAP1 (to total assets)			
	all banks	savings banks	coop. banks	*other banks*
	Coefficient	Coefficient	Coefficient	Coefficient
$RISK_t$	-0.0645	0.0304 ***	0.0691 *	0.0426
	(0.0765)	(0.0086)	(0.0383)	(0.1071)
$PROFIT_t$	1.8168 **	0.9764 ***	1.9442 **	0.9711 *
	(0.7418)	(0.2293)	(0.8240)	(0.5238)
BDR_t	0.0611	-0.0696 ***	-0.3297 ***	0.0462
	(0.1016)	(0.0207)	(0.0673)	(0.0840)
$PROV_t$	-0.6676	-0.4025 ***	-0.4007	-0.9843
	(0.5507)	(0.1519)	(0.6967)	(0.6207)
$REG1c_{t-1}$	0.0021 *	0.0004	0.0004	0.0080 ***
	(0.0012)	(0.0024)	(0.0011)	(0.0030)
$MERG_t$	0.0031	-0.0066 *	-0.0013	0.0103
	(0.0175)	(0.0038)	(0.0089)	(0.0366)
$SIZE_t$	-0.1297 ***	-0.0025	-0.0979 ***	-0.1300 ***
	(0.0327)	(0.0047)	(0.0219)	(0.0262)
Observations	6,927	3,298	2,079	1,550
Banks	920	438	274	208

Note: This Table refers to Table 5a and shows the long-run effects of the explanatory variables on *CAP1*. Asymptotic standard errors are in parentheses. *, **, *** indicates significance at the 0.10, 0.05, and 0.01 levels, respectively.

Table 5d: Static long-term effects on *CAP2* using GMM-DIF (Hoppenstedt data set)

	Results for CAP2 (to total assets)			
	all banks	savings banks	coop. banks	*other banks*
	Coefficient	Coefficient	Coefficient	Coefficient
$RISK_t$	-0.0354	0.0596 ***	0.0664 *	0.0433
	(0.0771)	(0.0155)	(0.0401)	(0.1114)
$PROFIT_t$	1.9116 ***	1.3941 ***	1.4207 *	1.0787 **
	(0.6609)	(0.4415)	(0.8630)	(0.4396)
BDR_t	0.0945	-0.0423	-0.3433 ***	0.0457
	(0.1083)	(0.0295)	(0.0724)	(0.0852)
$PROV_t$	-0.4327	0.1240	-0.7192	-0.4260
	(0.5674)	(0.2454)	(0.6790)	(0.6568)
$REG2c_{t-1}$	0.0041 **	0.0034 ***	0.0031 **	0.0081 **
	(0.0017)	(0.0006)	(0.0016)	(0.0035)
$MERG_t$	0.0045	-0.0052	0.0041	0.0151
	(0.0170)	(0.0061)	(0.0104)	(0.0368)
$SIZE_t$	-0.1272 ***	0.0010	-0.1101 ***	-0.1312 ***
	(0.0335)	(0.0100)	(0.0251)	(0.0286)
Observations	6,927	3,298	2,079	1,550
Banks	920	438	274	208

Note: This Table refers to Table 5b and shows the long-run effects of the explanatory variables on *CAP2*. Asymptotic standard errors are in parentheses. *, **, *** indicates significance at the 0.10, 0.05, and 0.01 levels, respectively.

7 Subordinate debt issue

Until now we have examined the determinants of the bank capital ratio and have found little evidence that the determinants differ depending on which definition of bank capital we use. Now, we turn to the structure of bank capital in detail, and analyse whether there are differences between the various banking groups. As shown in Table 1c, savings banks have issued subordinate debt in the reference period from 1992 to 2001 to a larger extent than other banks. Furthermore, Table 6a suggests that banks issuing subordinated debt have a lower capital ratio than non-issuing savings banks. Accordingly, we presume that a lack of equity capital could have led mainly savings banks to increase their Tier 1 + Tier 2 capital ratio by issuing subordinate debt, as for savings banks issuing subordinate debt is one of the few possibilities to increase regulatory capital besides retaining earnings.

To analyse our presumption, we regress the ratio of subordinate debt to proxy Tier 1 capital (*sub*) on the lagged ratio of proxy Tier 1 capital to risk-weighted assets (*CRWA3_1*).[16] We chose the lagged capital ratio because of potential endogeneity problems. Two interaction terms are added: firstly the lagged *CRWA3* interacted with a dummy being unity for all savings banks (*SB*), and secondly, the lagged *CRWA3* interacted with a dummy being unity for all cooperative banks (*CB*). Table 6b shows the results. As expected, the coefficient for all banks is significant and negative, signalling that all banks use subordinate debt to supplement their equity capital. This finding is consistent with Ito and Sasaki (1998), Horiuchi and Shimizu (1998) and Iwatsubo (2002) for Japanese banks. The coefficients of the interaction terms for the cooperative and savings banks are significant and negative, especially for the savings banks, suggesting that particularly savings banks were forced to increase capital by issuing subordinate debt. In this regard, the subordinated debt ratio may indicate the level of regulatory pressure.

Table 6a: Means of *CRWA3* for different banking groups

CRWA3	sub=0		sub>0	
	Obs.	mean	Obs.	mean
all banks	16,011	0.1472	12,014	0.0671
sav. banks	1,495	0.0711	4,219	0.0616
coop. banks	12,858	0.0786	6,716	0.0653
other banks	1,658	0.7482	1,079	0.0992

Note: Presented are means of proxy Tier 1 capital to risk-weighted assets (*CRWA3)* for banks with and without a positive ratio of subordinate debt to proxy Tier 1 capital (sub).

[16] A fixed effects logit model is estimated as well and shows similar results. An alternative random effects tobit model to take account of the information 'sub=0' is inappropriate here, as the Hausman test rejects the random effects assumption.

Table 6b: Subordinate debt issue by different banking groups

sub	Coef.	P-value
CRWA3_1	-0.1557	0.005
SB*CRWA3_1	-5.2214	0.000
CB*CRWA3_1	-2.8291	0.000
cons	0.5518	0.000
Obs.	12,013	
Banks:	1,617	
R^2 within	0.12	
R^2 between	0.04	
R^2 overall	0.01	

Note: These are fixed effects regression results of subordinate debt to proxy Tier 1 capital (sub) on lagged proxy Tier 1 capital to risk-weighted assets (*CRWA3_1)*. It is differentiated between savings banks (SB) and cooperative banks (CB) by interaction with *CRWA3_1*. Time dummies are included. Only banks with sub>0 are taken into account.

8 Conclusions

This study examines the relevance of potential determinants for the capital ratio of German banks. A unique data set provided by the Deutsche Bundesbank comprising yearly balance sheet and profit and loss account information from 1992 to 2001 for nearly all German banks is employed. Subsamples for savings banks, cooperative banks and *other banks* are examined to consider the characteristics of these three pillars of the German banking sector. We take account of the panel structure of the data set and apply generalised method of moments (GMM) to estimate the banks' dynamic adjustments of capital.

We find that portfolio risk has a positive and significant effect on the capital ratio for savings banks as regulation is more likely to be binding for these weaker capitalised banks. In the long run, this relationship holds even for cooperative banks. Profitability has a positive and significant short-term and long-term impact on the capital ratio for the savings banks. These banks particularly depend on retained earnings, as they have less alternatives to increase their capital ratio than other banks.

The results for the bank deposit ratio as a potential determinant of the bank capital ratio are less clear. There is only weak evidence of a positive long-run impact in case of less capitalised *other banks*, suggesting that these banks increase (decrease) their effort to raise the capital ratio, if a rise (decline) in the bank deposit ratio is suggesting higher (lower) future profits.

In addition, results suggest that loan loss provisions as a signal of bad financial health influence the capital ratio decision. We find a negative effect of the ratio of provisions to total assets on the capital ratio for the savings banks. In contrast, we obtain a positive effect for the group of *other banks*. Further analysis suggests that this effect is mainly due to highly profitable *other banks* retaining their earnings in bad financial health.

Regulatory pressure has a significant and positive effect on the capital ratio. Accordingly, banks with a capital ratio close to the regulatory minimum increase their capital ratio to a greater extent than other banks. Furthermore, we find some evidence that mergers among *other banks* have a positive impact on the capital ratio. Finally, size has a significant and negative impact on bank capital for *other banks*. For savings banks the effect is insignificant. The size effect is smaller for savings banks, as some arguments in favour of a negative size effect only hold for *other banks*.

We also examine the issue of subordinated debt by the three different banking groups. Results suggest that particularly savings banks use subordinated debt as an instrument to improve their relatively low capitalisation. This effect may be due to the limited alternatives of the savings banks to increase capital.

This study is to improve the understanding of how German banks determine their capital ratio. Further analysis might examine the relationship between the banks' capital ratio and the actual portfolio risk more closely. According to the current Basle Capital Accord, portfolio risk is defined imprecisely with the help of some broad risk classes. As the New Basel Capital Accord defines portfolio risk more precisely, it might be shown that the actual portfolio risk and the capital ratio become closer related.

Appendix

Definitions of variables (Bundesbank data set; notation of positions refer to *Deutsche Bundesbank, 2003*)

CAP1: Equity capital (position 310) / total assets (position 330)

CAP2: Proxy variable for Tier 1 + Tier 2 capital [Equity capital (position 310) – outstanding capital contributions (position 150) – own shares (position 160) + fund for general bank risks (position 300)} + profit-sharing capital (position 290)} + subordinate debt (position 280)] / total assets (position 330)

CAP3: Proxy variable for Tier 1 capital [Equity capital (position 310) – outstanding capital contributions (position 150) – own shares (position 160) + fund for general bank risk (position 300)] / total assets (position 330)

CRWA1: Equity capital (position 310) to risk-weighted balance sheet assets

CRWA2: Proxy variable for Tier 1 + Tier 2 capital [Equity capital (position 310) – outstanding capital contributions (position 150) – own shares (position 160) + fund for general bank risks (position 300)} + profit-sharing capital (position 290) + subordinate debt (position 280)] / risk-weighted balance sheet assets

CRWA3: Proxy variable for Tier 1 capital [Equity capital (position 310) – outstanding capital contributions (position 150) – own shares (position 160) + fund for general bank risks (position 300)] / risk-weighted balance sheet assets

RISK: Risk-weighted balance sheet assets according to the Basle Accord / total assets (position 330)

PROFIT: [Net interest income + net commission income] / total assets (position 330)

BDR: Liabilities to customers (position220) / total assets (position 330)

PROV: Provisions for possible loan losses, write-downs and write-ups of and value adjustments to claims and securities / total assets (position 330)

SIZE: Natural Logarithm of total assets (position 330)

SDEBT: Subordinate debt (position 280) / total assets (position 330)

PCAP: Profit-sharing capital (position 290)} / total assets (position 330)

Definitions of variables (Hoppenstedt data set; notation of positions according to Hoppenstedt in parentheses)

CAP1: Equity capital [gezei+einin+gegut+haftk+komei+akson+offen+sonek+bilge+auspo] / total assets (bisup)

CAP2: Proxy variable for Tier 1 + Tier 2 capital [gezei+einin+ggvmi+haftk+komei+akson+offen +sonek+bilge +auspo+foalr-nwvza-eigak-imanl-ausei+navbk+genka] / total assets (bisup)

CAP3: Proxy variable for Tier 1 capital [gezei+einin+ggvmi+haftk+komei+akson+offen +sonek+bilge+auspo+foalr-nwvza-eigak-imanl-ausei] / total assets (bisup)

CRWA1: Equity capital [gezei+einin+gegut+haftk+komei+akson+offen+sonek+bilge+auspo] / risk-weighted balance sheet assets

CRWA2: Proxy variable for Tier 1 + Tier 2 capital [gezei+einin+ggvmi+haftk+komei+akson +offen+sonek+bilge+auspo+foalr-nwvza-eigak-imanl-ausei+navbk+genka] / risk-weighted balance sheet assets

CRWA3: Proxy variable for Tier 1 capital [gezei+einin+ggvmi+haftk+komei+akson+offen +sonek+bilge+auspo+foalr-nwvza-eigak-imanl-ausei] / risk-weighted balance sheet assets

RISK: Risk-weighted balance sheet assets according to the Basle Accord / total assets (bisup)

PROFIT: Net interest income plus net commission income (erglg) / total assets (bisup)

BDR: Liabilities to customers (kunve) / total assets (bisup)

PROV: Provisions for possible loan losses, write-downs and write-ups of and value adjustments to claims and securities (yaeaf+yseab-yaeae-ysezu) / total assets (bisup)

SIZE: Natural Logarithm of total assets (bisup)

SDEBT: Subordinated debt (navbk) / total assets (bisup)

PCAP: Profit-sharing capital (genka) / total assets (bisup)

Explanatory note:

gezei	Subscribed capital
einin	Capital contribution of all members of the company with full liability
gegut	Capital contribution of all members of cooperative banks
ggvmi	Capital contribution of remaining members of cooperative banks
haftk	Capital contribution of the public owner of savings banks
komei	Capital contribution of limited partners and sleeping partners
akson	Non-specific capital components
offen	Open reserves
sonek	Non-specific capital components
bilge	Distributable profit
auspo	Adjustment items
foalr	Fund for general bank risks (general provisions)
nwvza	Nominal value of preference shares
ausei	Outstanding capital contributions
eigak	Nominal value of own shares
imanl	Intangible assets
genka	Profit-sharing capital
navbk	Subordinate debt

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