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Banks' regulatory capital buffer and the business cycle: evidence for German savings and cooperative banks

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Abstract

This paper analyzes the effect of the business cycle on the regulatory capital buffer of German savings and cooperative banks in the period 1993–2003. The capital buffer is found to fluctuate anticyclically over the business cycle. The fluctuation is stronger for savings banks than for cooperative banks, as, for savings banks, risk-weighted assets fluctuate more strongly with the business cycle. Further, low-capitalized banks do not catch up with their well-capitalized peers. The gap between low-capitalized and well capitalized banks even widened over the observation period. Finally, low-capitalized banks do not decrease risk-weighted assets in a business cycle downturn by more than well-capitalized banks. This finding seems to imply that their low capitalization does not force them to retreat from lending.

Keywords: Capital Regulation, Bank Capital, Business Cycle Fluctuations
JEL classification: G21, G28

Non-Technical Summary

The behavior of banks' regulatory capital ratio over the business cycle may reveal important information for supervisors about banks' lending behavior and financial stability. In this paper, we examine banks' capital buffer which is defined as the regulatory capital ratio minus the minimum required capital ratio of 8 percent. Shocks to banks' capital buffer may force banks to raise capital and/or reduce lending. The main source of capital shocks are credit losses, which are potentially rising in business cycle downturns. Hence, the expected credit loss increases in economic downturns and decreases in economic upturns. Given this behavior of credit losses, a forward-looking bank is expected to build up capital buffer in economic upturns. However, if banks fail to anticipate the behavior of credit losses, they expand their loan portfolio in an economic upturn without building up their capital buffer accordingly. In this case, when the economic downturn sets in, banks' capital buffer cannot absorb the materializing credit risks. Consequently, banks may have to increase their capital buffer ratio through a reduction in risk-weighted assets, which may happen through a reduction in lending activities.

We examine how the capital buffer of German banks fluctuates over the business cycle in the period 1993–2003. In particular, we inspect the claim that low-capitalized banks reduce risk-weighted assets by more than relatively well-capitalized banks in a business cycle downturn.

The results can be summarized as follows:

- Banks' capital buffers fluctuate anticyclically over the business cycle.
- A stronger fluctuation is found for savings banks than for cooperative banks.
- The fluctuation of risk-weighted assets is the main driver of the fluctuation of the capital buffer for savings banks.
- Low-capitalized banks do not decrease risk-weighted assets by more in a business cycle downturn than their relatively well-capitalized peers.

Especially, the latter finding implies that a low capitalization does not force banks to retreat from lending in business cycle downturns.

Nichttechnische Zusammenfassung

Die Entwicklung der regulatorischen Kapitalquote über den Konjunkturzyklus kann wichtige Informationen für die Bankenaufsicht bezüglich des Kreditvergabeverhaltens und der Finanzstabilität enthalten. In diesem Papier untersuchen wir den Kapitalpuffer von Banken. Der Kapitalpuffer ist definiert als die regulatorische Eigenkapitalquote abzüglich der Mindesteigenkapitalquote von 8 Prozent. Eine unerwartet starke Reduktion des Kapitalpuffers kann Banken dazu zwingen, ihr Kapital zu erhöhen und/oder ihre Kreditvergabe einzuschränken. Hauptursache für negative Kapitalschocks sind vor allem Kreditausfälle. Diese steigen in konjunkturellen Abschwüngen und fallen in konjunkturellen Aufschwüngen. Bei einem generellen Anstieg von Kreditausfällen im Konjunkturabschwung ist zu erwarten, dass eine vorausschauende Bank ihren Kapitalpuffer im konjunkturellen Aufschwung erhöht. Wenn Banken den Anstieg des Kreditrisikos nicht antizipieren, bauen sie ihre Kreditvergabe im konjunkturellen Aufschwung aus, ohne ihren Kapitalpuffer angemessen zu erhöhen. In diesem Fall kann der Kapitalpuffer zum Zeitpunkt des konjunkturellen Abschwungs die anfallenden Kreditrisiken nicht ausreichend abfedern. In Folge dessen muss eine Bank ihren Kapitalpuffer durch eine Erhöhung des Kapitals oder eine Reduktion der risikogewichteten Aktiva anpassen. Dies kann jedoch zu einer Einschränkung der Kreditvergabe durch die Banken führen.

Wir untersuchen das Verhalten des Kapitalpuffer deutscher Banken für die Jahre 1993 bis 2003. Insbesondere prüfen wir die Behauptung, dass schwach kapitalisierte Banken ihre risikogewichteten Aktiva stärker reduzieren als relativ gut kapitalisierte Banken.

Die Resultate können wie folgt zusammengefasst werden:

- Der Kapitalpuffer schwankt antizyklisch über den Konjunkturzyklus.

- Der Kapitalpuffer schwankt stärker für Sparkassen als für Genossenschaftsbanken.

- Die stärkere Schwankung des Kapitalpuffers beruht in erster Linie auf einer stärkeren Schwankung der risikogewichteten Aktiva.

- Schwach kapitalisierte Banken verringern die risikogewichteten Aktiva nicht stärker im konjunkturellen Abschwung als relativ gut kapitalisierte Banken.

Insbesondere das zuletzt genante Resultat deutet darauf hin, dass eine schwache Kapitalisierung von Banken im konjunkturellen Abschwung nicht zu einer Einschränkung der Kreditvergabe führt.

Content

Banks' Regulatory Capital Buffer and the Business Cycle: Evidence for German Savings and Cooperative Banks*

1 Introduction

Minimum capital requirements—today's most prominent regulatory instrument—form an artificial insolvency threshold for banks: In the presence of the Basel minimum capital requirements, banks default at a capital ratio of 8 percent rather than at a capital ratio of 0 percent. As banks do not have full control over their capital ratio due to stochastic returns, banks hold capital buffers above the regulatory minimum as a cushion to absorb negative capital shocks.

For traditional banks, the main source of such capital shocks is materializing default risk, i.e., credit risk. The materialization of credit risk is likely anticyclical in nature. In economic downturns, the probability of default increases, while recovery rates, i.e., the part of the outstanding loan that the bank recovers in the case of the debtor's default, decrease. Taken together, the expected credit loss increases in an economic downturn and decreases in an economic upturn. Further, the unexpected credit loss also increases in an economic downturn, as the debtors' financial situation becomes more heterogeneous while information asymmetries between banks and debtors become stronger.

To be clear, we refer to the term procyclical (anticyclical) in the sense of a variable that is commoving (moving in the opposite direction) with the business cycle as opposed to amplifying business cycle fluctuations.

The literature (e.g., Borio et al. 2001; Ayuso et al. 2004) argues that, given this anticyclical behavior of credit risk, a forward-looking bank is expected to show the following behavior. In an economic upturn, banks tend to expand their loan portfolio. In order to provide for the associated credit risk, banks are expected to also build up their capital buffers. This is expected all the more, as building up capital buffers is easier in an economic upturn than in an economic downturn. When the economic downturn sets in, banks' capital buffers can absorb the materializing credit risk. Hence, given a forward-looking bank, the capital buffer is expected to behave procyclically. However, if banks are shortsighted, they expand their loan portfolio in an economic upturn without building up their capital buffers accordingly. In this case, when the economic downturn sets in, banks' capital buffers cannot

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absorb the materializing credit risks. Then, banks have to increase their capital buffers in a situation where external capital sources are scarce and expensive and retaining earnings may not be an option either due to low returns. Hence, banks may have to increase their capital buffer through a reduction in risk-weighted assets. However, bank-specific assets are often not marketable and/or prices are depressed during a downturn to an extent that a sale implies prohibitive losses. Consequently, a decrease in risk-weighted assets occurs through the reduction or non-renewal of existing credit limits. In sum, given a shortsighted bank, the capital buffer is expected to behave anticyclically with potentially negative consequences for banks' loan supply in business cycle downturns.

The reasons why banks may be shortsighted are twofold. First, banks' choice of loan rating schemes may be tilted towards cyclical schemes (see Catarineu-Rabell et al. 2005). Banks assign ratings that are conditioned on the current point in time and, hence, are subject to greater variability and can cause wider lending cycles.[1] Second, other credit risk parameters such as default probabilities may insufficiently take into account macroeconomic factors and, thus, lead to greater procyclical lending behavior of banks (Lowe 2002).

A recent body of literature, although still scant, has tried to empirically assess the question whether banks' capital buffer fluctuates procyclically or anticyclically over the business cycle. In doing so, banks' capital buffers have been regressed on GDP growth and bank-specific control variables which may determine banks' capital buffer and which may also be cyclical. However, evidence is mixed. Ayuso et al. (2004) find a negative effect of the business cycle on the capital buffers of Spanish banks, which they interpret as shortsightedness of banks. In contrast, Lindquist (2003) finds a positive effect of the business cycle on the capital buffer of Norwegian banks. In the interpretation of Ayuso et al. (2004), this positive effect implies that banks build up their capital buffers in a boom possibly in anticipation of rising losses during a downturn. However, in a later version of the paper, Lindquist (2004) also finds a negative effect of the business cycle on the capital buffer of Norwegian banks.

This paper makes four contributions to this literature. First, regressing banks' capital buffer on the business cycle cannot distinguish between banks' deliberate capital buffer decisions, i.e., supply-side effects, and demand-side effects working through loan demand. As loan demand is known to fluctuate procyclically over the business cycle, demand-side effects may also lead to the anticyclical behavior of capital buffers through their effect on risk-weighted assets. However, this anticyclical behavior of capital buffers does not correspond to shortsighted banks. Moreover, if one could demonstrate that banks' capitalization affects the behavior of capital buffers, this would indicate the existence of supply-side effects. Hence, this paper tests for asymmetries with respect to the capitalization of banks.

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[1] In contrast, external rating agencies assign ratings through the cycle, which, consequently, should result in ratings that are relative immune from business cycle fluctuations (see Amato and Furfine (2004) for empirical evidence).

Second, beyond analyzing the effect of business cycle fluctuations on capital buffers, this paper analyzes what drives the detected negative effect. In order to do so, the capital buffer is decomposed into capital and risk-weighted assets, and the effect of business cycle fluctuations on both of these components is analyzed.

Third, this paper studies a banking market in which a potential retreat from lending in order to build up capital buffers may be particularly harmful. In Germany, bank lending constitutes 96 percent of outside funding for non-financial firms.[2] This number reflects the fact that the German economy is dominated by small- and medium-sized enterprises (the "Mittelstand"), which have limited access to external capital markets. As the small- and medium-sized enterprises borrow mainly from local savings and cooperative banks, this paper focuses on the behavior of these two banking groups.

Fourth, using one business cycle indicator for the economy as a whole may be too crude if the macroeconomic situation differs between regions. This problem is particularly consequential for savings and cooperative banks, which conduct their activities primarily within a limited regional area. Hence, this paper uses several business cycle indicators which are available on a state level.

The structure of this paper is as follows. Section 2 outlines the empirical model. Section 3 is concerned with the data. Section 4 presents the results and several robustness checks. Section 5 concludes.

2 The Empirical Model

As explained in the introduction, the aim of this paper is to estimate the effect of business cycle fluctuations on banks' capital buffers. This section describes the empirical model and the estimation strategy used here. First, it derives the empirical model, states the hypotheses to be tested, and describes the methodology. Second, it defines the measures of the variables of interest, banks' capital buffers and the business cycle. Third, it defines the measures and the impact of the bank-specific control variables.

2.1 A Partial Adjustment Model

The banking literature shows that banks have an incentive to hold a capital buffer as an insurance against violation of the regulatory minimum capital requirement (Marcus 1984; Milne and Whalley 2001; Milne 2004). This incentive derives from two assumptions: First, banks cannot adjust capital and risk instantaneously; otherwise they would not need to hold

[2] See Bank for International Settlements (2003). For comparison, in the US, bank lending constituted only 45 percent of outside funding for non-financial firms in 2001.

capital buffers.[3] And second, a violation of the regulatory minimum capital requirements triggers costly supervisory actions, possibly even leading to the bank's closure. Hence, banks stand to lose (part of) their charter value if they violate the regulatory minimum. However, raising capital is relatively costly compared to raising insured deposits. The trade-off between the cost of holding capital and the cost of failure (i.e., the charter value) determines the optimum capital buffer (Milne and Whalley 2001).

Apart from this, the optimum capital buffer depends on the probability that the regulatory minimum will be violated and, hence, on the volatility of the capital ratio, which is mainly determined by the bank's asset risk. For traditional banks, the main determinant of asset risk is credit risk. Thus, banks with higher credit risk have higher optimum capital buffers.

As argued in the introduction, the materialization of credit risk fluctuates procyclically over the business cycle. During economic upturns, loans are less likely to default than during economic downturns. However, banks are likely to take credit risks during economic upturns when banks expand their loan portfolios. Hence, forward-looking banks build up their capital buffers during economic upturns to be able to accommodate materializing credit risk during economic downturns. In contrast, shortsighted banks do not provide for credit risk during economic upturns, but have to increase their capital buffers during economic downturns.

These hypotheses are tested here using a partial adjustment framework, where banks aim at holding their respective optimum capital buffer. Hence, the specification becomes

$$\Delta BUF_{i,t} = \alpha(BUF^{*}_{i,t} - BUF_{i,t-1}) + u_{i,t}\,, \tag{1}$$

where $BUF_{i,t}$ ($BUF^{*}_{i,t}$) is the (optimum) capital buffer of bank i at time t, α is the speed of adjustment, and $u_{i,t}$ is the error term.

The optimum capital buffer is not readily observable, but it depends on the business cycle due to its effect on credit risk and bank-specific variables, as suggested by the banking literature. In order to obtain the standard form of an endogenous lag model, we add $BUF_{i,t-1}$ to both sides of Eq. (1).[4] Hence, the empirical model is specified as follows:[5]

$$BUF_{i,t} = \alpha_0 + \alpha_1 BUF_{i,t-1} + \alpha_2 CYCLE_{j,t} + X_{i,t}\alpha + u_{i,t}\,, \tag{2}$$

3 Banks may not be able to instantaneously adjust capital or risk when they face adjustment costs or illiquid markets. Furthermore, under asymmetric information, capital issues could be interpreted as a negative signal with regard to the bank's value (Myers and Majluf 1984), rendering banks unable or reluctant to react to negative capital shocks instantaneously.

4 Using the same representation as used in the literature simplifies comparisons of the results. Besides, using the standard form has the advantage that our model can be estimated both with DPD for Ox (Doornik et al. 2002) and the Stata xtabond2 command, written by D. Roodman and available as a Stata ado-file.

5 Ayuso et al. (2004) use a similar specification. However, they derive their specification from a theoretical model in which banks minimize the costs of holding and adjusting capital. Estrella (2004) presents a theoretical model very similar to Ayuso et al. (2004).

where $CYCLE_{j,t}$ is a measure of the business cycle in region j at time t, $X_{i,t}$ is a vector of bank-specific control variables for bank i at time t, and $\alpha_1 = 1 - \alpha$.

When we estimate Eq. (2) directly, α_1 is close to unity, indicating a unit root problem within the data series of *BUF*. This is not surprising, as banks try to build up their capital buffer over the observation period (Graph 1 of Section 3). The reason for this trend is likely to be the implementation of the Basel Capital Accord in Germany in 1993, which represented a negative shock to banks' capital buffers, as it raised capital requirement for most banks. Hence, in the aftermath of the implementation, banks tried to rebuild adequate capital buffers. By the end of the 1990s, the discussions on Basel II may have led to the prolongation of this positive trend.

We address this unit-root problem by taking first differences of the capital buffer and the bank-specific variables. While we also take first differences of the output gap, we include GDP growth rates without differencing, as the calculation of growth rates already incorporates differencing. We also do not take differences of the dummy variables. Hence, the model we estimate is the following:

$$\Delta BUF_{i,t} = \alpha_0 + \alpha_1 \Delta BUF_{i,t-1} + \alpha_2 \Delta CYCLE_{j,t} + \Delta X_{i,t}\alpha + u_{i,t} \quad (3)$$

where the error term $u_{i,t}$ is assumed to consist of a bank-specific component μ_i and white noise $\varepsilon_{i,t}$. Hence, $u_{i,t} = \mu_i + \varepsilon_{i,t}$, where $\mu_i \sim IID(0, \sigma_\mu^2)$, and $\varepsilon_{i,t} \sim IID(0, \sigma_\varepsilon^2)$, independent of each other and among themselves.

In contrast to the specification in levels, a negative α_2 is not to be interpreted such that the capital buffer actually *de*creases in business cycle upturns and *in*creases in business cycle downturns. A negative α_2 is, rather, to be interpreted such that the increase in capital buffers, given by the positive trend in the data series, is dampened in business cycle upturns and boosted in business cycle downturns. Hence, the idea behind this specification is that the effect of business cycle fluctuations superimposes on the build-up of capital buffers.

Beyond analyzing the effect of business cycle fluctuations on capital buffers, we also analyze the driving forces of this effect. In order to be able to do so, we decompose the capital buffer into capital and risk-weighted assets and analyze the effect of business cycle fluctuations on both of these components. Hence, as *CAP* and *RISK* also show positive trends, we estimate the following two equations:

$$\Delta CAP_{i,t} = \beta_0 + \beta_1 \Delta CAP_{i,t-1} + \beta_2 \Delta CYCLE_{j,t} + \Delta X_{i,t}\beta + v_{i,t} \quad (4)$$

$$\Delta RISK_{i,t} = \gamma_0 + \gamma_1 \Delta RISK_{i,t-1} + \gamma_2 \Delta CYCLE_{j,t} + \Delta X_{i,t}\gamma + w_{i,t} \quad (5)$$

where $CAP_{i,t}$ and $RISK_{i,t}$ are the regulatory capital and risk-weighted assets of bank *i* at time *t*. The error terms $v_{i,t}$ and $w_{i,t}$ are again assumed to consist of a bank-specific component and white noise, with the same assumptions as for Eq. (3).

2.2 Hypotheses

Taking as the null hypothesis that business cycle fluctuations do not have an impact on the change in banks' capital buffers, we can state our hypotheses in terms of the coefficient α_2 as follows:

H_{1a}: $\alpha_2>0$. The capital buffer fluctuates procyclically over the business cycle. *Interpretation:* During business cycle upturns, when banks expand lending, potential risks tend to rise and banks increase their capital buffers by more than on average in order to account for these increasing risks. In business cycle downturns, when risks materialize, banks can then draw on these higher capital buffers.

H_{1b}: $\alpha_2<0$. The capital buffer fluctuates anticyclically over the business cycle. *Interpretation:* The negative sign can be evidence for two competing arguments. It may point to banks actively increasing their capital buffers during business cycle downturns, implying short-sightedness, i.e., banks build up their capital buffers during business cycle upturns by less than on average, not accounting for the increasing risks. Alternatively, a negative sign may also indicate demand-side effects because increasing (decreasing) loan demand dampens (boosts) the increase in capital buffers in business cycle upturns (downturns).

If H_{1b} cannot be rejected, we cannot directly distinguish whether demand-side effects alone are behind the negative α_2 or whether supply-side effects also drive this result. However, evidence that banks with low capital buffers increase their risk-weighted assets in a business cycle downturn by less than banks with higher capital buffers would lend support to the existence of supply-side effects. In a business cycle downturn, banks with low capital buffers may be forced to increase their capital buffers relative to banks with high capital buffers through a relative decrease of risk-weighted assets. Taking as the null hypothesis that banks with low capital buffers decrease their risk-weighted assets in a business cycle downturn by the same amount as banks with higher capital buffers, we can state our hypotheses in terms of the coefficient γ_2 as follows:

H_{2a}: $\gamma_2\big|_{downturn,\ low\ capital\ buffer} > \gamma_2\big|_{downturn,\ higher\ capital\ buffer}$. During business cycle downturns, banks with low capital buffers increase their risk-weighted assets by less than banks with higher capital buffers. *Interpretation:* This asymmetry lends support to the claim that there are supply-side effects and, hence, that banks are shortsighted.

H_{2b}: $\gamma_2\Big|_{downturn,\ low\ capital\ buffer} < \gamma_2\Big|_{downturn,\ higher\ capital\ buffer}$. During business cycle downturns, banks with low capital buffers increase their risk-weighted assets by more than banks with higher capital buffers. *Interpretation:* This asymmetry does not lend support to the claim that there are supply-side effects and, hence, that banks are shortsighted, but indicates that banks may face some restrictions on adjusting their loan portfolio, which may also be behind their low capitalization.

2.3 Methodology

Given the model in Eqs. (3)–(5), we employ dynamic panel data techniques that control for the bank-specific component of the error term. The within estimator is known to produce biased estimates when the lagged dependent variable appears as a regressor.[6] The bias in such estimates (the "Nickell bias") approaches zero as T approaches infinity (Nickell 1981). However, in our case, T is relatively small compared to N. For this reason, we apply an instrumental variable approach to avoid the Nickell bias. In the following, we describe the estimation procedure by using Eq. (3) as an example. Eqs. (4) and (5) are estimated using an analogous procedure.

We take the first difference of the model specified in Eq. (3) in order to eliminate the bank-specific effect μ_i, and we try to find suitable instruments for $BUF_{i,t-1} - BUF_{i,t-2}$. Arellano and Bond (1991) suggest a generalized method of moments (GMM) estimator that uses the entire set of lagged values of $BUF_{i,t}$ as instruments. However, observed adjustments in capital buffers may possibly persist, which may result in the problem of weak instruments and losses in asymptotic efficiency when using the Arellano and Bond GMM estimator (Blundell and Bond 1998). Hence, we use the so-called system GMM estimator suggested by Blundell and Bond (1998), which uses lagged differences of $BUF_{i,t}$ as instruments for equations in levels in addition to the Arellano-Bond instruments.

In models with endogenous regressors, using too many instruments could result in seriously biased estimates. Hence, we only use a subsample of the whole history of the series

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6 Since $BUF_{i,t}$ is a function of μ_i, $BUF_{i,t-1}$ is also a function of μ_i. Hence, $BUF_{i,t-1}$, a right-hand regressor in Eq. (3), is correlated with the error term. This renders the OLS estimator biased and inconsistent. For the fixed effects estimator, the within transformation eliminates μ_i, but $(BUF_{i,t-1} - \overline{BUF}_{i.-1})$, where $\overline{BUF}_{i.-1} = \sum_{t=2}^{T} BUF_{i,t-1}/(T-1)$ is still correlated with $(\varepsilon_{i,t} - \bar{\varepsilon}_i)$ as $BUF_{i,t-1}$ is correlated with $\bar{\varepsilon}_i$ by construction. $\bar{\varepsilon}_i$ contains $\varepsilon_{i,t-1}$, which is correlated with $BUF_{i,t-1}$. Therefore, the fixed effects estimator is biased (Nickell 1981). Further, the random effects GLS estimator is also biased because quasi-demeaning is performed before applying GLS.

as instruments in the later cross-section. To determine the optimal lag length of the instruments, we use the procedure suggested by Andrews and Lu (2001). We start by using the full set of moment conditions and reduce them step by step. For each set of moment conditions, we compare the Hansen test to the Hansen test of the last regression. Once the Hansen test starts to increase in significance, we stop and take the last specification, which then has the highest *p*-value for the Hansen test. To further reduce the problem of biased estimates, we combine the columns of the optimal instrument matrix by addition and, hence, use only one instrument for each variable and lag distance, rather than one for each time period, variable, and lag distance.[7]

As, for our sample, the one- and two-step Blundell-Bond system GMM estimator produce quite similar estimates, we present only the (asymptotically) more efficient two-step estimates. However, the two-step estimates of the standard errors tend to be severely downward biased (Arellano and Bond 1991; Blundell and Bond 1998). To address this issue, we use the finite-sample correction to the two-step covariance matrix derived by Windmeijer (2005).

2.4 Measures of the Capital Buffer, Regulatory Capital, Risk-Weighted Assets, and Business Cycle Fluctuations

A bank's capital buffer is given by the capital banks hold in excess of the regulatory minimum capital requirement. Hence, we define banks' capital buffer (*BUF*) as the Basel capital to risk-weighted assets ratio minus the 8 percent regulatory minimum.

In order to estimate Eqs. (4) and (5), we decompose the capital buffer into regulatory capital and risk-weighted assets. In order to scale capital and risk-weighted assets, we define our capital variable *CAP* as total regulatory capital over total assets and our risk-weighted assets variable *RISK* as total risk-weighted assets over total assets.[8] *CAP* contains all items eligible for Tier 1 and Tier 2 capital and, as of 1998, also Tier 3 capital elements for market price risks. *RISK* is the sum of all assets weighted by their respective risk weight. The risk weights are largely determined by the respective borrower type with a preferential treatment of exposures to OECD countries. Table A3 in the appendix contains the various risk weight categories.

With respect to business cycle fluctuations (*CYCLE*), we use four main indicators (see Table A2 for the definition and source of the indicators). Our first indicator is the real GDP growth rate (*GDP*) for Germany. This indicator is also used by the literature (Ayuso et al. 2004; Lindquist 2003, 2004). However, the federal growth rate may not capture the

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7 See the helpfile for Stata command xtabond2 ("collapse" suboption) for details. This command was written by D. Roodman and is available as a Stata ado-file.

8 Note that weighting regulatory capital and risk-weighted assets by total assets yields a bank's leverage ratio and average risk weight.

relevant business cycles, as savings and cooperative banks operate mainly in their own region and economic situations may differ between regions. Hence, in addition to the federal growth rate, we also use the real GDP growth rates by state (*SGDP*), as states are the lowest level of disaggregation for which GDP data is available. Further, as real GDP growth is a combined measure of the business cycle *and* the economic trend, we additionally use the real output gap, which isolates the business cycle from the economic trend. We calculate the output gap by subtracting a non-linear trend from real GDP using the Hoddrick-Prescott filter. Again, we construct the output gap for Germany *(GAP)* and for each state (*SGAP*).

2.5 Bank-Specific Control Variables

In order to estimate the effect of business cycle fluctuations on changes in banks' capital buffers, we have to control for the effect of bank-specific variables on changes in the optimum capital buffer. In the following, we present the proxy variables suggested by the banking literature and their expected impact on changes in the optimum capital buffer. The variable definitions are also given in Table A2 in the Appendix.

As raising capital through the capital markets is costly, retained *earnings* are frequently used to increase capital buffers. This implies that changes in profits have a positive impact on changes in the optimum capital buffer. But a negative impact may also be conceivable: high profits may reflect high charter values and, hence, the ability to permanently generate high profits and to increase capital buffers through retained earnings. Thus, high profit banks need to hold lower capital buffers as an insurance against a probable violation of the regulatory minimum (Milne and Whalley 2001), which translates into changes in profits having a negative impact on changes in the optimum capital buffer. Hence, we include the banks' return on assets (*ROA*) with an ambiguous sign.

Changes in *asset risk* may have a positive as well as a negative impact on changes in the capital buffer. Banks may have reacted to the implementation of the Basel Capital Accord in 1993 by *increasing* asset risk and, hence, profitability in order to compensate for having to hold more expensive capital (Koehn and Santomero 1980). This moral hazard behavior would be reflected in changes in portfolio risk having a positive effect on changes in banks' capital buffers. In contrast, banks may have reacted to the implementation of the Basel Capital Accord *decreasing* portfolio risk, as higher capital levels reduce incentives for risk-taking and higher levels of risk reduce the incentive for decreasing capital (Furlong and Keeley 1989). This behavior would be reflected in changes in asset risk having a negative effect on changes in banks' capital buffers. As banks make loan loss provisions against expected losses of their portfolio, we use new net provisions over total assets (*LLOSS)* as a proxy for risk and include *LLOSS* with an ambiguous expectation regarding the estimated sign.[9]

Furthermore, banks' size may have an effect on the capital buffer through several channels. First, unexpected losses are in part due to asymmetric information between banks and their borrowers. Screening and monitoring reduce the asymmetry, but are costly and, thus, banks could balance the cost and gains from these activities against holding excess capital. If there are economies of scale in screening and monitoring, large banks should hold relatively less capital and instead undertake more monitoring and screening. Second, larger banks may have better investment and diversification opportunities.[10] Thus, they are subject to a lower probability of a large negative shock to their capital and only need to hold a lower capital buffer as insurance against such a shock. Third, there is a higher probability that larger banks will be bailed out by the public government in the case of financial distress, due to potential systemic effects ("Too big to fail"). Fourth, the size of a bank may be an indicator of the bank's access to capital. Savings banks as publicly owned entities and cooperative banks, which are organised as credit cooperatives, are not allowed to raise Tier 1 capital via equity markets. Hence, they depend on retained earnings and capital injections by their public owners and cooperative members, respectively. However, big savings and cooperative banks may use subordinated debt issues to raise Tier 2 capital.[11] Hence, we include the natural log of total assets (*SIZE*) to capture size effects with an expected negative sign.

Further, banks which hold *liquid assets* need less insurance against a possible violation of the minimum capital requirements and, thus, they have a lower optimum capital buffer. We use bond holdings plus share holdings over total assets (*LIQUID*) as a proxy for liquidity and include *LIQUID* with an expected negative sign.

We also include a dummy variable to capture *mergers* (*dyMERGER*). The reason for including this variable is the ongoing merger wave within the savings and particularly the cooperative bank sector (Deutsche Bundesbank 2003). The dummy variable is unity for the acquirer in the year of the merger and zero otherwise. The expected sign of the variable is positive given that acquiring banks are typically better capitalized before a merger.

Finally, we include a dummy variable in order to capture differences between *savings and cooperative banks*. *dySB* is unity if the bank is a savings bank and zero otherwise (cooperative bank).

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9 As the banking theory suggests that capital and risk may be simultaneously determined, we model risk as an endogenous variable to check robustness (see Section 4.4).

10 In principle, the argument can also run the other way around, as small and specialized banks may be in a better position to assess the quality of loans (Acharya et al. 2002). However, savings and cooperative banks are more universal than specialized banks.

11 There are 15 German savings banks (7 central giro institutions and 8 local savings banks) among the 50 banks with the highest number of subordinated debt issues in Basel Committee member states (Basel Committee on Banking Supervision 2003).

3 Data Description

As our results may have important implications for banks' loan supply, this paper focuses on savings and cooperative banks, which have traditionally played a dominant role in lending to small- and medium-sized enterprises (SMEs) in Germany. SMEs form the backbone of the German economy and, in contrast to larger firms, rely heavily on bank loans.[12] Although not directly comparable with SME lending, for which data are not available, the share of savings and cooperative banks in lending to non-financial firms highlights the significance of the two banking groups: At the end of 2003, the share of the savings bank sector was 39 percent, the share of cooperative bank sector was 13 percent, and the share of the commercial bank sector, including the four large banks, was 44 percent.

Our sample consists of all local savings and cooperative banks in west Germany. We exclude the central giro institutions from the sample, as they have a very different portfolio compared to local savings and cooperative banks. We also exclude the seven private savings banks (so-called free savings banks), as they are not subject to regional investment restrictions and have, hence, more degrees of freedom in deciding upon their loan portfolio. We also exclude east German banks from the sample, as east Germany had a very different business cycle up to 2000, due to the fact that the east German economy had to catch up with the west German economy in the years following reunification and as east German savings and cooperative banks financed a substantial part of this catching-up process. Further, our dataset includes 288 observations with negative capital buffers. These banks may undergo transitional adjustments in accordance with the supervisory authority. Alternatively, they may be distressed and, hence, may be under the control of the supervisory authority. In this case, they could not take deliberate investment and funding decisions. As we lack the data to discriminate between these two cases, we exclude these observations from the sample. Finally, there are ten observations for capital buffers with values above 40 percentage points. All ten observations come from the cooperative sector and bias our respective coefficient estimates significantly. For this reason, these observations are also excluded. Hence, the sample consists of an unbalanced panel of 492 German savings and 2159 cooperative banks in west Germany over the period 1993 to 2003. 1993 is the earliest date for which data on risk-weighted assets are available. 2003 is the latest date for which data were consistently available at the time this paper was written.

The data are obtained from two different sources. The balance sheet data are kindly provided by Deutsche Bundesbank, which collects bank-level data in its prudential function. The macroeconomic data are obtained from the German Federal Statistical Office.

Tables A4 and A4a–b provide descriptive statistics for the business cycle indicators and the bank-specific variables. Table A4a provides the descriptive statistics for the subsamples for savings and cooperative banks. It also contains a Wilcoxon rank-sum test, which tests

[12] For the importance of the German Mittelstand for employment and output, see Hauser (2000).

whether the subsamples come from the same population.[13] The test reveals that significant differences between the banks in each sector do indeed exist. Savings banks, on average, hold lower capital buffers (*BUF*), hold lower average risk-weighted assets (*RISK*), are larger (*SIZE*), and realize a lower return on assets (*ROA*) than their competitors in the cooperative sector. Hence, while savings and cooperative banks are both specialized in SME lending and compete with each other in their respective region, they exhibit several interesting differences with respect to their balance sheet structure and profitability. We account for this heterogeneity across banking sectors by running our regressions separately for the two subsamples.

Table A4b provides the descriptive statistics for the subsamples for banks with high capital buffers and banks with low capital buffers.[14] The Wilcoxon rank-sum test shows that, on average, banks with low capital buffers take higher risks, as given by higher risk-weighted assets (*RISK*), higher loan loss reserves (*LLOSS*), and a higher standard deviation of the returns on assets (*ROA*) and the returns on equity (*ROE*). However, they are not rewarded by higher returns on assets (*ROA*) and higher returns on equity (*ROE*). These findings points to a possible inefficiency of banks with low capital buffers.

Table A5 gives the correlation matrix. It shows that the four main business cycle indicators that are used in this paper are highly positively correlated with each other.[15] It also shows that three out of the four indicators indicate that capital buffers behave procyclically and that the fourth indicator indicates that capital buffers behave anticyclically. As will be seen below, controlling for bank-specific variables gives a more consistent picture.

Graph 1 shows the evolution of banks' capital buffers and the real output gap over the 11-year period from 1993 to 2003. First of all, Graph 1 shows that savings and cooperative banks have been building up their capital buffers since the first Basel Accord was enforced in Germany in 1993. This trend in capital buffers causes unit root problems in the estimation. Hence, we take first differences of the capital buffers and explain changes in capital buffers as being the result of real GDP growth rates and changes in the real output gap (as described in Section 2.1). Further, Graph 1 shows that an increase in the real output gap tends to dampen the increase in capital buffers for both well- and low-capitalized banks. This is further evidence that capital buffers behave anticyclically over the business cycle. Additionally, Graph 1 shows that, while both banking sectors have built up capital buffers, well-capitalized cooperative banks have consistently maintained a capital buffer above well-capitalized

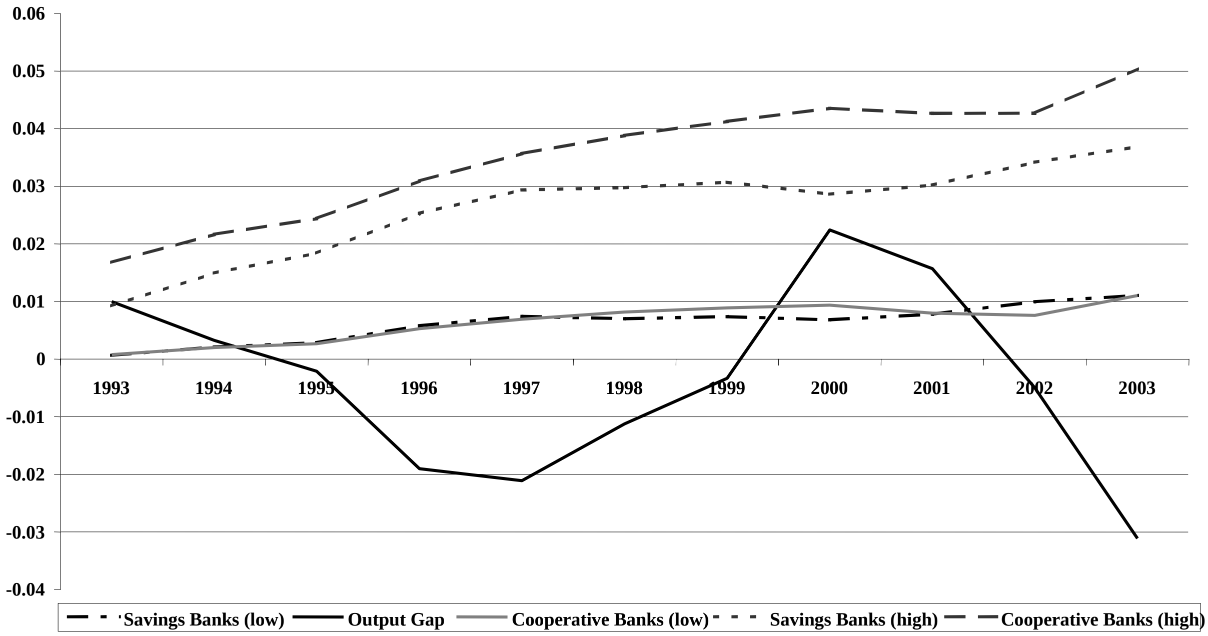
[13] Given that we primarily test financial ratios, which are typically not normally distributed, we use the Wilcoxon rank-sum test, which does not dependent on the normality assumption.

[14] A bank is defined to have a low capital buffer if it is among the 5 percent least capitalized banks in its banking group for a respective year. Otherwise, it is defined as a bank with a high capital buffer.

[15] Further, most variables are significantly correlated with each other. Most probably, this correlation stems from fixed effects, which the simple correlations do not take into account. The multivariate regression techniques, which we employ, do however account for such bank-specific fixed effects.

savings banks. This gap also widened over the observation period. Finally, Graph 1 shows that the gap between well- and low-capitalized banks also widened.

Graph 1: Capital Buffers of German Savings and Cooperative Banks over the Business Cycle, 1993–2003



Notes: The capital buffer is defined as the Basel Capital Ratio minus 0.08. The output gap in this graph is defined as the real output gap in billions of chained (1970) euros. Low indicates banks that are among the 5 percent least capitalized banks in their banking group for a respective year. High refers to all remaining banks.

Source: Deutsche Bundesbank Banking Statistics, Federal Statistical Office.

4 Regression Analysis

In the following subsections, we present the results of estimating Eqs. (3)–(5). First, we show the baseline results for Eq. (3) for the full sample, using all four main business cycle indicators, and for savings and cooperative banks separately. Second, we test for asymmetries in the behavior of capital buffers with respect to economic upturns and downturns as well as with respect to the capitalization of banks. Third, we decompose the capital buffer into capital and risk-weighted assets and show the effect of the business cycle on these two components, corresponding to estimating Eqs. (4) and (5). Fourth and finally, we show further robustness checks.

4.1 Adjustments in the Capital Buffer

Columns 1–4 of Table 1 present the baseline results of estimating Eq. (3) for the full sample using our four main business cycle indicators, the Hansen J statistic, and the tests of serial correlation in the first-differenced residuals. With respect to *CYCLE*, we find a highly significant and negative coefficient for all of our four business cycle indicators, i.e., real GDP growth at the federal level (*GDP*), real GDP growth at the state level (*SGDP*), the real output gap at the federal level (*GAP*), and the real output gap at the state level (S*GAP*). This consistent picture indicates that capital buffers behave anticyclically and, thus, lends support to H_{1b}. The implied effects are, however, small: when real GDP growth increases by 1.0 percentage point, the increase in the capital buffer decreases by 0.09 percentage points.

The findings with respect to the other variables are also worth mentioning. The estimated coefficients of the lagged capital buffer confirm our dynamic specification at the five percent significance level across all indicators. As we take first differences of the variables before running the Blundell-Bond procedure, the estimated coefficient of the lagged capital buffer gives the speed of adjustment of the *change* in the capital buffer, which is rather fast: the estimated speeds imply that shocks to the change in the capital buffer are halved within 0.4 years.

The estimated coefficient of the return on assets (*ROA*) is significant and negative, implying that high-profit banks hold lower capital buffers as insurance against a probable violation of the regulatory minimum, as they can retain earnings to increase capital buffers. The estimated coefficient of *SIZE* is highly significant and negative, pointing to economies of scale, diversification effects, and advantages in the access to capital. The estimated coefficient of *LLOSS* is positive but not significant. The estimated coefficient of *LIQUID* is significant and positive. This unexpected positive effect implies that banks with a high proportion of liquid assets in their portfolios hold higher capital buffers. As we approximated liquidity by share and bond holdings, this positive effect may be interpreted alternatively such that banks hold capital buffers in order to provide for the corresponding market risk. Our control variable for mergers (*dyMERGER*) yields the expected positive sign, implying that acquirers hold higher capital buffers. A reason for the positive coefficient may be the fact that weak savings and cooperative banks are merged with stronger, i.e., better capitalized, banks.[16]

The highly significant and negative coefficient for *dySB* indicates that savings banks and cooperative banks differ with regard to changes in their capital buffers. Given the evidence in Graph 1, the negative dummy variable reflects the fact that the gap between the capital buffers of cooperative and savings banks widens over the observation period.

Including dummy variables is the simplest way to take the heterogeneity between savings and cooperative banks into account. But, given the evidence presented in Table A4 in the

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[16] A positive sign could also simply be due to the fact that the statistics indicate the bank with larger capital buffers as the acquirer.

Appendix, this heterogeneity is likely to be also contained in the slope coefficients. Hence, in Specifications 5 and 6 in Table 1, we split the sample into savings and cooperative banks and run regressions on each of these subsamples separately. As the results for the other business cycle indicators are qualitatively the same, we only present the results for the output gap at the federal level (*GAP*).

With respect to *CYCLE*, differentiating between savings and cooperative banks reveals some interesting differences in the behavior of the capital buffer: while the capital buffers of both savings and cooperative banks behave anticyclically over the business cycle, the capital buffers of savings banks react more than three times stronger to the business cycle than the capital buffers of cooperative banks.

Table 1: Blundell-Bond Two-Step System GMM Estimates for the Capital Buffer, All Banks, Savings Banks, and Cooperative Banks, 1995–2003

	(1)	(2)	(3)	(4)	(5)	(6)
	All Banks	All Banks	All Banks	All Banks	Savings Banks	Cooperative Banks
Dependent Variable: ΔBUF_t	Real GDP growth (*GDP*)	State-level real GDP growth (*SGDP*)	Real output gap (*GAP*)	State-level real output gap (*SGAP*)	Real output gap (*GAP*)	Real output gap (*GAP*)
ΔBUF_{t-1}	0.0372**	0.0370**	0.0334**	0.0345**	0.0409*	0.0297*
	(2.38)	(2.36)	(2.15)	(2.21)	(1.86)	(1.69)
$\Delta CYCLE$	-0.0906***	-0.0525***	-0.0610***	-0.2457***	-0.1321***	-0.0394***
	(10.10)	(8.47)	(12.05)	(10.37)	(15.57)	(6.56)
ΔROA	-0.4055***	-0.4138***	-0.4071***	-0.4188***	-0.5339***	-0.3940***
	(4.40)	(4.34)	(4.38)	(4.28)	(4.45)	(4.15)
$\Delta SIZE$	-0.0150***	-0.0151***	-0.0153***	-0.0152***	-0.0107***	-0.0151***
	(10.11)	(10.12)	(10.24)	(10.19)	(4.17)	(9.15)
$\Delta LIQUID$	0.0256***	0.0263***	0.0256***	0.0260***	0.0149***	0.0281***
	(11.93)	(12.32)	(12.04)	(12.15)	(3.35)	(11.82)
$\Delta LLOSS$	0.0238	0.0185	0.0259	0.0195	0.0124	0.0296
	(1.13)	(0.88)	(1.22)	(0.92)	(0.32)	(1.28)
dySB	-0.0011***	-0.0011***	-0.0010***	-0.0010***		
	(9.49)	(9.59)	(9.22)	(9.34)		
dyMERGER	0.0053***	0.0054***	0.0055***	0.0054***	0.0024	0.0054***
	(9.01)	(9.04)	(9.20)	(9.10)	(1.61)	(8.39)
Constant	0.0050***	0.0046***	0.0036***	0.0037***	0.0021***	0.0037***
	(31.98)	(32.82)	(33.69)	(34.67)	(13.99)	(32.37)
# Obs.	19560	19560	19560	19560	4085	15475
# Banks	2651	2651	2651	2651	492	2159
Hansen test	0.387	0.240	0.275	0.268	0.001	0.290
AR(1) test	0.000	0.000	0.000	0.000	0.000	0.000
AR(2) test	0.525	0.647	0.474	0.659	0.203	0.417

Notes: The dependent variable is $\Delta BUF_{i,t}$. *BUF* is defined as the Basel Capital Ratio minus 0.08. *CYCLE* is defined differently for the various specifications. The respective definition is given in the respective column. *ROA* is defined as the return on assets ratio. *SIZE* is defined as the natural log of total assets. *LIQUID* is defined as bond and share holdings over total assets. *LLOSS* is defined as new net loan loss provisions over total assets. *dyMERGER* is unity for an acquiring bank in the year before the merger and zero otherwise. *dySB* is unity if the bank is a savings bank and zero otherwise (cooperative bank). In order to account for the unit root of *BUF*, all variables are first first-differenced, before applying the Blundell-Bond procedure. Exceptions are the dummy variables and the GDP growth rates. Lagged differences of BUF_i are used as instruments for equations in levels, in addition to lagged levels of BUF_i that are used as instruments for equations in first differences. Δ indicates the first difference. The absolute *t*-values are given in parentheses. ***, **, and * indicate statistical significance at the 1, 5, and 10 percent level, respectively, in a two-tailed *t*-test. Hansen test refers to the test of overidentifying restrictions. AR(1) and AR(2) test refer to the test for the null of no first-order and second-order autocorrelation in the first-differenced residuals.

The findings with respect to the other variables are also worth mentioning. With respect to the lagged dependent variable, the results again confirm our dynamic specification at the 10 percent significance level for both savings banks and cooperative banks. With respect to the other bank-specific variables, *ROA*, *SIZE*, *LIQUID*, and *LLOSS* have the same qualitative effect on capital buffers for both savings and cooperative banks. However, *LLOSS* is again found to insignificant. The merger dummy variable *dyMERGER* is significant and positive for cooperative banks only, for which we could observe a merger wave in the period under study.

4.2 Asymmetries

In this subsection, we test for two asymmetries in the reaction of capital buffers to business cycle fluctuations. First, we test whether capital buffers react differently in business cycle upturns and downturns. To do so, we define a dummy variable, *dyUP*, which is unity during an economic upturn, i.e., *GAP*>0, and zero otherwise. Then, we interact the dummy variable with the output gap and one minus the dummy variable with the output gap and include both interaction terms in the regression. Thus, the two coefficients correspond to business cycle upturns and downturns, respectively, which we then compare by means of a Wald test. Specifications 1 and 2 in Table 2 show the results. For savings banks, we find again an anticyclical behavior of capital buffers, as the increase in capital buffers decreases in business cycle upturns and increases in downturns. A Wald test shows that the strength of the reaction in downturns is statistically higher at the 1 percent level. For cooperative banks, business cycle downturns also boost the increase in capital buffers, but business cycle upturns *also* boost the increase in capital buffers. However, the boost during a business cycle upturn is only half as strong as in a downturn, this difference being statistically significant, as confirmed by a Wald test. The result points to an interesting asymmetry for cooperative banks, since both business cycle upturns and downturns seem to boost the increase in their capital buffers, the boost being stronger in a downturn.

Table 2: Blundell-Bond Two-Step System GMM Estimates for the Capital Buffer, Savings Banks and Cooperative Banks, 1995–2003

	(1)	(2)	(3)	(4)
	Savings Banks	Cooperative Banks	Savings Banks	Cooperative Banks
Dependent Variable: ΔBUF_t	Real output gap (*GAP*)	Real output gap (*GAP*)	Real output gap (*GAP*)	Real output gap (*GAP*)
ΔBUF_{t-1}	0.0399*	0.0265	0.0438**	0.0305*
	(1.81)	(1.51)	(2.03)	(1.74)
*ΔCYCLE*dyUP*	-0.1291***	0.0759***		
	(10.21)	(7.74)		
ΔCYCLE(1-dyUP)*	-0.1364***	-0.1553***		
	(12.17)	(18.78)		
*ΔCYCLE*dyUP*dyLOW*			-0.2999***	-0.1916***
			(9.65)	(8.86)
ΔCYCLE(1-dyUP)*dyLOW*			0.1451***	0.2158***
			(5.96)	(9.80)
*ΔCYCLE*dyUP*(1-dyLOW)*			-0.1184***	0.0912***
			(9.00)	(9.19)
ΔCYCLE(1-dyUP)*(1-dyLOW)*			-0.1544***	-0.1756***
			(13.63)	(21.02)
ΔLLOSS	0.0118	0.0312	0.0101	0.0301
	(0.30)	(1.41)	(0.26)	(1.39)
ΔROA	-0.5370***	-0.3589***	-0.5116***	-0.3417***
	(4.41)	(4.46)	(4.31)	(4.20)
ΔSIZE	-0.0106***	-0.0125***	-0.0090***	-0.0123***
	(4.12)	(7.61)	(3.67)	(7.65)
ΔLIQUID	0.0147***	0.0258***	0.0136***	0.0249***
	(3.29)	(10.98)	(3.17)	(10.73)
dyMERGER	0.0024	0.0045***	0.0017	0.0042***
	(1.60)	(7.02)	(1.14)	(6.68)
Constant	0.0021***	0.0033***	0.0020***	0.0033***
	(13.72)	(28.07)	(13.66)	(28.38)
# Observations	4085	15475	4085	15475
# Banks	492	2159	492	2159
Hansen test	0.001	0.293	0.001	0.279
AR(1) test	0.000	0.000	0.000	0.000
AR(2) test	0.199	0.748	0.179	0.995

Notes: The dependent variable is $\Delta BUF_{i,t}$. *BUF* is defined as the Basel Capital Ratio minus 0.08. *CYCLE* in this table is defined as the real output gap. *dyUP* is unity during an economic upturn, i.e., *GAP*>0, and zero otherwise. *dyLOW* is unity if the bank is among the 5 percent least capitalized banks in its banking group for the respective year and zero otherwise. *ROA* is defined as the return on assets ratio. *SIZE* is defined as the natural log of total assets. *LLOSS* is defined new net loan loss provisions over total assets. *LIQUID* is defined as bond holdings plus share holdings over total assets. *dyMERGER* is unity for an acquiring bank in the year before the merger and zero otherwise. In order to account for the unit root of *BUF*, all variables are first first-differenced, before applying the Blundell-Bond procedure. The only exception is the merger dummy variable. Lagged differences of BUF_i are used as instruments for equations in levels, in addition to lagged levels of BUF_i that are used as instruments for equations in first differences. Δ indicates the first difference. The absolute *t*-values are given in parentheses. ***, **, and * indicate statistical significance at the 1, 5, and 10 percent level, respectively, in a two-tailed *t*-test. Hansen test refers to the test of overidentifying restrictions. AR(1) and AR(2) test refer to the test for the null of no first-order and second-order autocorrelation in the first-differenced residuals.

Second, we test whether banks with low capital buffers react differently to business cycle fluctuations than banks with high capital buffers. To do so, we define a dummy variable, *dyLOW*, which is unity if a bank is among the 5 percent least capitalized banks in its banking group for a respective year and zero otherwise.[17] The idea behind this definition is that the fact that a bank is badly capitalized compared to its peers, i.e., banks in the same banking group, may signal problems within the bank. Principally, differing risk attitudes could also be behind differing capitalizations. However, we control for banks' risk-taking by including *LLOSS* in the regression. Further, risk attitudes are likely to differ only to a minor extent within the savings bank sector and the cooperative bank sector. Once we have defined the capitalization dummy variable, *dyLOW*, we interact it with the interaction terms defined in the last paragraph, as the capitalization may matter more in a business cycle downturn.

Specifications 3 and 4 in Table 2 show that the results for banks with high capital buffers are in line with our previous results. For savings banks with high capital buffers, the increase in capital buffers decreases in a business cycle upturn and increases in a business cycle downturn. For cooperative banks with high capital buffers, the increase in capital buffers increases both in a business cycle upturn and downturn. On the contrary, both for savings banks with low capital buffers and for cooperative banks with low capital buffers, the increase in capital buffers slows down both in a business cycle upturn and downturn. Hence, the 5 percent banks with the lowest capital buffers lag further and further behind their peers over the observation period.

The results are also interesting with respect to the questions whether changes in the capital buffer over the business cycle simply reflect changes in loan demand. The finding that banks with low capital buffers increase their capital buffers by less than their peers in a business cycle downturn indicates that supply-side effects also play a role in the behavior of banks' capital buffers: if capital buffers were determined by loan demand only, the capital buffers of low-capitalized banks and the capital buffers of their well-capitalized peers should both behave similarly. We test this hypothesis more directly in the next subsection by running regressions on the two components of the capital buffer, i.e., capital and risk-weighted assets. The effect of loan demand is then expected to show in the regression for risk-weighted assets.

4.3 Adjustments in Regulatory Capital and Risk-Weighted Assets

In this subsection, we decompose the capital buffer into its numerator, i.e., regulatory capital, and its denominator, i.e., risk-weighted assets. Regressing capital and risk-weighted assets on

[17] As a robustness check, we also use other thresholds to distinguish between banks with low and high capital buffers. The results are consistent for different thresholds. However, the higher the threshold, the more banks with moderate capital buffers are classified as banks with low capital buffers. Hence, the difference in the effects for the two groups declines as the threshold rises.

business cycle fluctuations allows direct observation of where the adjustment in the capital buffer over the business cycle comes from.

Specifications 1 and 2 in Tables 3 and 4 show the results for capital and risk-weighted assets. Capital fluctuates anticyclically for savings banks and procyclically for cooperative banks. Further, risk-weighted assets fluctuate procyclically over the business cycle for savings and cooperative banks, the fluctuation, however, being stronger for savings banks. As risk-weighted assets are highly correlated with lending, our findings suggest that lending by savings banks fluctuates more strongly over the business cycle than lending by cooperative banks. The effect of the business cycle on capital and risk-weighted assets taken together explains why the effect of the business cycle on banks' capital buffer is higher for savings banks than for cooperative banks. The anticyclical behavior of the capital buffer for cooperative banks stems from the procyclical fluctuation of risk-weighted assets which overcompensates the procyclical fluctuation of capital. For savings banks, the anticyclical fluctuation of capital and the procyclical fluctuation of risk-weighted assets jointly drive the anticyclical fluctuation of the capital buffer.

In addition, decomposing the capital buffer into capital and risk-weighted assets allows testing whether changes in the capital buffer over the business cycle simply reflect changes in the loan demand or whether changes in the capital buffer are also driven by supply-side effects. To do so, we again interact the business cycle with our dummy variables indicating economic upturns and downturns as well as distinguishing between banks with low capital buffers and banks with high capital buffers and include the four interaction terms in the regression. Specifications 3 and 4 in Tables 3 and 4 show the results for capital and risk-weighed assets, respectively.

Cooperative banks with high capital buffers boost the increase in capital, irrespective of the business cycle. Similarly, savings banks boost the increase in capital in a business cycle downturn, but they dampen the increase in capital in a business cycle upturn. With respect to risk-weighted assets, the behavior of banks with high capital buffers is more coherent: both savings and cooperative banks boost the increase in risk-weighted assets in a business cycle upturn and dampen it in a business cycle downturn. Consequently, the build up of the capital buffer of well-capitalized cooperative banks during business cycle upturns has its roots in a proportionately stronger increase in capital than in risk-weighted assets.

With regard to banks with low capital buffers, the finding that these banks fall further behind their well-capitalized peers over the observation period, irrespective of the economic situation, is driven by a lower increase in capital and a higher increase in risk-weighted assets. While cooperative banks boost the increase in risk-weighted assets even in business cycle downturns, savings banks dampen the increase in risk-weighted assets in business cycle downturns, thereby moderating the effect on the capital buffer. As a consequence, business cycle downturns dampen the increase in capital buffers more strongly for cooperative banks with low capital buffers than for savings banks with low capital buffers.

Table 3: Blundell-Bond Two-Step System GMM Estimates for Capital, Savings Banks and Cooperative Banks, 1995–2003

	(1)	(2)	(3)	(4)
	Savings Banks	Cooperative Banks	Savings Banks	Cooperative Banks
Dependent Variable: ΔCAP_t	Real output gap (*GAP*)	Real output gap (GAP)	Real output gap (*GAP*)	Real output gap (*GAP*)
ΔCAP_{t-1}	0.014	-0.013	0.023	-0.026
	(0.52)	(0.53)	(0.86)	(1.06)
ΔCYCLE	-0.033***	0.019***		
	(6.86)	(5.30)		
*ΔCYCLE*dyUP*dyLOW*			-0.128***	-0.021
			(6.70)	(1.45)
ΔCYCLE(1-dyUP)*dyLOW*			0.104***	0.105***
			(6.78)	(7.89)
*ΔCYCLE*dyUP*(1-dyLOW)*			-0.018**	0.117***
			(2.49)	(19.36)
ΔCYCLE(1-dyUP)*(1-dyLOW)*			-0.054***	-0.079***
			(8.01)	(17.96)
ΔLLOSS	0.058**	0.108***	0.051**	0.099***
	(2.50)	(4.78)	(2.19)	(4.81)
ΔROA	-0.218***	-0.248***	-0.201**	-0.213***
	(2.83)	(4.54)	(2.54)	(4.90)
ΔSIZE	-0.011***	-0.016***	-0.011***	-0.014***
	(7.81)	(12.84)	(7.67)	(11.76)
ΔLIQUID	-0.006**	0.001	-0.007***	-0.002
	(2.48)	(0.97)	(2.89)	(1.16)
dyMERGER	0.004***	0.006***	0.003***	0.005***
	(3.67)	(11.45)	(3.38)	(10.17)
Constant	0.002***	0.003***	0.002***	0.003***
	(23.44)	(35.31)	(23.16)	(32.36)
# Observations	4085	15475	4085	15475
# Banks	492	2159	492	2159
Hansen test	0.000	0.300	0.000	0.066
AR(1) test	0.000	0.000	0.000	0.000
AR(2) test	0.002	0.117	0.006	0.453

Notes: The dependent variable is $\Delta CAP_{i,t}$. *CAP* is defined as regulatory capital over total assets. *CYCLE* in this table is defined as the real output gap. *dyUP* is unity during an economic upturn, i.e., *GAP*>0, and zero otherwise. *dyLOW* is unity if the bank is among the 5 percent least capitalized banks in its banking group for the respective year and zero otherwise. *ROA* is defined as the return on assets ratio. *SIZE* is defined as the natural log of total assets. *LLOSS* is defined new net loan loss provisions over total assets. *LIQUID* is defined as bond holdings plus share holdings over total assets. *dyMERGER* is unity for an acquiring bank in the year before the merger and zero otherwise. In order to account for the unit root of *CAP*, all variables are first differenced, before applying the Blundell-Bond procedure. The only exception is the merger dummy variable. Lagged differences of CAP_i are used as instruments for equations in levels, in addition to lagged levels of CAP_i that are used as instruments for equations in first differences. Δ indicates the first difference. The absolute *t*-values are given in parentheses. ***, **, and * indicate statistical significance at the 1, 5, and 10 percent level, respectively, in a two-tailed *t*-test. Hansen test refers to the test of overidentifying restrictions. AR(1) and AR(2) test refer to the test for the null of no first-order and second-order autocorrelation in the first-differenced residuals.

Table 4: Blundell-Bond Two-Step System GMM Estimates for Risk-Weighted Assets, Savings Banks and Cooperative Banks, 1995–2003

	(1)	(2)	(3)	(4)
	Savings Banks	Cooperative Banks	Savings Banks	Cooperative Banks
Dependent Variable: $\Delta RISK_t$	Real output gap (*GAP*)	Real output gap (*GAP*)	Real output gap (*GAP*)	Real output gap (*GAP*)
$\Delta RISK_{t-1}$	-0.035	-0.045**	-0.030	-0.049***
	(1.62)	(2.51)	(1.40)	(2.68)
ΔCYCLE	0.440***	0.317***		
	(14.75)	(14.46)		
*ΔCYCLE*dyUP*dyLOW*			0.716***	1.076***
			(4.25)	(8.38)
ΔCYCLE(1-dyUP)*dyLOW*			0.131*	-0.470***
			(1.80)	(5.75)
*ΔCYCLE*dyUP*(1-dyLOW)*			0.510***	0.423***
			(10.60)	(12.09)
ΔCYCLE(1-dyUP)*(1-dyLOW)*			0.364***	0.208***
			(10.59)	(7.86)
ΔLLOSS	0.373***	0.479***	0.342**	0.496***
	(2.69)	(4.22)	(2.44)	(4.32)
ΔROA	0.685**	-0.062	0.613**	-0.032
	(2.36)	(0.24)	(2.10)	(0.13)
ΔSIZE	-0.101***	-0.058***	-0.099***	-0.056***
	(5.94)	(8.58)	(5.98)	(8.29)
ΔLIQUID	-0.133***	-0.135***	-0.135***	-0.135***
	(9.34)	(14.60)	(9.46)	(14.54)
dyMERGER	0.037***	0.017***	0.037***	0.016***
	(6.56)	(6.08)	(6.47)	(5.91)
Constant	0.013***	0.006***	0.013***	0.005***
	(16.20)	(14.55)	(15.75)	(13.04)
# Observations	4085	15475	4085	15475
# Banks	492	2159	492	2159
Hansen test	0.787	0.001	0.884	0.001
AR(1) test	0.000	0.000	0.000	0.000
AR(2) test	0.549	0.245	0.642	0.250

Notes: The dependent variable is $\Delta RISK_{i,t}$. *RISK* is defined as risk-weighted assets over total assets. *CYCLE* in this table is defined as the real output gap. *dyUP* is unity during an economic upturn, i.e., *GAP*>0, and zero otherwise. *dyLOW* is unity if the bank is among the 5 percent least capitalized banks in its banking group for the respective year and zero otherwise. *ROA* is defined as the return on assets ratio. *SIZE* is defined as the natural log of total assets. *LLOSS* is defined new net loan loss provisions over total assets. *LIQUID* is defined as bond holdings plus share holdings over total assets. *dyMERGER* is unity for an acquiring bank in the year before the merger and zero otherwise. In order to account for the unit root of *RISK*, all variables are first differenced, before applying the Blundell-Bond procedure. The only exception is the merger dummy variable. Lagged differences of $RISK_i$ are used as instruments for equations in levels, in addition to lagged levels of $RISK_i$ that are used as instruments for equations in first differences. Δ indicates the first difference. The absolute *t*-values are given in parentheses. ***, **, and * indicate statistical significance at the 1, 5, and 10 percent level, respectively, in a two-tailed *t*-test. Hansen test refers to the test of overidentifying restrictions. AR(1) and AR(2) test refer to the test for the null of no first-order and second-order autocorrelation in the first-differenced residuals.

The results in this section can be summed into two points. First, capital fluctuates procyclically for cooperative banks and anticyclically for savings banks, while risk-weighted assets move in tandem with the business cycle for both sectors. Second, the effect is asymmetric with regard to the capitalization of banks: banks with low capital buffers dampen the increase in capital and cooperative banks with low capital buffers even boost the increase in risk-weighted assets in both business cycle upturns and downturns.

The results also shed some light on the question whether the anticyclical behavior of capital buffers reflects the fact that banks are shortsighted. According to the argumentation of Ayuso et al. (2004), banks that do not build up capital sufficiently in upturns to provide for the higher exposure to credit risk will be forced to increase buffers during downturns. Our findings show that, while low-capitalized savings banks indeed increase their exposure to credit risk by boosting the increase in risk-weighted assets in an upturn, they fail to boost the increase in capital correspondingly. In a business cycle downturn, however, low-capitalized savings banks do not manage to increase capital either. Thus, they dampen the increase in risk-weighted assets. However, they dampen the increase in risk-weighted assets by less than their well-capitalized peers, thereby failing to boost the increase in capital buffers in a downturn. This lends support to H_{2b}, i.e., savings banks with low capital buffers may face barriers to adjustments. Even more, cooperative banks with low capital buffers *boost* the increase in risk-weighted assets in a downturn.

Thus, our results support the view that fluctuations in banks' capital buffers are not exclusively driven by fluctuations in loan demand over the business cycle, but also by the deliberate decisions of banks, i.e., supply-side effects. Our results, however, do not support the widely held concern that banks with low capital buffers retreat from lending in order to increase their capital buffers in a business cycle downturn, thereby further aggravating the downturn. Instead, the supply-side effects show up in the unexpected behavior of low-capitalized banks, which dampen the increase in capital buffers in a downturn.

4.4 Robustness Checks

For most of our specifications, the Hansen test indicates that we have used valid instruments. But for a few specifications, it rejects the chosen instruments at the 5 percent level. However, the Hansen test is well known for its tendency to overreject. Further, the test for second-order autocorrelation in the first-differenced residuals points to potential problems in some specifications. Hence, we additionally run pooled OLS and fixed effects (FE) estimations including the lagged buffer as a robustness check. The reason for doing so is that simulation studies show that the OLS estimator is typically biased upwards, while the FE estimator is biased downwards in bivariate dynamic specifications (Bond 2002). In multivariate dynamic specifications, as in our case, it is not necessarily true that the GMM estimates lie in between the OLS and FE estimates. But if both the OLS estimator and the FE estimator give similar results, this may nevertheless serve as an indicator of the robustness of our results. The results reported in Table A6 in the Appendix again lend support to the hypothesis that the capital buffers of both savings banks and cooperative banks behave anticyclically.

In addition, we also run OLS estimations for the *CAP* and *RISK* specifications as a robustness check. The results are given in Table A7 in the Appendix. The results confirm the findings for the GMM estimations.

So far, we have treated the bank-specific control variables as exogenous. However, they may also be endogenous. For instance, banking theory suggests that capital and risk may be simultaneously determined. Hence, we model risk as an endogenous variable to check robustness. To do so, we include GMM-style instruments also for the *LLOSS* in addition to the GMM-style instruments for the capital buffer. However, treating *LLOSS* as an endogenous variable does not substantially change the result, while the Hansen test deteriorates (Table A8 in the Appendix). When modeling *ROA* and *SIZE* as endogenous variables, the results again remain qualitatively the same (Table A8 in the Appendix). In particular, the anticyclical behavior of the capital buffer remains. However, the Hansen test again deteriorates. Against the background that the Hansen test of the original specification indicates that we use valid instruments, we stick with treating *LLOSS*, *ROA*, and *SIZE* as exogenous.

Further, including dummy variables for the capitalization of banks creates an endogeneity problem, as the endogenous variables *BUF*, *CAP*, and *RISK* determine the capitalization of banks. Thus, as a robustness check, we include GMM-style instruments for the interaction terms. The results are given in Table A9 in the Appendix. The coefficient of $CYCLE*(1-dyUP)*dyLOW$ keeps its sign, but turns insignificant for cooperative banks, while turning negative and insignificant for savings banks. However, the Hansen test indicates that we have used invalid instruments when controlling for the endogeneity problem. Hence, we are confident in our original specification, as the endogeneity problem may not be severe enough for the Hansen test to reject the overidentifying restrictions of the original specification.

Last but not least, we drop the observations for 2003 and run regressions on this shortened subsample. The reason for doing so is the construction of the real output gap, our main business cycle indicator, by help of the Hoddrick-Prescott filter. The Hoddrick-Prescott filter is known to have a bad fit for the first and the last observation. To prevent the bad fit for the first observation, we construct our filtered GDP time-series on the basis of a longer GDP time-series back into the past. This leaves us with the bad fit for the last observation and, hence, we check robustness by running regressions on the subsample without observations for 2003. The results are again in line with the findings for the full sample.

5 Conclusion

This paper examines how the capital buffers of German savings and cooperative banks fluctuate over the business cycle. We find strong evidence that capital buffers behave anticyclically, the capital buffers of savings banks reacting more strongly to the business cycle than the capital buffers of cooperative banks. What drives the stronger reaction of savings banks is the stronger procyclical fluctuation of risk-weighted assets and the anticyclical fluctuation of capital for savings banks compared to a procyclical fluctuation of capital for cooperative banks.

Further, banks with low capital buffers react differently to the business cycle than banks with relatively higher capital buffers:

In business cycle downturns, low-capitalized banks dampen the increase in capital, while their well-capitalized peers boost the increase in capital. In addition, low capitalized banks dampen by less (savings banks) the increase in risk-weighted assets or even boost the increase in risk-weighted assets (cooperative banks).

In business cycle upturns, low-capitalized banks dampen by more (savings banks) or boost by less the increase in capital (cooperative banks) than their well-capitalized peers. In addition, they boost considerably more the increase in risk-weighted assets.

These findings imply that low-capitalized banks do not catch up with their well-capitalized peers, but fall further behind over the observation period. The reasons may be manifold. One plausible explanation may be differing risk attitudes. A low capital buffer would then simply reflect banks' lower risk aversion. However, as we controlled for banks' risk-taking, this explanation is only valid if the proxy variable we used does not fully capture banks' risk attitude. An alternative explanation may be poor risk management of low-capitalized banks. However, our analysis does not allow for such conclusions. Hence, further research on this topic is clearly required.

While this issue may raise supervisory concerns, it also implies that low capitalized banks do not retreat from lending, as low capitalized banks do not decrease risk-weighted assets in a downturn. Hence, the result does not lend support to the widely held concern that banks with low capital buffers retreat from lending in order to increase their capital buffers in a business cycle downturn, thereby further aggravating the downturn. However, this conclusion is subject to the caveat that we have not directly analyzed the impact of banks' capital buffer on lending, but rather on risk-weighted assets. Hence, future research will have to model the relationship between banks' capital buffer, the business cycle, and loan supply in more detail.

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7 Appendix

Table A1: Definition of the Business Cycle Indicators

Variable	Definition	Available for States (Bundesländer)
GDP	Annual real GDP growth rate	No
SGDP	Annual real GDP growth rate	Yes
GAP	Annual real output gap in billions of chained (1970) euros	No
SGAP	Annual real output gap in billions of chained (1970) euros	Yes

Notes: All variables come from the Federal Statistical Office Germany

Table A2: Definition of the Bank-Specific (Control) Variables

Variable	Definition
BUF	Basel capital to risk-weighted assets ratio minus 0.08
CAP	Regulatory capital to total assets ratio
RISK	Risk-weighted assets to total assets ratio
SIZE	Natural log of total assets
ROA	Annual net profit over total assets
LLOSS	New net provisions over total assets
LIQUID	Bond holdings plus share holdings over total assets
dyMERGER	Unity for the acquirer in the year of the merger and zero otherwise.
dySB	Unity if bank is a savings bank, zero otherwise (cooperative bank)
dyLOW	Unity if bank is among the 5 percent least capitalized banks in its banking group for a respective year and zero otherwise

Notes: All variables come from a confidential supervisory database kindly provided by Deutsche Bundesbank.

Table A3: Basel I Risk Weights

	OECD	Non-OECD
Sovereign	0%	100% (0%)[a]
Bank	20%	100% (20%)[b]
Corporate	100%	100%

Source: BIS (1998)
Note: a) For claims on central governments denominated and funded in national currency a risk weight of 0 percent is applied.
b) For claims on banks with a residual maturity of up to one year a risk weight of 20 percent is applied.

Table A4: Descriptive Statistics for the Business Cycle Indicators

Variable	Mean	Std. Dev.	Minimum	Maximum
GDP	0.0118	0.0118	-0.0109	0.0286
SGDP	0.0096	0.0163	-0.0474	0.0516
GAP	-0.0038	0.0163	-0.0312	0.0224
SGAP	-0.0004	0.0024	-0.0087	0.0088

Table A4a: Descriptive Statistics for the Bank-Specific (Control) Variables by Banking Sector

	Cooperative Banks			Savings Banks			
Variable	Obs.	Mean	Std. Dev.	Obs.	Mean	Std. Dev.	Wilcoxon Test
BUF	15475	0.0360	0.0265	4085	0.0277	0.0156	17.21***
RISK	15475	0.6216	0.0983	4085	0.5844	0.0702	26.22***
CAP	15475	0.0711	0.0157	4085	0.0626	0.0095	37.83***
ROA	15475	0.0027	0.0028	4085	0.0024	0.0019	14.15***
SIZE	15475	18.6693	1.1018	4085	20.7117	0.9621	-81.61***
LIQUID	15475	0.2009	0.0936	4085	0.2357	0.0702	-27.98***
LLOSS	15475	0.0033	0.0049	4085	0.0035	0.0037	-11.47***
dyMERGER	15475	0.0605	0.2384	4085	0.0228	0.1492	9.61***

Notes: H_0: Samples are from an identical population versus two-sided alternatives. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively, in a two-tailed *t*-test.

Table A4b: Descriptive Statistics for the Bank-Specific (Control) Variables by Capitalization

	95 Percent Highest Capitalized Banks (*dyLOW*=0)			5 Percent Lowest Capitalized Banks (*dyLOW*=1)			
Variable	Obs.	Mean	Std. Dev.	Obs.	Mean	Std. Dev.	Wilcoxon Test
BUF	18537	0.0358	0.0246	1023	0.0072	0.0031	52.08***
RISK	18537	0.6104	0.0935	1023	0.6752	0.0888	27.33***
CAP	18537	0.0699	0.0151	1023	0.0589	0.0082	-21.49***
ROA	18537	0.0027	0.0020	1023	0.0022	0.0079	13.40***
ROE	18537	0.1333	0.0840	1023	0.1233	0.3835	5.52***
SIZE	18537	19.0816	1.3637	1023	19.3547	1.2145	-7.09***
LIQUID	18537	0.2105	0.0906	1023	0.1652	0.0734	16.24***
LLOSS	18537	0.0032	0.0046	1023	0.0050	0.0055	-12.84***
dyMERGER	18537	0.0537	0.2255	1023	0.0323	0.1768	3.00***

Notes: H_0: Samples are from an identical population versus two-sided alternatives. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively, in a two-tailed *t*-test.

Table A5: Correlation Matrix

	BUF	*RISK*	*CAP*	*ROA*	*SIZE*	*LIQUID*	*dyMERGER*	*LLOSS*	*dySB*	*GDP*	*SGDP*	*GAP*
BUF	1.00											
RISK	-0.34***	1.00										
CAP	0.68***	0.43***	1.00									
ROA	0.12***	-0.01*	0.11***	1.00								
SIZE	-0.25***	-0.04***	-0.26***	-0.11***	1.00							
LIQUID	0.25***	-0.59***	-0.21***	0.05***	0.05***	1.00						
dyMERGER	-0.01	0.07***	0.04***	-0.05***	0.14***	-0.04***	1.00					
LLOSS	-0.14***	0.26***	0.07***	-0.22***	0.11***	-0.22***	0.06***	1.00				
dySB	-0.14***	-0.16***	-0.23***	-0.06***	0.61***	0.16***	-0.07***	0.02**	1.00			
GDP	-0.05***	-0.02***	-0.07***	-0.01	-0.07**	0.01	0.02***	-0.07***	-0.02**	1.00		
SGDP	0.01	0.05***	0.04***	-0.06***	-0.07***	-0.00	0.04***	-0.02**	-0.05***	0.75***	1.00	
GAP	0.01	0.05***	0.05***	-0.05***	0.05***	-0.05***	0.07***	-0.02***	0.02***	0.55***	0.42***	1.00
SGAP	0.03***	0.02***	0.04***	-0.05***	0.07***	-0.02***	0.05***	-0.04***	0.03***	0.43***	0.39***	0.81***

Notes: ***, **, * indicate significance at the 1, 5, and 10 percent level, respectively.

Table A6: Fixed Effects and Pooled OLS Estimates for the Capital Buffer, Savings and Cooperative Banks, 1995–2003

Dependent Variable ΔBUF_t	Savings Banks		Cooperative Banks	
	FE	POLS	FE	POLS
ΔBUF_{t-1}	-0.061***	0.007	-0.106***	-0.001
	(3.82)	(0.34)	(12.50)	(0.07)
$\Delta CYCLE$	-0.122***	-0.120***	-0.035***	-0.039***
	(16.59)	(16.78)	(6.47)	(6.97)
$\Delta LLOSS$	0.004	-0.000	0.028*	0.025
	(0.13)	(0.01)	(1.86)	(1.10)
ΔROA	-0.493***	-0.418***	-0.354***	-0.326***
	(6.42)	(3.56)	(12.39)	(3.68)
$\Delta SIZE$	-0.002	-0.003**	-0.007***	-0.008***
	(1.42)	(2.55)	(8.71)	(8.10)
$\Delta LIQUID$	0.016***	0.017***	0.031***	0.033***
	(4.39)	(4.56)	(15.67)	(13.41)
dyMERGER	-0.001	-0.000	0.003***	0.003***
	(0.98)	(0.18)	(5.38)	(4.98)
Constant	0.002***	0.002***	0.004***	0.004***
	(15.70)	(15.29)	(43.20)	(35.88)
No. of Obs.	4085	4085	15475	15475
No. of Banks	492		2159	
R-squared	0.09	0.08	0.05	0.04

Notes: The dependent variable is $\Delta BUF_{i,t}$. *BUF* is defined as the Basel Capital Ratio minus 0.08. *GDP* is defined as real GDP growth. *ROA* is defined as the return on assets ratio. *SIZE* is defined as the natural log of total assets. *LLOSS* is defined new net loan loss provisions over total assets. *LIQUID* is defined as bond and share holdings over total assets. *dyMERGER* is unity for an acquiring bank in the year before the merger and zero otherwise. In order to account for the unit root of *BUF*, all variables are first first-differenced, before applying the fixed effects and the OLS procedure. The only exception is the merger dummy variable. Δ indicates the first difference. The absolute *t*-values are given in parentheses. ***, **, and * indicate statistical significance at the 1, 5, and 10 percent level, respectively, in a two-tailed *t*-test.

Table A7: Pooled OLS Estimates, Savings and Cooperative Banks, 1995–2003

	(1)	(2)	(3)	(4)	(5)	(6)
	Savings Banks	Savings Banks	Savings Banks	Coop. Banks	Coop. Banks	Coop. Banks
Dependent Variable	*ΔBUF*	*ΔCAP*	*ΔRISK*	*ΔBUF*	*ΔCAP*	*ΔRISK*
Dep. Variable$_{t-1}$	0.008	-0.016	-0.044***	0.008	-0.055*	-0.053***
	(0.43)	(0.80)	(2.61)	(0.48)	(1.83)	(2.87)
*CYCLE*dyUP* dyLOW*	-0.319***	-0.134***	0.709***	-0.236***	-0.049***	1.162***
	(11.37)	(7.02)	(4.61)	(11.58)	(3.21)	(9.96)
CYCLE(1-dyUP)* dyLOW*	0.183***	0.110***	-0.054	0.269***	0.124***	-0.639***
	(9.44)	(9.09)	(0.62)	(16.79)	(12.42)	(8.47)
*CYCLE*dyUP* (1-dyLOW)*	-0.112***	-0.012*	0.486***	0.110***	0.122***	0.400***
	(9.29)	(1.91)	(10.56)	(11.40)	(20.65)	(12.68)
CYCLE(1-dyUP)* (1-dyLOW)*	-0.135***	-0.048***	0.292***	-0.159***	-0.082***	0.107***
	(12.52)	(8.20)	(8.68)	(20.26)	(17.99)	(4.39)
ΔROA	-0.395***	-0.143**	1.003***	-0.277***	-0.183***	0.009
	(3.43)	(2.01)	(3.71)	(3.71)	(4.34)	(0.07)
ΔSIZE	-0.003**	-0.005***	-0.030***	-0.006***	-0.006***	-0.016***
	(2.49)	(3.02)	(2.69)	(7.21)	(9.30)	(4.33)
ΔLIQUID	0.016***	-0.008***	-0.165***	0.030***	-0.004***	-0.182***
	(4.44)	(4.16)	(12.97)	(12.36)	(3.03)	(21.73)
ΔLLOSS	-0.003	0.061***	0.532***	0.022	0.079***	0.580***
	(0.10)	(3.19)	(4.45)	(1.01)	(3.74)	(4.73)
dyMERGER	-0.001	0.002**	0.018***	0.002***	0.002***	0.005***
	(0.61)	(2.12)	(3.49)	(3.75)	(6.13)	(2.61)
Constant	0.002***	0.002***	0.010***	0.003***	0.003***	0.003***
	(15.68)	(21.20)	(14.94)	(32.81)	(29.25)	(10.68)
No. of Obs.	4085	4085	4085	15475	15475	15475
R-squared	0.11	0.09	0.14	0.09	0.11	0.09

Notes: The dependent variable is defined differently for the different specifications as given in the respective columns. *BUF* is defined as the Basel Capital Ratio minus 0.08. *CAP* is defined as regulatory capital over total assets. *RISK* is defined as risk-weighted assets over total assets. *GDP* is defined as real GDP growth. *ROA* is defined as the return on assets ratio. *SIZE* is defined as the natural log of total assets. *LLOSS* is defined new net loan loss provisions over total assets. *LIQUID* is defined as bond and share holdings over total assets. *dyMERGER* is unity for an acquiring bank in the year before the merger and zero otherwise. In order to account for the unit root of *BUF*, all variables are first first-differenced, before applying the pooled OLS procedure. The only exception is the merger dummy variable. Δ indicates the first difference. The absolute *t*-values are given in parentheses. ***, **, and * indicate statistical significance at the 1, 5, and 10 percent level, respectively, in a two-tailed *t*-test.

Table A8: Blundell-Bond Two-Step System GMM Estimates for the Capital Buffer (*LLOSS*, *ROA*, and *SIZE* Modeled as Endogenous Variables), Savings Banks and Cooperative Banks, 1995–2003

Dependent Variable ΔBUF_t	(1)	(2)	(3)	(4)	(5)	(6)
	GMM-Style Instr. for *LLOSS*			GMM-Style Instr. for *ROA* & *SIZE*		
	All Banks	Cooperative Banks	Savings Banks	All Banks	Cooperative Banks	Savings Banks
ΔBUF_{t-1}	0.033**	0.029	0.041*	0.035**	0.039**	0.034
	(2.06)	(1.59)	(1.87)	(2.14)	(2.07)	(1.10)
$\Delta CYCLE$	-0.060***	-0.040***	-0.131***	-0.058***	-0.049***	-0.127***
	(10.02)	(5.74)	(13.43)	(9.64)	(6.18)	(9.96)
$\Delta LLOSS$	0.021	0.050	0.013	-0.046	-0.023	-0.224**
	(0.21)	(0.47)	(0.10)	(1.48)	(0.74)	(2.39)
ΔROA	-0.427***	-0.403***	-0.544***	-1.508***	-1.383***	-2.850***
	(4.37)	(4.21)	(3.69)	(5.14)	(4.70)	(4.65)
$\Delta SIZE$	-0.014***	-0.014***	-0.010***	-0.006	-0.025***	0.109***
	(9.87)	(8.82)	(4.11)	(0.76)	(3.06)	(7.38)
$\Delta LIQUID$	0.025***	0.027***	0.015***	0.024***	0.026***	0.001
	(10.57)	(10.54)	(3.32)	(9.82)	(9.44)	(0.10)
dySB	-0.001***			-0.001***		
	(9.38)			(9.36)		
dyMERGER	0.005***	0.005***	0.002	0.001	0.008***	-0.039***
	(8.92)	(8.18)	(1.52)	(0.53)	(2.78)	(6.24)
Constant	0.004***	0.004***	0.002***	0.003***	0.004***	-0.003***
	(32.63)	(31.26)	(13.78)	(11.59)	(13.11)	(4.69)
No. of Obs.	19560	15475	4085	19560	15475	4085
No. of Banks	2651	2159	492	2651	2159	492
Hansen Test	0.006	0.014	0.004	0.002	0.001	0.469
AR(1) test	0.000	0.000	0.000	0.000	0.000	0.000
AR(2) test	0.477	0.410	0.209	0.526	0.537	0.042

Notes: The dependent variable is $\Delta BUF_{i,t}$. *BUF* is defined as the Basel Capital Ratio minus 0.08. *GDP* is defined as real GDP growth. *ROA* is defined as the return on assets ratio. *SIZE* is defined as the natural log of total assets. *LLOSS* is defined new net loan loss provisions over total assets. *LIQUID* is defined as bond and share holdings over total assets. *dyMERGER* is unity for an acquiring bank in the year before the merger and zero otherwise. In order to account for the unit root of *BUF*, all variables are first first-differenced, before applying the Blundell-Bond procedure. The only exception is the merger dummy variable. Lagged differences of *BUF*, *LLOSS* (Specifications 1–3), *ROA* (Specifications 4–6), and *SIZE* (Specifications 4–5) are used as instruments for equations in levels, in addition to lagged levels of *BUF*, *LLOSS* (Specifications 1–3), *ROA* (Specifications 4–6), and *SIZE* (Specifications 4–5) that are used as instruments for equations in first differences. In addition, GMM-style instruments for *LLOSS*, *ROA*, and *SIZE* are included. Δ indicates the first difference. The absolute *t*-values are given in parentheses. ***, **, and * indicate statistical significance at the 1, 5, and 10 percent level, respectively, in a two-tailed *t*-test.

Table A9: Blundell-Bond Two-Step System GMM Estimates (Interaction Terms Modeled as Endogenous Variables), Savings Banks and Cooperative Banks, 1995–2003

	(1)	(2)	(3)	(4)	(5)	(6)
	Savings Banks	Savings Banks	Savings Banks	Coop. Banks	Coop. Banks	Coop. Banks
Dependent Variable	*ΔBUF*	*ΔRISK*	*ΔCAP*	*ΔBUF*	*ΔRISK*	*ΔCAP*
ΔDep. Variable$_{t-1}$	0.0581**	-0.0059	0.0391	0.0460**	-0.0822***	0.0385
	(2.00)	(0.26)	(1.40)	(1.97)	(5.17)	(1.02)
*ΔCYCLE*dyUP* dyLOW*	-0.4203***	1.1627***	-0.1499***	-0.1862**	1.5810***	0.0376
	(3.86)	(3.22)	(2.70)	(2.13)	(4.19)	(0.62)
ΔCYCLE(1-dyUP)* dyLOW*	-0.0160	1.6512***	0.1168**	0.0449	1.1401***	0.1070*
	(0.17)	(3.89)	(2.11)	(0.50)	(2.89)	(1.79)
*ΔCYCLE*dyUP* (1-dyLOW)*	-0.0970***	0.4705***	-0.0116	0.0615***	0.3785***	0.0893***
	(6.01)	(8.29)	(1.53)	(4.55)	(9.47)	(10.60)
ΔCYCLE(1-dyUP)* (1-dyLOW)*	-0.0806***	0.2120***	-0.0342***	-0.1230***	0.0760**	-0.0667***
	(5.93)	(4.27)	(4.45)	(11.63)	(2.18)	(10.08)
ΔROA	-0.4807***	0.6220*	-0.1866*	-0.4677**	-0.1907	-0.2623***
	(2.77)	(1.84)	(1.90)	(2.40)	(0.88)	(3.81)
ΔSIZE	-0.0047**	-0.1094***	-0.0083***	-0.0097***	-0.0470***	-0.0110***
	(2.04)	(6.04)	(6.21)	(5.06)	(6.72)	(7.87)
ΔLIQUID	0.0167***	-0.1332***	-0.0058**	0.0257***	-0.1337***	-0.0039**
	(3.25)	(8.44)	(2.43)	(9.23)	(12.64)	(2.42)
ΔLLOSS	-0.0105	0.3790**	0.0427*	0.0051	0.8019***	0.0424*
	(0.22)	(2.50)	(1.73)	(0.17)	(4.53)	(1.82)
dyMERGER	0.0002	0.0387***	0.0027***	0.0036***	0.0099***	0.0040***
	(0.14)	(6.44)	(2.83)	(4.69)	(3.45)	(7.01)
Constant	0.0020***	0.0126***	0.0022***	0.0033***	0.0053***	0.0025***
	(12.61)	(13.62)	(22.27)	(23.02)	(12.17)	(22.09)
No. of Obs.	4085	4085	4085	15475	15475	15475
No. of Banks	492	492	492	2159	2159	2159
Hansen Test	0.000	0.011	0.000	0.000	0.000	0.000
AR(1) test	0.000	0.000	0.000	0.000	0.000	0.000
AR(2) test	0.275	0.893	0.007	0.772	0.007	0.839

Notes: The dependent variable is defined differently for the different specifications as given in the respective columns. *BUF* is defined as the Basel Capital Ratio minus 0.08. *CAP* is defined as regulatory capital over total assets. *RISK* is defined as risk-weighted assets over total assets. *GDP* is defined as real GDP growth. *ROA* is defined as the return on assets ratio. *SIZE* is defined as the natural log of total assets. *LLOSS* is defined new net loan loss provisions over total assets. *LIQUID* is defined as bond and share holdings over total assets. *dyMERGER* is unity for an acquiring bank in the year before the merger and zero otherwise. In order to account for the unit root of *RISK*, all variables are first first-differenced, before applying the Blundell-Bond procedure. The only exception is the merger dummy variable. Lagged differences of the dep. variable and the interactions terms are used as instruments for equations in levels, in addition to lagged levels of the dep. variable and the interactions terms that are used as instruments for equations in first differences. Δ indicates the first difference. The absolute *t*-values are given in parentheses. ***, **, and * indicate statistical significance at the 1, 5, and 10 percent level, respectively, in a two-tailed *t*-test.

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