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Banks' buffer capital: How important is risk

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Abstract

Most banks hold a capital to asset ratio well above the required minimum level defined by the present capital adequacy regulation (Basel I). Using bank-level panel data from Norway, important hypotheses concerning the determination of the buffer capital is tested. Focus is particularly on the importance of: (i) the buffer as an insurance, (ii) portfolio risk, (iii) the competition effect, (iv) regulatory monitoring, and (v) economic growth. The results imply that buffer capital is used both as an insurance against failure to meet the capital requirement and a competition parameter. A negative risk effect suggests that moral hazard is present, but increased regulatory scrutiny increases the buffer capital of commercial banks. The buffer capital of commercial banks behaves counter-cyclically.

Keywords: Banking; Excess capital; Risk; Panel data
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1 Introduction and motivation

Despite the last decades of market deregulation of the banking industry in many countries, banking is still one of the most regulated industries in the world. Regulation is in general justified on the basis of market failures and the importance of preserving financial stability, although there is still no consensus on how they should be regulated (Santos (2000)).

As other forms of regulation are demolished, capital adequacy regulation gets relatively more important, which partly explains an increased focus on banks' capital to asset ratio. In addition, the experience from banking crisis in several countries during the last decades have made both regulators, supervisory authorities, the banks themselves and probably also their share holders more aware of the importance of a sufficient capital to assets ratio, for Norway see Stortinget (1998) and Steigum (2002). Both the 1988 Basel Capital Accord (Basel I) and the proposals from the Basel Committee on Banking Supervision to update and revise this legislation (the forthcoming Basel II) include minimum capital requirements. Banks' balance sheets show that most banks hold a capital ratio well above the required minimum[1], however, and a better understanding of how these capital buffers are determined and how they vary across banks and over time may help us to understand the need for and effect of capital adequacy regulation.

In the literature, it is argued that banks hold excess capital to avoid costs related to market discipline and supervisory intervention if approaching or falling below the regulatory minimum capital-ratio, see e.g. Furfine (2000). A poorly capitalised bank runs a risk of loosing market confidence and reputation. Thus, excess capital acts as an insurance against costs that may occur due to unexpected loan losses and difficulties in raising new capital. On the margin, the insurance premium equals the return on equity or interest rate on subordinated debt that the bank must pay to attract new capital.[2] We expect an increase in price to have a negative effect on excess capital. If this "insurance against failing to meet the requirement" argument is important, the buffer capital should vary positively with uncertainty.

Unexpected loan losses may be due to purely random shocks or asymmetric information in the lender-borrower relationship. In the latter case, more extensive screening and monitoring

[1] Banks must hold a "capital to risk adjusted asset" ratio of minimum 8 per cent.
[2] Banks face restrictions on the ratio of subordinated debt to equity capital in addition to the minimum capital-ratio requirement.

of borrowers could increase the banks understanding of the risk involved in each project (see Hellwig (1991)). Screening and monitoring is costly, however, and the bank will balance the cost of and gain from these activities against the cost of excess capital. In the presence of scale economies in screening and monitoring for a bank, one would expect large banks to substitute relatively less of these activities with excess capital. Hence, one may find a negative size effect on excess capital. A negative size effect may also be due to a diversification effect. The argument is that portfolio diversification reduces the probability of experiencing a large drop in the capital ratio, and that diversification increases with bank size. A third reason for a negative size effect is given by the "too-big-to-fail" hypothesis. If large banks expect support from the government in the event of difficulties, while this is not, to the same degree, expected by small banks, we should expect large banks to hold lower capital buffers.

An important issue is how the buffer capital varies with the risk profile of the banks' assets. From a regulator's perspective, one would prefer that banks with a relatively risky portfolio hold a relatively high level of buffer capital. Otherwise these banks are more likely to fall below the minimum capital ratio, which could give rise to a credit crunch. In the worst case, poorly capitalised banks may spur systemic risk and hence threaten the financial stability.

It has been argued that a more risk sensitive capital adequacy regulation, such as Basel II, may reduce banks' willingness to take risk. If banks already risk-adjust their total capital, i.e. minimum capital plus buffer capital, more than implied by Basel I, replacing Basel I with Basel II may not affect the capital to asset ratio or risk profile of banks' portfolio as much as feared. Theoretically it has been shown, however, that although capital adequacy regulation may reduce the total volume of risky assets, the composition may be distorted in the direction of more risky assets. The result may well be an increase in average risk. An introduction of risk consistent weights is not sufficient to correct for this moral hazard effect in a limited liability bank. See Koehn and Santomero (1980), Kim and Santomero (1988), Rochet (1992a,b) and Freixas and Rochet (1997), section 8.3.3). Rochet, in line with Merton (1977), shows that banks with a low capital to assets ratio will choose a portfolio with maximal risk and minimum diversification. Hence, if this moral hazard effect is important, we may find a negative relationship between risk and buffer capital.

According to Furfine (2001), changes in regulatory monitoring of banks affect their capital ratios. Consistently we may expect an increase in regulatory scrutiny to increase banks' capital buffer. Furthermore, a bank may use excess capital as a signal on its solvency or probability of non-failure. Hence, excess capital may serve as an instrument, which the bank is willing to pay for, in the competition for unsecured deposits and money market funding. We therefore expect banks to care about their relative buffer, i.e. the size of their own capital buffer relative to those of their competitors. Berger et al. (1995) argues that banks may hold excess capital to be able to exploit unexpected investment opportunities. One may expect the importance of this argument to depend on how difficult it is for the bank - on a very short notice – to increase its capital.

It is generally assumed that the proposals for Basel II will enforce the pro-cyclical effects of the present capital legislation. See, among others, Basel Committee on Banking Supervision (2001), Borio et al. (2001), Danielsson et al. (2001) and European Central Bank (2001). The increased pro-cyclicality comes from the closer link between risk and capital requirement. In an economic downturn, risk is more likely to increase and also materialise, and the capital requirement may therefore increase. Banks are expected to respond by reducing their supply of new loans, and this will hamper economic growth and hence amplify the business cycle. The opposite is expected to happen in an economic upswing. Banks may use their buffer capital to either dampen or increase these pro-cyclical effects, however, as a result of their evaluation of future risk and investment opportunities today contra tomorrow. It is therefore clearly of interest to analyse the relationship between the buffer capital and economic growth.

Within an optimising framework, banks should balance the overall gain from holding excess capital against the cost of holding this capital. In this paper we analyse empirically the capital buffers of Norwegian banks within such a "cost-benefit" framework. We focus on five issues: i) Whether excess capital acts as an insurance against falling below the required minimum capital to asset ratio, ii) Whether excess capital depends on the risk profile of the bank's portfolio, iii) Whether banks use excess capital as a signal, i.e. a competition parameter, and relative capital buffers matter, iv) Whether the level of regulatory monitoring matters, and v) Whether the buffer capital depends on economic growth.

We also emphasise bank heterogeneity, which within a financial stability framework, clearly is important. Although the (arithmetic) average buffer capital of Norwegian banks has varied around 8-12 per cent since the early nineties, i.e. the average capital ratio of Norwegian banks' is around twice the required minimum level, the data show important variation across banks. The distribution of coefficients and elasticities may give us a better understanding of how different banks and categories of banks adjust their buffer capital.

Section 2 presents the model to be estimated, the data and empirical results are discussed in Section 3, Section 4 concludes, and the Appendix presents the empirical variables in more detail.

2 *The model*

In the empirical analysis of banks' buffer capital, our starting point is Ayuso et al. (2002), who analyse the behaviour of the buffer capital of Spanish banks using annual data for 1986-2000. We add to the literature in several ways. First, we take explicitly into account the "insurance against falling below the required minimum capital ratio" argument. Second, we take into account that relative capital buffers may matter due to competition. Third, to test the conclusion in Furfine (2001) we include a variable that represents monitoring of banks. Fourth, we analyse the importance of risk profile of banks' loan portfolio for the size of the buffer capital. A more sophisticated measure than Ayuso et al. is applied. Fifth, while Ayuso et al. include fixed effects in their model and a shift parameter for small and large banks, we apply a random effect approach and estimate the model on the whole sample and two sub-groups of banks, i.e. savings banks and commercial banks. This allows all slope coefficients to vary across the two sub-groups.

Our most general model is defined in equation (1). Subscripts *i*, *t* and *k* denote bank, period and sub-group of banks respectively. Small letters indicate data on logarithmic form, i.e. buf=ln(BUF), pec=ln(PEC), etc.

$$(1)\ \mathrm{buf}_{it} = \beta_{0i} + \beta_1\,\mathrm{pec}_t + \beta_2\,\mathrm{vres}_i + \beta_{3i}\,\mathrm{rpr}_{it} + \beta_4\,\mathrm{cbuf}_{k,t-1} + \beta_5\,\mathrm{reg}_t + \beta_6\,\mathrm{gdpg}_t + \beta_7\,\mathrm{size}_{it} + \beta_8\,\mathrm{uslp}_{i,t-1} + \beta_9\,\mathrm{trend}_t + \beta_{10}\,\mathrm{Q2} + \beta_{11}\,\mathrm{Q3} + \beta_{12}\,\mathrm{Q4}$$

where **BUF** is the capital buffer measured as the "excess-capital to risk-weighted asset" ratio; **PEC** is the price of excess capital. The deflated 10 years interest rate on private bonds is used as an empirical proxy[3]; **VRES** is the variance of each bank's quarterly result calculated over

[3] Ideally we should have used the return on equity or interest rate on subordinated debt that each bank must pay to attract new capital. We have historical data on these variables for only a small number of banks, however.

its observation period; **CBUF** is the competitors' average capital buffer calculated separately for two different groups, i.e. savings banks and commercial bank. There is a relatively large number of small savings banks and a small number of larger commercial banks in Norway, and banks are expected to compete most heavily with banks of the same category; **RPR** represents the 'risk profile' of the banks' assets; **REG** represents regulatory scrutiny and is measured by the number of on-site inspections by the supervisory authority, Kredittilsynet; **GDPG** denotes the four quarter growth rate of gross domestic product; **SIZE** is total financial assets incl. guarantees and represents bank size; **USLP** is the stock of unspecified loan loss provisions relative to risk weighted assets; **TREND** is a simple deterministic trend variable; **Q2**, **Q3**, **Q4** are quarterly dummy-variables included to capture seasonal effects. A more detailed presentation of the empirical variables is given in the Appendix.

The motivation for including the price of excess capital, PEC, and the variance of each bank's result, VRES, is to identify the importance of the insurance argument for buffer capital. While the price is assumed to reflect the development in the insurance premium, the variance is assumed to reflect how valuable this insurance is for the bank. The variance represents uncertainty faced by the bank, or, alternatively, bears information on the "risk type" of each bank. A high variance implies high uncertainty or a high-risk bank, and the probability of falling below the required minimum level of the capital ratio is assumed to increase with VRES. We therefore expect the buffer capital to vary positively with this variable. Since VRES only includes cross sectional variation, i.e. it is constant along the time dimension, one interpretation of this variable is that we take out a systematic part of the variation in the constant term across banks.

We have calculated and applied alternative empirical proxies for the risk profile of banks, RPR, but the empirical results are qualitatively independent of the choice of empirical variable.[4] Banks may vary significantly in their willingness to take risk, and the measures of risk-profile are assumed to bear information on bank type with respect to this. Although Basel I includes some risk sensitivity in the calculation of the capital requirement, it is in general assumed to be too rude, with the consequence that risk is not properly taken into account.

[4] Other measures for RPR applied in the analysis are: (i) The risk-weighted to unweighted assets ratio. The risk-weighted assets are calculated in accordance with the rules in Basel I. This measure takes values between zero and one, and increasing value implies increasing risk, and (ii) Twelve quarters moving average of the flow variable loan loss provisions relative to total assets. Ayoso et al. (2002) use the ratio of non-performing loans to total loans and credits as a risk measure. This is comparable with measure (ii), since banks with non-performing loans are obliged to provision for loan losses.

Therefore, if banks consider the true risk in their portfolios when deciding on the total amount of capital, one would expect the buffer capital to vary positively with any risk measure that is closer to replicate the true risk profile of banks' portfolios than the risk weights in Basel I. Since both VRES and RPR is assumed to capture information about bank type with respect to risk, both variables should be taken into account when interpreting the importance of risk for banks' buffer capital.

The GDPG variable is included to capture business cycle effects. Our observation period does not include a whole business cycle, however, and the effect of this variable should therefore be interpreted with care.

To some degree, banks have the option to do unspecified loan loss provisions. From the insurance against "falling below the minimum capital requirement" perspective, this represents an alternative to increasing the capital buffer. We therefore expect a negative effect on the buffer capital from USLP.

The trend variable, TREND, is included to capture secular changes in the capital buffer not captured by the other variables, see Furfine (2001) and Boyd and Gertler (1994). However, the increased importance of off-balance-sheet items, such as letters of credit and loan commitments, is taken into account in the calculation of the capital buffer, and hence this should not give rise to trend effects in the capital buffer. In principle, the trend effect represents the net trend effect of all excluded variables.

We expect $\beta_1 < 0$, $\beta_2 > 0$, $\beta_4 > 0$, $\beta_5 > 0$, $\beta_7 < 0$ and $\beta_8 < 0$. If $\beta_3 > 0$, then banks with more risky assets have a higher buffer capital, and if $\beta_3 < 0$ we conclude that the moral hazard effect explained earlier dominates. If $\beta_6 > 0$, we conclude that the buffer capital has a pro-cyclical behaviour, while $\beta_6 < 0$ implies that the buffer capital dampens the cyclical effects on the capital ratio of the capital legislation. The trend effect represented by β_9 and the seasonal effects represented by β_{10}, β_{11} and β_{12} can take any sign.

3 Data and empirical results

The data

To estimate equation (1) we use an unbalanced bank-level panel data set for Norwegian banks. Primarily we use quarterly accounts data that all banks are obliged to report to Norges

Bank, combined with Norwegian national account data and information from the supervisory authority in Norway, Kredittilsynet. The data applied cover the period 1992q3-2001q4, i.e. 38 quarters. We have access to data back to 1991q4, but banks were adjusting their capital ratios in accordance with the forthcoming Basel I capital adequacy requirements, which were fully implemented for Norwegian Banks 31. December 1992. The estimations start in 1992q4, but since many banks largely had adjusted to Basel I prior to 1992q4, we use 1992q3 to calculate lagged variables.

From the dataset we exclude 18 observations with a capital ratio below the required minimum level, which implies that the buffer capital is negative. These banks are subject to intervention by the supervisory authorities. We also exclude 178 observations due to missing observations on explanatory variables. Due to the lag structure of the model in equation (1), the number of observations used for estimation is reduced from 5419 to 5278. We have a total of 153 different banks in our sample, of which 133 is observed over the whole estimation period. The variables used in the analysis are summarised in Table 1.

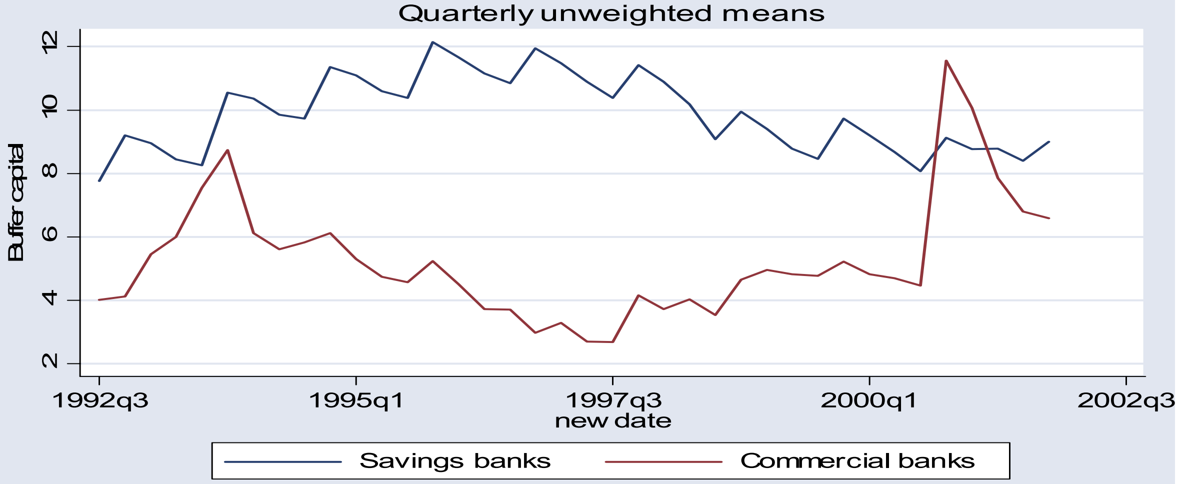
Table 1. Main features of the data, 1992q3-2001q4. Based on 5419 observations

Variable	Mean	Std. dev.	Min.	Max.
BUF	9.436	6.295	0.003	90.471
PEC	7.728	1.725	5.885	12.870
VRES	2725.823	20072.850	0.011	223552.800
RPR	0.016	0.006	0.004	0.069
CBUF	11.708	18.928	3.914	366.383
REG	12.074	1.310	10.000	14.250
GDPG[1]	3.023	1.866	-0.372	7.991
SIZE[2]	$1.3\cdot10^4$	$7.0\cdot10^4$	27.944	$95.8\cdot10^4$
USLP	0.009	0.006	$1.0\cdot10^{-7}$	0.066

[1] Main land Norway, i.e. excess oil, natural gas and shipping.
[2] Mill. NOK.

Figure 1-5 show the development over time in some of the variables. We calculate quarterly arithmetic means and split between savings banks and commercial banks. Our observation period starts at the end of a four-year period of banking crisis in Norway (1988-1992). During the crisis, many banks saw their capital erode, and it is not surprising that banks used the following years to build up their buffer capital (BUF). The buffer capital of savings banks increased gradually over several years, while commercial banks increased their buffer capital very much during a relatively short period and then started to build it down. Around 1996/1997 the trend of the buffer capital of both groups was reversed, however, i.e. the buffer capital of savings banks started to decline while that of commercial banks started to increase. The data for 2001 suggest that the decline in the buffer capital of savings banks has halted. It is also interesting to note that particularly the capital buffer of savings banks seems to follow a systematic seasonal pattern.

Figure 1. Buffer capital in per cent of weighted assets
Quarterly unweighted means



Note: Assets are risk-weighted in accordance with Basel I rules.

Figure 2 shows that the variance of quarterly results (VRES) has increased for commercial banks. This is due to a bank composition effect, however, since, by calculation, the variance is constant for each bank over time.

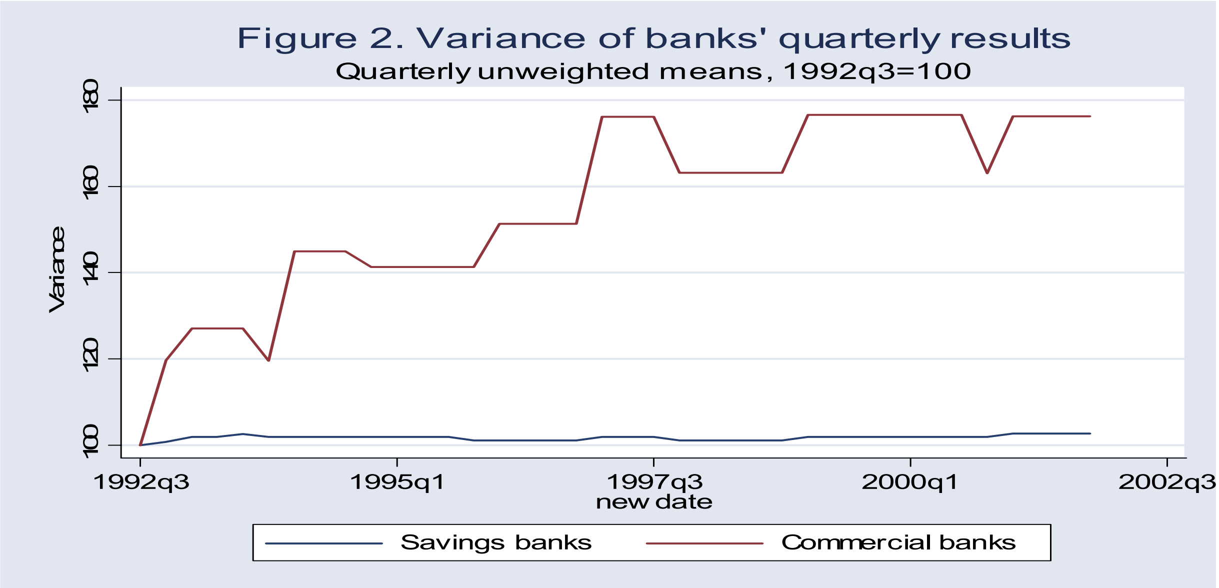


Figure 3 shows the average default probabilities (RPR). The banking crisis in Norway coincided with a downswing in the business cycle, and the fall in the default probabilities during the first years reflects a more positive business climate due to an economic upswing. It is interesting to note that the average default probability is higher for savings banks than for commercial banks. This implies that savings banks in general lend to industries and counties with relatively high default probabilities, such as the industry Hotel and restaurant management.

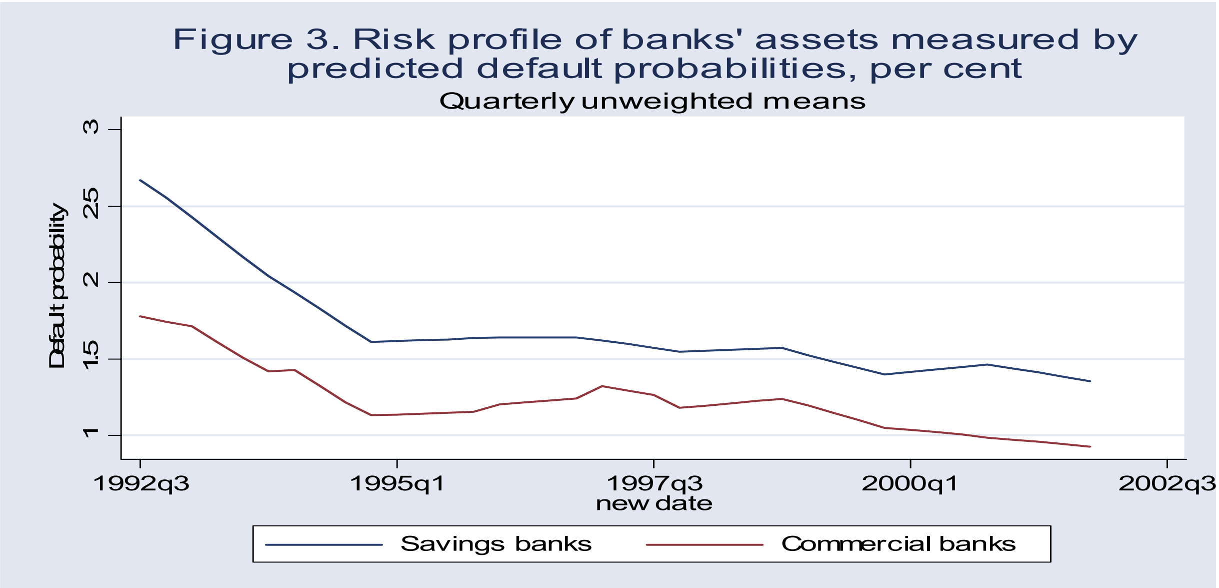
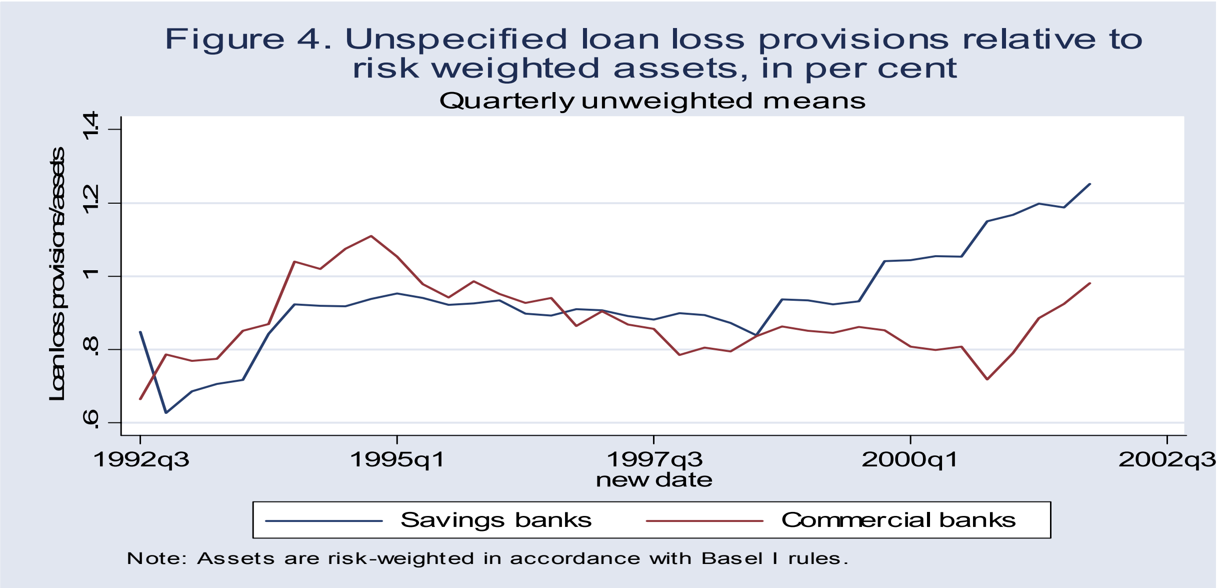
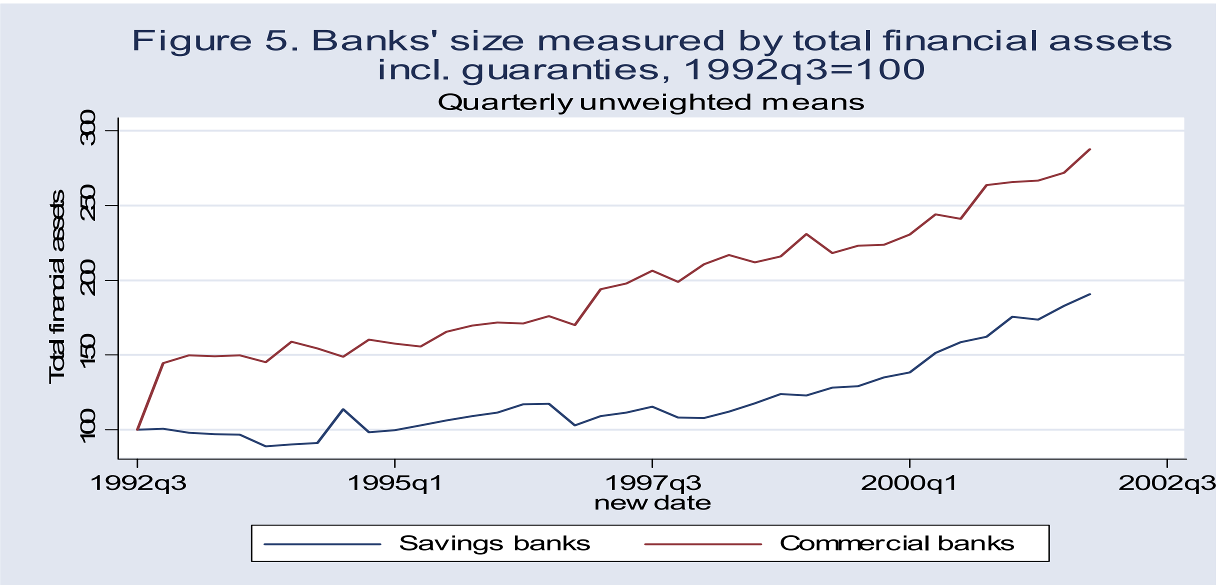


Figure 4 shows that unspecified loan loss provisions measured relative to risk weighted assets largely follow the same pattern over time for the two groups of banks.



From Figure 5 it is clear that, measured by total financial assets incl. guaranties, the average size of both type of banks have increased over time. The increase is larger for commercial banks than for savings banks.



Empirical results

As a starting point, we estimate equation (1) using the whole sample and assuming random effects. I.e., we assume that there is a time-invariant bank specific effect on the level of the buffer capital, while the slope coefficients, i.e. the estimated elasticities, are equal across banks. We use the Generalised Least Squares (GLS) Random-Effects Model procedure in

STATA 7.0 (StataCorp (2001)). The Breusch and Pagan (1980) Lagrange multiplier test, which tests if the variance of the random component is zero, is applied to test the relevance of the random effects specification. To test the appropriateness of the random effects estimator applied, which assumes that the random effects and the regressors are uncorrelated, we apply the Hausman (1978) specification test.

According to the results in Tables 2, the hypothesis of "no random effects" is clearly rejected, while the hypothesis of "no correlation between the random effects and the explanatory variables" is not. Model I is the most general model, as defined in Eq. (1), and all the explanatory variables are significant at the five per cent significance level. We find a negative price effect (PEC) on excess capital as expected, and banks with high uncertainty, manifested as a high variance on the result (VRES), hold a higher buffer capital than banks with less uncertainty. These results support the insurance explanation to buffer capital, i.e. banks hold excess capital to avoid falling below the regulatory minimum capital-ratio. Failing to meet the requirement could be costly due to market discipline and supervisory intervention. The intervention would certainly involve a requirement to increase the capital-ratio, either through an increase in capital or by reducing the volume of risky assets. For a poorly capitalised bank, increasing the capital can be difficult or expensive. The selling-assets option probably implies that the bank must sell the most profitable part of its portfolio.

The risk profile (RPR) has a negative effect on the buffer capital, which implies that banks with a relatively risky portfolio do not in general have a higher buffer capital. On the contrary, banks with a relatively high risk have a smaller capital buffer than banks with a low risk. One interpretation of this result is that the behaviour of Norwegian banks is characterised by moral hazard – at least among banks that are relatively willing to take risk. Hence, a shift to a more risk sensitive capital regulation may affect Norwegian banks. On the other hand, this negative relationship does not imply that high-risk banks are poorly capitalised relative to the risk in their portfolio, it may rather be due to too much capital in low-risk banks. This could very well give a negative relationship between risk and buffer capital. Small savings banks in Norway have a large share of low-risk housing loans and at the same time relatively large capital buffers, while the larger commercial bank have more high-risk business loans and in general more modest capital buffers. This may reflect that banks evaluate and react very differently to risk, depending on how risk-adverse they are. If this "variation in risk-adverseness" explanation is important, small savings banks must in general be more risk-adverse than commercial banks.

Table 2. Alternative random effects specifications. Left hand side variable is buf_i [1]

	Coefficient[2]			
Variable	Model I	Model II	Model III	Model IV
const	4.751	4.830	4.960	4.493
	(0.287)	(0.289)	(0.284)	(0.278)
pec	-0.160	-0.184	-0.269	-0.168
	(0.042)	(0.042)	(0.035)	(0.042)
$vres_i$	0.073	0.077	0.044	
	(0.020)	(0.020)	(0.019)	
rpr_i	-0.202	-0.198	-0.247	-0.207
	(0.024)	(0.024)	(0.022)	(0.024)
$cbuf_{i,t-1}$	0.055	0.038	0.050	0.057
	(0.014)	(0.014)	(0.014)	(0.014)
reg	0.207	0.245	0.160	0.198
	(0.053)	(0.053)	(0.052)	(0.053)
gdpg	0.153	0.170	0.120	0.159
	(0.032)	(0.033)	(0.032)	(0.032)
$uslp_{i,t-1}$	-0.011	-0.012	-0.009	-0.011
	(0.002)	(0.002)	(0.002)	(0.002)
$size_i$	-0.341	-0.347	-0.293	-0.298
	(0.020)	(0.020)	(0.017)	(0.017)
trend	0.175	0.170		0.131
	(0.038)	(0.038)		(0.036)
Q2	-0.040		-0.039	-0.040
	(0.013)		(0.013)	(0.013)
Q3	-0.087		-0.081	-0.087
	(0.013)		(0.013)	(0.013)
Q4	0.052		0.058	0.053
	(0.012)		(0.012)	(0.013)
R^2 : Within	0.121	0.097	0.117	0.120
Between	0.272	0.276	0.271	0.265
Overall	0.256	0.252	0.247	0.236
Random effects[3]	0.000	0.000	0.000	0.000
Hausman[4]	0.999	0.991	0.987	0.157

[1] The number of observations is 5278, the number of banks is 153.

[2] Standard error in parentheses. All coefficients in Model I are significant at the five per cent significance level. The same is true for the coefficients in Models II-IV also.

[3] Breusch and Pagan (1980) Lagrange multiplier test. H_0 is no random effects. Prob>$\chi^2(1)$ is reported.

[4] Hausman's (1980) specification test. H_0 is zero correlation between the random effects and the explanatory variables. Prob>$\chi^2(5)$ is reported.

The negative risk effect is, however, consistent with the results in Kim, Kristiansen and Vale (2001). They find a negative relationship between the buffer capital and interest rate margins. If interest rate margins reflect, i.e. increase with, risk, their results imply that the buffer capital is negatively related to risk – as evaluated by the banks, and that small savings banks in general take on less risk than large commercial banks. Ayuso et al. (2002) also find a negative relationship between the capital buffer and their risk measure. As argued in Section 2, however, the effects of VRES and RPR may both capture risk effects on banks' buffer capital. The positive effect of VRES for a particular bank may well dominate the negative effect of RPR.

The results also show that the buffer capital of competitors (CBUF) matters. This suggests that banks use buffer capital as an instrument in the competition for funding. Buffer capital probably acts as a signal on solvency and probability of non-failure. The pass-through is not very strong, however, and if the buffer capital of the competitors increases by one per cent, the bank increases its own buffer capital by only 0.03-0.04 per cent. This weak result may be due to the definition of competitors, since we define all banks within the same group, i.e. savings banks and commercial banks respectively, as equally important. A more correct measure may involve a weighting of different institution along both geographical location, specialisation on industries, funding strategies, etc. This is a very complicated approach, which we have not had the possibility to apply.

There is a clear positive effect of increased regulatory monitoring (REG) on banks' buffer capital. Hence, our results support the conclusion in Furfine (2001). Although our data does not include a whole business cycle, there is some cyclical variation in the GDP growth rates. The GDP growth rate increases in the early nineties and then levels off towards the end of our observation period. The positive effect of increased GDP growth (GDPG) on the buffer capital implies that banks adjust the buffer capital over the business cycle so that the pro-cyclical effect of the present capital regulation is dampened. The negative effect of unspecified loan-losses provisions (USLP) suggests that banks – although to a minor degree - choose this alternative rather than holding excess capital. Even if it is tractable for tax reasons to reduce the asset side of the balance sheet through unspecified loan-losses provisions, it may act as a poor signal to the market. Unspecified loan-losses provision implies that the bank expects losses on a category of loans rather than on one specific loan, and this may be interpreted as lack of control since one may expect several loans to perform weakly.

We find a clear negative size (SIZE) effect, which, as explained earlier, may be due to several reasons. A higher level of monitoring and screening in large banks due to scale effects in these activities may reduce the need for buffer capital as an insurance. The negative size effect may also come from a diversification effect not captured by the measure of risk profile (RPR). A third explanation is the too-big-to-fail hypothesis. There is a positive trend (TREND) effect, which suggests that there is a systematic increase in the buffer capital of banks over 1992-2001 not counted for by the other explanatory variables of Eq, (1). We also find systematic seasonal variation in the buffer capital, as suggested by the significant coefficients of the quarterly dummy-variables (Q2-Q4). The buffer capital tends to be highest in the fourth quarter and lowest in the third quarter according to the results. The quarterly effects suggest that banks scale down their buffer capital over the three first quarters of a year, but then build up the buffer capital significantly in the fourth quarter. This may be due to a higher focus on the results at the end of an accounting year than on the intermediate quarterly results. This may also be due to GDP level-effects on the buffer capital, however, which we have not included explicitly in our regressions. GDP shows a seasonal pattern that largely coincides with the seasonal pattern of the buffer capital. Our regressions include GDP growth rates, which do not show a similar seasonal pattern.

Models II-IV are reductions of the most general Model I. These reductions are done to check the robustness of the results if we leave out variables, which for different reasons, may be problematic. In Model II we exclude the seasonal effects (Q2, Q3, Q4), and in Model III we, in addition, exclude the trend (TREND), since, in general, the economic interpretation of this variable is difficult. In Model IV we, in addition to the seasonal effects, exclude the variance of the result (VRES), since this is an empirical proxy for uncertainty which may be more or less correlated with the true variable. In general, the results are very robust to these reductions. The most important change is for the p-value of the Hausman test of Model IV, where the variable VRES and Q2-Q4 are excluded from the regression.

Because the number of observations on savings banks is much larger than the number of observations on commercial banks, the behaviour of savings banks will tend to dominate when doing the full sample estimations. Particularly the discussion of the effect of RPR on the buffer capital suggests that there may be important to split the sample in two sub groups, i.e. savings banks and commercial banks, when estimating Eq. (1). The result from this is presented in Table 3.

Table 3. Alternative random effects specifications, estimation is done separately on savings banks (SB) and commercial banks (CB). Left hand side variable is buf_i[1]

	Coefficient[2]				
Variable	SB Model V	SB Model VI	SB Mod. VII	CB Mod.VIII	CB Model IX
const	4.010	4.100	5.357	2.349	3.437
	(0.354)	(0.338)	(0.338)	(1.458)	(1.207)
pec	0.032			-0.754	-0.531
	(0.035)			(0.274)	(0.241)
$vres_i$	0.176	0.175	0.216	-0.077	
	(0.023)	(0.024)	(0.024)	(0.064)	
rpr_i	-0.091	-0.092	-0.114	-0.600	-0.634
	(0.020)	(0.020)	(0.021)	(0.177)	(0.172)
$cbuf_{i,t-1}$	0.761	0.741	0.477	-0.028	
	(0.041)	(0.036)	(0.036)	(0.032)	
reg	0.131	0.150	0.203	0.636	
	(0.043)	(0.040)	(0.042)	(0.376)	
gdpg	-0.020		0.073	-0.627	-0.708
	(0.029)		(0.029	(0.205)	(0.200)
$uslp_{i,t-1}$	-0.007	-0.007	-0.008	-0.087	-0.087
	(0.002)	(0.002)	(0.002)	(0.014)	(0.014)
$size_i$	-0.482	-0.481	-0.561	-0.066	-0.097
	(0.027)	(0.027)	(0.028)	(0.051)	(0.046)
trend	0.487	0.472	0.516	-0.716	-0.735
	(0.036)	(0.031)	(0.032	(0.250)	(0.236)
Q2	-0.026	-0.026		-0.028	
	(0.010)	(0.010)		(0.079)	
Q3	-0.049	-0.049		-0.010	
	(0.011)	(0.011)		(0.082)	
Q4	0.140	0.139		0.089	
	(0.011)	(0.011)		(0.077)	
R^2 : Within	0.262	0.262	0.204	0.137	0.124
Between	0.189	0.189	0.187	0.309	0.307
Overall	0.206	0.206	0.191	0.193	0.162
RE[3]	0.000	0.000	0.000	0.000	0.000
Hausman[4]	0.233	0.982	0.412	0.837	0.086

[1] SB: The number of observations is 4777, the number of banks is 131. CB: The number of observations is 501, the number of banks is 22.

[2] Standard error in parentheses. Models VI and IX are reductions of Models V and VIII respectively. Coefficients that are not significant at the five per cent significande level are restricted to zero.

[3] Breusch and Pagan (1980) Lagrange multiplier test. H_0 is no random effects. Prob>$\chi^2(1)$ is reported.

[4] Hausman's (1980) specification test. H_0 is zero correlation between the random effects and the explanatory variables. Prob>$\chi^2(5)$ is reported.

Again we find that the hypothesis of “no random effects” is clearly rejected, while the hypothesis of “no correlation between the random effects and the explanatory variables” is not. A comparison of Tables 2 and 3 reveals some important differences. While, according to Table 3, the negative price effect on the buffer capital is significant only for commercial banks, uncertainty, as represented by the variance of the result, is important only for savings banks. Hence commercial banks are price sensitive, while savings banks are sensitive to uncertainty. Hence, the insurance argument is important for both groups, but for different reasons.

The risk profile has a negative effect on the buffer capital for both groups, but the effect is stronger for commercial banks than for savings banks. Furthermore, if the variance of results captures risk effects, the positive coefficient on VRES for savings banks will tend to weaken the negative risk effect from RPR even more relative to that of commercial banks. If moral hazard is important, we would expect this to be more pronounced in commercial banks, since these banks in general face a tougher request for return on equity than savings banks. Hence, there is a higher pressure on commercial banks to increase profits, which probably put a downward pressure on the capital buffer.

The buffer capital of competitors is not important for commercial banks, while it is important for savings banks. This is a bit surprising, since we would expect the smaller group of commercial banks to compete relatively heavy with each other and savings banks to be more protected from each other due to the importance of location for their customers.

The estimated effect of regulatory scrutiny on buffer capital is positive for both savings and commercial banks, but the effect is not significant at the five per cent significance level for commercial banks. However, although not significantly different from zero, restricting rpr to zero reduces the Hausman specification test-statistic relatively much. This shows that the exclusion of this variable involves a cost according to other statistical criteria than the t-value. With respect to GDP growth, we find a significant negative effect for commercial banks. Hence, the capital buffer of commercial banks tends to boost the business cycle. According to Model V, the buffer capital of savings banks is independent of GDP-growth. This may be due to a discrepancy between the “true” variable and the variable that is applied, however. Most savings banks operate within a limited geographical area, and hence we should have used an area specific growth rate and not the growth in total main-land GDP. Quarterly area specific growth rates are not easily available. The conclusion that GDP growth does not affect the buffer capital of savings banks depends on the inclusion of seasonal dummies, however. If we exclude Q2-Q4 from the model, we find a significant positive GDP growth effect on the buffer capital, which, according to this model, suggests that the buffer capital of savings banks dampens the pro-cyclical effect of capital regulation.

The size effect is negative for both groups, but the marginal effect is larger for savings banks than for commercial banks. This may reflect a diminishing negative size effect due to diminishing scale economies in monitoring and screening or in the diversification effect. While the trend effect is positive for savings banks over 1992-2001, the trend effect is negative for commercial banks. The seasonal effects are not significant for commercial banks, while the buffer capital of savings banks follows the pattern found in Table 2. I.e. the buffer capital of savings banks is highest at the end of a year and lowest in the third quarter.

4 Conclusions

Using unbalanced bank-level panel data for Norway, we estimate a model for the buffer capital. Buffer capital is defined as the ratio of excess capital to risk-weighted assets. We focus on five issues: i) Whether excess capital acts as an insurance against falling below the required minimum capital to asset ratio, ii) Whether excess capital depends on the risk profile of the bank's portfolio, iii) Whether banks use excess capital as a signal, i.e. competition parameter, and relative capital buffers matter, iv) Whether the level of regulatory monitoring matters, and v) Whether the buffer capital depends on economic growth.

We estimate the model using both all banks and two sub groups, i.e. savings banks and commercial banks, as the information set. The results reveal interesting differences across the two groups of banks. We find that the insurance argument is important for both groups, but for different reasons. While commercial banks are price sensitive and the buffer capital decreases with an increase in the price, savings banks are sensitive to uncertainty, and higher uncertainty increases the buffer capital.

While we expected a positive effect of the risk profile of banks' portfolios on the buffer capital, a negative effect is found for both savings banks and commercial banks, but the marginal effect is stronger for commercial banks than for savings banks. This may be due to moral hazard in banks. If, in addition to the risk-profile variable, the variance of results captures risk effects, the positive coefficient on this latter variable for savings banks will tend to weaken the negative risk effect even more relative to that of commercial banks. If moral hazard is important, we would expect this to be more pronounced in commercial banks, since these banks in general face a tougher request for return on equity than savings banks. Hence, there is a higher pressure on commercial banks to increase profits, which probably put a downward pressure on the capital buffer. The negative risk effect may also reflect that banks evaluate risk very differently, however, and that low-risk banks have too much capital seen from the outside.

The capital buffer of competitors is important for savings banks but not for commercial banks. This is a bit surprising, since we expected the smaller group of commercial banks to compete relatively heavy with each other and savings banks to be more protected from each other due to the importance of location for their customers.

Increased regulatory scrutiny increases the buffer capital, but the effect is significant for savings banks only. Hence, commercial banks have not changed their strategy with respect to holding excess capital as a result of increased activity by the supervisory authorities in Norway. With respect to economic growth effects, we find that the buffer capital of commercial banks behaves counter-cyclically, and hence commercial banks tend to boost the pro-cyclical effect of the capital regulation on the business cycle in their adjustment of the buffer capital. The buffer capital of savings banks is independent of GDP-growth, which may be due to a discrepancy between the "true" variable and the variable that is applied. Most savings banks operate within a limited geographical area, and hence we should have used an area specific growth rate and not the growth in total main-land GDP. Quarterly area specific growth rates are not easily available, however.

We find the expected negative size effect on the buffer capital, i.e., large banks tend to hold a higher capital buffer than small banks. We find a positive trend effect for savings banks and a negative trend effect for commercial banks.

Appendix

The empirical variables

BUF is the capital buffer measured as the "excess-capital to risk-weighted assets" ratio. Risk weighted assets is calculated in accordance with Basel I.

PEC is the price of excess capital. We can not observe this price directly, and the deflated 10 years interest rate on private bonds is used as an empirical proxy. The consumer price index (CPI) is used as a deflator. Compared with government bonds, the interest rate on private bonds includes a risk premium that varies over time.

VRES is the variance of each bank's capital buffer calculated over its observation period. This variable has cross sectional variation but is constant over time

CBUF is the competitors' average capital buffer. We split the banks in two groups, i.e. savings banks and commercial bank. While the capital of commercial banks basically consists of equity capital, accumulated reserves and for some banks also subordinated debt, the capital of savings banks consists primarily of accumulated reserves and a hybrid capital instrument intended to mimic equity capital.

RPR represents the 'risk profile' of the banks' assets. We measure this as the bank specific probability of default of limited liability firms with bank loans. We have access to predicted default probabilities of all limited liability firms in Norway from a bankruptcy prediction model developed at Norges Bank, see Bernhardsen (2001). We also have access to the volume of bank loans of each firm. We can not match these firm data directly with the banks, however, since we do not have information on the borrower-lender identity. We therefore calculate industry and county specific default probabilities where the volume of bank loans of each firm is used as weights. By exploiting available information on industry and county for each loan in banks' portfolio, the aggregate default probabilities are used to calculate bank specific default probabilities. Since firm specific default probabilities are calculated using annual accounts data, we define this as the fourth quarter default probability and interpolate linearly between these observations.

REG represents regulatory scrutiny. Two alternative measures are applied: (i) REG(N) is the number of employees at the beginning of each year at Kredittilsynet, which is the supervisory authority in Norway. (ii) REG(I) is the annual number of on-site inspections by Kredittilsynet divided by four. The results do not depend on the choice of empirical variable, and we present the results with REG(I) in the paper.

GDPG denotes the four quarter growth rate of Main land Norway gross domestic product, i.e. excess oil, natural gas and shipping. Measured in per cent.

SIZE is total financial assets incl. guaranties and represents bank size.

USLP is unspecified loan loss provisions relative to risk weighted assets.

TREND is a simple deterministic trend variable.

Qj, j=2, 3, 4, are quarterly dummy-variables that are one in quarter j and zero elsewhere.

Table A1-A3 give the correlation matrix of the variables used in the regressions. All variables are on logarithmic form.

Table A1. The correlation matrix of the variables used in the regression, all banks

	buf_{it}	pec_t	$vres_i$	rpr_{it}	$cbuf_{k,t-1}$	reg_t	$gdpg_t$	$size_{it}$	$uslp_{i,t-1}$	$trend_t$
buf_{it}	1.000									
pec_t	-0.032	1.000								
$vres_i$	-0.023	-0.039	1.000							
rpr_{it}	0.121	0.285	-0.019	1.000						
$cbuf_{k,t-1}$	0.010	-0.041	-0.022	-0.029	1.000					
reg_t	0.0002	0.589	-0.027	0.173	0.103	1.000				
$gdpg_t$	0.059	0.007	-0.013	0.035	0.183	-0.258	1.000			
$size_{it}$	-0.476	-0.067	0.069	-0.349	0.033	0.054	-0.045	1.000		
$uslp_{i,t-1}$	-0.015	0.034	0.068	0.174	-0.048	0.060	-0.086	0.070	1.000	
$trend_t$	-0.001	-0.765	0.050	-0.393	0.183	0.402	-0.207	0.111	0.156	1.000

The variables are on logarithmic form. Based on 5279 observations.

We find a large and negative correlation coefficient between buf_{it} and ass_{it}, i.e. between the capital buffer and bank size. Among the explanatory variables, we find a high correlation coefficient (in absolute term) between the price, pec_t, and both regulatory scrutiny, reg_t, and the trend, $trend_t$.

Table A2. The correlation matrix of the variables used in the regression, savings banks

	buf_{it}	pec_t	$vres_i$	rpr_{it}	$cbuf_{k,t-1}$	reg_t	$gdpg_t$	$size_{it}$	$uslp_{i,t-1}$	$trend_t$
buf_{it}	1.000									
pec_t	-0.023	1.000								
$vres_i$	-0.268	0.011	1.000							
rpr_{it}	0.041	0.318	-0.127	1.000						
$cbuf_{k,t-1}$	0.163	-0.027	0.003	-0.013	1.000					
reg_t	0.004	0.588	0.009	0.120	0.036	1.000				
$gdpg_t$	0.093	0.007	0.001	0.033	0.468	-0.110	1.000			
$size_{it}$	-0.361	-0.112	0.927	-0.225	-0.087	-0.068	-0.066	1.000		
$uslp_{i,t-1}$	0.008	-0.210	0.111	-0.027	-0.030	-0.126	-0.057	0.135	1.000	
$trend_t$	-0.018	-0.764	-0.012	-0.393	-0.237	-0.523	-0.209	0.171	0.258	1.000

The variables are on logarithmic form. Based on 4777 observations.

Table A3. The correlation matrix of the variables used in the regression, commercial banks

	buf_{it}	pec_t	$vres_i$	rpr_{it}	$cbuf_{k,t-1}$	reg_t	$gdpg_t$	$size_{it}$	$uslp_{i,t-1}$	$trend_t$
buf_{it}	1.000									
pec_t	-0.025	1.000								
$vres_i$	-0.298	-0.065	1.000							
rpr_{it}	-0.050	0.200	-0.203	1.000						
$cbuf_{k,t-1}$	-0.009	-0.109	-0.012	0.009	1.000					
reg_t	0.049	0.595	-0.066	0.313	0.313	1.000				
$gdpg_t$	-0.119	0.006	0.010	0.072	0.084	-0.100	1.000			
$size_{it}$	-0.347	-0.018	0.862	-0.356	-0.004	0.001	-0.019	1.000		
$uslp_{i,t-1}$	-0.310	-0.150	0.020	0.282	0.042	-0.105	0.050	-0.050	1.000	
$trend_t$	0.014	-0.767	0.075	-0.333	-0.066	-0.548	-0.188	0.056	0.121	1.000

The variables are on logarithmic form. Based on 501 observations.

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