Is bank capital procyclical? A cross-country analysis

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Abstract

This article investigates the determinants of commercial banks' own internal capital targets and potential sensitivity of these levels to the business cycle. World-wide results make clear that banks' own risk is only slightly dependent on the business cycle. Banks tend to hold substantial capital buffers on top of minimum requirements, reflecting that they hold capital for other reasons than strictly meeting the capital requirements. These results suggest that actual capital levels may not become substantially more procyclical under the new risk-sensitive Basel II regime. However, a number of banks, especially smaller ones, combine a relatively risky portfolio with limited buffer capital. A more risk-sensitive capital regulation regime could force these banks to obtain higher capital levels, which would make them more procyclical.

JEL: E32, G21, G28, G31;
Key words: Basel II, BIS capital ratio, bank's own capital targets, credit crunch, business cycle;

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1. Introduction

Bank capital plays a pivotal role in bank solvency: the more capital banks have, the more robust their buffers are with which to absorb unexpected losses and, hence, to avoid bankruptcy. It follows naturally that capital is also crucial for accommodating bank lending to firms, which is itself indispensable for healthy macroeconomic development (particularly in bank-based countries): the more capital banks have, the more capacity is available for an expansion in the supply of credit. As is well known, the availability of credit may be threatened when economic conditions grow worse. During a cyclical downturn, the quality of banks' assets generally deteriorates, which increases risk exposure and, hence, economic capital (the total amount of capital needed to cover all risks, as perceived by the institution), exactly at a time when new capital becomes more expensive or, for weaker banks, simply unobtainable. Moreover, loan losses may increase and erode bank capital. As a consequence, banks may be forced to cut back on lending. Particularly in countries where corporate lending is provided mainly by banks, this would further weaken cyclical conditions into a so-called credit crunch, which would in turn exacerbate the downturn.[2]

In order to promote bank solvency and to avoid procyclical behaviour by banks, bank supervisors keep an eye on bank capital in relation to credit and other risks. One of their tools is to prescribe minimum required capital levels, as has been done since 1988 under the Basel capital Accord, known as Basel I. In 2004, the banking supervisors, gathered in the Basel Committee on Banking Supervision,[3] have agreed on a new capital regime (BCBS, 2004). One of the main objectives underlying the new Basel Agreement is to substantially increase the risk sensitivity of the minimum capital requirements for banks. Earlier draft versions of the Agreement ('consultative documents') have prompted a lively debate in both policy circles and the economic literature about the potential procyclical effect such risk-sensitive requirements might have on the economy (*e.g.* Segaviano and Lowe, 2003; Borio *et al.*, 2001; Daníelsson *et al.*, 2001; Carpenter *et al.*, 2001; Turner, 2000). New proposals by the Basel Committee have substantially reduced the possible procyclical effects of the new Agreement and thereby reduced the risks of financial instability. Yet the new capital requirements continue to be more risk-sensitive than before as,

[2] Strong empirical evidence for the existence of the credit crunch has failed to come up (Sharpe, 1995). See also Berger and Udell (1994), Peek and Rosengren (1995), Wagster (1999) and, for an overview, Bikker (2004, Chapter 7).

[3] The Basel Committee on Banking Supervision consists of senior representatives of banking supervisory authorities and central banks from the (extended) G-10: Belgium, Canada, France, Germany, Italy, Japan, Luxembourg, the Netherlands, Spain, Sweden, Switzerland, the UK and the US.

incidentally, they should be in order to promote the financial soundness of banks. Hence, the issue of possible procyclicality continues to exist.

In practice, we observe that many banks hold more capital than the required minimum. Many assess their risks independently, for instance, using their own economic capital models. In the trade-off between risk and return, they set an appropriate capital level, depending on their risk aversion. A bank may also prefer to hold more than the required capital as a signal to the market regarding its own soundness in order to be able – as a very solvent bank – to raise funds at lower interest rates and for competitive reasons. Banks could also hold buffers as an insurance to avoid costs related to market discipline and supervisory intervention if they approached the regulatory minimum capital ratio (Estrella, 2004, Furfine, 2000), or as a cushion to absorb economic recessions, thus limiting the procyclical effect of capital. Finally, banks may respond to regulatory scrutiny by holding higher buffers. Many supervisors require extra buffers in a systematic way or based on individual assessment.[4] All in all, for various reasons, 98% of the banks are above the minimum level, and as many as 86% even hold a quarter more capital than they are required to. It is not clear in advance whether banks will change their capital buffer behaviour after the changeover to Basel II. There is little doubt that banks will further improve their risk measurement tools and that they may arrive at a more risk sensitive internal risk assessment. Nevertheless, we expect that banks will continue to base their final capital level decisions on their own internal capital targets. It has been argued that a more risk sensitive capital adequacy framework 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 is feared by some (Lindquist, 2004). For that reason, it is interesting to investigate the cyclical behaviour of banks over the last decade, as this behaviour will probably also be typical for the next decade. Therefore, this article develops a comprehensive model for the possible determinants of bank's own capital target, including business cycle effects. The aim is to detect cyclical patterns in current bank capital behaviour which, if found, might be continued or somewhat amplified under Basel II.

A number of recent studies in the economic literature investigate bank capital behaviour. They tend to focus on certain aspects of capitalisation, not always including procyclicality, in a single country only, *e.g*. Estrella (2004); Lindquist (2004); Ayuso *et al.* (2004); Rime (2001) and Ediz *et al.* (1998), respectively on the US, Norway, Spain, Switzerland and the UK. Some more international studies do not focus on procyclicality, but on the impact of Basel I (see the next section). We have opted for a broader approach, applying a comprehensive bank capital target model and using a large data set, which enables us to obtain robust estimates, assuming that

[4] Particularly, supervisors in the US and UK are known for their pressure on banks to hold extra buffers in order to become 'well-capitalised' banks.

similarities in capital behaviour of banks across countries weights heavier than disparities. This approach allows us to compare bank capital behaviour across countries and may reveal world-wide patterns of conduct regarding capital as well as idiosyncratic country-specific deviations. This article is the first that presents such world-wide investigations to bank capital behaviour and procyclicality.

For this purpose, we investigate, for each bank, the equity capital level as recorded in its annual reports, that is, including reserves and retained profits, expressed as share of total assets (called equity ratio or leverage ratio) and the capital buffers according to the BIS definitions, that is, its BIS capital as a ratio of so-called risk-weighted assets. The BIS capital ratio is the most interesting one, as it is a risk-adjusted measure of capital and reflects the impact of regulatory requirements more accurately than other capital measures. Unfortunately, the availability of BIS ratio data is rather limited compared to equity capital data. For the equity capital investigations we can employ a large set of over 16,000 bank-year observations from twenty-nine OECD countries over 1990-2001,[5] compared to 7,000 for the BIS ratio analyses.

The outline of this article is as follows. Section 2 reviews minimum capital requirements and actual capital levels against the background of changing supervisory regimes. Section 3 presents a model for banks' capital levels and constructs proxies for factors that could determine the capital ratio. Section 4 elaborates on the data used in the empirical analysis. Section 5 reports the results of a dynamic multivariate panel regression model for the equity ratio, whereas the next section investigates the BIS capital ratios. Section 7 repeats the analyses for various bank-size classes in order to assess the equity model's sensitivity to bank sizes. Finally, Section 8 summarises and draws conclusions.

2. Banks capital buffers and regulatory regimes

2.1 Basel I

In 1988, the Basel Committee introduced the first Basel Accord on minimum capital requirements for internationally active banks, in order to promote sound and stable banking systems and a world-wide level-playing field. At present, over 100 countries have adopted this capital regulatory framework, often also applying it to locally active banks. The BIS or solvency ratio shows a bank's actual own funds (capital) as a percentage of its risk-weighted assets, and must not fall below 8%. The risk-weighted assets relate mainly to the credit risk run by banks, but other risks – such as market risk – are also included in the denominator of the BIS ratio. This ratio therefore indicates a bank's capability to absorb losses. However, as not all risks are explicitly taken into account for in the BIS ratio – take for example operational risk – banks are required to maintain a capital adequacy ratio of over 8%. The denominator is calculated by multiplying a

[5] The data set does not include Slovakia, which joined the OECD only in 2000.

bank's assets by a weighting coefficient. The greater the (credit) risk, the higher the coefficient. Currently, five coefficients are distinguished: 0%, 10%, 20%, 50% and 100%. The actual own funds forming the numerator of the BIS ratio consist of Tier 1, Tier 2 and Tier 3 capital less deductible items. Tier 1 capital, or core capital, tops the list in qualitative terms. It is made up mainly of equity capital, reserves and retained profits, but may, subject to conditions, also include certain innovative forms of capital. At least half of a bank's capital requirement should consist of such core capital, which means that the ratio of Tier 1 capital to risk-weighted assets should be at least 4%. Tier 2 capital is made up of preferred shares and debt certificates with no fixed maturity (upper Tier 2) and of preferred shares with a limited life span and long-term subordinated debts (lower Tier 2).[6] Tier 3, at the bottom of the list in qualitative terms, consists of short-term subordinated debts, and accounts for only a small share of actual own funds.

Table 1: Bank-size weighted averages of annual capital ratios (29 OECD countries)

	BIS capital ratio				**Equity capital ratio**				**Equity/**
Year	*Average* [a]	*Median* [b]	*Total assets* [c]	*No. of ob-servations*	*Average* [a]	*Median* [b]	*Total assets*	*No. of ob-servations*	**BIS**
1990	0.087	0.091	1.2	17	0.042	0.047	1.9	78	0.48
1991	0.091	0.098	2.1	30	0.045	0.058	2.7	152	0.50
1992	0.096	0.100	2.8	64	0.045	0.067	3.4	372	0.47
1993	0.103	0.117	12.4	368	0.044	0.070	14.1	1,306	0.43
1994	0.101	0.125	18.7	759	0.047	0.073	21.7	1,833	0.46
1995	0.105	0.129	18.9	838	0.047	0.076	21.8	1,945	0.44
1996	0.106	0.125	18.7	891	0.048	0.076	22.1	2,030	0.45
1997	0.107	0.123	21.9	906	0.046	0.077	25.3	2,037	0.43
1998	0.115	0.124	23.0	911	0.050	0.075	28.4	2,051	0.44
1999	0.115	0.118	24.7	994	0.053	0.075	29.6	1,993	0.46
2000	0.114	0.117	26.4	914	0.054	0.077	30.3	1,801	0.47
2001	0.120	0.123	9.8	382	0.068	0.086	11.6	428	0.56
All [d]	*0.109*	*0.122*	*180.5*	*7,074*	*0.050*	*0.075*	*212.9*	*16,026*	*0.46*

[a] Weighted with total assets; [b] The median is not weighted. [c] In thousands of billions of US $; [d] Here, median is the world wide median: the ratio of the 3,037th and 8,014th bank-year observation, respectively.

Table 1 presents figures of the BIS capital ratio for our data sample of 7,074 bank-year observations of the BIS ratio, stemming from 1,320 banks.[7] A clear increase of this ratio emerges for the first years from 8.7% on average in 1990 to 10.1% on average in 1994, until in 1995 a tentative equilibrium level has been reached – which is, incidentally, well above the 8% minimum

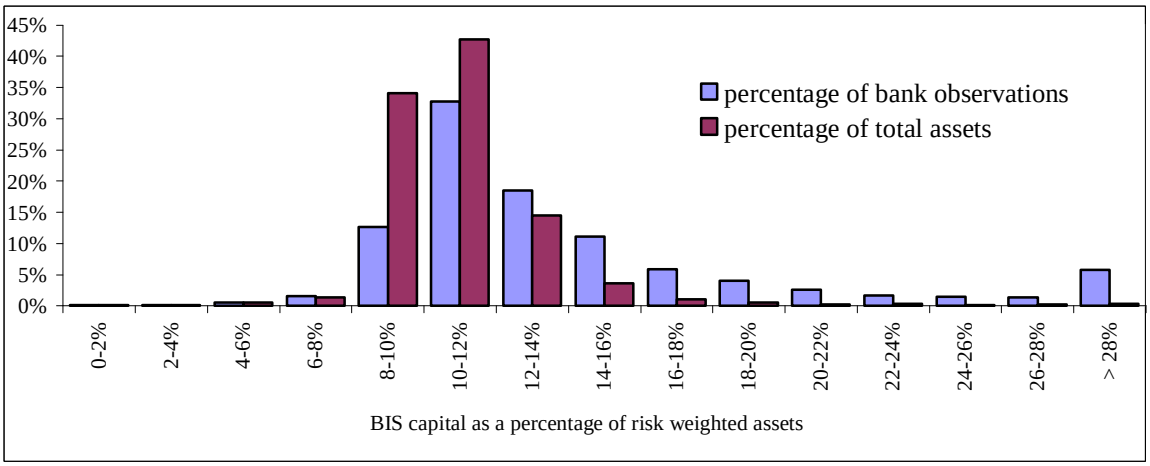
[6] Tier 2 also includes, up to certain limits, provisions for general loan loss reserves. This might be a more favourable purpose for retained earnings than equity as, in many countries, such provisions are tax deductible. Bikker and Metzemakers (2005), who investigate bank provisioning behaviour and procyclicality, indeed found a negative relationship between (i) equity and (ii) provisions on the profit and loss account, both taken as shares of total assets.

[7] The number of observations for the earliest years (1990-1992) and the last year (2001) is much smaller than for the other years. Clearly, the mass of information comes from the central years 1994-2000. Nevertheless, the other years also provide some useful information.

level. A similar tendency can be observed for the median figures, be it on a higher level.[8] Between 1994 and 2001, the median BIS ratio fluctuated around 12.2%, an ample 50% above the minimum. The persistently higher level of the median reflects skewness of the distribution of the BIS ratio across banks, in the sense that the many small banks tend to maintain higher ratios, whereas the fewer – more diversified – large banks maintain lower ratios (see also Table A.5 in the appendix). This is also illustrated by Chart 1, where the frequency distribution of unweighted banks is compared to the frequency distribution of total assets (or size-weighted banks).

In the early 1990s only a few banks reported their BIS capital ratio.[9] Using data from national supervisors and the Basel Committee, Jackson *et al.* (1999) observed that between 1988 and 1992, the transition period, the average capital ratio of the whole sector rose significantly. Apparently, the Accord indeed strongly induced banks to increase their capital reserve.

Chart 1: Frequency distribution BIS capital ratio (29 OECD countries, 1990–2001)



Apart from raising capital, US banks shifted sharply from risky corporate lending to investment in save government securities. There is an extensive amount of literature on this topic due to the fact that the adjustment to Basel I capital levels coincided with a recession in most industrialised countries. A number of studies made a persuasive case that capital requirements played a role in this switch to less risky assets, supporting the credit crunch hypothesis,[10] but others have provided evidence suggesting that this decline in private lending is better explained by banks' own internal capital targets than by regulatory capital requirements (Hancock and Wilcox, 1993; Ediz *et al.*, 1998).[11]

[8] The tendency of increasing BIS ratios is also reflected in the number of banks that fail to meet the 8% requirement. The share of such weakly capitalised banks falls sharply in the first years, to below 2% in later years. In 1999 this share rises temporarily to above 4%.

[9] This was due to the fact that while industrialised countries adopted risk-based capital standards in 1988, these standards were implemented only gradually, taking full effect as late as 1993.

[10] Hall (1993), Haubrich and Wachtel (1993), Thakor (1996) and Calem and Rob (1999).

[11] Other studies investigated whether, within asset categories with equal regulatory risk weights, banks have substituted safer, lower-yielding assets for riskier, higher-yielding investment (Shrieves and Dahl, 1992;

The world-wide (total-assets weighted) average of above 11% indicates that banks choose to maintain capital levels that in almost all cases result in BIS ratios well above the required minimum (see also Chart 1). This outcome underlines that banks may have their own motives for setting capital targets independently from supervisory rules. Banks may be more risk-averse and aim at lower funding costs, they may assess the risk of their portfolio as being higher than the outcome of the BIS risk weighting scheme (De Bondt and Prast, 2000), or they may wish to hold a capital buffer enabling them to exploit unexpected investment opportunities (Berger *et al.*, 1995). An alternative would be that banks set their capital a certain time-invariant percentage (points) above minimum requirements. Ediz *et al.* (1998) found for the UK that banks adjust their capital upwards if it comes close to the minimum requirement level or to the trigger value of the UK supervisors (where the supervisors start 'drastic actions'). By contrast, Hancock and Wilcox (1993) did not find such adjustments for the US banks.

Table 1 also shows the equity capital ratio data, based on 16,026 bank-year observations from 2,536 banks. For two reasons, the (average) ratio is substantially lower than the BIS ratio, in fact, somewhat less than half the BIS ratio.[12] First, equity is equal to the Tier 1 capital, that is, only the highest quality tranche of the buffer capacity. Secondly, the assets in the denominator are not reduced by risk weighting coefficients, ranging from 0% to 100%. The correlation between the BIS and equity capital ratios is 0.65 (with P-value 0.01), significantly different from 1,[13] making it clear that BIS and equity capital ratios often diverge quite strongly. The larger equity ratio sample deviates from the smaller BIS-ratio sample in the sense that the former includes many smaller banks. Hence, these two samples are not fully comparable.[14] The average equity ratio experienced the same rise in the early nineties as the average BIS ratio, be it on a lower level. Apparently, and logically, the rise in the BIS ratio is due mainly to strengthening of the capital structure, rather than to a reduction of the share of risky assets (although such a reduction may have occurred sometimes, see the literature discussion above). The relationship between the equity and BIS ratios has been fairly stable (last column of Table 1).

Table 2 presents the BIS and equity ratios for 29 OECD countries. Averaging below 10%, the BIS ratios are lowest in South Korea and Japan, countries known for their banking problems, and in Iceland and Italy. In terms of median values, Germany is also among the countries with the less strongly capitalised banks. The very stable banks in Switzerland and the more risky banks in Turkey, Mexico and Eastern Europe appear to be among the better capitalised ones.

Haubrich and Wachtel, 1993; Jacques and Nigro, 1997). From a theoretical point of view, such substitution can be proven to be sensitive to assumptions about banks objective functions (Rochet, 1992 a).

[12] On the other hand, the BIS ratio can be pressed down due to risky off-balance sheet items.

[13] By significant (or very significant) we mean, throughout this article, at the 95% (or 99%) level of confidence.

[14] This issue is dealt with in the sensitivity to bank-size discussions in Section 7.

Table 2: Bank-size weighted averages of capital ratios per country (1990-2001)

	BIS capital ratio				Equity capital ratio				Equity/
Countries	*Average* [a]	*Median* [b]	Total assets [c]	*No. of observations*	*Average* [a]	*Median* [b]	Total assets	*No. of observations*	**BIS**
Australia	0.107	0.112	3.7	129	0.069	0.060	4.0	255	0.65
Austria	0.104	0.107	0.9	42	0.038	0.065	1.3	310	0.37
Belgium	0.115	0.116	4.0	70	0.033	0.051	5.9	333	0.29
Canada	0.119	0.119	2.4	128	0.054	0.075	2.6	344	0.45
Czech republic	0.135	0.137	0.2	67	0.070	0.069	0.4	167	0.52
Denmark	0.113	0.143	1.7	394	0.054	0.112	1.7	428	0.48
Finland	0.127	0.127	1.2	56	0.049	0.050	1.2	57	0.38
France	0.102	0.111	15.2	569	0.039	0.063	19.3	1,918	0.38
Germany	0.103	0.099	13.6	100	0.035	0.069	17.3	1,671	0.34
Greece	0.125	0.136	0.5	34	0.063	0.079	0.9	100	0.50
Hungary	0.142	0.141	0.1	50	0.079	0.100	0.2	173	0.56
Iceland	0.096	0.098	0.0	26	0.065	0.069	0.0	29	0.67
Ireland	0.124	0.124	1.0	37	0.063	0.066	1.3	147	0.51
Italy	0.098	0.119	9.7	440	0.052	0.075	12.2	755	0.53
Japan	0.099	0.095	57.3	419	0.040	0.040	59.8	597	0.40
Korea, South	0.095	0.097	3.1	104	0.047	0.049	4.2	194	0.49
Luxemburg	0.125	0.122	1.3	122	0.034	0.036	3.4	905	0.28
Mexico	0.138	0.133	0.5	30	0.082	0.118	0.7	193	0.60
Netherlands	0.122	0.137	6.2	161	0.042	0.065	6.5	321	0.35
Norway	0.113	0.110	0.4	74	0.061	0.065	0.6	87	0.54
New Zealand	0.104	0.106	0.4	55	0.044	0.048	0.5	65	0.42
Poland	0.144	0.152	0.2	133	0.101	0.118	0.3	263	0.70
Portugal	0.111	0.116	1.1	90	0.055	0.068	1.5	247	0.50
Spain	0.106	0.111	3.9	128	0.062	0.085	7.6	618	0.58
Sweden	0.120	0.125	1.9	57	0.043	0.043	2.0	70	0.36
Switzerland	0.133	0.133	9.5	71	0.050	0.131	11.3	1,496	0.38
Turkey	0.206	0.156	0.1	44	0.106	0.096	0.6	238	0.52
UK	0.117	0.160	9.3	231	0.047	0.093	14.4	781	0.41
US	0.121	0.125	31.0	3,213	0.082	0.083	31.3	3,264	0.68
All [d] */total*	*0.109*	*0.122*	*180.5*	*7,074*	*0.050*	*0.075*	*212.9*	*16,026*	*0.46*

[a] Weighted with total assets; [b] The median is not weighted; [c] In thousands of billions of US $; [d] Here, median is the world wide median: the ratio of the 3,037th and 8,014th bank, respectively.

The ranking according to equity ratios deviates strongly from that according to BIS ratios. Banks in a number of European countries and in Japan have the lowest equity ratios. Again, Turkey is at the top of the list, followed by Eastern European countries and the US. This indicates serious differences across countries with respect to the capital structure, the riskiness of the assets, or both. Apparently, due to differences in legal structures and accounting, supervisory and tax rules, large dissimilarities exist across countries with respect to the use of lower quality components in BIS capital across countries. Differences in both capital structure and riskiness of assets are also reflected in the last column of Table 2, which shows the relationship between the BIS and equity ratios. In some countries, such as Poland, the US and Iceland, equity is the major component of the BIS capital (around two thirds, against an average share below 50%), whereas in other countries such as Luxemburg, Belgium and Germany, the equity ratio makes up for less than one third of the BIS capital (reflecting both a higher attractiveness of Tier 2 capital, parts of which are

tax deductible, and lower *risk weights* in the BIS ratio). This diverging behaviour of BIS and equity ratios across countries will also show up in our empirical analysis.

2.2 Basel II

Under the new Basel Capital Agreement, risk-weighting for solvency measurement has been substantially refined in that banks – under the so-called standardised approach – will be permitted to make use of external ratings by acknowledged rating agencies. This introduces risk differentiation for counterparties, whereas uniform risk weights applied under Basel I.[15] In addition, banks able to demonstrate the adequacy of their own credit risk measurement methods – under the so-called Internal-Rating Based (IRB) approach – are allowed to use internal ratings of lending risk. This IRB approach is even more risk-sensitive.[16] In addition, the new Agreement makes greater allowance for risk-reducing factors such as collateral and guarantees. Also, it provides for a risk-sensitive capital adequacy requirement for operational risk. Finally, the Supervisory Review of Pillar II requires banks to demonstrate that their capital is sufficient to cover (all) risks, given their specific activities and environment, both under normal and stress conditions.

Under the risk-sensitive Basel II regime, the minimum required capital depends on the business cycle, following the general assumption that credit risk increases during a downturn, and as is also reflected by the measurement approaches (Catarineu-Rabell *et al.*, 2005). As raising new capital is costly – especially during a downturn – increasing capital requirements might force banks to reduce lending, which might exacerbate or prolong the recession. Of course, such behaviour will only be exhibited by the relatively few banks that do not have capital well in excess of the minimum requirements. At an earlier stage, the Basel Committee recognized the possible procyclical effects of the Agreement and made far-reaching adjustments, elaborated in the recent proposals of the new Agreement. First, the final new capital requirements are less risk-sensitive than earlier proposals, reducing the procyclical impact by one third (Segaviano and Lowe, 2003). Second, banks are allowed to treat some types of loans to small and medium-sized enterprises as retail loans, which carry lower capital requirements and are less risk sensitive, because the dispersion of small loans over many counterparties in the retail portfolio reduces the risk run by the bank. Third, more types of collateral are recognized for capital reduction, an instrument typically used by banks when the business cycle deteriorates. In the fourth place, banks need to show by means of *stress testing* that their capital is adequate to cope with a recession (that is, six months without economic growth) without a reduction of lending. Finally, banks are free to estimate through-the-cycle ratings instead of point-in-time ratings.[17] In the end,

[15] For instance, the risk weight for all enterprises was 100% under Basel I, whereas its value ranges from 20% to 150% under Basel II.
[16] Under IRB, risk weights for enterprises range from as little as 3% to as much as 600% and more.
[17] So far, most banks do not yet estimating through-the-cycle ratings as that is more intricate.

risk-sensitive capital is thought to trade off greater efficiency in capital allocation across banks against macroeconomic stability.

In recent years, a number of empirical studies have touched upon the issues of the possible procyclicality of Basel II. Carpenter *et al.* (2001) examined the potential cyclical effects of the revised standardised approach for the US. They combined data on borrower credit ratings with the risk profile of business loans by commercial banks to approximate the capital requirements over the preceding period according to the standardised approach. They did not find any substantial additional cyclicality of the new Agreement relative to the current regime. Of course, the risk-sensitivity of the standardised approach is less than that of the IRB approach. For Spain, Ayuso *et al*. (2004) found a significantly negative relationship between capital buffers and GDP growth under the current Accord, although the effect of GDP is quite moderate. They argue that if banks maintain a sufficient buffer in excess of the minimum requirements, the alleged procyclicality of the new Agreement will turn out to be non-existent. For Norway, Lindquist (2004) also found a negative relation between capital buffers and GDP growth. This result should be interpreted with caution, however, because her data do not cover a full business cycle. Lowe and Segoviano (2002) examines how capital requirements might have moved over time in Mexico had the 'foundation' IRB approach been in place during the nineties. They use credit ratings to construct a transition matrix. The authors conclude that required capital increased significantly in the aftermath of the crisis of 1995, and fell as the economy recovered.[18] If actual capital shows the same cyclical variation under the new Agreement, business cycle fluctuations may be amplified. Estrella (2004) develop a dynamic model for banks where the optimum capital level is related to a period-dependent Value at Risk (VaR) model, while the optimum probability of failure is determined endogenously. He finds that regulatory minimum capital requirements based on VaR, if binding, would probably be procyclical. Peura and Jokivuolle (2004) develop a simulation model to estimate the necessary buffers on top of the minimum requirements.[19] They find that capital requirements are lower under Basel II, but that the major part of that reduction is needed as extra buffer. Jackson *et al.* (2002) also conclude that Basel II capital requirements will not represent a binding constraint on bank's current operations, given their current buffers.

Under the current Accord, the minimum capital requirements for credit do not fluctuate over the business cycle.[20] Under Basel II, they will become cyclical, but the measures of the Basel Committee listed above have strongly limited the possible range of cyclical fluctuations. There is no compelling prior evidence on whether banks will change their actual own capital buffer targets

[18] The revised standardised approach of Basel II with pseudo risk-weighting produces capital requirements that are lower and less cycle-sensitive than those under the IRB approach.
[19] The necessary buffers follow from simultaneous modelling of Basel II capital requirements, based on rating transitions, and actual bank capital, driven by bank income and default losses.
[20] If banks would shift systematically from commercial loans to government bond during a certain phase of the business cycle, this would effect their capital requirements. Generally, capital requirement for market risk do depend on the business cycle.

after the changeover to Basel II. Banks will further improve their risk measurement tools and may arrive at a more risk sensitive risk assessment. Nevertheless, we expect banks to continue basing their final capital level decisions on their own risk-aversion, an optimal funding strategy, buffers allowing them to exploit unexpected investment opportunities and other arguments based on their own independent judgement. Borio *et al.* (2001) assume that underlying risks are built up during booms instead of during recessions, so that forward-looking banks will reserve capital in time, that is, in a manner that is neutral to the cycle or even countercyclically. That would also contribute to capital levels that are, on balance, less cyclical. If banks already risk-adjust their capital more than implied by Basel I, Basel II may not affect the capital much. Tables 1-2 and Chart 1 above show convincingly that most banks set their capital reserve well above the minimum level. If continued, this policy will provide most banks with large 'buffers' to absorb fluctuations in their minimum requirements. An exception would be the strategy to set capital a fixed percentage (points) above the minimum requirements.

Our approach in this article is to investigate present cyclical bank capital behaviour, which is interesting in the light of the current debate on bank capital, procyclicality and credit crunches. It might also be interesting in the light of the new Basel II regime, which may amplify the cyclicality of actual capital movements, if it exists. In any case, the outcome can help to evaluate the current and future risks of cyclical bank capital behaviour.

3. Model for banks' own capital targets

This section presents a common partial adjustment model, which is representative of the approach adopted by many researchers (*e.g.* Ediz *et al.*, 1998; Ayuso *et al.*, 2004; Estrella, 2004).[21] This model adjusts banks' current capital ratio K to its optimal level K^* according to:

$$\Delta K_{i,t} = \gamma\left(K^*_{i,t} - K_{i,t-1}\right) + \varepsilon_{i,t} \qquad (1)$$

where γ is a positive adjustment parameter, ε is a random error term, i indexes banks and t indexes time. In the long run K converges to the optimal K^*, whereby γ reflects the speed of adjustment. Since a bank's desired level of capital cannot be observed, K^* is approximated by a range of variables intended to capture the factors affecting the optimal capital structure.

Estrella (2004) developed a dynamic model of optimum bank capital, in which the bank minimizes the costs associated with raising capital, holding capital and failure. These three cost factors are taken as explanatory variables in the model for the optimal level of capital. In line with Estrella and Ayuso *et al.* (2004), we approximate the cost of capital adjustment using the lagged level of capital. The so-called Koyck lag model of Equation (1) assumes that the actual capital

[21] See Ayuso *et al.* (2004) or Estrella (2004) for theoretical derivations of this model.

level adjusts gradually over time towards its optimal model value (Theil, 1971). The higher the adjustment costs are, the higher the coefficient of the lagged dependent variable will be and, hence, the lower the speed of adjustment. Of course, the sign of the coefficient of the lagged dependent variable is expected to be positive.

The cost of holding capital is assumed to be proportional to the bank's capital level and is approximated by the respective country's bank-size weighted average returns on equity (CROE).[22] Its effect on capital is expected to be negative. Our approach differs from that of *e.g.* Ayuso *et al*. (2004) who used bank-specific ROEs. The disadvantage of the latter approach is that bank-specific ROEs are related to leverage which is highly correlated with the dependent variable: banks with more leverage will have a higher ROE for any given profitability of assets. By taking averages of ROEs per country, we can avoid this endogenous bank-specific leverage effect.

The actual cost of failure can be seen as the loss of the share's value times the probability of failure. The latter depends in particular on the bank's risk profile, which could best be approximated by non-performing loans (Ayuso *et al.*, 2004). However, a lack of sufficient numbers of OECD observations on problem loans forces us to employ alternative proxies of the risk profile.[23] More indirect measures of risk are credit growth and the total loans-to-assets ratio (Greenawalt and Sinkey, 1991; Keeton, 1999; Bikker and Hu, 2002). The total customer loans to total assets ratio is often used as an indicator of credit risk itself, for want of anything better. A smaller ratio indicates that a bank invests more in less risky mortgage and government loans, advances against securities and interbank deposits than in more risky customer loans. Some authors associate an increase in the loan growth rate with too optimistic expectations about future developments and with diminishing monitoring efforts (Borio *et al*., 2001; Lowe, 2003). While excessive credit growth may well be related to an increase in risk exposure, this risk will only materialise – through an increase in problem loans – with a considerable lag estimated at around three years (Clair, 1992; de Lis *et al*., 2001). As opposed to total problem loans, these two variables are *ex ante* risk measures. The signs of their coefficients are expected to be positive as long as banks set their capital in line with the riskiness of their portfolios. However, Rochet (1992 a, b) shows that it could be rational for banks with low capital to assets ratios to opt for maximum risk portfolios. If such moral hazard behaviour were widespread, we might find a negative relationship between risk and buffer capital.

In addition to Estrella's structural determinants of capital, cyclical variables are used in order to incorporate the effect of economic conditions. Credit risk and losses are negatively

[22] Bank-size weighted average ROEs are calculated as the sum of all profits and losses of banks in a country divided by the sum of their equity capital values.
[23] Estimation results with the smaller sample including non-performing loans are quite similar to those of the larger sample without non-performing loans. The variable non-performing loans itself is significant for the equity ratio (with the expected positive sign), but is not significant for the BIS capital ratio.

correlated with the business cycle. The likelihood of unexpected – large and infrequent – credit losses that need to be covered by capital increases during a downturn. Therefore, risk-sensitive behaviour would imply a negative relationship between the level of capital and the business cycle (BC), proxied by the deviation of GDP growth from its country specific average.[24] A positive relation, by contrast, would reflect forward-looking and (also) prudent behaviour, as it would indicate the use of fat years to retain profits for lean years. Another business cycle-related variable is the interest term structure (ITS), the differential between the long-term and short-term interest rate. The opportunity cost of holding capital increases if the interest margin widens, hence we expect a negative relation. An alternative explanation of the interest term structure is that it acts as a proxy of future cyclical fluctuations, which would also imply a negative relationship.

Retained earnings are an important source of capital financing and affect the adjustment cost of capital. This justifies the inclusion of returns on assets (ROA), defined as the ratio of after-tax profit and the average of the current and former balance sheets' assets. Its coefficient is expected to be positive.[25]

Bank behaviour may be influenced by a country's legal, regulatory or institutional framework, tax and accounting regime, market or financial structure and business culture, to name a few important country-specific conditions. This was also observed in Table 2. These country-specific characteristics are taken into account by inclusion of dummy variables (d_j) for countries. This brings us to the following equation for capital:

$$(\text{Capital/TA})_{i,j,t} = \alpha_1 + \alpha_2\,(\text{Capital/TA})_{i,j,t-1} + \alpha_3\,\text{CROE}_{j,t} + \alpha_4\,(\text{Customer loans/TA})_{i,j,t} + \alpha_5\,\Delta \ln \text{Customer loans}_{i,j,t} + \alpha_6\,\text{BC}_{j,t} + \alpha_7\,\text{ITS}_{j,t} + \alpha_8\,\text{ROA}_{i,j,t} + \Sigma_{j=1\ldots28}\,\alpha_{8+j}\,d_j + \varepsilon_{i,j,t} \qquad (2)$$

Index *i* represents individual banks, *j* the country in which the bank is located, and *t* refers to the respective year. Note that all variables are expressed in percentages or are scaled by total assets (TA), which allows comparison across banks of different sizes and across countries. The equation is applied to a 'world-wide' or OECD sample, the EU and a number of individual countries, as far as ample data are available. A similar model applies to the BIS capital as a ratio of risk weighted assets: we replace the dependent variable Capital/TA and its one-period lagged value in Equation (2) by, respectively, the BIS ratio and its one-period lagged value. Multicollinearity between explanatory variables is not a problem, see Tables A.1 and A.2 in the appendix.

[24] An alternative would be GDP growth itself. This variable is probably less precise as the average level of GDP growth may differ across countries. The 'alternative' empirical results do not deviate much.
[25] However, Ediz *et al.* (1998) assumes a negative relationship, probably assuming that high profits are the consequence of low provisioning and low risk, indicating a financial health which allows lower capital. In our view, profit is determined by many factors, provisioning being only one of them. Moreover, higher risk need not harm profits as long as risk is adequately covered by risk premiums.

The BIS variant of Equation (2) explains the BIS ratio, but can easily be rewritten in terms of a *buffer* above the minimum BIS requirement as in Ayuso *et al.* (2004), where the explanatory variable is defined as (BIS-0.08)/0.08. The latter, after all, is a linear transformation, where Equation (2) is a linear model. The statistical results would, hence, be identical and the coefficients would be a factor 1/0.08 (that is, 12.5) times higher. Similarly, Equation (2) can be rewritten as a capital ratio buffer equation by subtracting the optimal level of the capital ratio K^* from its current value K (in terms of Equation (1)). However, we cannot explain such buffers empirically as we cannot observe the optimal level K^*. Earlier we observed that banks may hold buffers as (1) a signal to the market regarding its own soundness to raise funds at lower interest rates, (2) an insurance to avoid costs related to market discipline and supervisory intervention if they approached the regulatory minimum capital ratio, (3) a cushion to absorb economic recessions, thus limiting the procyclical effect of capital, or (4) because supervisors require extra buffers in a systematic way or based on individual assessment. In general, these buffers help strongly in reducing possible procyclical risks. For that reason, the second pillar of Basel II requires banks to demonstrate that their capital is sufficient to meet the minimum capital requirements during downswings in macroeconomic conditions, forcing them to evaluate risk in a more forward-looking sense.

Although we are particularly interested in cyclical determinants of bank capital ratios and possible increased procyclical risks of Basel II, our model is not designed to detect procyclical effects. Instead, our approach is to assess, firstly, whether ample buffers are standard for most banks and, secondly, whether the capital ratio tends to fluctuate with the business cycles. Of course, in our model, various determinants may contribute to cyclical behaviour of the equity ratio, besides the cyclical indicators (GDP growth and interest term structure), in particular loans and returns on assets. The loan portfolio is the major origin of credit risk for which capital is needed. On the other hand, banks might also use loans as an instrument to smooth the equity ratio over time, for instance, by reducing new lending or switching to less risky lending,[26] when the capital ratio decreases. Of course, such policy would increase the risk of procyclicality. This article does not investigate this issue. If, controlled for the effects of other determinants including loans, the ratio would still be positively correlated with the cycle, this could indicate the risk of a lower capital ratio during cyclical downturns, which could again point to increased risk on a credit crunch. If such correlation would be absent or negative, we may expect that buffers indeed function well in cushioning cyclical risks. When banks themselves aim at sufficient buffers and

[26] The former would make itself felt through the denominator of the capital ratio, whereas the latter would affect the weighting in the BIS ratio.

meet the new second pillar requirements, Basel II is not expected to raise procyclical risk substantially.

4. Data and estimation approach

The analyses are based on pooled cross-section and time series data of individual banks' balance sheet items from 29 OECD countries (listed in Table 2) and country-specific macroeconomic indicators for these countries, over a ten year period from 1992 to 2001.[27] As such, this data set forms a so-called unbalanced panel – unbalanced as observations are missing due to new entries, mergers or acquisitions, or because of lacking data. The episode 1992 to 2001 covers a full business cycle for all the countries included. Overall, the cycle develops from a trough in the earlier nineties, an economic boom in the mid nineties to a slowdown beginning in 2001. Some countries, such as South Korea, Mexico and Turkey, experienced a severe financial crisis during this period. The macroeconomic data were obtained from the OECD and the IMF (see Appendix 2 of Bikker and Hu, 2002), whereas the balance sheet data were taken from the Bankscope database (Fitch-IBCA). Bank-specific data allow for the investigation of individual banks' capital level characteristics. Moreover, the high number of available observations on banks' capital levels provides a rich source of information. We employed data from commercial banks only, in order to obtain a more homogeneous group of banks. Banks experiencing extreme circumstances are excluded from the sample. Therefore, equity and BIS ratios and loan shares are between 0 and 1, ROA is between -100% and 100% and loan growth is between -80% and 500%. This reduces the sample of the equity ratios by around 4% and that of the BIS ratios by around 3%. The sample selection does not affect the thrust of the estimation results. Similar selections were applied by Cavallo and Majnoni (2002) and Laeven and Majnoni (2003). More details on the data are reported in the appendix.

We applied the Generalized Method of Moments (GMM) estimator approach in order to avoid possible biases in the estimates caused by interdependence between the lagged endogenous variable (equity ratio or BIS ratio) and eventual autoregressive terms in the error. This prevents us from making wrong inferences from the t-values, such as regarding significance (Greene, 2000). We estimated Equation (2) but alternatively also considered lags of the explanatory variables. In a number of our regressions, the country's average cost of holding capital (CROE) was lagged more significant than contemporaneous, whereas the contemporaneous CROE was never more significant than lagged. This is plausible as the market's cost of capital is observed with delay, whereas adjustment of equity (or BIS) capital also takes time. Therefore, we applied this lag in all regressions. Lags of other variables did not improve the results and are not shown.

[27] The basis data cover 12 year (1990-2001), whereas the model uses observations over 10 year (1992-2001) due to lag structures.

The analysis employs a large set of over 16,000 bank-year observations of equity and over 7.000 bank-year observations of the BIS ratio. The number of observations per equation in the estimations is much lower, due to the lagged endogenous variables (reduction to around 13,300 and 5,700, respectively) and the second lags of the endogenous variable as instrumental variable used in the GMM procedure (further reduction to 10,500 and 4,300, respectively). Tables A.1-5 in the appendix describe sample statistics.

5. Empirical results for the equity capital ratio

We start with the investigation of the equity to total assets ratio, as far more data are available on equity than on the BIS capital ratio. Therefore, the equity model can provide us with the most robust estimation outcomes. The left-hand column of Table 3 presents the estimation results of the dynamic multivariate panel regression Equation (2) applied to the world-wide sample.[28] The disturbances have been tested for serial correlation using the Durbin-Watson (DW) test.[29]
The coefficient of the proxy for the cost of capital adjustment is 0.92, reflecting a rather slow adjustment of capital to the target level. This implies that the costs of adjustment are substantial: on average, it takes years before the level of capital is adjusted.[30] It may also reflect that bank capital is driven by bank income and default losses rather than by continuous policy adjustments. Apparently, capital reserves adjust more slowly towards their optimal (or model) value than is observed by a similar model for the level of loan loss provisions (0.79 versus 0.92) or for annual additions to provisions (0.41; see Bikker and Metzemakers, 2005). This result supports the 'capital management view' that provisions might (also) be used to manage the total capital buffer, because provisions can be adjusted more quickly and at lower cost.

[28] The correlation matrices in Tables A.1-2 in the appendix show that multicollinearity is a problem in neither this regression nor later ones. We tested the model for influences caused by any possible correlation by regressing the lagged dependent and macroeconomic variables first, and then one by one regressing the other variables on the residuals of the preceding regression. The value and significance of all the coefficients remained unchanged. In order to test for stability, we applied a Chow test and re-estimated our model on two sub samples, 1992-1997 and 1998-2001. We observe a slight but significant difference between both sub-samples. Granger (1998) explains that common tests loose their validity in the case of very large samples. Similar differences would emerge when the sample has been split along other lines, for example for bank-size classes as in Section 7, or countries as in Tables 3 and 4. A second reason for the significant difference might be that the cyclical effects can be observed less accurately in samples over a few years only, so that we consider the two (short) sub-samples as less suitable. For those reasons we accept the estimation results over the full sample period 1992-2001.
[29] The DW test statistic is not applicable to a model with a lagged dependent variable, but the high number of observations made the formula of the appropriate Durbin's h-test statistic intractable. DW test values below 1.60 may well be within the critical limit. This limit is derived from an estimated critical lower limit, D1, which is downward-distorted as the number of explanatory variables (k) increases. The usual DW tables run to k=6 as a maximum with a DW index of 1.57. As this model and subsequent models in this and following tables all contain considerably more than six variables and considerably more observations, we may deduce that the critical D1 is well below 1.57.
[30] Interpreting the model as a weighted average between the old capital level (with weight 0.92) and the optimal model value (with weight 0.08).

The coefficient of a country's cost of holding capital (CROE) is negative, as expected (the more expensive capital is, less of it will be held), but not significantly so (at the 95% level of confidence). The risk proxies, customer loan shares and customer loan growth, are both significant, but have counterintuitive negative signs. This has also been observed for Norway by Lindquist (2004). Banks with a relatively risky portfolio do not generally hold more buffer capital. On the contrary, the correlation between equity and loan share is negative (see also Table A.1 in the appendix). Table A.4 shows how banks with high loan shares of 60%-80% maintain

Table 3: Estimates of the equity capital ratio model (1992-2001)

	OECD		**EU**		**US**	
Variables	*Coefficient*	*t-value* [a]	*coefficient*	*t-value* [a]	*coefficient*	*t-value* [a]
Intercept	0.0173	**5.3	0.0189	**5.6	0.0072	0.2
Capital, lagged	0.9159	**63.4	0.9225	**46.2	0.8699	**26.2
Country return on equity, lagged	-0.0154	-1.3	-0.0348	*-2.0	0.0737	0.3
Customer loans share	-0.0079	**-2.9	-0.0071	*-2.2	-0.0025	-0.4
Customer loan growth	-0.0167	**-8.7	-0.0175	**-5.7	-0.0089	**-2.7
Business cycle	0.0124	0.5	0.0700	*2.3	-0.1360	**-3.0
Interest term structure	-0.0120	-0.4	-0.1216	*-2.4	-0.0310	-0.2
Return on assets	0.2018	*2.5	0.3982	**5.2	0.1071	0.7
Country dummies						
Australia	-0.0020	-1.1				
Austria	-0.0036	-1.6	-0.0047	-1.9		
Belgium	-0.0070	**-3.0	-0.0065	*-2.6		
Canada	-0.0023	-0.7				
Czech republic	-0.0094	**-3.4				
Denmark	-0.0015	-1.5	-0.0024	-1.0		
Finland	-0.0090	**-3.5	-0.0111	**-4.7		
France	0.0013	0.6	—			
Germany	-0.0015	-0.7	-0.0019	-0.9		
Greece	0.0103	*2.5	0.0073	1.5		
Hungary	-0.0036	-1.0				
Iceland	-0.0022	-0.9				
Ireland	-0.0073	-1.8	-0.0086	-1.9		
Italy	-0.0058	**-3.0	-0.0076	**-4.1		
Japan	-0.0078	**-3.2				
Korea, South	-0.0117	**-4.7				
Luxembourg	-0.0065	**-3.1	-0.0053	-1.9		
Mexico	0.0053	0.6				
the Netherlands	-0.0038	*-2.1	-0.0035	-1.4		
Norway	-0.0028	-1.6				
New Zealand	-0.0035	-1.9				
Poland	-0.0016	-0.3				
Portugal	-0.0090	**-4.2	-0.0101	**-4.3		
Spain	-0.0011	-0.5	-0.0035	-1.4		
Sweden	-0.0094	*-2.3	-0.0086	-1.8		
Switzerland	0.0000	0.0				
Turkey	-0.0109	**-2.7				
UK	0.0006	0.4	-0.0008	-0.2		
US	—	—				
No. of observations	10,477		5,681		2,266	
Adjusted R^2	0.86		0.86		0.81	
Durbin-Watson test statistic	1.64		1.63		1.98	

[a] One and two asterisks indicate 95% and 99% levels of confidence, respectively. Coefficients with one or two asterisks are significant.

the lowest capital ratios, which remains true when weighting by the bank sizes (see the last column), whereas, vice versa, the lowest BIS capital ratios of 8-12% have the highest average loan shares, which, again, remains true when bank are weighted by size (see the average loan share rows).[31] One possible explanation is that the additional credit risk is sufficiently covered by provisions – or even amply as loan loss reserves are usually tax deductible.[32] Larger loan shares and loan growth indeed do significantly increase loan loss provisioning (Bikker and Metzemakers, 2005). However, inclusion of LLP in Equation (2) does not change the results (not presented), where lower coefficients would have been expected if more risky portfolios were to go hand in hand with higher provisions. If included, the alternative *ex post* indicator of risk 'total problem loans' has indeed the expected significantly positive effect on capital (not reported). A disadvantage is that this variable is only available for 40% of the observations.

An alternative explanation is that banks may show moral hazard behaviour, that is, that banks with relatively risky portfolios do not in general hold more buffer capital. If that were the case, a shift to a more risk sensitive capital regulation regime – as under Basel II – would (in principle) force these banks to hold a higher capital level. However, it should be noted that the negative relationship between risk indicators and capital does not necessarily imply that high-risk banks are (too) poorly capitalised relative to the risk in their portfolio. It may rather be due to too much capital in low-risk banks, in line with the substantial capital buffers over the minimum level as observed in Tables 1 and 2. This may reflect strong differences in the way banks evaluate and react to risk, depending on how risk-adverse they are.

Another explanation of this negative relationship is that an acceleration of lending – which would increase both the loan share and the loan growth – is, initially, financed mainly through additional funding (rather than additional capital), which automatically lowers the capital ratio. This would be in line with the slow adjustment of capital as observed above. Such financing by funding only can typically be expected during booms, when credit risks are assessed to be lower. Such imprudent behaviour would support the theory of Borio *et al.* (2001) that financial imbalances mount during periods of excessive lending. This conduct would increase the risk of a credit or capital crunch, as the capital buffer is eroded, just before the business cycle bends downwards.

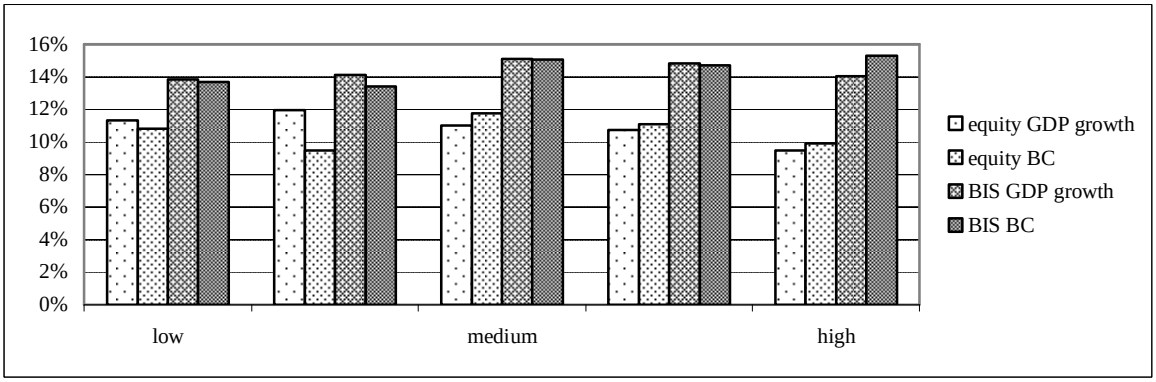
The cyclical effects appear to be fairly limited: neither the business cycle indicator BC (defined as 'the deviation of GDP growth from its country specific average') nor interest term structure has a significant impact. This holds also when these variables are lagged (not reported). One explanation is that the banks' own assessment of credit risk is not sensitive to economic fluctuations. Another is that the other cycle-dependent explanatory variables have already picked

[31] This holds true for BIS capital, as in Table A.4, as well as equity capital.
[32] Note, however, that provisioning covers expected losses whereas capital covers unexpected losses.

up this cyclical effect. Finally, return on assets, indicating the ability to retain earnings, has an expected positive effect. The long-run elasticity between capital and ROA is 0.21 so that the capital would increase by at least one fifth, when a bank's profit doubles.[33]

Various variables in the equity ratio model may include cyclical patterns: the business cycle indicator, the interest term structure, loan growth and the profit variable, ROA. The multiple regression coefficients provide little or no insight into the *net* effect of the cycle on the capital level. An alternative approach is to use a simple bilateral comparison between the capital ratio and the business cycle BC, proxied by 'the deviation of GDP growth from its country specific average', see Chart 2. The classes 'low', 'medium' and 'high' refer to BC values of, respectively, more than 3% below the average GDP growth, around the average GDP growth and GDP growth of more than 3% above the average.[34] Chart 2 shows that fluctuations in BC do not correlate with equity (nor with the BIS ratio). Actually, it is remarkable that GDP growth itself (as an alternative indicator of the business cycle) does – slightly – correlate negatively with equity. On average, in periods of GDP growth below 3%, capital is 15% higher (namely 11.7%) than in periods with GDP growth above 3% (where the ratio is 9.9%).[35] This indicates that, hidden behind the various explanatory variables, the capital ratio depends on one of the possible business cycle indicators and suggests that a certain procyclical effect of capital behaviour might exist. Capital appears to depend much less on the business cycle (if at all) than provisioning, which, in periods of GDP growth below 3%, are 60% higher than in periods with GDP growth above 3% (Bikker and Metzemakers, 2005). The BIS capital ratio does not systematically rise or fall with GDP growth, confirming that it does not depend on cyclical fluctuations.

Chart 2: Relationship between business cycle and capital ratios (OECD, 1990-2001)



[33] The long-run elasticities can be calculated given the coefficients of Table 3, the mean values of Table A.1 in the appendix and the lag structure: -0.2018*0.009/(0.103*(1-0.9159)).
[34] Here, the classes 'low', 'medium' and 'high' refer to GDP growth, respectively, below 0%, between 2 and 4% and above 6%. The two other classes lie in between.
[35] The correlation between GDP growth and capital is -0.08.

All significant country dummies indicate a lower average level of capital compared to the US, the Greek one being the only exception.[36] The higher capital levels of US banks – after correction for other explanatory factors – could be due to supervisory pressure on *adequately capitalised* banks to hold 2 percentage points additional capital and become *well-capitalised* banks. For example, a bank is well-capitalised if it holds a certain buffer above the adequate levels (which are similar to the minimum requirements of the Basel Accord). This means a bank is well-capitalised if its leverage or equity ratio is above 6 percent and its BIS-ratio is above 10 percent. Exactly this distinction between adequately and well capitalised may induce US banks to increase their capital ratios above the Basel requirements. Of course, the *well-capitalised* label may be profitable for a bank as it signals its strength and may lower its cost of funding. In addition, Bikker and Metzemakers (2005) observed that banks outside the US provision more for loan losses. Apparently, US banks hold more capital and provision less than non-US banks. This could be the result of either less risky behaviour on both sides of the balance sheet in the US or more widespread use of general loan loss provisions to increase Tier 2 in Europe.

The results of the capital model for the EU – second column of Table 3 – have a number of characteristics in common with the world-wide model: the speed of adjustment is similar, the coefficient of returns on assets has a significantly positive sign as expected, the credit risk proxies loan share and loan growth have their 'imprudent' negative signs, and the coefficients of the EU business cycle and the country-specific return on equity are not significant. There are, however, also differences. For the EU, both the lagged cost of capital proxy, CROE, and the interest term structure variable, reflecting the opportunity cost of holding capital, has a significantly negative sign, in line with expectations. The business cycle indicator, BC, is significantly positive, suggesting prudent forward looking behaviour. Finally, judging by the country dummy coefficients (now in deviation from France instead off the US), also within Europe, differences across countries occur, reflecting diverging accounting and tax rules and other country-specific institutional and economic conditions and behaviour.

The right-hand column of Table 3 presents estimates for the US model. Bank capital behaviour in the US differs significantly from that in the OECD and the EU. The cost of adjusting capital – measured by the speed of adjustment – is substantial lower in the US than elsewhere. The coefficients of CROE, ROA, loans share, and interest term structure are not significant. The business cycle indicator, BC, is significantly negative, reflecting credit risk sensitivity. All in all, the 'own capital target model' used by US banks seems to be rather weak, in terms of its number of (significant) determinants, but its degree of fit is satisfactory.

We also obtained estimation results for a number of other individual countries with large data samples, namely Denmark, France, Germany, Italy, Japan, Spain and the UK (not reported

[36] We used data from 29 countries, but only 28 country dummies. The capital ratio of the country with the most bank-year observations – the US – is chosen to be reflected by the intercept.

here). In general, the number of significant coefficients is lower than for the world-wide or EU sample. This underlines that a cross-country sample is necessary to obtain a reliable picture of across-the-board capitalisation behaviour.[37] It also underlines the differences across countries. Where coefficients are significant, they are in line with the values and signs of the full-sample estimates of Table 3, except for Japan, where the immense banking crisis thwarts normal capitalisation behaviour. Significant coefficients for one of the (two) business cycle measures are rare, but have the expected – that is negative – sign. Although many differences between countries exist, the main results appear to be rather similar across countries and regions.

6 Empirical results for the BIS capital ratio

We repeat the analysis for the BIS capital ratio which, being a *risk-adjusted* measure of capital, is even more interesting (because more precise) than the equity ratio.[38] However, the number of available BIS capital ratio observations is less than half that of equity capital observations (7,000 versus 16,000 bank-years). The left-hand column of Table 4 presents the regression results for Equation (2), applied to the BIS capital ratio data of the 'world-wide' sample. Overall, the results are rather similar to those of the equity capital ratio model. Adjustment costs reflected by lagged BIS capital are substantial lower than in the equity equation. The risk proxies (loan share and loan growth) and the availability of fresh funding represented by ROA have highly significant coefficients with signs identical to those of the equity ratio regression. The long-term elasticities of the two 'risk' and two 'return' variables are higher – in absolute terms – than they were in the equity model. CROE and the business cycle indicator have a significant (negative) impact on the BIS ratio, whereas they did not affect the equity capital. Apparently, credit risk as assessed by the banks, and hence the BIS capital ratio (measured using the BC), do depend significantly on economic fluctuations. Also based on a simple bilateral comparison between the BIS capital ratio and the business cycle indicator, Chart 2 above illustrates that, on balance, the BIS capital ratio itself does not systematically depend on cyclical fluctuations. Apparently, in this respect, the various cyclical effects of the model variables cancel each other out.

Eight significant country dummies indicate lower average capital levels compared to the US. The dummies for Turkey and UK indicate significant higher average capital levels. Judging

[37] Note that some of the single country studies, as listed in Section 1, did benefit from more detailed supervisory information regarding risk, which generally helped to improve estimation results. For instance, Lindquist (2004) and Ayuso *et al.* (2004) find significantly negative coefficients for GDP growth in Norway and Spain, respectively. Moreover Lindquist uses quarterly data, increasing the number of observations.

[38] Note that our specification, that is Equation (2) with the BIS ratio instead of the equity ratio (Capital/TA), is essentially identical to the buffer ratio approach of Ayuso et al. (2004) where the explanatory variable is (BIS-0.08)/0.08. After all, the latter is a linear transformation, where Equation (2) is a linear model. The statistical results would be identically and the coefficients would be a factor 1/0.08 (that is, 12.5) times higher.

by the country dummy coefficients, serious differences across countries also occur with respect to the BIS capital ratio.

The second column of Table 4 presents the estimated parameters of the BIS ratio model for the EU. The coefficients have values and signs comparable to those found earlier, except for the BC and ROA, which are no longer significant. Only two EU country dummies are significant, meaning that capital as defined according to the BIS rules appears to be more homogeneous across EU countries than across the OECD, or than is shown by equity figures for the EU.

Table 4: Estimates of the BIS capital ratio model (1992-2001)

	OECD		**EU**		**US**	
Variables	*coefficient*	*t-value* [a]	*coefficient*	*t-value* [a]	*coefficient*	*t-value* [a]
Intercept	0.0466	**5.5	0.0485	**4.4	0.0782	*2.2
BIS capital, lagged	0.8049	**22.8	0.7983	**16.6	0.8464	**17.3
Country return on equity, lagged	-0.0444	**-2.8	-0.0834	**-2.6	-0.3339	-1.3
Customer loans share	-0.0227	**-3.2	-0.0263	*-2.2	-0.0168	-1.7
Customer loan growth	-0.0169	**-5.2	-0.0290	**-3.6	-0.0145	**-3.4
Business cycle	-0.0850	*-2.3	0.0939	0.7	-0.1094	-1.9
Interest term structure	0.0734	1.4	-0.0962	-0.9	0.0155	0.1
Return on assets	0.2602	**2.8	0.4572	2.0	0.1245	1.1
Country dummies						
Australia	-0.0013	-0.7				
Austria	-0.0189	-0.5	-0.0144	-0.4		
Belgium	-0.0132	**-3.7	-0.0073	-1.4		
Canada	0.0026	0.9				
Czech republic	-0.0107	-1.6				
Denmark	-0.0049	*-2.1	0.0017	0.4		
Finland	-0.0112	*-2.2	-0.0107	-1.7		
France	-0.0043	-1.3	—	—		
Germany	-0.0098	**-3.7	-0.0040	-1.1		
Greece	0.0079	0.6	0.0108	0.8		
Hungary	-0.0028	-0.6				
Iceland	-0.0025	-0.8				
Ireland	-0.0032	-1.2	0.0033	0.6		
Italy	-0.0071	-1.9	-0.0034	-0.8		
Japan	-0.0143	**-4.0				
Korea, South	-0.0125	**-3.5				
Luxemburg	-0.0084	-0.9	-0.0018	-0.2		
Mexico	0.0019	0.4				
Netherlands	0.0048	1.0	0.0130	*2.2		
Norway	0.0041	1.3				
New Zealand	0.0028	1.1				
Poland	-0.0076	-1.1				
Portugal	-0.0109	**-3.3	-0.0058	-1.3		
Spain	-0.0093	**-3.0	-0.0061	-1.5		
Sweden	0.0119	0.6	0.0197	1.0		
Switzerland	-0.0050	-1.1				
Turkey	0.0221	*2.0				
UK	0.0118	**2.8	0.0189	**2.7		
US	—	—				
No. of observations	4,287		1,447		2,238	
Adjusted R^2	0.75		0.74		0.77	
Durbin-Watson test statistic	1.67		1.36		2.14	

[a] One and two asterisks indicate a level of confidence of 95% and 99%, respectively. Coefficients with one or two asterisks are significant..

Different from the EU, the market's cost of capital, CROE, and the customer loan share do not affect BIS capital in the US (right-hand column of Table 4). The US model performs better with BIS ratio figures (where it has the highest R^2) than with equity figures (where it had the lowest R^2). The model has also been applied to BIS capital ratios of other single countries with sufficient data sets, namely Denmark, France, Italy, Japan and the UK (not reported). These outcomes were somewhat disappointing in terms of coefficient significance. They underline the differences observed across countries. As before, the recent Japanese BIS capital-related bank behaviour did not fit well into our model.

All in all, the features of the BIS ratio model are quite similar to those of the equity model, for each of the investigated regions. Limited differences in parameter values underline that banks set their equity capital and their BIS capital according to somewhat different targets. Not surprisingly, as the composition of capital matters, whereas the risk assessment according to Basel I appears to be not always in line with banks' own risk measurement.

7. Sensitivity to bank sizes

In the regressions above all banks have equal weight, independent of their size, whereas the bulk of assets and capital are in the hands of the large banks. Equal weighting is no problem as long as small and large banks show identical capitalisation behaviour. However, Tables 1, 2 and A.5 provide evidence that large banks maintain substantially lower capital ratios than small banks. This is plausible as large banks can more easily diversify risk, but there may be also other reasons for their diverging behaviour. This section investigates the sensitivity of capitalisation behaviour to bank size. Table 5 repeats the equity model estimations for large, medium-sized and small banks. Large banks have a balance sheet total of above € 22 billion in 1998 and make up 10% of all banks. They cover 83% of the total assets in our OECD sample. Small banks have a balance sheet total of below € 1.1 billion in 1998 and make up 50% of all banks.

Table 5: Estimates of the OECD equity ratio model for various bank-size classes

	Large		**Medium**		**Small**	
Variables	*coefficient*	*t-value* [a]	*coefficient*	*t-value* [a]	*coefficient*	*t-value* [a]
Intercept	0.0063	1.6	0.0066	**3.4	0.0202	**5.8
Equity capital, lagged	0.7669	**5.1	0.8736	**26.1	0.9177	**59.6
Country return on equity, lagged	-0.0099	-1.6	0.0028	0.4	-0.0305	*-2.5
Customer loans share	0.0099	1.5	0.0020	1.0	-0.0103	**-2.9
Customer loan growth	-0.0012	-1.1	-0.0090	**-5.9	-0.0224	**-7.6
Business cycle	-0.0521	-1.7	-0.0557	*-2.5	0.0966	*2.0
Interest term structure	0.0150	0.5	0.0308	1.4	0.0042	0.1
Return on assets	0.4455	*2.3	0.4106	**5.1	0.1684	1.7
No. of observations	1,060	(10%)	4,241	(40%)	5,176	(50%)
Adjusted R^2	0.81		0.79		0.85	
Durbin-Watson test statistic	1.40		1.99		1.58	

[a] See Table 3.

The main result of these estimations is that the coefficients of the risk proxies no longer have counterintuitive significant negative signs for large banks, while the customer loans share coefficient for medium-sized banks also ceases to be significantly negative. Apparently, possible explanations such as moral hazard behaviour or slow adjustment of capital to expanding loan portfolios (or abundant coverage of credit risk by tax deductible provisions), as discussed in Section 5, do not apply as strongly to large banks as to small banks. Particularly important for supervisory policy is that possible moral hazard risk seems to be concentrated in smaller banks rather than larger banks, which makes it less risky. Still, it is remarkable that we do never observe significant positive signs for these risk proxies.

The other significant coefficients are in line with theory, where significant. Large banks show higher capital adjustment speeds than small ones. The sign of the BC coefficient is unstable and varies from negative (risk sensitive) to positive (forward looking). All in all, capitalisation behaviour appears to differ across sizes classes.

Table 6 presents estimates of BIS capital ratio models for large, medium-sized and small banks, with bank-size classes defined as above. Because relatively more large and medium-sized banks report BIS ratios, these classes are comparatively better presented (see the allocation of numbers of observations across classes in Table 6 compared to Table 5). Again, the main result is that the coefficients of the risk proxies are no longer significant negative for the large banks, confirming the conclusions presented above for the equity results. The other significant coefficients have signs as expected.

Table 6: Estimates of the OECD BIS capital ratio model for various bank-size classes

	Large		**Medium**		**Small**	
Variables	*coefficient*	*t-value* [a]	*coefficient*	*t-value* [a]	*coefficient*	*t-value* [a]
Intercept	0.0312	**3.3	0.0289	**5.7	0.0635	**3.6
BIS capital, lagged	0.7750	**10.0	0.8252	**27.0	0.7730	**12.1
Country return on equity, lagged	-0.0079	-1.1	0.0143	0.7	-0.0359	-1.1
Customer loans share	-0.0085	-1.8	-0.0147	*-2.4	-0.0368	*-2.2
Customer loan growth	-0.0004	-0.2	-0.0132	**-4.2	-0.0319	**-4.2
Business cycle	-0.1086	**-2.7	-0.1378	**-2.6	0.0470	0.4
Interest term structure	-0.0091	-0.2	0.0053	0.1	0.1519	1.4
Return on assets	0.1002	1.2	0.3363	**3.4	0.2484	1.1
No. of observations	864	(20%)	2,194	(51%)	1,229	(29%)
Adjusted R^2	0.71		0.71		0.74	
Durbin-Watson test statistic	1.87		1.64		1.68	

[a] See Table 3.

8. Concluding remarks

Minimum requirements for bank capital will become more risk-sensitive under the new Basel II regime for capital adequacy, effective from 2007. As a result, minimum capital requirements will

fluctuate more strongly with the business cycle. This could harm economic development, if minimum requirements were binding, so that lending might be reduced during cyclical downturns. In the past decade, almost all banks world-wide have had substantial buffers, that is, BIS capital in excess of the minimum requirements, so that more volatile minimum requirements will affect only a part of the banks, depending on the degree of volatility.

The question arises whether actual capital levels will also become more cycle-dependent under Basel II. To address this question, this article investigates the determinants of commercial bank's own capital targets. For the world-wide equity capital ratio model, we find no (direct) cyclical effect at all, but significant business cycle influence emerges for the world-wide BIS ratio model, as well as for some world-wide bank size class models and for some individual countries. These results indicate that banks' own risk assessment does not depend heavily on the business cycle or that banks prefer to avoid strong cyclical variations in their capital – nor, however, is capital fully independent from the business cycle. As far as bank's own capital targets are likely to remain roughly as they are for the near future, we may expect capital to remain fairly stable over the business cycle. On the other hand it should be recognised that banks' own risk assessment may become more risk sensitive, under the influence of new risk measurements techniques needed under Basel II, which could introduce more cyclical components in the bank's capital targets.

Remarkable outcomes of the capital target model are that higher customer loan shares and customer loan growth do not lead to significant higher capital ratios. For smaller banks this relationship is even significantly negative. The smaller banks with relatively risky portfolios generally hold lower rather than higher capital ratios, a phenomenon that could point to eventual moral hazard behaviour. A shift to a more risk-sensitive capital regulation regime as under Basel II, would (in principle) force these banks to maintain higher – but still binding – capital levels, which could imply a behavioural change towards more procyclical capital policies. However, it should be noted that the observed perverse risk effect does not necessarily imply that high-risk banks are (too) poorly capitalised. It may, conversely, be due to low-risk banks holding too much capital, reflecting strong differences between banks in their evaluations of and reactions to risk, or indicating that banks hold buffer capital for other reasons, such as take-over funds. Nevertheless, our analyses point to typically smaller high-risk, low-capital banks, where more risk might exist for shortcoming capital levels during economic downturns when credit risks increase, with potential procyclical effects.

The investigations in this article reveal that capital is currently at most moderately cyclical in such a way that procyclical risks might increase slightly. However, for a wide range of reasons banks' own capital targets are generally well above the minimum requirements. Therefore, we expect that under Basel II capital procyclicality will increase only to a limited degree. We can not exclude that some banks will typically set its capital ratio a certain fixed percentage points above

the (cyclically dependent) minimum requirements, which would imply cyclicality but not necessary procyclicality. Under the new Agreement, Pillar II requires banks to demonstrate that their capital is sufficient to meet the minimum capital requirements during downswings in macroeconomic conditions, forcing them to evaluate risk in a more forward-looking sense. Strict and adequate stress testing and accompanying capital levels would further reduce the risk of increasing bank capital procyclicality (Peura and Jokivuolle, 2004). This holds in particular for the subset of banks with high loan shares and low buffers above the minimum levels.

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APPENDIX: Data statistics

Table A.1: Data statistics of determinants of the equity ratio model (all OECD countries)

	Equity capital ratio	Idem lagged	Country return on equity, lagged	Cust. loan share	Cust. loan growth	Busi-ness cycle	Interest term structure	Return on assets
Mean	0.103	0.102	0.097	0.518	0.126	0.005	0.011	0.009
Median	0.076	0.075	0.091	0.545	0.057	0.007	0.014	0.006
Standard deviation	0.104	0.104	0.069	0.251	0.462	0.015	0.021	0.019
No. of observations	10,477							
Correlation matrix								
Equity capital ratio	1.00							
Idem, lagged	0.92	1.00						
Country return on equity, lagged	-0.02	-0.01	1.00					
Customer loan share	-0.18	-0.18	-0.03	1.00				
Customer loan growth	0.00	0.08	0.07	0.03	1.00			
Business cycle	0.00	0.01	0.19	0.02	0.07	1.00		
Interest term structure (%)	-0.02	-0.03	-0.23	0.02	-0.11	-0.18	1.00	
Return on assets	0.27	0.26	0.20	-0.02	0.08	0.06	-0.12	1.00

Explanation: Data statistics refer to estimation sample of first column of Table 3.

Table A.2: Data statistics of determinants of the BIS capital ratio model (OECD countries)

	BIS capital ratio	Idem, lagged	Country return on equity, lagged	Loan share	Loan growth	Busi-ness cycle	Interest term structure	Return on assets
Mean	0.145	0.146	0.114	0.581	0.154	0.006	0.012	0.010
Median	0.122	0.123	0.132	0.610	0.082	0.008	0.015	0.010
Standard deviation	0.072	0.077	0.065	0.190	0.420	0.014	0.013	0.012
No. of observations	4,287							
Correlation matrix								
BIS capital ratio	1.00							
Idem, lagged	0.86	1.00						
Country return on equity, lagged	0.07	0.08	1.00					
Customer loan share	-0.33	-0.33	0.13	1.00				
Customer loan growth	-0.05	0.05	0.07	0.07	1.00			
Business cycle	0.03	0.06	0.17	0.01	0.06	1.00		
Interest term structure (%)	0.01	0.00	-0.18	0.04	-0.07	-0.13	1.00	
Return on assets	0.19	0.19	0.27	0.11	0.11	0.08	-0.14	1.00

Explanation: Data statistics refer to estimation sample of first column of Table 4.

Table A.3: Median of bank-specific and economic model variables per country

	AUS	AUT	BEL	CAN	CZECH	DEN	FIN
Equity capital ratio	0.061	0.062	0.050	0.075	0.066	0.115	0.049
BIS capital ratio	0.109	0.105	0.120	0.116	0.126	0.136	0.125
Country return on equity, lagged	0.162	0.080	0.105	0.088	0.088	0.135	0.067
Customer loan share	0.800	0.492	0.296	0.734	0.411	0.598	0.487
Customer loan growth	0.045	-0.004	0.013	0.040	0.164	0.017	0.044
Business cycle	0.008	0.002	0.002	0.015	-0.010	0.005	0.022
Interest term structure (%)	0.015	0.013	0.023	0.014	0.007	0.016	0.017
Return on assets	0.007	0.004	0.004	0.004	0.005	0.011	0.004
Number of observations	*175*	*187*	*212*	*224*	*96*	*307*	*39*
	FRA	GER	GRE	HUN	IRE	ITA	JPN
Equity capital ratio	0.067	0.067	0.089	0.097	0.060	0.074	0.041
BIS capital ratio	0.112	0.099	0.125	0.153	0.122	0.116	0.102
Country return on equity, lagged	0.024	0.062	0.145	0.229	0.160	0.034	0.017
Customer loan share	0.507	0.466	0.420	0.446	0.583	0.511	0.694
Customer loan growth	-0.005	0.000	0.161	0.122	0.140	0.066	-0.122
Business cycle	-0.001	-0.004	0.011	0.021	0.028	0.001	0.012
Interest term structure (%)	0.016	0.016	-0.005	-0.025	0.011	0.009	0.014
Return on assets	0.004	0.002	0.012	0.014	0.006	0.005	0.001
Number of observations	*1,258*	*1,112*	*59*	*118*	*87*	*498*	*280*
	KOR	LUX	MEX	NETH	NOR	NZEA	POL
Equity capital ratio	0.047	0.036	0.124	0.070	0.065	0.050	0.110
BIS capital ratio	0.098	0.119	0.137	0.134	0.108	0.107	0.142
Country return on equity, lagged	0.055	0.036	0.090	0.117	0.184	0.203	0.208
Customer loan share	0.507	0.151	0.584	0.482	0.847	0.811	0.487
Customer loan growth	0.100	-0.012	0.170	0.109	0.073	0.100	0.283
Business cycle	0.008	0.017	0.016	0.006	0.011	-0.007	0.003
Interest term structure (%)	-0.017	0.018	0.017	0.025	-0.003	0.005	-0.021
Return on assets	0.002	0.004	0.002	0.005	0.010	0.011	0.014
Number of observations	*120*	*627*	*100*	*210*	*58*	*39*	*163*
	POR	SPA	SWE	SWI	TUR	UK	USA
Equity capital ratio	0.062	0.079	0.039	0.119	0.084	0.088	0.084
BIS capital ratio	0.112	0.109	0.122	0.144	0.190	0.160	0.123
Country return on equity, lagged	0.066	0.087	0.153	0.040	0.242	0.194	0.133
Customer loan share	0.492	0.515	0.582	0.546	0.394	0.453	0.648
Customer loan growth	0.095	0.066	0.042	0.014	0.242	0.090	0.099
Business cycle	0.010	0.014	0.018	0.031	0.038	0.009	0.008
Interest term structure (%)	0.012	0.008	0.019	0.014	-0.132	0.002	0.015
Return on assets	0.005	0.007	0.004	0.007	0.022	0.009	0.012
Number of observations	*171*	*383*	*42*	*1,008*	*128*	*489*	*2,266*

Explanation: Data statistics refer to estimation sample of first column of Table 3 (BIS ratio: first column of Table 4). Iceland has been omitted as their number of bank-year observation is too low.

Table A.4: Distribution of number of banks and total assets over BIS capital ratio and customer loan-share classes

	BIS ratio					**Avgs BIS**
Loan share	*8%-10%*	*10%-12%*	*12%-14%*	*>14%*	*Total*	**ratio[a]**
	Number of banks					
0%-40%	1.8	3.0	2.5	11.3	18.5	20.4
40%-60%	4.1	8.8	6.1	12.1	31.1	14.5
60%-80%	5.6	17.8	8.6	8.8	40.8	12.6
80%-100%	1.5	4.0	1.8	2.4	9.6	13.1
Total	*13.0*	*33.5*	*18.9*	*34.6*	*100.0*	*14.7*
Avgs loan share	60.0	63.2	59.6	48.4	57.1	
	Total assets					
0%-40%	2.4	7.6	3.5	3.4	16.9	12.5
40%-60%	9.9	18.6	5.6	2.0	36.2	11.0
60%-80%	22.1	16.3	5.2	0.8	44.4	10.3
80%-100%	0.3	1.2	0.5	0.6	2.5	13.3
Total	*34.8*	*43.6*	*14.8*	*6.8*	*100.0*	*10.9*
Avgs loan share	61.3	55.2	52.0	41.5	55.7	

Explanation: The table is based on data of banks from all OECD countries over 1990-2001. [a] Respectively, unweighted (upper part) and weighted with *total assets* (lower part).

Table A.5: Distribution of number of banks and total assets over BIS capital ratio and bank-size classes

	BIS ratio					**Avgs BIS**
Bank size	*8%-10%*	*10%-12%*	*12%-14%*	*>14%*	*Total*	**ratio[a]**
	Number of banks					
Small [b]	5.1	17.8	10.4	27.5	60.9	16.4
Medium	6.4	13.3	4.9	4.2	28.8	11.3
Large	2.1	5.6	1.9	0.7	10.3	11.4
Total	*13.6*	*36.7*	*17.2*	*32.5*	*100.0*	14.3
	Total assets					
Small	0.5	1.5	0.7	1.3	3.9	14.6
Medium	4.6	10.3	3.0	2.1	20.1	11.9
Large	10.5	39.1	20.6	5.8	76.0	11.5
Total	*15.6*	*50.9*	*24.2*	*9.3*	*100.0*	*11.6*

Explanation: The table is based on 1999 data of banks from all OECD countries. [a] Respectively, unweighted (upper part) and weighted with *total assets* (lower part). [b] Large banks have in 1999 a balance sheet total of above 44 billion and small banks have a balance-sheet total of below 3.1 billion. These borders are twice or triple times those of the equity ratio regressions in Section 7, as many small banks report capital ratios but do not report BIS ratios.