Bank capital ratios in the 1990s: cross-country evidence *

GABE J. DE BONDT and HENRIËTTE M. PRAST

1. Introduction

Economic theory has paid a lot of attention to capital ratios, their impact on financial stability and their relation with risk, especially in the light of capital regulation. However, very little has been done empirically on the behaviour of banks, especially on the effects of the Basle Capital Accord, which has been implemented gradually. This is largely due to the limited availability of data. A complicating factor in evaluating the effect of the Basel capital requirements is that countries do have different additional capital requirements supplementing the Basel Capital Accord. These may or may not be formally laid down and may or may not be bank-specific. Rather than investigating the effect of capital requirements on bank behaviour we shall therefore concentrate on a more modest question. This study aims at assessing empirically the determinants of changes in bank capital ratios in the 1990s. By applying a cross-country analysis we try to find out whether banks in different countries show similar behavioural patterns in this respect. This question is also important given the fact that one of the purposes of the Basle Capital Accord of 1988 was to create a level playing field for banks worldwide. The countries studied are the

---

□ De Nederlandsche Bank, Econometric Research and Special Studies Department, Amsterdam (The Netherlands);

De Nederlandsche Bank, Econometric Research and Special Studies Department, Amsterdam and University of Amsterdam, Faculty of Economics and Econometrics, Department of Economics, Amsterdam (The Netherlands).

* We would like to thank Peter Vlaar, Peter van Els and two anonymous referees for their comments on an earlier version.

United States (US), the United Kingdom (UK) and four EMU-countries, namely Germany, France, Italy and the Netherlands.

The paper is organised as follows. The next section addresses the theory with regard to capital behaviour by banks and briefly surveys empirical studies in this area. It also looks at capital regulation and capital requirements and their purpose as formulated in the 1988 Capital Accord by the Basel Committee for Banking Supervision. Section 3 presents an empirical model of capital ratios. Section 4 describes the data and Section 5 discusses the empirical results. Concluding remarks are given in Section 6.

2. Capital ratios

2.1. *Banks' capital behaviour in theory*

The solvency ratio of banks lies at the heart of many theoretical studies into bank behaviour. Thus, for example, it is argued that with more capital at stake, banks tend to exhibit less moral hazard. Also, and in relation to this, the theory and practice of bank regulation has the risk-based capital ratio as its main focus. The outstanding characteristic of banks is that their balance sheets combine liabilities that can be withdrawn at any time (deposits), whereas many of their assets are non-marketable (corporate loans). This makes banks especially susceptible to changes in depositor confidence and implies that even solvent banks can go bankrupt if depositors become panic-stricken (Freixas and Rochet 1997, Hebbink and Prast 1998). Maintaining sufficient solvency is one way for banks to deal with this problem, as this may generate confidence in the banking sector as a whole. However, according to the theory, as a result of asymmetric information the market itself may not be able to generate a sufficiently-safe banking sector. Bank owners have limited liability and tend therefore to take on too much risk. In the case of perfect information, market discipline would ensure that a bank that engages in riskier behaviour compensates its stockholders and depositors with a higher rate of return (Rochet 1992). But small depositors are unable to monitor banks, and there is a free-rider problem in acquiring information.

Also, deposit insurance may take away incentives for depositors to monitor their bank (Freixas and Rochet 1997).[1] Capital requirements by the regulator are regarded as one of the solutions to this problem. It is important to prevent bank panics, since they tend to be contagious, the so-called systemic risk. Capital standards require banks to hold a prescribed amount of capital, usually in relation to the risky assets in the portfolio. They try to ensure that there is more to distribute among creditors and more to be lost for the shareholder if the bank fails, with safer behaviour as a hoped-for consequence. This may also lead to more confidence in the banking system on the part of depositors.

It should be kept in mind that even in the absence of regulatory requirements, banks would choose to have a certain ratio of capital-to-assets. Although bank shareholders may want the bank to take on risky projects in the hope of getting high returns, it is in the interest of both the shareholders and the bank management that bankruptcy is prevented. The bank's capital and its risk are subject not only to deliberate decision-making (banks moving in the direction of their target capital and target risk-adjusted rate of return or obeying regulatory standards) but also to shocks, that is to changes in the bank balance sheet that are outside the control of the bank. An example of the latter is a fluctuation in the value of loan collateral (real estate for example). In practice, a bank's capital ratio will thus be affected by discretion of the bank itself to reach its capital target, by discretionary action taken by the bank in response to regulation, and by exogenous factors.

Discretionary measures by the bank to change its capital ratio, whether or not in response to regulatory prescriptions, may come in various ways. A bank that wishes to change its risk-based capital ratio because it comes close to the target chosen by the bank itself – which may of course be affected by regulation (in practice most banks have a degree of capitalisation well above the minimum requirements) – or comes close to the minimum regulatory standards, can reduce its asset portfolio, shift its asset portfolio away from the high-weight catego-

[1] This depends on the design of the insurance. With fair deposit insurance premiums, there is no moral hazard. If deposit insurance is limited to a maximum amount, or pays out only a fraction of deposits, depositors may want to monitor their bank.

ries and/or raise equity capital by issuing new shares.[2] This is summed up in equation (1)

$$(1) \qquad (C/RWA)' = C' - (RWA/A)' - A'$$

with C = capital, RWA = risk-weighted assets, A = total assets and where $'$ indicates a proportionate change.

The ratio C/RWA can be regarded as the bank's own target capital ratio or, when capital requirements are binding, as the regulatory requirements. The variable RWA can be interpreted as that defined by regulatory standards, or as chosen by the bank itself, for example based on its internal risk model. For reasons of data availability, in our empirical analysis we will use for RWA the risk weighting implied by the Basle Capital accord.

As equation (1) shows, if the capitalisation relative to risk-weighted assets increases either in order to obey regulatory standards or because of the bank's own preferred risk/return profile, this can be done by increasing capital, by reducing the risky assets in proportion to total assets and by reducing total assets.

As far as the change in the bank's risk profile is concerned, it is important to distinguish between changes in the direction of the bank's own capital target and changes induced by regulatory requirements. In the latter case, banks may be forced to take on less risk than they would have chosen themselves. Depending on its shareholders' risk/return appetite, the bank may react to capital requirements by choosing riskier projects, obeying the minimum solvency requirements by reducing the size of the risky portfolio (size effect) but not reducing (and maybe increasing) the riskiness of the bank by choosing riskier projects (reshuffling effect). This is because the bank offsets the forced lower risk (and expected return!) due to the solvency requirements by choosing very risky assets. The reduction of the risky portfolio would be reflected, in equation (1), by a decline in RWA, but the move inside this category toward riskier projects cannot be measured directly. It is important to emphasize that our empirical results focus on the determinants of changes in capital ratios and not on the effects of regulation per se.

---

[2] Another possibility is to employ off-balance sheet activities (see below).

Another way banks may react to regulatory policy is by increasing off-balance-sheet (OBS) activities. Standby letters of credit and loan commitments do not appear on the bank's balance sheet because at the time they are issued there is no financial transaction involved. However, as these activities involve promises to pay at some future time under certain conditions, they imply a risk to the bank. For this reason, regulatory capital standards incorporate the risk of OBS.[3]

Finally, it could be argued that, in the absence of capital requirements, banks would choose a solvency ratio above the minimum requirement, for example to signal their quality to the market. It could then even be the case that regulatory capital requirements reduce rather than raise actual capital ratios. Moreover, as the capital ratio may decline because of factors beyond their control, it could be that banks choose to be 'on the safe side' by holding on to excess capital in order to prevent regulatory action.

As, according to the theory, a bank's choice of capital and its reaction to regulatory capital requirements depend on its taste for risk and return, empirical research into actual bank behaviour is needed. Before turning to a brief survey of existing empirical research in this area, we shall describe, in the next subsection, the capital requirements according to the Basle Capital Accord of 1988. This is done because the countries investigated have implemented the requirements and because many studies surveyed in Section 2.3. focus on the effects of these requirements on bank behaviour.

2.2. *The 1988 Basle Capital Accord*

The capital adequacy requirements according to the Basle Agreement of 1988 imply that banks must have own funds (capital) of an amount at least equal to 8% of a weighted sum of its risky assets and its OBS activities.[4] The purpose of the Accord was to promote financial stability in the wake of the Third World debt crisis. The standardiza-

---

[3] Both the theoretical and empirical literature show ambiguous results as far as the effect of OBS activitities on bank's credit risk is concerned. Aggarwal, Jacques, and Rice (1999) find for the US that capital-constrained banks increase their use of stand-by letters of credit and loan commitments and that these activities increase credit risk, but they mention other research coming to different conclusions.

[4] An amendment to accommodate maket risk was introduced in 1996.

tion of capital requirements internationally created a level playing field for banks. The bank's assets and OBS activities are allocated into four different categories, according to their credit risk (default risk). The weighted asset portfolio for the application of the capital/asset ratio is computed according to the formula:

(2) $$RWA = 0 \cdot (\text{category 1}) + 0.2 \cdot (\text{category 2}) + 0.5 \cdot (\text{category 3}) + 1.0 \cdot (\text{category 4})$$

and the bank has to meet two capital requirements, namely:

(3a) $$\text{stockholder equity capital (tier 1)} = 0.04 \cdot RWA$$

and

(3b) $$\text{stockholder capital} + \text{loan loss reserves} + \text{subordinated debt} = 0.08 \cdot RWA\ A$$

where category 1 consists of assets with zero default risk (e.g. government securities), category 2 of assets with a low default risk (e.g. interbank deposits), category 3 of medium-risk assets (mortgage loans) and the remaining assets fall into category 4 (commercial loans). The OBS activities are also assigned to one of these categories, depending on their risk. The minimum requirements of the Basle Accord – 4% for tier 1 and 8% for total capital – are in practice for many banks not binding, i.e. most banks are more capitalised than is required. Some authors therefore argue that the requirements are ineffective. Still, it could be that lower requirements would induce banks to hold less capital, i.e. it may be that banks apply a standard mark-up to the minimum requirements, for example for reputational considerations. Also, a bank can be officially classified as "well-capitalised". The condition is that it has a stockholder equity capital ratio of 6%, and a total capital ratio of 10%. Furthermore, it should be kept in mind that in some countries the Basle requirements are complemented with additional regulatory standards. Thus in the UK, for example, a bank comes under closer scrutiny when its capital ratio falls below a value that is higher than the Basle minimum (Ediz, Michael and Perraudin 1998). And in addition to the Basle agreements, US banks face the restriction that total capital must be 3% of total unweighted assets (Haubrich and Wachtel 1993).

2.3. *Bank capital ratios: existing empirical research*

The Basle Committee (1999a) surveys empirical studies concentrating on the effects of the Basle Accord on bank behaviour in the US and Japan. The general conclusion is that, given the outcomes of these studies, it is difficult to assess how capital ratios have been affected by the 1988 Basle Capital Accord.

We shall focus here on listing the explanatory variables used in studies analyzing changes in capital ratios. When studying determinants of changes in risk-adjusted bank capital, a distinction should be made between changes beyond the control of the bank, and deliberate changes. Compliance with regulatory requirements is part of the latter category.

Several empirical studies investigate the relationship between capital and risk-taking. Shrieves and Dahl (1992), Haubrich and Wachtel (1993) and Jacques and Nigro (1997) concentrate on US banks, whereas Ediz, Michael and Perraudin (1998) use UK bank data. Wagster (1999) studies banks in Canada, the US, the UK, Germany and Japan to verify the causes of what he calls the credit crunch in the years 1989-92. A more general assessment of how banks' balance sheets evolved in the G-10 countries in the period following the Basle Capital Accord is given in Groeneveld (1998).

Shrieves and Dahl (1992) explain changes in bank capital ratios and in portfolio risk by discretionary adjustment and exogenous random shocks. The discretionary changes are thought of as reflecting (partial) adjustments to capital and risk targets. The unobservable targets are assumed to depend on bank size (reflecting access to capital markets), whether or not the bank is affiliated with a holding company (possibility of capital and risk being managed for the holding company as a whole), bank income (higher income permits banks to use retained earnings) and actual changes in capital and risk (reflecting adjustment-to-targets behaviour). Shrieves and Dahl conclude that target capital is significantly affected by risk and *vice versa*: banks try to match increasing capital with higher risk exposure and *vice versa*. The relationship applies to both over- and undercapitalised banks, indicating that if there is no regulatory need, bank risk-taking is self-constrained (managerial risk aversion). As in under-capitalised banks the speed of adjustment of capital was faster than that of overcapitalised banks, Shrieves and Dahl conclude that capital regulation was ef-

fective. Target capital is significantly affected by bank size (inverse relationship) only for undercapitalised banks. This may be because large banks feel less pressure to increase capital when they are undercapitalised ('too big to be closed' effect).

Aggarwal and Jacques (1998) use the model developed by Shrieves and Dahl (1992) to assess the impact of the 'prompt corrective action' provisions in the US. In December 1991 the FDICI (Federal Deposit Insurance Company Improvement) Act was passed in the US Congress, with the purpose of reducing moral hazard by banks, as a reaction to the bank crises in the 1980s. Introduction of prompt corrective action can be regarded as an intensification of the regulator's monitoring effort. The provision enables the regulator to restrict activities of a bank when its capital ratio declines. The restrictions include limits on asset growth, on transactions with affiliated banks and even on interest paid on deposits (this in order to prevent 'gambling for resurrection' strategies). The dataset used by Aggarwal and Jacques includes over 2500 banks (FDIC-insured), for the years 1990-93. To the explanatory variables used by Shrieves and Dahl they add dummies for whether or not the bank is adequately capitalised, this in order to reflect the potential pressure of prompt corrective action on bank behaviour. Aggarwal and Jacques conclude that the prompt corrective action pressure positively and significantly affected capital ratios in both adequately capitalised and under-capitalised banks, with a faster speed of adjustment in undercapitalised banks. Thus, their conclusion is similar to that of Shrieves and Dahl in the sense that regulatory policy is shown to affect bank behaviour with regard to the capital ratio.

Haubrich and Wachtel (1993) study bank portfolios in the US in the period 1973-93. They show that there was a portfolio shift by US banks toward government securities after 1989. That this shift has taken place is without doubt. Haubrich and Wachtel investigate the determinants of this shift, and whether it can be attributed partly to a reaction to regulatory incentives. The alternative would be that it was a flight to quality in reaction to the large loan losses in the 1980s (that were, by the way, the trigger to the new regulatory policy) and/or caused by a reduction in loan demand because of the business cycle slowdown in the period under consideration. Finally, it might have been because of an increase in the return on government securities thanks to a large supply and thus low price. Haubrich and Wachtel

conclude that the shift has been the result of a reaction to the risk-based capital regulation in force since 1990. This conclusion is supported by the result that banks that exhibited the largest shift toward government securities were those with the lowest capital-assets ratios at the time the new capital adequacy requirements were introduced. The outcome gives some support to the credit crunch hypothesis: commercial bank credit is reduced in favour of government securities.

Wagster (1999) studies bank behaviour in Canada, the UK, the US, Germany and Japan to assess the determinants of what he calls the 1989-92 US credit crunch. Thus, his aim is not to compare bank behaviour in different countries per se. Rather, he uses the data for the countries other than the US to allow him to discard some hypotheses about US bank behaviour. He studies four, not mutually exclusive, hypotheses, namely *i*) that the credit crunch was a voluntary action by banks aimed at reducing risk, *ii*) that more monitoring by the US supervisor encouraged banks to replace high-risk loans by government securities, *iii*) that it was the Basle Capital accord inducing this reallocation toward assets with a low risk-weight, and finally *iv*) that US regulation in the form of an unweighted capital ratio was behind this reallocation. Comparing the behaviour of banks in the US with that by banks in countries not facing typical US restrictions contributes to determining which of these hypotheses can be discarded. Wagster uses data for the years 1986-92 for 52 banks in the five countries, selected on, among other criteria, the availability of balance sheet data. His cross-country comparison suggests that increased monitoring, hypothesis *ii*), is the most likely explanation for the portfolio changes of US banks.

Ediz, Michael and Perraudin study balance sheet and income data for 94 banks in the UK in the years 1989-94. Their purpose is to assess the effect of capital regulation (Basle Capital Accord adequacy rules supplemented by UK-specific regulation) on capital ratios of UK banks. They use confidential supervisory data and find that, when the capital ratio of banks (total capital to risk-weighted assets) in the UK approaches its trigger value (the minimum value required by the supervisor), banks increase their capital ratio in the following quarter. The relationship is not linear, however, implying according to Ediz, Michael and Perraudin that banks change their behaviour when they get close to the 'danger zone'. The ratio of very risky (100% weighted) assets to total RWA does respond only slightly to changes

in the capital ratio. According to Ediz, Michael and Perraudin this implies that there is no evidence that UK banks increase risk-taking in order to make up for the lower risk forced upon them by the solvency requirements. Ediz, Michael and Perraudin conclude for the UK, that the increase in capital ratio of banks in the 'danger zone' is likely to come from an increase in narrow capital (change in funding). Evidence for this conclusion is provided by multivariate regression analysis designed to explain changes in the capital ratio. As it can be assumed that banks have internal capital targets, the analysis should be directed at finding out whether the observed bank behaviour can be attributed not only to this internal target, but at least partly to the regulatory pressure. The bank's internal target is approached by net interest and fee income and the ratio of very risky over total risky assets (reflecting the bank's risk exposure), deposits in relation to RWA (reflecting the bank's fragility on the liability side, i.e. its vulnerability for bank runs), profit and loss and provisions as a fraction of RWA (a measure of the bank's financial health). OBS activities are introduced because they increase the bank's liquidity and thus decrease the vulnerability to bank runs. To reflect the pressure from the threat that the supervisor can take action as soon as the bank falls below the trigger value, a dummy is added for banks whose trigger values have been increased lately by the supervisor, and one for banks whose ratio comes close to the regulatory minimum. The results indicate that the capital requirements significantly affect the capital ratio. The other variables do not have a significant effect, with the exception of the OBS activities, they increase capital, a result the authors do not comment on. The ratio of very risky assets to total risky assets is not significantly affected by the regulation, whereas tier 1 capital and, to a lesser extent, tier 2 capital are increased, indicating according to Ediz, Michael and Perraudin that banks respond to regulatory pressures by an increase in narrow capital.

Groeneveld (1998) describes the development of capital ratios of European banks in the period 1990-97. He concludes that at first sight it seems that, at least for continental Europe, capital restrictions are not binding. However, he also mentions results from surveys among European bankers indicating that capital regulations are important driving forces in the behaviour of banks.

2.4. *Conclusion*

The purpose of this section is to indicate what factors may influence (risk-weighted) bank capital ratios according to the theory, and to give an impression of which determinants have been included in empirical studies analyzing the behaviour of banks with respect to their capital ratio. A general conclusion may be that bank capital is affected both by internal targets, by regulatory requirements and by shocks that are outside the control of banks. In the remainder of this paper we present the results of our own empirical analysis of the determinants of risk-weighted capital ratios, and interpret our results against the background of this section.

3. Empirical model of bank capital ratios

The former section has reviewed what banking theory considers as determinants of bank capital augmentations and has looked at the determinants that show up in empirical studies. This section examines how the risk-adjusted capital ratios (RACR) of the Basle Committee have developed in the 1990s and which factors play a key role in this respect. We address this issue from a cross-country perspective to find out whether banks in different countries show similar behaviour patterns in this respect. The countries analysed are the EMU countries Germany, France, Italy and the Netherlands and the Anglo-Saxon economies of the UK and the US.

As shown in equation (1) in Section 2.1., an increase in the risk-adjusted capital ratio (RACR) can be decomposed into an increase in capital, a reduction in risky assets relative to total assets and a decline in total assets. Even more simply, changes in the RACR are caused by changes in capital, the numerator effect, and by changes in the RWA, the denominator effect. The numerator and denominator are, however, determined by a wide spectrum of factors. The importance of potential determinants of RACR is, given the sometimes-ambiguous effects according to the theoretical literature as described in the former section, surely a matter of empirical research. The equation we shall use to address this issue is as follows.

$$(4) \quad \Delta RACR_{it} = \alpha_i + \beta_1 X_{it-1} + \beta_2 X_t + \beta_3 t + \beta_4 \text{capitalization dummy}_{t-1} + \varepsilon_{it}$$

The RACR analysed are the tier 1 ratio and the total capital adequacy ratio, as described in more detail in Section 2.2. We assume the unobservable bank-specific effects, α_i, are fixed and capture all factors not taken into account explicitly, such as management philosophy and autonomous changes in risk-aversion and capital preferences, etc. The explanatory variables are divided into factors at the bank level, X_{it}, at the banking industry level including a time trend, X_t and t, and a capitalisation dummy. Because of endogeneity problems the bank-specific variables and the dummy variable are lagged one period. The explanatory variables, their definitions and economic rationale are summarised in Table 1.

The first bank-specific characteristic focuses on changes in capital, mainly determined by its cost. The cost of capital is captured by the return on average equity (see Table 1). The theory says that the higher the cost of core capital, equity, the more expensive capital augmentation and, *ceteris paribus*, the lower the RACR. The next two bank-specific variables focus on the riskiness of bank assets, namely on-balance-sheet and OBS riskiness. Both variables influence the RWA certainly, but banks may also react to changes in the risk profile by changing their capital. The loan ratio, defined as loans divided by total assets, takes into account the most important risky bank assets. An increase in the loan ratio implies a higher risk profile of the bank balance sheet and therefore a rise in RWA and, with unchanged bank capital, RACR will decline. The RACR rises, however, if bank managers increase bank capital more than strictly necessary according to the Basle Accord weighting scheme. In other words, a positive relationship between the RACR and the loan ratio implies that bank managers estimate the credit and interest rate risk of the bank portfolio higher than according to the Basle Committee standards. In addition, banks are involved in OBS activities for which the same arguments apply as for the most important bank asset, loans. An increase in the OBS ratio implies a rise in RWA and therefore, given capital, a decline in RACR. When, however, OBS are inadequately incorporated in the risk-adjusted Basle capital ratios, an increase in OBS risk leads to a rise in capital such that the RACR ratio increases. The fourth and final bank-specific variable considered is asset growth, that

is the percentage change in the balance sheet total. We take this variable into account to investigate in which direction the growth of on-balance-sheet activities, in contrast to the former bank-specific variable that measures the growth of OBS activities relative to on-balance-sheet activities, changes RACR. Balance sheet growth implies an increase in RWA and, *ceteris paribus*, a decline in the RACR, but asset growth may, just as the two proxies of bank risk, also change bank capital. Both a capital augmentation and deterioration are possible.

TABLE 1

EMPIRICAL MODEL VARIABLES

Variable	Definition	Economic rationale
Cost of capital	Net income/average equity · 100	Cost of capital ↑ ⇒ capital ↓ ⇒ RACR ↓
Loan ratio	Loans/total assets · 100	Loan ratio ↑ ⇒ RWA ↑ ⇒ RACR ↓ Loan ratio ↑ ⇒ credit risk ↑ ⇒ inadequacy Basle-weights ↑ ⇒ RACR ↑
OBS ratio	OBS items/total assets · 100	OBS ratio ↑ ⇒ RWA ↑ ⇒ RACR ↓ OBS ratio ↑ ⇒ OBS risk ↑ ⇒ ↑ ⇒ inadequacy Basle-weights ↑ ⇒ RACR ↑
Asset growth	Total asset growth in %	Asset growth ↑ ⇒ RWA ↑ ⇒ RACR ↓ Asset growth ↑ ⇒ capital ↑/↓ ⇒ capital ratio ↑/↓
Bank sentiment	Bank share index minus total market index in %	Bank sentiment ↑ ⇒ relative conditions in banking sector ↑ ⇒ RACR ↑
Trend	Linear trend, 1 in 1990	Trend ↑ ⇒ banking competition ↑ ⇒ overcapitalisation ↓ ⇒ RACR ↓
Dummy capitalisation	1 if RACR < median, 0 otherwise	Dummy capitalisation ↑ ⇒ undercapitalization ↑ ⇒ pressure to fill capital gap ↑ ⇒ RACR ↑

Not only market forces at the bank level, but also conditions at the banking industry level may influence capital ratios. Of course many developments within the banking industry, for example, interest rate movements, the stance of monetary policy and the business cycle may have an impact on bank capital behaviour and are also (partially) reflected in bank-specific variables such as the cost of capital. The banking industry variable included in our empirical analysis reflects bank sentiment, measured by the stock market performance of banks relative to the performance of the total stock market index. If the bank sentiment increases due to favourable conditions in the banking sector, one may expect that during these good times the RACR will increase. Another relevant development in the banking industry is the increasing competition that forces banks to use their

capital more efficiently, leading to a decrease in RACR. This effect is captured by a linear time trend.

The seventh and last factor taken into account is that bank capital is regulated and therefore one may suspect that banks that are relatively undercapitalised will make more effort, forced by the regulator or voluntarily, to increase their capital. This effect is taken into account by a capitalisation dummy, which is 1 if the RACR is less than the 'normal' level in the banking sector, proxied by the overall median, and 0 otherwise. The use of the median as the threshold value is somewhat arbitrary, but unfortunately there is no information about the threshold values used by the banks themselves or the national regulators and the Basle Committee threshold values of 4% and 8% are seldom binding.

4. Data

Bank-specific data are obtained from BankScope, a database of account figures on an annual basis maintained by Fitch IBCA and Bureau van Dijk, a major rating agency and a publisher of financial databases on CD-ROM, respectively. If both consolidated and unconsolidated account data are available, consolidated figures are used because we want to study the capital behaviour of the parent company. Movements within a year are not analysed, because data with a higher frequency are not available for most banks in our sample. The main advantage of examining annual data is the focus on long-term tendencies in bank capital instead of short-run fluctuations in capital ratios. In other words, by using annual data we capture more discretionary than autonomous behaviour.

For each country separately, an unbalanced panel data set is constructed, consisting of individual commercial bank data for the years 1990-97. The main benefit of considering commercial banks at a country level is that they face more or less the same accounting standards and national regulatory conditions. As mentioned in the introduction, countries have implemented capital restrictions that are supplementary to the Basle accord. We analysed commercial banks, be-

cause capital behaviour may depend on the type of bank activities, and commercial banks are the most common bank type in Europe and the US. Banks that did not report both the tier 1 ratio and the total capital adequacy ratio for three consecutive years are omitted from the data set. Also, capital ratios above 50% are deleted from the sample. Moreover, mergers and acquisitions in the 1990s unbalance our panel. Banks that disappeared through mergers or take-overs, however, remain part of the sample, because their assets and liabilities appear on the balance sheet of the acquiring bank. The sample period starts in 1990 and ends in 1997.

Table 2 lists the median of the tier 1 ratio and total capital adequacy ratio across the years 1990-97. For all countries the median of the RACR is far above the minimum required level of 4 and 8%, respectively. The median of the tier 1 ratio varies between 5 and 6% in Germany and France, between 5 and 8% in Italy and the Netherlands and between 5 and 10% in the UK and the US. The median of the total capital adequacy ratio varies between 9 and 12%, with the exception of the UK where the median is 14%. The total number of banks and observations in our sample varies between a minimum of 8 banks and 38 observations for the Netherlands and a maximum of 448 banks and 2381 observations for the US. The German sample contains 12 banks with a total of 67 observations, while for France, Italy and the UK about 18 banks and 100 observations are analysed. Looking at the distribution across years, it becomes clear that capital ratios are not constant over time. Moreover, it is striking that in the early 1990s only a few banks reported both capital ratios. This is due to the fact that industrialised countries adopted risk-based capital standards in 1988, but these standards were implemented only gradually in the 1990s, taking full effect in 1993. Although the median in the early 1990s is a little bit lower than the overall median, there is no clear movement of the median of the capital ratios over time. Most striking is the improvement in the capital ratios in 1994 in all countries, except the US.

Table 3 presents the median of the bank-specific model variables. The capital ratios are as described above. The median of the cost of capital is low in Germany, France and Italy compared to the Netherlands, the UK and the US. In the first group of countries the rate of return on equity is 7% and in the Netherlands and the Anglo-Saxon countries is over 10%. In the US the median of the return on

average equity is 15%, in line with a comparatively large return on equity of non-financial firms. The cross-country differences are perhaps related to differences in riskiness. The riskiness of a bank's loan portfolio can be proxied by its interest income as a fraction of its assets: high-risk projects can be expected to pay high interest rates on their loans. However, de Haan and Prast (1999) show that interest rates in continental Europe are lower than those in the US for firms with the same rating. A possible explanation is that banks in Europe are less efficient because of a lack in transparency and competition.

TABLE 2

MEDIAN TIER 1 AND TOTAL CAPITAL RATIO ACROSS YEARS

Year	GE		FR		IT		NL		UK		US	
Tier 1 ratio												
1990	5.9	(4)	4.4	(8)	7.8	(4)	-	-	5.5	(8)	5.1	(2)
1991	6.0	(7)	4.7	(10)	6.9	(7)	-	-	8.6	(12)	7.8	(88)
1992	5.4	(7)	5.0	(11)	6.9	(10)	6.0	(3)	7.4	(13)	9.5	(224)
1993	5.7	(9)	5.2	(13)	6.7	(12)	6.9	(5)	7.7	(14)	10.0	(328)
1994	6.0	(10)	5.7	(13)	7.7	(15)	7.9	(8)	10.6	(17)	10.0	(409)
1995	5.9	(11)	6.1	(16)	9.1	(17)	8.8	(8)	10.0	(19)	10.4	(445)
1996	5.5	(11)	5.9	(16)	9.3	(15)	7.9	(8)	10.4	(18)	10.2	(445)
1997	5.9	(8)	5.9	(13)	7.4	(13)	8.1	(6)	9.3	(17)	10.1	(440)
1990-97	5.7	(67)	5.4	(100)	7.6	(93)	7.9	(38)	9.6	(118)	10.1	(2381)
Total capital ratio												
1990	9.1	(4)	8.0	(8)	9.6	(4)	-	-	10.3	(8)	8.4	(2)
1991	8.8	(7)	8.7	(10)	9.0	(7)	-	-	12.0	(12)	9.6	(88)
1992	9.3	(7)	8.7	(11)	9.2	(10)	10.3	(3)	12.0	(13)	11.4	(224)
1993	9.1	(9)	9.0	(13)	9.7	(12)	11.2	(5)	13.1	(14)	11.9	(328)
1994	9.6	(10)	9.8	(13)	10.5	(15)	12.8	(8)	14.4	(17)	11.8	(409)
1995	9.4	(11)	9.7	(16)	11.0	(17)	12.5	(8)	15.0	(19)	12.1	(445)
1996	9.4	(11)	9.9	(16)	10.2	(15)	12.4	(8)	15.4	(18)	11.9	(445)
1997	9.9	(8)	10.4	(13)	10.2	(13)	10.8	(6)	14.2	(17)	11.8	(440)
1990-97	9.4	(67)	9.2	(100)	10.1	(93)	11.3	(38)	14.2	(118)	11.8	(2381)
Number of banks		12		17		17		8		19		448

Explanatory note: number of observations in parentheses.

TABLE 3

MEDIAN BANK-SPECIFIC MODEL VARIABLES

	GE	FR	IT	NL	UK	US
Tier 1 ratio	5.7	5.4	7.6	7.9	9.6	10.1
Total capital adequacy ratio	9.4	9.2	10.1	11.3	14.2	11.8
Cost of capital	7.08	6.78	6.60	10.08	11.13	15.17
Loan ratio	62.4	47.9	48.0	63.7	52.7	62.8
OBS ratio	13.9	31.1	13.7	11.4	18.4	24.9
Asset growth	11.1	3.5	6.5	8.9	8.3	6.0

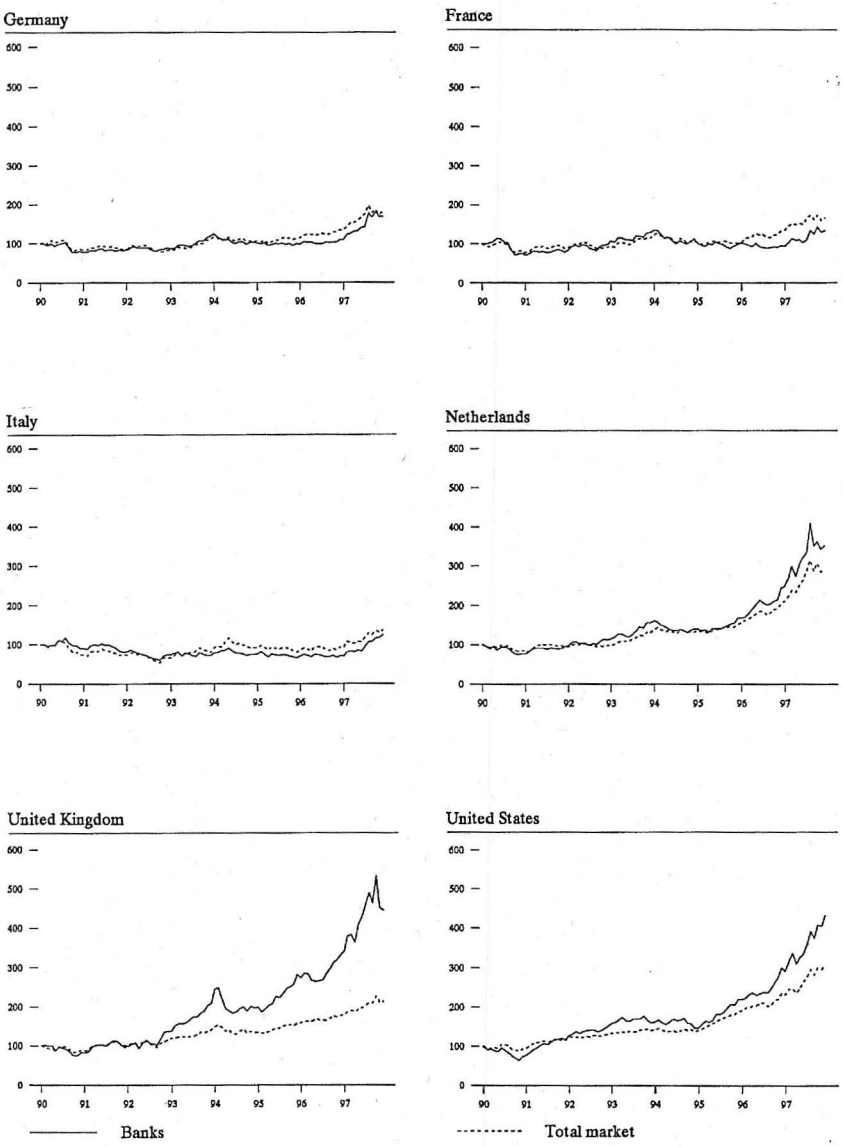
The introduction of the euro can be expected to change this. The cross-country differences in the rate of return on equity are most probably related to the riskiness of the bank portfolios. Loans account for 50% of total assets in France, Italy and the UK and for 60% in the other countries considered. The median of OBS items is about 10% of total assets in Germany, Italy and the Netherlands, about 20% in the UK and the US and 30% in France. The relatively large figures for the UK and the US are as expected; perhaps more surprising is the large figure for France, indicating that banks in France are comparatively active on the OBS market.[5]

Figure 1 plots the stock market performance of banks relative to the total stock market to provide more information on bank sentiment. The most striking observation of Figure 1 is that bank share prices in the UK performed much better than the shares of all sectors after 1993. In Germany, France and Italy the return on bank stocks underperforms, while in the Netherlands and the US the outperformance is substantial but modest compared to that in the UK. Another observation from the figure is that fluctuations in the bank share index are larger than in the total stock market index, in particular in (again) the Netherlands, the UK and the US. This suggests that in these countries the sensitivity of bank stock prices to movements in the stock market as a whole (the so-called beta) is considerably larger than 1. This circumstantial evidence of the riskiness of the commercial banking industry in the Netherlands, the UK and the US, together with the high rate of return on equity as shown in Table 3, support the hypothesis that banks that are engaged in riskier activities are compensated with a higher return due to market discipline.

[5] See chapter 3 in de Bondt (2000) for more details about OBS diffusion in Europe.

FIGURE 1

STOCKMARKET PERFORMANCE BANKS AND TOTAL MARKET
JANUARY 1990=100



Source: Datastream.

Moreover, the high riskiness of commercial bank activities in the Netherlands, the UK and the US together with their high total capital adequacy ratios suggest that the riskiness is inadequately captured by the Basle Committee risk weights.

5. Empirical results

5.1. *Tier 1 ratio*

Table 4 shows the estimation results of equation (4) with the change in the tier 1 ratio as dependent variable and with bank-specific constants. The model equation explains about 90% of the variation in the change in the tier 1 ratio. The standard error of regression (SE) varies between 0.6 percentage points in Germany to 2.2 percentage points in the UK. Based on the SE it seems to be the case that for France and the Anglo-Saxon countries the tier 1 ratio of commercial banks is comparatively difficult to explain using the factors included in our regression equation (equation 4).

In all countries two or more bank-specific factors significantly explain bank capital behaviour.[6] The impact of the cost of capital on the tier 1 ratio is significantly negative in all countries other than Germany and France: an increase in the cost of capital lowers capital itself. In Germany, however, the tier 1 ratio rises significantly following an increase in the return on average equity. This result suggests that, in Germany, banks use net income partially to augment the tier 1 capital, because the return on equity is not only a proxy for the cost of capital but also for bank profitability, and retained earnings can be used for capital augmentation. Additional regressions for Germany, not shown here, with profitability as an additional explanatory variable, show an insignificant effect of the cost of capital. The loan ratio has a significant positive impact on the change in the tier 1 ratio in the US. In the US an increase in the loan ratio with 1 percentage point results in a 0.02 percentage point increase of the tier 1 ratio. This may imply that in the US the risk-weights of the Basle Capital

[6] Throughout the paper significance refers to a significance level of 5%, unless stated otherwise.

Accord are viewed by the banks themselves or the national regulators as being inadequate, since US banks raise the tier 1 ratio when the loan ratio increases. This could be explained by the fact that the Basle Committee requirements ignore interest-rate risk. In this sense, the capital behaviour could reflect managerial philosophy and attitude toward risk. Note, also, the additional capital requirements in force in the US that we mentioned earlier in the paper (see section 2.2.). In all countries except the Netherlands and the US, an increase in OBS activities relative to on-balance-sheet activities result in an increase in the tier 1 ratio. This suggests, again, that – this time in the eyes of the managers of European banks – the risks of OBS products be inefficiently taken into account in the tier 1 ratio. In contrast, in the US an increase in OBS activities results in a reduction in the tier 1 ratio due to an increase in RWA. Perhaps this finding for the US is due to the fact that the OBS market is comparatively well developed. The active use of OBS products by US banks leads to an increase in RWA. The impact of the last bank-specific variable considered, asset growth, on the tier 1 ratio is positive in Europe, but negative in the US. In Europe, in particular in France, the Netherlands and the UK, fast-growing banks improve their tier 1 capital, resulting in an increase in the tier 1 ratio, while in the US the negative impact of an increase in RWA dominates, leading to a deterioration in the tier 1 ratio.

In all countries except the Netherlands, developments in the banking industry do help in explaining the change in the tier 1 ratio. The irrelevance of factors at the banking industry level in the Netherlands is probably due to the few observations for this country. In Germany, France and the US, an optimistic sentiment in the banking sector relative to the other sectors in the economy is significantly accompanied by a rise in the tier 1 ratio. In these countries banks use the 'good' times to improve their capitalisation. In contrast, for the UK we found a negative relationship between bank sentiment and the tier 1 ratio. Given the solid capital position in the UK, it could be the case that banks in the UK use the 'good' times to reduce their capital or, more likely, tend to lend to a more risky class of borrowers during 'good' times, both resulting in a decline in the tier 1 ratio. This excessive optimism on risk-taking is perhaps, as mentioned before, another explanation of the extreme outperformance of the bank share index compared to the total stock market index in the UK (see Figure 1). In all countries except France and the Netherlands, there is a sig-

TABLE 4

ESTIMATION RESULTS CHANGE IN TIER 1 RATIO

	GE		FR		IT		NL		UK		US	
Cost of capital	0.079	**	0.003		−0.024	**	−0.395	***	−0.073	***	−0.017	***
	(2.26)		(0.77)		(2.11)		(4.42)		(12.88)		(10.20)	
Loan ratio	−0.006		0.023		0.020		0.169	*	−0.005		0.027	***
	(0.20)		(1.29)		(0.46)		(1.96)		(0.40)		(36.32)	
OBS ratio	0.029	**	0.031	**	0.079	***	−0.039		0.030	***	−0.003	***
	(2.23)		(2.65)		(4.48)		(0.47)		(7.63)		(4.40)	
Asset growth	0.012		0.024	***	0.019		0.033	***	0.017	***	−0.001	***
	(1.42)		(5.46)		(1.39)		(11.33)		(11.97)		(3.27)	
Bank sentiment	0.005	**	0.008	***	−0.006		0.043		−0.018	***	0.021	***
	(2.32)		(6.54)		(1.06)		(1.52)		(9.10)		(36.61)	
Trend	−0.163	***	−0.000		−0.370	**	0.110		−0.074	**	−0.210	***
	(3.40)		(0.00)		(2.42)		(0.34)		(2.09)		(47.15)	
Capitalisation dummy	0.602	***	0.252	*	1.065	***	0.887		0.678	***	2.016	***
	(3.01)		(1.73)		(4.56)		(1.53)		(11.17)		(172.51)	
R^2	0.968		0.916		0.964		0.934		0.990		0.999	
R^2 adjusted	0.948		0.878		0.934		0.850		0.986		0.999	
SE	0.589		2.125		1.442		1.380		2.189		1.882	

***, ** and * denote significance at the 1, 5 and 10% level, respectively; heteroscedasticity-corrected t-ratios in parentheses.

nificant negative trend. The smallest decline was in the UK, where the ratio has fallen by 0.1 percentage point a year, the highest in Italy, with a yearly decline of 0.4 percentage point. This downward trend can be attributed to the growing competition in the banking industry. The Anglo-Saxon countries are well known to have market-based financial systems with strong competition that in recent years, as the estimates suggest, has become even stronger, while Germany and Italy are known as bank-based systems where competition intensified only recently.

Finally, in all countries there is a positive relationship between the capitalisation dummy and the change in the tier 1 ratio. Based on our data it is, however, unclear whether this is forced by the (inter)national regulators or a voluntarily decision. In the US this effect is at least twice as large as in the other countries: a tier 1 ratio below the 'normal' level in the banking industry results after one year in a rise by 2 percentage points.

5.2. *Total capital adequacy ratio*

The estimates of equation (4) with the change in the total capital adequacy ratio as dependent variable and with bank-specific constants are presented in Table 5. Again, the model fits the data pretty well: in all countries more than 90% of the variation of the change in the capital adequacy ratio is explained. Adjusted for degrees of freedom the R2 is relatively low in the Netherlands, which is due to the low number of observations. The SE is relatively small in Germany and France and large in the Anglo-Saxon countries. In all countries bank-specific variables, factors at the banking industry level and the capitalisation dummy contribute to the explanatory power of the model.

The cost of capital plays an important role in the Anglo-Saxon countries. The higher the rate of return on equity, the lower the capital adequacy ratio in the UK and the US. This result implies that the growing importance of shareholder value for continental Europe could lead to lower capital ratios. The capital adequacy ratio increases in France and the US when the share of loans increases in their banks' portfolio, indicating that the existing Basle Committee risk-weights are perceived as inadequate, something which may be explained by managerial risk aversion, possibly related to interest-rate risk. In all

countries except the Netherlands and the US, an increase in the OBS ratio results in a rise in the total capital adequacy ratio. In these countries OBS products are, on balance, viewed as increasing bank risk more than according to the Basle Committee risk weighting standards and therefore create a need to increase the total capital adequacy ratio. In the Netherlands and the US, however, the impact of the increase of RWA dominates, causing the total capital adequacy ratio declines. Just as with the estimation results for the tier 1 ratio, fast-growing banks increase their total capital ratio's in Europe and decrease them in the US. This growth effect is significant in all cases.

Factors at the banking industry level play a significant role, too, in explaining the change in the total capital adequacy ratio. Bank sentiment has a significant positive impact on the total capital adequacy ratio in Germany, France and the US and a negative one in the UK. In Germany, Italy and the US there is a significant negative trend in the capital ratio.

The capitalisation dummy increases the capital ratio significantly in all countries: a shortfall of tier 1 and 2 capital is restored the next period. This effect is modest in France (0.5), large in the Netherlands and the Anglo-Saxon countries (about 2) and in between in Germany and Italy.

TABLE 5

ESTIMATION RESULTS CHANGE IN TOTAL CAPITAL ADEQUACY RATIO

	GE		FR		IT		NL		UK		US	
Cost of capital	−0.001		−0.001		−0.029		−0.096		−0.085	***	−0.021	***
	(0.03)		(0.22)		(1.29)		(0.58)		(10.07)		(15.06)	
Loan ratio	0.075	*	0.078	***	0.059		−0.059		−0.008		0.022	***
	(1.72)		(3.97)		(1.38)		(0.43)		(0.49)		(19.21)	
OBS ratio	0.050	***	0.024		0.038		−0.257	***	0.034	***	−0.004	***
	(4.10)		(1.56)		(1.13)		(4.29)		(4.89)		(7.63)	
Asset growth	0.027	**	0.061	***	0.036	***	0.019	**	0.007	**	−0.001	***
	(2.40)		(10.25)		(3.20)		(3.02)		(2.35)		(7.69)	
Bank sentiment	0.016	***	0.003	**	−0.010	*	0.020		−0.006	**	0.025	***
	(4.27)		(2.10)		(1.71)		(0.73)		(2.23)		(37.99)	
Trend	−0.206	***	0.062		−0.483	**	0.623	*	−0.046		−0.273	***
	(3.51)		(1.62)		(2.44)		(1.80)		(1.21)		(53.23)	
Capitalisation dummy	0.932	***	0.511	***	1.573	***	2.042	***	2.318	***	1.821	***
	(5.09)		(4.90)		(5.97)		(3.95)		(16.60)		(145.79)	
R^2	0.972		0.984		0.965		0.910		0.989		0.999	
R^2 adjusted	0.956		0.977		0.936		0.795		0.985		0.999	
SE	0.921		1.113		1.801		1.843		2.359		1.946	

***, ** and * denote significance at the 1, 5 and 10% level, respectively; heteroscedasticity-corrected t-ratios in parentheses.

5.3. *Overall assessment and comparison with other studies*

The first conclusion to be drawn from our empirical results is that bank-specific factors are not the only significant determinants of the RACR. Factors at the banking industry level and the degree of bank capitalisation also play a role in explaining bank capital behaviour. The importance of the degree of capitalisation, or more specifically the impact of regulation on capital, has also been noted by others, as described in Section 2.3.

Second, the empirical results show that, in both Europe and the US, an increase in loans relative to the balance sheet total results in an increase in the RACR. This positive relationship between capital and credit and interest rate risk suggests that commercial banks or their national regulators view the existing Basle Committee risk weights as being inadequate. Insofar the underlying factor is not related to additional regulatory requirements, this gives an indication of the independent role of the managerial philosophy, and the banks' attitude toward risk. The fact that interest rate risk is not taken account of by the Basle Committee capital requirements may play a role, as well as the bank managers' detailed knowledge about their loan portfolio.

A positive relationship between capital and risk has also been found by others. Shrieves and Dahl (1992), for example, find evidence that capital targets are affected by risk.

The third conclusion is that the impact of some determinants of the RACR differs remarkably between countries, while the impact of other determinants is fairly similar. The direction of the impact of a change in the OBS ratio and of asset growth on RACR differs between Europe and the US. The empirical results suggest that in Europe OBS products are viewed as being more risky than the Basle Accord risk standards imply, and asset growth is accompanied by an improvement in the RACR. Ediz, Michael and Perraudin (1998) found for the UK also that OBS activities increase capital. In contrast, in the US both OBS growth relative to on-balance-sheet growth and asset growth itself result in a lower capital ratio due to a proportionately larger increase in RWA than in capital. In the US, either commercial banks have a greater risk appetite than in the other countries, or they are faced with difficulties in improving capital relative to RWA, for example because of a high required rate of return by shareholders. A positive sentiment about the banking sector – measured by

the relative stock market performance of banks – is accompanied by a rise in capital ratios in all countries, except the UK. Although statistically significant, this effect is quite small: if the share index of banks outperforms the total stock market index with 10 percentage points, the capital ratio increases by at most 0.4 percentage point. In the period under consideration, the bank sentiment in the UK showed an enormous increase and was during more than half of the decade excessively high compared to that in the other countries. Whether this may explain why UK banks do not increase the capital ratio in response to bank sentiment is unclear. A possibility could be that the extremely favourable stock market performance led bank managers to conclude that their banks were safe anyway. The results on the time trend, capturing the increasing competition in the banking industry, are very similar between countries and indicate that, in the 1990s, the tier 1 ratios and the total capital adequacy ratios have declined yearly by about 0.2 percentage points. This effect is particularly significant in Germany, Italy and the US. In all countries, under-capitalised banks increase their capital, forced by the regulator or voluntary. If the capital ratio of a bank is below the 'normal' level in the commercial banking industry, that bank will increase its capital ratio after one year with about 0.5 percentage point in France to around 2 percentage point in the US. This corresponds to the result of Shrieves and Dahl (1992) that the speed of adjustment of capital is faster for under-capitalised banks than for overcapitalised banks, and to the result of Ediz, Michael and Perraudin (1998) that banks whose ratio comes close to the regulatory minimum improve their capital position. All these results indicate that capital regulation is effective.

6. Concluding remarks

This paper studies the capital behaviour of commercial banks in the 1990s in the EMU countries Germany, France, Italy and the Netherlands and the Anglo-Saxon economies of the UK and the US. Although capital behaviour in the UK and the US has been studied before, this study is, according to our knowledge, the first one that empirically investigates capital behaviour in several EMU countries.

Against the background of a literature overview, an empirical equation of the change in the tier 1 ratio and total capital adequacy ratio is presented. Based on the empirical results presented, five implications for the monetary authorities and regulators can be drawn.

First, this study shows empirically that factors both at a bank level and at a banking industry level and the degree of undercapitalization are relevant for bank capital behaviour. Second, our data and empirical results suggest that in some countries banks or their national regulators view the Basle risk weights as inadequate, providing empirical support for the recent proposals to change the existing Basle Committee-weighting scheme (Basle Committee on Banking Supervision 1999b) and for the practice that banks have their own capital targets. Moreover, this paper provides circumstantial evidence that commercial banks in the Netherlands, the UK and the US are less risk-averse than banks in Germany, France and Italy. Third, the results imply that if the banking industry in Europe should become more similar to the US, this may result in a change in direction of the impact of OBS and on-balance-sheet asset growth on capital behaviour. During our sample period OBS and asset growth have resulted in Europe in a rise in RACR. This is in contrast with US experience. Moreover, the cost of capital plays an important role in the Anglo-Saxon countries. The higher the required rate of return on equity by the shareholders, the lower the total capital adequacy ratio in the UK and the US. This result implies that a growing importance of shareholder value could lead to lower capital ratios. Fourth, the increasing competition in the banking industry in the 1990s have led to a yearly erosion of the RACR of about 0.2 percentage points. The fifth and final regulatory policy implication is that the afore-mentioned pressures facing banks to lower capital ratios will be offset by an increase in capital ratios when they reach a level below the 'normal' level in the banking industry. This suggests that capital regulation has an additional impact on bank capital.

REFERENCES

AGGARWAL, R. and K.T. JACQUES (1998), "Assessing the impact of prompt corrective action on bank capital and risk", *Federal Reserve Bank of New York Policy Review*, October, pp. 23-31.

AGGARWAL, R., K.T. JACQUES and T. RICE (1999), "Bank off-balance sheet activities and credit risk under risk-based capital: a simultaneous equations approach", paper presented at De Nederlandsche Bank/BIS Workshop on Financial Stability, April.

BERGER, A.N. (1995), "The relationship between capital and earnings in banking", *Journal of Money, Credit and Banking*, vol. 27, no. 2, pp. 432-56.

BASLE COMMITTEE ON BANKING SUPERVISION (1988), *International Convergence of Capital Measurement and Capital Standards*, Basle.

BASLE COMMITTEE ON BANKING SUPERVISION (1999a), "Capital requirements and bank behaviour: the impact of the Basle Accord", *Working Paper*, Basle.

BASLE COMMITTEE ON BANKING SUPERVISION (1999b), "A new capital adequacy framework", *Consultative Paper*, Basle, June.

DE BONDT, G.J. (2000), *Financial Structure and Monetary Transmission in Europe: A Cross-Country Study*, Edward Elgar, Cheltenham/Northampton (forthcoming).

DE HAAN, L. and H.M. PRAST (1999), "Betekenis Europese kapitaalmarkt voor de financiering van bedrijven", *Research Memorandum WO&E*, no. 596, De Nederlandsche Bank (also published in English in *DNB Quarterly Bulletin*, December, pp. 33-42).

EDIZ, T., I. MICHAEL and W. PERRAUDIN (1998), "The impact of capital requirements on UK bank behaviour", *Federal Reserve Bank of New York Economic Policy Review*, vol. 4, no. 3, pp. 15-22.

FREIXAS, X. and J.-C. ROCHET (1997), *Microeconomics of Banking*, MIT Press, Cambridge, Mass.

GROENEVELD, J.M. (1998), "The impact of capital adequacy standards on bank behaviour in continental Europe: a brief overview of the literature", *Research Series Supervision*, no. 7, De Nederlandsche Bank.

HAUBRICH, J.G. and P. WACHTL (1993), "Capital requirements and shifts in commercial bank portfolios", *Federal Reserve Bank of Cleveland Economic Review*, no. 3, pp. 2-15.

HEBBINK, G. and H.M. PRAST (1998), "Regulation and banking: a survey", *Research Memorandum WO&E*, no. 565, De Nederlandsche Bank.

JACQUES, K.T. and P. NIGRO (1997), "Risk-based capital, portfolio risk and bank capital: a simultaneous equations approach", *Journal of Economics and Business*, pp. 533-47.

ROCHET, J.-C. (1992), "Capital requirements and the behaviour of commercial banks", *European Economic Review*, no. 36, pp. 1137-78.

SHRIEVES, R.E. and D. DAHL (1992), "The relationship between risk and capital in commercial banks", *Journal of Banking and Finance*, no. 16, pp. 439-57.

WAGSTER, J.D. (1999), "The Basle Accord of 1988 and the international credit crunch of 1989-1992", *Journal of Financial Services Research*, vol. 15, no. 2, pp. 123-43.