DEUTSCHE
BUNDESBANK

Cyclical implications of minimum capital requirements

Frank Heid

Discussion Paper
Series 2: Banking and Financial Studies
No 06/2005

Discussion Papers represent the authors' personal opinions and do not necessarily reflect the views of the Deutsche Bundesbank or its staff.

Editorial Board: Heinz Herrmann
Thilo Liebig
Karl-Heinz Tödter

Deutsche Bundesbank, Wilhelm-Epstein-Strasse 14, 60431 Frankfurt am Main,
Postfach 10 06 02, 60006 Frankfurt am Main

Tel +49 69 9566-1
Telex within Germany 41227, telex from abroad 414431, fax +49 69 5601071

Please address all orders in writing to: Deutsche Bundesbank,
Press and Public Relations Division, at the above address or via fax +49 69 9566-3077

Reproduction permitted only if source is stated.

ISBN 3–86558–068–8

Abstract

Capital requirements play a key role in the supervision and regulation of banks. The Basel Committee on Banking Supervision is now changing the current framework by introducing risk-sensitive capital charges. There have been concerns that this will unduly increase volatility in the banks' capital. Furthermore, when the credit supply is rationed, capital requirements may exacerbate an economic downturn. We examine the problem of cyclicality in a macroeconomic model which explicitly takes regulatory constraints into account. We find that the capital buffer which banks hold on top of the required minimum plays a crucial role in mitigating the volatility in capital requirements. Therefore, despite the fact that capital charges may vary significantly over time, the effects on the macroeconomy will be moderate.

Keywords: minimum capital requirements, regulatory capital, economic capital, capital buffer, pro-cyclicality, business cycle, bank lending channel

JEL classification: E32, E44, G21

Non-technical summary

In 2004 the Basel Committee on Banking Supervision published a framework paper on capital measurement and capital standards. The revised accord - known under the acronym *Basel II* - will eventually replace the existing accord on capital standards. Its main purpose is to achieve a better alignment of regulatory capital with economic capital by means of an adequate measurement of the quality of the banks' assets. However, concerns have been voiced that the increased risk sensitivity of Basel II might lead to excessive volatility in capital requirements. In fact, previous research has shown that capital requirements might increase by up to 45% over the course of the business cycle. The Basel Committee has met some of those initial concerns by making the requirements less sensitive to risk changes than originally envisaged. Having said that, many observers still expect the cyclicality of capital charges to be significant.

A better measurement of credit risk in Basel II will bring about clear microeconomic benefits as it reduces the opportunity for regulatory arbitrage. On the other hand, capital management might become more difficult because capital charges may increase just when banks are seeing their equity capital erode due to write-offs in their loan portfolios. Furthermore, cyclical changes in capital charges can have a pro-cyclical effect on the macroeconomy when banks are forced to reduce their lending during an economic downturn.

Previous research has largely focused on the pure cyclicality of capital charges, whereas our paper tries to assess their pro-cyclical effect on the macroeconomy, too. To this end, we introduce a model of the bank lending channel which explicitly takes into account minimum capital requirements. One novel feature of this model is that it allows banks to hold a capital buffer on top of the regulatory minimum. This is important because a bank might react to an increase of capital charges by reducing its capital buffer rather than its loan supply.

When calibrated to real data our findings suggest that the capital buffer does indeed play a crucial role in mitigating the volatility in capital charges as it reduces the cyclicality of the actual capital ratio by roughly half when compared to the regulatory minimum. The results also show that the pro-cylical effects on the macroeconomy are unlikely to be severe.

Nichttechnische Zusammenfassung

Im Jahr 2004 veröffentlichte der Baseler Ausschuss für Bankenaufsicht eine neue Rahmenvereinbarung zu Mindesteigenkapitalanforderungen an Banken (Basel II). Ziel der Vereinbarung ist es, auf der Grundlage einer verbesserten Risikobewertung der Bankaktiva das regulatorische Kapital stärker als bisher auf das ökonomische Kapital auszurichten. Kritiker des neuen Akkords befürchten jedoch, dass die stärkere Risikosensitivität zu einer übermäßigen Volatilität der Eigenkapitalanforderungen führen könnte. Empirische Analysen bestätigen in der Tat, dass die Eigenkapitalanforderungen im Verlaufe eines Konjunkturzyklusses um bis zu 45 % steigen könnten. Der Baseler Ausschuss ist diesen Einwänden im Verlaufe des Konsultationsprozesses durch eine Reduzierung der Risikosensitivität der Eigenkapitalanforderungen begegnet. Dennoch ist weiter von einer deutlichen Zyklizität der Kapitalanforderungen auszugehen.

Aus mikroökonomischer Sicht ist die verbesserte Kreditrisikomessung in Basel II insgesamt positiv zu bewerten, da sie die Möglichkeiten zur regulatorischen Arbitrage deutlich verringern wird. Allerdings steht zu befürchten, dass das Eigenkapitalmanagement der Banken unter Umständen deutlich schwieriger wird. Die Eigenkapitalanforderungen dürften nämlich tendenziell gerade dann steigen, wenn sich die Kapitalbasis des Kreditinstituts aufgrund von Abschreibungen im Kreditgeschäft verringert. Darüber hinaus könnte die Zyklizität der Eigenkapitalanforderungen - so wird gelegentlich argumentiert - zu einer erheblichen Verschärfung realwirtschaftlicher Konjunkturzyklen führen, wenn Banken im Abschwung zu einer weiteren Drosselung ihrer Kreditvergabe gezwungen werden.

Der Schwerpunkt bisheriger Forschung zu den prozyklischen Auswirkungen von Basel II lag vor allem in der Untersuchung der Zyklizität der Eigenkapitalanforderungen und deren Auswirkungen auf das Risikomanagement. Demgegenüber rückt dieses Papier verstärkt die prozyklischen Auswirkungen auf die Realwirtschaft in das Zentrum der Analysen. Zu diesem Zweck wird ein Modell des Bankkreditkanals unter Berücksichtigung regulatorischer Mindesteigenkapitalanforderungen entwickelt. Im Unterschied zu anderen Arbeiten wird dabei der Tatsache Rechnung getragen, dass die Banken üblicherweise mehr Kapital halten als aufsichtlich gefordert. Die Berücksichtigung des Kapitalpuffers bei der Untersuchung der prozyklischen Auswirkungen auf die Realwirtschaft ist zwingend, da Banken auf einen Anstieg der Kapitalanforderungen möglicherweise nicht mit einer

Rückführung ihrer Kreditvergabe, sondern mit einer Reduzierung ihres Kapitalpuffers reagieren könnten.

Eine Kalibrierung des Modells anhand verfügbarer Daten zeigt, dass der Kapitalpuffer in der Tat die Volatilität der Eigenkapitalanforderungen deutlich abfedern könnte; die *tatsächlichen* Eigenkapitalquoten der Banken dürften nur etwa halb so stark schwanken wie die Eigenkapital*anforderungen*. Die Ergebnisse zeigen zudem, dass die prozyklischen Auswirkungen auf die Realökonomie nicht sehr schwerwiegend sein dürften.

Contents

Cyclical Implications of Minimum Capital Requirements

1 Introduction

Once again capital requirements have attracted considerable attention since the Basel Committee on Banking Supervision announced a revision of the current accord[1] on capital regulation (Basel II). A revision was deemed necessary since the existing accord led to severe market distortions as banks swapped low-risk assets against riskier ones with more favourable risk weighting relative to their expected returns (regulatory arbitrage). The new accord, which will take effect in 2006, envisages better aligning regulatory capital with economic risk (sometimes dubbed economic capital) by attributing more adequate risk weights to the banks' assets.[2]

Although the micro-economic foundations of capital requirements are now fairly well understood, their macroeconomic consequences are still rather opaque. Concerns have been voiced that the increased risk sensitivity of Basel II might lead to excessive volatility in banks' capital ratios. Hence, in opposition to the original intention, overall financial stability might be jeopardised.

In essence, minimum capital requirements consist of a measure of portfolio risk and a mapping of risk to minimum capital. Banks which are subject to minimum capital requirements are required to hold at least the minimum required capital. With respect to the measurement of credit risk, two approaches are usually considered: either by asset type or by asset quality. The first one ranks assets by classes of borrowers and attributes a fixed risk weight to each of them according to their perceived fundamental risk. Total credit risk of a bank's portfolio is given as the weighted sum of its constituent assets. By construction, portfolio risk does not change over time when the total sum of assets and the share of each asset type remain constant. By contrast, risk measures based on asset quality such as the value at risk (VaR) try to assess potential economic losses and may vary over time. We will say that corresponding risk weights are risk-sensitive.[3]

[1] Basel Committee on Banking Supervision (1988)

[2] Basel Committee on Banking Supervision (2004)

[3] Quality based risk measures can be further distinguished between those, which are calculated for each asset separately on a stand-alone basis and those which also take correlation effects between assets into account.

In order to harmonise international capital regulation, the Basel Committee published the so-called Basle Capital Accord in 1988, which has since become a cornerstone of international capital regulation. It largely depends on fixed risk weights. Credit risk is measured as the 8 per cent share of a bank's risk weighted credit exposure.[4] For example, OECD countries have a risk weight of 0 %, banks in OECD countries have a risk weight of 20 %, mortgage banks of 50 % and non-financial firms of 100 %.

The accord has always been subject to criticism since it does not truly reflect a bank's credit risk. To remedy that deficiency the Basel Committee recently carried out a major revision of the capital accord (Basel II). When it takes effect in 2006, banks will be able to choose from among several approaches. The standard approach is based on the borrowers public ratings such as those from Moody's, Standard & Poor's or Fitch IBCA. Specific risk weights are attributed to the respective rating classes, ranging from 0% for a AAA rating to 150% for ratings below B-. More sophisticated banks will be eligible for the two IRB approaches [5], which permit the use of the banks' own internal rating systems to quantify the creditworthiness of their debtors. In the IRB approaches banks must estimate the probability of default (PD) of their debtors, which is calibrated to a time horizon of one year. Capital charges are calculated by means of a risk weight function which attributes a specific risk weight to the probability of default. In both the standard approach and the IRB approaches total capital charges are given by the 8 per cent share of risk-weighted assets.

Aligning regulatory and economic capital has obvious microeconomic benefits as it reduces regulatory arbitrage. However, by increasing the sensitivity to credit risk, the new accord will also make required minimum capital more cyclical. This might pose severe capital management problems to banks, as capital charges are likely to increase in an economic downturn just when banks are seeing their equity capital erode due to write-offs in their loan portfolios. Importantly, the cyclicality of capital charges might also have significant macroeconomic consequences in an economic downturn, when raising new capital is difficult and banks are forced to reduce their lending. In the following we will therefore distinguish between the cyclicality of capital charges and its pro-cyclical

[4] The Accord was amended in 1998 by the inclusion of market risk in order to take account of the growing significance of banks trading book positions. Apart from the prudential recognition of market risk, the 1998 amendment was important in regard to another aspect, as it allowed banks for the first time to calculate their market risk positions by means of their own value-at-risk based market models.

[5] Internal Ratings Based Approach

consequences to the macroeconomy. We think that, in doing so, we are filling a gap in the existing literature, since most studies so far have concentrated on the purely cyclical effects of Basel II.

Many empirical studies on Basel II expect significant swings in minimum capital over the course of a business cycle. However, the variety of estimates is rather large. To a great deal this can be explained by the different approaches the authors take. Most of these studies assess the cyclical patterns of capital charges under Basel II by performing numerical simulations on hypothetical or real world portfolios. Those portfolios are held constant over time and no adjustments are assumed over the observation period. For example, Ervin and Wilde (2001) start from a hypothetical portfolio of BBB-rated borrowers. They conclude, that, in 1990, a bank with an initial capital ratio of 8% would have seen its capital ratio fall to 6.8% under the IRB approach.[6] A similar approach is taken by Kashyap and Stein (2004) who base their simulation on a set of borrowers, which had a public rating of S&P or KMV. Their results show that for an average portfolio the increase in capital charges would have been in the range of 30% to 45% over the period from 1998 to 2002. Rösch (2002) differentiates between the default risk effect and the transition risk effect. Using S&P's transition and default rates from 1982 to 2000 he concludes that these effects may lead to an offset in capital requirements and, thus, Basel II might be even less cyclical than the current accord. A different approach is taken by Carling, Jacobson, Lindé, and Roszbach (2002) who directly estimate the quality distribution of a credit portfolio from a larger Norwegian bank. They show that macroeconomic conditions have a significant impact on borrowers' PD and thus on regulatory capital under the IRB approach of Basel II.

Although empirical studies show that capital charges will vary significantly over the business cycle for a fixed portfolio, it would be premature to assume a similar pattern for a bank's actual capital ratio. In fact, banks might hold a certain capital buffer to offset unexpected shortfalls in capital or increases in capital charges. A more recent study comes from Barrios and Blanco (2000), who show that banks hold a positive capital cushion even if economic capital is below the regulatory minimum.

Several studies tried to estimate the bank's optimal capital buffer. One early study is from Marcus (1983) who set out to explain the dramatic decline of capital of U.S.

[6]Calculations were based on the proposed risk weight function as of 2001. As the risk weight function has changed since, the effect is likely to be smaller.

commercial banks from 1961 to 1978. A recent study along this line is by Ayuso, Pérez, and Saurina (2004) who estimate the relationship between the Spanish business cycle and the capital buffer held by Spanish commercial and savings banks. An interesting application of capital buffer theories to Basel II is provided by Jokivuolle and Peura (2001), who run simulations for different hypothetical portfolios to obtain estimates for both capital charges and the capital buffer of a typical bank.

Two main conclusions can be drawn from the empirical and theoretical studies on the cyclicality of minimum capital requirements and capital buffers: (i) Under Basel II, capital requirements are likely to increase during economic downturns and decrease during upturns. (ii) Capital buffers are generally positive, but there is no consensus on whether they move in parallel or instead in reverse to the overall economic development.

As we mentioned above, it is important to distinguish between the pure cyclicality of capital charges and capital ratios, on the one hand, and their pro-cyclical effect on the macroeconomy, on the other. So far, little research has been carried out on the second aspect. One exception is Blum and Hellwig (1995) who claim that minimum capital requirements (with fixed risk weights) reinforce macroeconomic fluctuations. They derive their theoretical results from a straightforward macroeconomic model which accounts for regulatory constraints on banks' ability to lend. However, in our view, one drawback of their model is the crude way it models the bank lending channel. This is one reason, why it is unable to explain banks' capital buffer, ie. in this model minimum capital requirements are always binding.

There is an ongoing debate among macroeconomists over the role of bank lending in the propagation of business cycles and the transmission of monetary policy. In this context, bank lending has a special role as a source of finance, which cannot be easily assumed by decentralised capital markets.[7]

Traditional theories of the bank lending channel did not account for regulatory constraints on banks' ability to lend. In a recent theoretical paper Van den Heuvel (2002) examines the role of bank lending in the transmission of monetary policy in the presence of capital adequacy regulations. An interesting side aspect of his model is, that regulatory constraints do not necessarily become binding, ie banks hold a positive capital buffer.

The present paper is organised as follows: In chapter 2 we present a simple model of the banking industry. We introduce the regulatory framework and derive the target function

[7] cf Diamond and Dybvig (1983), Diamond (1984), Boyd and Prescott (1986), Allen (1990)

of a representative bank for its actual capital ratio. In chapter 3 we assess the cyclicality of banks' capital ratio. The second part of the paper investigates the pro-cyclical effects of capital requirements on the macroeconomy. Chapter 4 provides the macroeconomic framework before we examine macroeconomic volatility under different regulatory regimes in chapter 5. In chapter 6 we try to calibrate the model to real world data. Chapter 7 concludes.

2 A model of the banking sector

In our framework for the financial sector the banking industry can be described by a representative bank. The bank can invest into two different assets: riskless bonds (B) and loans (L), which are subject to default risk. The bank finances its investments through equity capital (E) and customer deposits (D). We assume that the bank is unable to raise additional equity capital, which seems a reasonable assumption for the short term horizon we have in mind. Therefore, the only way the bank can increase its capital base is by retained earnings. In addition, we presume that the amount of deposits is fully determined by money demand.

In the sequel, we assume a time horizon of one period (usually one year). At the beginning of that period the bank decides on its portfolio of loans and bonds. Its decision depends on interest rates, which we denote by r and ρ for bonds and for loans respectively. It also depends on the perceived credit risk of loans, since the bank takes into account that a random fraction s of the borrowers defaults at the end of the period. For simplicity, we assume that, if the borrower defaults, the bank must write off the total amount of the loan.[8] Hence, assuming that interest rates on bonds and loans are given by r and ρ, respectively, and ignoring any interest payments on deposits, the profit or loss at the end of the period is given by $\pi = (\rho - s)\, L + r\, B$. In table 1 we depict a bank's typical balance sheet at the start and at the end of the period.

The bank is not fully free to determine the composition of its asset portfolio. Even in the absence of any regulatory or reserve requirements, the bank must protect itself against insolvency due to an unexpected loss in its loan portfolio. Usually a default is assumed to occur when the bank's equity capital is used up. The bank is also bound by regulatory constraints, which require that the regulatory capital ratio exceeds a threshold a. The

[8] Alternatively we may also assume a fixed, positive recovery rate, but that would not change the subsequent analysis in a significant way.

Table 1: Balance sheet of the representative bank at the beginning and at the end of the period

ASSETS	LIABILITIES
B	E
L	D
A	A

ASSETS	LIABILITIES
B*	E + π
L*	D
A + π	A + π

regulatory capital is defined as the ratio of equity capital to risk weighted assets. Without loss of generality, we assume that risk weighted assets are given by $w \cdot L$, with w being the risk weight for loans (bond are weighted with 0). It is convenient to normalise the bank balance sheet variables by L. Denoting the capital-loan ratio (CL-ratio) by e regulatory constraints require that e exceeds $a \cdot w$.

In our model, the regulatory requirements ($e > w \cdot a$) are stricter than the solvency requirements ($e > 0$). In fact, we argue that regulatory requirements shift the default point from 0 to $a \cdot w \cdot L$. Because the default is associated with significant costs to the owner or to the managerial board, the bank holds a positive capital buffer (CL-buffer) $e - a\,w$ against unexpected losses in its loan portfolio. However, holding a capital buffer is not cost-free because, by investing in riskless bonds, the bank foregoes lending margins. For the sake of simplicity we dispense with modelling the costs of default explicitly. Instead, we assume that the bank tries to achieve a target probability of its own default p. A conservative bank would target a small p, a bank with a large appetite for risk a large p. The parameter p may be associated with a certain rating the bank tries to achieve.

In our model the bank derives its optimal portfolio of loans and bonds by maximising expected profits under funding constraints and regulatory requirements. At the end of the period the bank's equity capital is given by the banks initial capital plus or minus any profits achieved or losses incurred during the course of the period. Since the loan loss rate s is random the bank is unable to predict the realisation of s with certainty. We do assume, however, that the bank knows its exact probability distribution.

Provided that the bank's target probability of default is given p the regulatory constraint can be written as:

$$\mathrm{P}[e + \pi/L < a\,w] = p \tag{1}$$

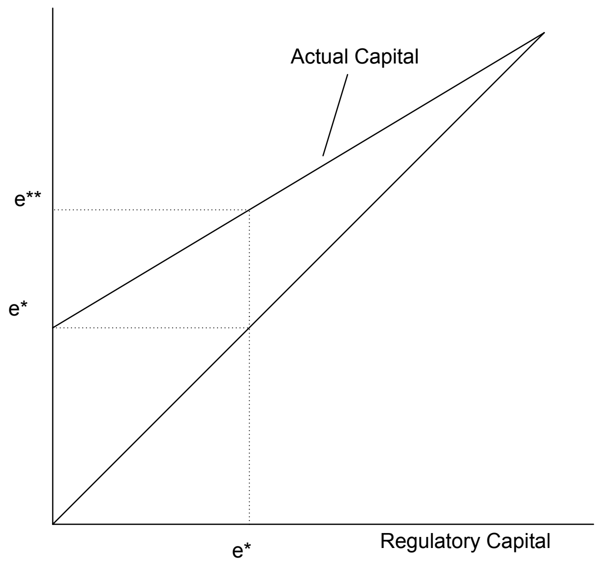

Figure 1: Buffer capital of banks

In the appendix we derive the following expression for the bank's optimum CL-ratio:

$$e = k\,(\alpha - \rho + r + \bar{s} + w\,a) \tag{2}$$

where k is a parameter which depends negatively on the bank's leverage ratio $\frac{A}{E}$, and α is an indicator of the bank's risk aversion.[9].

Thus, the bank's CL-buffer is given by

$$\Delta = e - w\,a = k\,(\alpha - \rho + r + \bar{s}) + (k-1)w\,a \tag{3}$$

Note that the CL-buffer is positive provided that the bank is sufficiently risk averse, ie that its target probability of default p is small.[10]

The more risk averse the bank is, the higher it sets its CL-buffer. Apart from the bank's risk aversion, the buffer also depends on interest rates. The bank will extend more loans when loan interest rates rise and it will reallocate a greater portion of its funds to bonds when the loan spread contracts. The relation of capital charges and capital is depicted in figure 1.

Note that an increase in capital charges by one percentage point does not lead to an increase in the capital buffer to the same amount. Instead it will increase by k percent. If calibrated to real world data k takes values at around 0.5 (cf chapter 6)

[9]The parameter α depends negatively on p.

[10]Therefore we do not need to introduce an additional regulatory constraint for the start of the period.

3 The cyclical effects of capital requirements

As we stated above, we distinguish between the cyclical effects of capital requirements on the bank's actual capital and their pro-cyclical effect on the macroeconomy. With respect to the former, the cyclicality of capital has two aspects: the cyclicality of capital charges and the cyclicality of the CL-buffer.

We do not examine the cyclicality of capital charges in greater detail here as it has already been analysed extensively in the literature, in particular with regard to the new Basel Accord. Instead we simply take for granted that credit risk is indeed subject to cyclical variations. We therefore assume that the risk weight for loans depends on GDP, which we denote by y:[11]

$$w = w(y), \tag{4}$$

Furthermore we will assume a pro-cyclical effect of y on w:

$$w_y(y) < 0, \tag{5}$$

It simplifies the subsequent analysis if we impose the following linear structure on $w(y)$, ie

$$w(y) = w_0 - \frac{m}{a}\,(y - y_0) \tag{6}$$

In equation (6), y_0 and w_0 may be interpreted as average production and the average risk weight over the course of the business cycle. For our subsequent analysis it is necessary to distinguish between two possible changes in the regulatory framework: a rise in the level of capital charges and an increase in their risk sensitivity. Therefore we have stated the slope of w in terms of a, in the case of which a rise in the capital threshold a does not affect $\frac{\partial}{\partial y} w\, a$.

We now turn to the problem of the cyclicality of capital. In this context it is important to distinguish between two related hypotheses, which have been stated in the literature. The hypothesis of cyclical capital buffers holds, that banks decrease their capital ratio in an economic upturn, or, by the same token, that banks increase their loan supply. The second hypothesis, which is more important, claims that the stricter regulatory requirements are the more pronounced the cyclical patterns of capital ratios or CL-buffers are.

[11] This relationship should be interpreted in a statistical sense. In the context of Basel II w is determined the borrower's probability of default (PD), which itself depends on GDP: $w = w(PD(y))$. Furthermore y might be interpreted as GDP growth or as output gap to account for time trends.

In our setting we define cyclicality of CL-ratios by the sensitivity of e with respect to changes in production y. Since k_y and s_y may be assumed to be negative (cf Appendix) we derive

$$e_y = k(\bar{s}_y - m) + e\frac{k_y}{k} < 0 \tag{7}$$

Therefore, the CL-ratio decreases in an economic upturn and decreases in an economic downturn. In this sense, we can say that CL-ratios move cyclically.

It has been claimed in the literature that capital buffers absorb some of the volatility in capital charges. However, in view of equation (7) this might not be the case. In fact if m is small the CL-buffer might even add to the cyclicality of capital charges as can be seen by the following equation:

$$\Delta_y = k\bar{s}_y + e\frac{k_y}{k} + (1-k)m \tag{8}$$

Note, that while the first two terms on the right hand side are negative the third term is positive[12], with the overall effect being ambiguous.

We now turn to the second hypothesis - whether or not capital requirements tend to increase the volatility of CL-ratios. First, note that a bank will *ceteris paribus* increase their CL-ratios if regulatory requirements increase. At the same time they will decrease their CL-buffer:

$$e_a = k\,w \geq 0 \tag{9}$$

$$\Delta_a = (k-1)\,w \leq 0 \tag{10}$$

However, although a bank decreases its CL-buffer in response to an increase in capital charges, this does not imply that the *volatility* of CL-ratios decreases. Quite to the contrary, from equation (9) we derive:

$$e_{ya} = k_y\,w_0 < 0 \tag{11}$$

Thus, an increase in a even reinforces the cyclical behaviour of the bank's CL-ratio e. This is true even if risk weights are fixed and do not change over the course of the business cycle. Note that the CL-buffer exhibits the same change in volatility as e, ie. $\Delta_{ya} = e_{ya}$, as we formulated risk weights in such a way that their sensitivity to changes in y is not affected by an increase in a.

[12] Note that $0 < k < 1$, cf Appendix.

Turning now to analysing an increase in m, it is not surprising that the cyclicality of risk weights affects the cyclicality of CL-ratios. It is easily verified that

$$e_{ym} = -k < 0 \tag{12}$$

In contrast to the case analysed in the previous paragraph, the CL-buffer does absorb some of the volatility in capital charges. In fact,

$$\Delta_{ym} = 1 - k > 0 \tag{13}$$

To sum up, the following conclusion can be drawn from the analysis above: Banks adjust their CL-ratio in a cyclical way and regulatory requirements, whether with fixed or risk sensitive risk weights, are likely to increase the cyclicality of CL-ratios. More precisely, both the level of capital charges (a) and the cyclicality of risk weights (m) tend to enhance the cyclicality of capital-loan ratios. Wether or not CL-buffers add to the cyclicality of CL-ratios, on top of the cyclicality of capital charges, depends on the slope of the risk weight function. Only if risk weight exhibit a relatively strong sensitivity to risk does our model predict a dampening effect of the CL-buffer.

Our results have important implication for the assessment of the cyclicality of Basel II. First, one might overestimate the volatility of capital ratios if one looks at likely changes in capital charges alone without taking account of capital buffers, which tend to absorb some of the volatility. Second, the size of the capital buffer does not only depend on the riskiness of loans and on the risk aversion of the bank but it also depends on the level of capital charges and on their sensitivity to macroeconomic changes. In particular, according to our findings, the CL-buffer is likely to have a dampening effect with regard to changes in GDP if risk weights exhibit a relatively strong sensitivity to risk. They may increase the cyclicality of CL-ratios if the risk sensitivity is small. Therefore, the prospective cyclicality of capital under Basel II cannot be assessed, as was done in some analyses, by combining capital charges of Basel II and capital buffers observed under the current framework.

4 The macroeconomic framework

In the preceding section we analysed to what extent the business cycle influences the banks' capital and lending decisions. This is an important question but it is only one part of a wider problem, since capital requirements can also influence the business cycle. To analyse the feedback mechanism between the financial and the real sector of an economy we need to build a model of the credit channel which takes the regulatory framework into account. Our model, which is presented below, builds on standard models found elsewhere in the literature.[13]

To simplify the analysis, we assume in our model that output is fully driven by real demand. This is not a severe restriction as our model can easily be generalised to also accommodate the supply side. In our model real demand y^d depends on income y and interest rates ρ and r respectively. The equilibrium state of the goods market is given by

$$y = y^d(\rho, r, y) \tag{14}$$

The demand for deposits arises from the transaction motive and is a function of the riskless rate r and income y. We assume, that total deposits are exogenous to the bank:

$$D = D(r, y) \tag{15}$$

In the following we assume that the riskless interest rate r stays constant over time as we assume no change of monetary policy. This allows us to analyse the cyclical effects of capital regulation on the macroeconomy in isolation from any potential countermeasures by the central bank. In contrast to the riskless interest rate, the loan rate is an endogenous parameter, and its equilibrium value is determined on the credit market. Using L^d and L^s to denote the loan demand and loan supply respectively, we give the market clearing condition on the credit market by

$$L^d(\rho, r, y) = L^s(\rho, r, y). \tag{16}$$

We can tie this in with chapter 2 to derive the representative bank's loan supply from its target capital:

$$L^s = E \cdot e^{-1} \tag{17}$$

In addition to standard assumptions contained in standard macroeconomic models, loan supply depends not only on interest rates and output but also on the regulatory framework (cf equation 2). As regards loan demand, we do not impose any particular functional form apart from standard assumption on the coefficients of elasticities.[14]

[13]One similar version, for example, can be found in Bernanke and Blinder (1988). However this model does not account for capital requirements.

[14]That is, we assume L^s_ρ to be negative (price effect) and L^s_y to be positive (income effect). L^s_r is assumed to be positive since financial investments represent alternative investments to those in fixed assets, which are financed by loans.

5 The pro-cyclical effect on the macroeconomy

When analysing the impact of capital regulatory requirements on bank lending and the wider economy, it is important to distinguish between short and long-term effects.[15] For example, raising the level of capital charges will effect transitory adjustment measures of banks, which in turn will influence the macroeconomy through the bank lending channel. The effect will be the more pronounced the shorter the spell is between the announcement of a regulatory change and its implementation. The impact can be significant, but eventually the economy will return to its long term growth path. However, although capital requirements are unlikely to have permanent effects on growth *per se*, we argue that they may have permanent effects on the *volatility* of bank lending and on the macroeconomy as a whole.

A suitable way to address the volatility of production is by means of the demand multiplier, which measures the extent to which exogenous shocks in production are amplified through the course of the business cycle.

Let us assume, for example, that the demand for output is perturbed by an amount ε. The new output equilibrium is attained at

$$y = y^d(\rho, r, y) + \varepsilon \tag{18}$$

Differentiating (18) with respect to ε now yields the well-known demand multiplier:

$$y_\varepsilon = (1 - y_y^d - y_\rho^d \rho_y)^{-1} \tag{19}$$

Under standard assumptions the multiplier is positive and larger than 1. The crucial question is to what extent the multiplier depends on the level or on the structure of capital requirements. By inspection of equation (19) it is clear that in our model capital requirements can influence the multiplier only via the equilibrium loan interest rate. In particular one needs to assess how ρ_y depends on the level and on the risk sensitivity of capital charges ie. on a and m respectively. By virtue of equation (19), if ρ_y is a decreasing function of a then an increase in a will have a pro-cyclical effect on the economy as a result of a rise in the multiplier y_ε. In contrast, if ρ_y depends positively on a the overall effect on the economy will be anti-cyclical.

As we explained in section above, it is important to distinguish between short-term and long-term effects of a change in capital charges. The short term effect of a rise in a

[15] This point is also stressed in Blum and Hellwig (1995).

will be a reduction in lending. In the longer term, however, banks will be able to raise new capital to bring lending back to its initial level. Let us assume, as a useful working hypothesis, that a is being increased by the amount Δa and, at the same time, the bank is being compensated by an increase in its capital to the amount of ΔE. By virtue of equation (2), if $\Delta E = e_0^{-1}\, k_0\, w_0\, E_0 \cdot \Delta a$ the bank will not change its lending. Therefore, to isolate long term effects from transitory effects and to account for short term adaption processes we will assume that $E_a = k_0\, w_0$ rather than E being fixed.

The market clearing condition on the loan market is given by

$$L^s = L^d \tag{20}$$

or, in logarithms

$$\ln L^s = \ln E - \ln e = l \tag{21}$$

where $l = lnL^s$.

As regards loan demand, we assume that it is a function of interest rates and income $l = l(\rho, r, y)$. Implicit differentiation of (21) yields

$$- e^{-1}(e_\rho \rho_y + e_y) = l_\rho \rho_y + l_y \tag{22}$$

$$\Rightarrow \quad k\rho_{ya} + k\, m - k\, s_y - \frac{k_y}{k} e = e(l_\rho\, \rho_y + e\, l_y) \tag{23}$$

$$\Rightarrow \quad (k - l_\rho e)\rho_{ya} = k\, w(l_y + l_\rho \rho_y + \frac{k_y}{k}) \tag{24}$$

While the first term on the right-hand side is positive, the sign of the term on the right hand-side is ambiguous. Note that $l_y + l_\rho \rho_y$ is the equilibrium loan growth, which can be assumed to be positive. It is easy to show that $\frac{k_y}{k}$ is equal to $k\, r\, E^{-1}\, D_y$, ie it is a negative function of money growth. The sign ρ_{ya} depends on whether the "credit effect" or the "money effect" is dominating. It is negative if equilibrium credit growth is strong and positive if money growth dominates instead.

By comparison, a rise in m has an unambiguous effect on ρ_y. Implicit Differentiation of equation (22) with respect to m yields:

$$\rho_{ym} = -\frac{k}{k - e\, l_\rho} < 0 \tag{25}$$

What consequences do our findings so far have for the problem of pro-cyclicality?

One important result is that an increase in the *level* of capital charges does not necessarily increase the cyclicality of y. This is in contrast with claims elsewhere in the literature (cf Blum and Hellwig (1995). In fact, a rise in a may even have a dampening effect on the volatility in production if the income elasticity of money demand is large. The second finding is that an increase in the *risk sensitivity* of risk weights does indeed have a visible pro-cyclical effect on the macroeconomy.

6 Calibration

In section 3 we analysed how macroeconomic fluctations influence banks' capital, while in section 5 we studied the feedback mechanism from the financial sector to the real sector. By means of a theoretical model of the banking sector and the bank lending channel, we were able to show that regulatory capital requirements are important in this regard. Of course, whether or not pro-cyclicality is significant in magnitude depends on the relevant parameters. In the following we will investigate this issue in greater detail. It should be clear from the beginning, though, that a full empirical analysis is not feasible (due to lack of data) nor is it the aim of this paper, which is mainly focussed on the theoretical part of the problem. However, although it is inappropriate to directly apply our model to real world data, a first, albeit crude appraisal of the magnitude of the expected effects seems feasible.

We first turn to the problem of the cyclicality of banks' capital and investigate the effects of a rise in the level (a) and in the risk sensitivity of capital charges (m). As noted in chapter 3 we measure cyclicality of capital-loan ratios by e_y. In our baseline scenario the regulatory threshold of the risk weighted capital ratio is given by 8%. We also assume a decrease in GDP of $dy = 1\%$. In the first scenario we assume a rise in a by $da = .01$, while in the second scenario we assume a rise in m by $dm = 0.08$. Scenarios 1 and 2 are comparable in the sense that in both scenarios capital charges would increase by 1 percentage point over the course of the business cycle. From equations (11) and (12) we deduce that a bank's capital would increase by

$$e_{ya} = k_y \, w_0 \, dy \, da \tag{26}$$

$$e_{ym} = -k \, dy \, dm \tag{27}$$

In the appendix we show that

$$k = \left(1 + \frac{A}{E} r\right)^{-1} \tag{28}$$

Under reasonable assumption for the relevant parameters, [16] capital-loan ratios would change by 0.03 percentage point in scenario 1 and 0.5 percentage point in scenario 2. Of course, those estimates are rather crude and depend on the assumptions made. However, what the calculations do show is that a rise in m leads to a much higher increase in cyclicality as compared to a similar rise in a. Furthermore, the calculations also show, that the buffer capital plays a crucial role in mitigating the cyclical effects of a rise in m. In fact, it reduces cyclicality by roughly 50%.

We now turn to analysing the pro-cyclical effect of a rise in m on the macroeconomy. We abstain from analysing a rise in a since the overall effect is ambiguous (cf previous chapter). In any case it would be insignificant by magnitude from above discussion.

According to (19), a rise in m would lead to an increase in the multiplier

$$dy_\varepsilon \approx y^d_\rho \rho_{ym}\, dm \tag{29}$$

with

$$\rho_{ym} = -\frac{k}{k - e\, l_\rho} < 0 \tag{30}$$

Since e and l_ρ are likely to be small as compared to k (which is approximately 0.5) one can assume $\rho_{ym} = -1$. Therefore

$$dy_\varepsilon \approx |y^d_\rho|\, dm \tag{31}$$

In other words, the increase of the multiplier is approximately equal to the loan interest rate sensitivity of GDP, or equivalently, to its loan spread sensitivity.

What do the above results tell us for the pro-cyclicality of Basel II? As mentioned in the introduction, the major change which Basel II will bring about concerns the risk sensitivity of capital charges. In the notation of our model it will change the value of m from 0 to some positive amount m^*. As other research papers have pointed out, it is not unrealistic to assume that a rise in GDP of 1 percent will decrease the capital charge by up to 30 %.[17]. According to our analysis, the change in the capital ratio will be approximately half that amount. The pro-cyclical effect on the macroeconomy largely depends on how many banks adopt the advanced approach and how many the standardised approach. If all banks followed the advanced approach, the average value for the risk sensitivity of

[16] $r = 0.05, \quad A/E = 20, \quad A_y/A = 0.1$

[17] This estimate also complies with our own empirical analysis on loan loss default rates

capital charges m would be equal to approximately 0.2. But even under such an extreme assumption, equation (31) shows that the effect on output volatility will be moderate provided that y_ρ is smaller than 1. In fact, even if we assume a rather large value for the interest elasticity of output, say 0.5 (with respect to one year) and if we assume that dm is equal to 0.2, the demand multiplier would only increase by approximately 0.1. This increase seems small when compared to the total size of the multiplier which is likely to be within the range of 1 to 1.5.

7 Conclusion

Our paper contributes twofold to the existing literature on the pro-cyclicality of minimum capital requirements. First, we address the problem by examining the effects on the banks' capital buffer, whereas previous research has largely focussed on fluctuations in capital charges alone. Second, we make a clear distinction between the cyclicality of regulatory capital ratios, on the one hand, and its pro-cyclical effect on the real economy on the other. We analyse the pro-cyclical effect on the macroeconomy by modeling a version of the bank lending channel which explicitly takes the banks' capital decisions into account.

With regard to the cyclicality of the capital buffer we find that it is important to distinguish between fixed and risk sensitive risk weights. If risk weights are fixed, the capital buffer is likely to move anti-cyclically, ie it decreases in upturns and increases in downturns. Furthermore, the influence of the level of capital charges on the capital buffer is likely to be small. With risk sensitive risk weights, the picture can change completely. If risk sensitivity is relatively large, then capital buffers are likely to move pro-cyclically. In addition, the sensitivity of risk weights to risk changes can have a large impact on the size of those fluctuations. This finding has important consequences for the analysis of the prospective effects of Basel II. In view of our model, the regulatory framework is not exogenous to the capital buffer. Therefore, it is illegitimate to analyse the behaviour of capital under Basel II by simply adding today's capital buffer to future capital charges, which some previous papers seem to have suggested.

When calibrated to real world data our findings suggest that the capital buffer indeed plays a crucial role in mitigating the volatility in capital charges as it reduces cyclicality of the actual capital ratio roughly by half when compared to the regulatory capital ratio. As regards the pro-cyclical effect on the macroeconomy we find only a limited effect of a change in capital charges on output.

Appendix

The target capital ratio

The bank's profit at the end of the period is given by

$$\pi = (\rho - s)L + rB \tag{32}$$

where s is the random default rate, which has an expected value of $\bar{s}$. We assume that the distribution of the normalised default rate $s - \bar{s}$ is given by F.

Since profits are random, the bank might be unable to fulfil the regulatory requirements if it runs out of capital. A default occurs if $E + \pi < a\,w\,L$. We assume that, when determining its credit exposure, then bank sets itself a target probability of default p, ie with probability p or less the bank's capital at the end of the period will be to low to meet the regulatory requirements. In mathematical terms:

$$p := \text{Prob}(E + \pi < w\,a\,L) \tag{33}$$

We assume that the bank maximises its expected profits E[π] given its target probability of default PD $= p$ and its funding condition $B + L = D + E$.

In equilibrium, the riskless rate r will be less than the net expected return on loans $\rho - \bar{s}$. Let us assume that r is larger than $\rho - \bar{s}$. Since the profit function (32) of is monotonously increasing in L and B, the bank will then invest all of its assets in riskless bonds if $r > \rho - \bar{s}$, which cannot happen in an equilibrium state of the loan market. Because of the monotonicity of the profit function, the default constraint is binding for a profit-maximising bank.

After replacing π by (32) in equation (33) and after some transformations, we derive

$$\text{F}\left(e + \rho + rb - w\,a - \bar{s}\right) = p \tag{34}$$

where F is the cumulative distribution function of $s - \bar{s}$, and e denotes E/L and b denotes B/L.

Thus

$$e + \rho + rb - w\,a - \bar{s} = \alpha \tag{35}$$

where $\alpha = F^{-1}(1-p)$. Since $b = e\frac{A}{E} - 1$ one gets

$$e = k(\alpha + w\,a - \rho + r + \bar{s}) \tag{36}$$

with $k = \left(1 + \frac{A}{E}r\right)^{-1}$.

References

Allen, F., 1990, The market for information and the origin of financial intermediation, *Journal of Financial Intermediation* 1, 3–30.

Ayuso, J., D. Pérez, and J. Saurina, 2004, Are Capital Buffers Pro-Cyclical? Evidence from Spanish Panel Data, *Journal of Financial Intermediation* 13, 249–264.

Barrios, V. E., and J. M. Blanco, 2000, *The Effectiveness of Capital Adequacy Requirements: A Theoretical and Empirical Approach*, University of Valencia, unpublished working paper.

Basel Committee on Banking Supervision, 1988, *International Convergence of Capital Measurement and Capital Standards,* Bank for International Settlement.

——— , 2004, *International Convergence of Capital Measurement and Capital Standards: A Revised Framework,* Bank for International Settlement.

Bernanke, B. S., and A. S. Blinder, 1988, Credit, Money, and Aggregate Demand, *American Economic Review, Supplement* 78, 435–439.

Blum, J., and M. Hellwig, 1995, The Macroeconomic Implications of Capital Adequacy Requirements for Banks, *European Economic Review* 39, 739–749.

Boyd, J.H., and E.C. Prescott, 1986, Financial intermediary-coalitions, *Journal of Economic Theory* 38, 211–232.

Carling, K., T. Jacobson, J. Lindé, and K. Roszbach, 2002, Capital Charges under Basel II: Corporate Credit Risk Modelling and the Macro Economoy, *Sveriges Riksbank Working Paper Series* 142.

Diamond, D.W., 1984, Financial intermediation and delegated monitoring, *Review of Economic Studies* 51, 401–419.

Diamond, D., and P. Dybvig, 1983, Bank runs, deposit insurance, and liquidity, *Journal of Political Economy* 91, 401–19.

Ervin, D. W., and T. Wilde, 2001, Pro-cyclicality in the new Basel Accord, *Risk* 14, 28–32.

Jokivuolle, E., and S. Peura, 2001, A value-at-risk approach to banks' capital buffers: An application to the new basel accord, *Bank of Finland Discussion Papers.*

Kashyap, A. K., and J. C. Stein, 2004, Cyclical implications of the Basel II capital standard, *Economic Perspectives,* Federal Reserve Bank of Chicago.

Marcus, A. J., 1983, The Bank Capital Decision: A Time Series-Cross Section Analysis, *The Journal of Finance* XXXVIII, 1217–1232.

Modigliani, F., and M. Miller, 1958, The Cost of Capital, Corporation Finance, and the Theory of Investment, *American Economic Review* 38, 261–297.

Rösch, D., 2002, *Mitigating Pro-Cyclicality in Basel II,* Faculty of Business and Economics, University of Regensburg, unpublished working paper.

Van den Heuvel, S. J., 2002, *The Bank Capital Channel of Monetary Policy,* The Wharton School, University of Pennsylvania.

The following Discussion Papers have been published since 2004:

Series 1: Economic Studies

1	2004	Foreign Bank Entry into Emerging Economies: An Empirical Assessment of the Determinants and Risks Predicated on German FDI Data	Torsten Wezel
2	2004	Does Co-Financing by Multilateral Development Banks Increase "Risky" Direct Investment in Emerging Markets? – Evidence for German Banking FDI	Torsten Wezel
3	2004	Policy Instrument Choice and Non-Coordinated Monetary Policy in Interdependent Economies	Giovanni Lombardo Alan Sutherland
4	2004	Inflation Targeting Rules and Welfare in an Asymmetric Currency Area	Giovanni Lombardo
5	2004	FDI versus cross-border financial services: The globalisation of German banks	Claudia M. Buch Alexander Lipponer
6	2004	Clustering or competition? The foreign investment behaviour of German banks	Claudia M. Buch Alexander Lipponer
7	2004	PPP: a Disaggregated View	Christoph Fischer
8	2004	A rental-equivalence index for owner-occupied housing in West Germany 1985 to 1998	Claudia Kurz Johannes Hoffmann
9	2004	The Inventory Cycle of the German Economy	Thomas A. Knetsch
10	2004	Evaluating the German Inventory Cycle Using Data from the Ifo Business Survey	Thomas A. Knetsch
11	2004	Real-time data and business cycle analysis in Germany	Jörg Döpke

12	2004	Business Cycle Transmission from the US to Germany – a Structural Factor Approach	Sandra Eickmeier
13	2004	Consumption Smoothing Across States and Time: International Insurance vs. Foreign Loans	George M. von Furstenberg
14	2004	Real-Time Estimation of the Output Gap in Japan and its Usefulness for Inflation Forecasting and Policymaking	Koichiro Kamada
15	2004	Welfare Implications of the Design of a Currency Union in Case of Member Countries of Different Sizes and Output Persistence	Rainer Frey
16	2004	On the decision to go public: Evidence from privately-held firms	Ekkehart Boehmer Alexander Ljungqvist
17	2004	Who do you trust while bubbles grow and blow? A comparative analysis of the explanatory power of accounting and patent information for the market values of German firms	Fred Ramb Markus Reitzig
18	2004	The Economic Impact of Venture Capital	Astrid Romain, Bruno van Pottelsberghe
19	2004	The Determinants of Venture Capital: Additional Evidence	Astrid Romain, Bruno van Pottelsberghe
20	2004	Financial constraints for investors and the speed of adaption: Are innovators special?	Ulf von Kalckreuth
21	2004	How effective are automatic stabilisers? Theory and results for Germany and other OECD countries	Michael Scharnagl Karl-Heinz Tödter

22	2004	Asset Prices in Taylor Rules: Specification, Estimation, and Policy Implications for the ECB	Pierre L. Siklos Thomas Werner Martin T. Bohl
23	2004	Financial Liberalization and Business Cycles: The Experience of Countries in the Baltics and Central Eastern Europe	Lúcio Vinhas de Souza
24	2004	Towards a Joint Characterization of Monetary Policy and the Dynamics of the Term Structure of Interest Rates	Ralf Fendel
25	2004	How the Bundesbank really conducted monetary policy: An analysis based on real-time data	Christina Gerberding Andreas Worms Franz Seitz
26	2004	Real-time Data for Norway: Challenges for Monetary Policy	T. Bernhardsen, Ø. Eitrheim, A.S. Jore, Ø. Røisland
27	2004	Do Consumer Confidence Indexes Help Forecast Consumer Spending in Real Time?	Dean Croushore
28	2004	The use of real time information in Phillips curve relationships for the euro area	Maritta Paloviita David Mayes
29	2004	The reliability of Canadian output gap estimates	Jean-Philippe Cayen Simon van Norden
30	2004	Forecast quality and simple instrument rules - a real-time data approach	Heinz Glück Stefan P. Schleicher
31	2004	Measurement errors in GDP and forward-looking monetary policy: The Swiss case	Peter Kugler Thomas J. Jordan Carlos Lenz Marcel R. Savioz

32	2004	Estimating Equilibrium Real Interest Rates in Real Time	Todd E. Clark Sharon Kozicki
33	2004	Interest rate reaction functions for the euro area Evidence from panel data analysis	Karsten Ruth
34	2004	The Contribution of Rapid Financial Development to Asymmetric Growth of Manufacturing Industries: Common Claims vs. Evidence for Poland	George M. von Furstenberg
35	2004	Fiscal rules and monetary policy in a dynamic stochastic general equilibrium model	Jana Kremer
36	2004	Inflation and core money growth in the euro area	Manfred J.M. Neumann Claus Greiber
37	2004	Taylor rules for the euro area: the issue of real-time data	Dieter Gerdesmeier Barbara Roffia
38	2004	What do deficits tell us about debt? Empirical evidence on creative accounting with fiscal rules in the EU	Jürgen von Hagen Guntram B. Wolff
39	2004	Optimal lender of last resort policy in different financial systems	Falko Fecht Marcel Tyrell
40	2004	Expected budget deficits and interest rate swap spreads - Evidence for France, Germany and Italy	Kirsten Heppke-Falk Felix Hüfner
41	2004	Testing for business cycle asymmetries based on autoregressions with a Markov-switching intercept	Malte Knüppel
1	2005	Financial constraints and capacity adjustment in the United Kingdom – Evidence from a large panel of survey data	Ulf von Kalckreuth Emma Murphy

2	2005	Common stationary and non-stationary factors in the euro area analyzed in a large-scale factor model	Sandra Eickmeier
3	2005	Financial intermediaries, markets, and growth	F. Fecht, K. Huang, A. Martin
4	2005	The New Keynesian Phillips Curve in Europe: does it fit or does it fail?	Peter Tillmann
5	2005	Taxes and the financial structure of German inward FDI	Fred Ramb A. J. Weichenrieder
6	2005	International diversification at home and abroad	Fang Cai Francis E. Warnock
7	2005	Multinational enterprises, international trade, and productivity growth: Firm-level evidence from the United States	Wolfgang Keller Steven R. Yeaple
8	2005	Location choice and employment decisions: a comparison of German and Swedish multinationals	S. O. Becker, K. Ekholm, R. Jäckle, M.-A. Muendler
9	2005	Business cycles and FDI: evidence from German sectoral data	Claudia M. Buch Alexander Lipponer
10	2005	Multinational firms, exclusivity, and the degree of backward linkages	Ping Lin Kamal Saggi
11	2005	Firm-level evidence on international stock market comovement	Robin Brooks Marco Del Negro
12	2005	The determinants of intra-firm trade: in search for export-import magnification effects	Peter Egger Michael Pfaffermayr

13	2005	Foreign direct investment, spillovers and absorptive capacity: evidence from quantile regressions	Sourafel Girma Holger Görg
14	2005	Learning on the quick and cheap: gains from trade through imported expertise	James R. Markusen Thomas F. Rutherford
15	2005	Discriminatory auctions with seller discretion: evidence from German treasury auctions	Jörg Rocholl
16	2005	Consumption, wealth and business cycles: why is Germany different?	B. Hamburg, M. Hoffmann, J. Keller
17	2005	Tax incentives and the location of FDI: evidence from a panel of German multinationals	Thiess Buettner Martin Ruf
18	2005	Monetary Disequilibria and the Euro/Dollar Exchange Rate	Dieter Nautz Karsten Ruth
19	2005	Berechnung trendbereinigter Indikatoren für Deutschland mit Hilfe von Filterverfahren	Stefan Stamfort
20	2005	How synchronized are central and east European economies with the euro area? Evidence from a structural factor model	Sandra Eickmeier Jörg Breitung
21	2005	Asymptotic distribution of linear unbiased estimators in the presence of heavy-tailed stochastic regressors and residuals	J.-R. Kurz-Kim S.T. Rachev G. Samorodnitsky
22	2005	The Role of Contracting Schemes for the Welfare Costs of Nominal Rigidities over the Business Cycle	Matthias Pastian

Series 2: Banking and Financial Studies

1	2004	Forecasting Credit Portfolio Risk	A. Hamerle, T. Liebig, H. Scheule
2	2004	Systematic Risk in Recovery Rates – An Empirical Analysis of US Corporate Credit Exposures	Klaus Düllmann Monika Trapp
3	2004	Does capital regulation matter for bank behaviour? Evidence for German savings banks	Frank Heid Daniel Porath Stéphanie Stolz
4	2004	German bank lending during emerging market crises: A bank level analysis	F. Heid, T. Nestmann, B. Weder di Mauro, N. von Westernhagen
5	2004	How will Basel II affect bank lending to emerging markets? An analysis based on German bank level data	T. Liebig, D. Porath, B. Weder di Mauro, M. Wedow
6	2004	Estimating probabilities of default for German savings banks and credit cooperatives	Daniel Porath
1	2005	Measurement matters – Input price proxies and bank efficiency in Germany	Michael Koetter
2	2005	The supervisor's portfolio: the market price risk of German banks from 2001 to 2003 – Analysis and models for risk aggregation	Christoph Memmel Carsten Wehn
3	2005	Do banks diversify loan portfolios? A tentative answer based on individual bank loan portfolios	Andreas Kamp Andreas Pfingsten Daniel Porath
4	2005	Banks, markets, and efficiency	F. Fecht, A. Martin

5	2005	The forecast ability of risk-neutral densities of foreign exchange	Ben Craig Joachim Keller
6	2005	Cyclical implications of minimum capital requirements	Frank Heid