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Norwegian banks in a recession: Procyclical implications of Basel II

by Henrik Andersen

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Norwegian banks in a recession: Procyclical implications of Basel II[1]

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Abstract

While the new capital adequacy framework, Basel II, aims to make the banks' capital requirements more sensitive to the underlying risk of the assets, it may also introduce an additional source of procyclicality in the banking sector. A growing share of the literature has assessed the potential cyclicality of Basel II. However, only parts of the banks' assets have been considered. In addition, the cyclicality of the capital positions is usually left out of the calculations. This paper applies the stress testing framework of Norges Bank to analyse the cyclicality of capital positions and the cyclicality of Basel II capital requirements for the entire bank portfolio of Norwegian banks. We find a substantial increase in the calculated Basel II capital requirements in a recession scenario for the Norwegian economy. We also find a negative co-movement between capital positions and Basel II capital requirements. Hence, our analysis demonstrates that Basel II may introduce an additional source of procyclicality.

JEL Code: E32, G21, G28, G33

Keywords: Basel II, procyclicality, capital positions

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[1] The views expressed in this paper are those of the author and should not be interpreted as reflecting those of Norges Bank (the Central Bank of Norway). The author is indebted to Farooq Akram, Sigbjørn Atle Berg and Eivind Bernhardsen for useful comments.

1. Introduction

Bank regulation has the potential to amplify the procyclicality inherent in bank lending behaviour, see Kashyap and Stein (2004). This may particularly be the case with respect to the new capital adequacy framework, Basel II, which was implemented by the European Commission in the Capital Requirements Directive (CRD)[2]. Basel II aims to make minimum capital requirements more sensitive to the underlying risk of the banks' operations, but ideally independent of the economic cycle.

However, the risk sensitive capital requirements may potentially enhance procyclicality in the banking sector, see Borio et al. (2001). If bank assets, and loans in particular, are considered to be more risky during economic downturns (as the borrowers' income and collateral values decline), required capital will increase. At the same time capital positions tend to deteriorate as loan losses accelerate. Thus, during an economic downturn banks' capital may indeed fall below (or close to) the required regulatory minimum, which may induce banks to reduce lending and increase lending margins, thereby amplifying the procyclical impact of bank lending. Conversely, during an economic upturn excess capital holdings may contribute to expanding credit volumes and risks fuelling a credit-led boom.

Banks may respond in a number of ways when the capital adequacy ratio falls below desirable levels, see Benford and Nier (2007). Instead of curbing the loan growth in order to reduce the capital requirements, they might cut dividends in order to increase the regulatory capital. Banks could also raise new capital, though this might be costly during a period where the banking sector is under pressure and the access to capital is low. Alternatively, banks could attempt to sell their existing assets. Still, empirical research suggests that the overall response is likely to involve a reduction in the loan growth. Nier and Zicchino (2005) find that the strength of the loan growth response is non-linear and depends on the capital buffer available to absorb losses. If capital buffers are low, banks cut their lending by more than if the capital buffers are ample.

It may be argued that the Basel II framework will not have procyclical effects on the economic activity if every borrower has access to non-bank financing during downturns, see Saurina and Trucharte (2006). However, the ongoing financial crisis has demonstrated that the

[2] As defined by the recast directives 2006/48/EC and 2006/49/EC.

borrowers' access to non-bank financing may be seriously hampered at the same time as banks contain their lending. In addition, borrowers classified as SMEs or retail exposures, which do not have perfect access to non-bank financing, represent the majority of the borrowers in the Norwegian banking sector. Consequently, a reduction in the supply of bank loans may have a considerable negative impact on the activity in the Norwegian economy.

Studies simulating the internal rating based (IRB) approach of Basel II find significant cyclicality in the capital requirements determined by internally estimated risk parameters, see e.g. Altman et al. (2005), Kashyap and Stein (2004) and Marcelo and Scheicher (2005). Typically these simulation studies track the rating for a hypothetical portfolio of *corporate exposures* using either rating transition matrices, or market indicators of probability of default (PD), as a proxy for an IRB bank's rating system. These studies map changes in PDs to changes in capital requirements and hence estimate how capital requirements might vary over a business cycle. Simulation studies applying different versions of Merton's option pricing model, such as Moody's KMV[3], are often classified as describing a point-in-time (PIT) rating system. Studies based on rating agency transition matrices are often classified as more through-the-cycle (TTC). According to Kashyap and Stein (2004), TTC models lead to increases in capital requirements between 30 and 45 percent, whereas PIT models produce increases between 70 and 90 percent.

Other studies arrive at similar conclusions about the potential importance of procyclicality. Catarineu-Rabell et al. (2003) employed a theoretical general equilibrium model of the banking system and demonstrated that a PIT approach could increase procyclicality substantially. Saurina and Trucharte (2006) and Benford and Nier (2007) extended the literature by considering the likely cyclicality of rating systems for the *retail mortgage portfolio*. While Saurina and Trucharte (2006) found that the difference between the minimum and the maximum capital requirements calculated by a TTC model was 56 percent, Benford and Nier (2007) found that the maximum TTC capital requirements were between 170 and 202 percent higher than the minimum TTC capital requirements.

In the Norwegian context, Karlsen and Øverli (2001) analysed the magnitude of the cyclical variations in Basel II capital requirements for corporate portfolios based on an enterprise

[3] Moody's KMV default risk forecast is established as a commonly used indicator to calculate an enterprise's default risk on the basis of its stock price, balance sheet information and an option pricing model.

sector model. They found that the IRB capital charges for corporate portfolios would have fallen by nearly 50 percent from the beginning of the 1990s, i.e. during the Norwegian banking crisis, to the end of the 1990s.

Ultimately, it is the cyclicality in the capital adequacy, which is determined by both the capital positions and the capital requirements, that matters. Thus, the macroeconomic effects of Basel II will depend on how the banks' capital buffers are affected by the business cycle. The majority of the literature finds a negative relationship between the cycle and the capital buffer, see for example Ayuso et al. (2004), Lindqvist (2004), Bikker and Metzemakers (2004) and Stolz and Wedow (2005). This negative relationship justifies the concern that Basel II may introduce an additional source of procyclicality since banks do not appear to be accounting for mitigating risks during an economic upturn, building up buffers when it is cheaper to do so.

This paper analyses the cyclicality of the Basel II capital adequacy framework for the entire bank portfolio of the largest Norwegian banks. We simulate the capital positions and the capital requirements based on a bank model developed to stress-test financial stability and input from a macro model and estimated Basel II risk parameters from an enterprise model, a risk index for banks and a household model. Employing Basel II capital requirements in the bank model provides fruitful knowledge of the implications of the new capital adequacy framework during different scenarios for the macro economy.

Based on a recession scenario for the Norwegian economy, we document a substantial increase in the calculated Basel II capital requirements even when the banks employ a through-the-cycle rating system where the risk parameters are based on a ten-year observation period. At the same time, bank capital deteriorates as the banks record high losses on loans and securities. Hence our analysis demonstrates that Basel II may introduce an additional source of procyclicality in the banking sector.

The contribution of this paper to the literature is three-fold: first, as opposed to the existing literature, we calculate the Basel II capital requirements for the entire bank portfolio; second, this paper analyses both the cyclicality of capital positions and the cyclicality of Basel II capital requirements at the same time; third, we apply a set of models different from those frequently applied in the literature.

This paper is organised as follows. Section 2 gives a description of the Basel II capital requirement formula and inputs to this formula. In section 3, the data and methodology employed are presented. Section 4 details the results of our analysis, and section 5 provides conclusions.

2. The Basel II risk exposures, formula and risk parameters

The Basel II framework is based on three mutually reinforcing pillars: minimum capital requirements (Pillar I), the supervisory review process (Pillar II) and market discipline (Pillar III). [4] Focusing on Pillar I, the Basel II framework contains three different approaches for calculating capital requirements for *credit risk*, namely the standardised approach, the foundation IRB approach and the advanced IRB approach. The computation of *market risk* is left basically unchanged compared to the Basel I capital requirements, but Basel II introduces a new capital charge for *operational risk*. In the area of operational risk, a bank can calculate its capital requirements on the basis of its gross income (basic indicator approach and standardised approach) or by using its own model (advanced measurement approach).

Under the IRB credit risk approaches, banks must categorise banking-book exposures into broad classes of assets with similar underlying risk characteristics. The classes of assets are: Corporate, Sovereign, Bank, Retail, Equity and Eligible purchased receivables.

Within the Basel II framework the formula for calculating risk-weighted assets (RWA) is a modified version of the so-called Gaussian asymptotic single risk factor model of credit risk. The solvency margin of the formula is set at 99.9 percent, i.e. the probability that a bank violates the capital requirements should be less than 0.1 percent over a one-year horizon. The formula is a function of probability of default (PD), loss given default (LGD), exposure at default (EAD) and maturity (M). In addition, the formula includes a parameter for maturity adjustment (b) and a parameter for asset correlation (R).

Under the advanced IRB approach, banks provide their own estimates of the PD, the LGD, the EAD and the M. According to the Capital Requirements Directive, internal estimates of PD, LGD and EAD must be grounded on historical experience and empirical evidence. The CRD does not specify whether recent observations should be given more weight or not.

[4] For a more detailed description of the framework, see Basel Committee on Bank Supervision (2006b)

Although the time horizon used in the *PD* estimation is one year, the length of the underlying historical observation period must be at least five years. For corporate, retail and bank exposures, the one-year PD cannot be below 0.03 percent. The *LGD* and *EAD* estimates should reflect economic downturn conditions and the observation period must be at least seven years (five years for retail exposures). The *LGD* estimates used for the IRB capital calculation cannot be less than the long-run default-weighted average.

The formula for calculating RWA for corporate, sovereign, bank and retail exposures is:

$$RWA = 12.5 * EAD * \left| LGD * N\left(\frac{G(PD) + \sqrt{R} * G(0.999)}{\sqrt{1-R}} \right) - (PD * LGD) \right| \frac{(1 + (M - 2.5)b)}{(1 - 1.5b)}$$

where *N* is the cumulative standard normal distribution function and *G* its inverse. The maturity adjustment (*b*) is given by $b = \left(0.11852 - 0.05478 * \ln(PD)\right)^2$, except in the case of all retail exposures where *b* is set equal to zero. The decision to adjust for maturity reflects the intuitive notion that, on the one hand, risk increases with loan duration and, on the other hand, the likelihood that the PD will deteriorate increases when the initial PD is low and the maturity of the exposure is large. These factors suggest that capital requirements should increase with the maturity of the exposures.

In the case of corporate, sovereign and bank exposures, the correlation factor (*R*) is given by:

$$R = 0.12\left(\frac{1 - e^{-50PD}}{1 - e^{-50}} \right) + 0.24\left(1 - \frac{1 - e^{-50PD}}{1 - e^{-50}} \right) - c\left(1 - \frac{S - 5}{45} \right)$$

where *c* is equal to zero for all exposures, except in the case of SME borrowers where the parameter is set equal to 0.04. *S* is expressed as total sales in million Euros. For residential mortgage exposures and qualifying revolving retail exposures *R* is equal to 0.15 and 0.04 respectively. For all other retail exposures *R* is given by:

$$R = 0.03\left(\frac{1 - e^{-35PD}}{1 - e^{-35}} \right) + 0.16\left(1 - \frac{1 - e^{-35PD}}{1 - e^{-35}} \right)$$

The formula takes only the correlation between the idiosyncratic risk of an exposure and the systematic risk into account, ignoring correlations between the idiosyncratic risks of different exposures in a portfolio. Thus, the formula is based on the assumption that all idiosyncratic risks are diversified away.

3. Data and methodology

In this section we outline our procedures for projecting Basel II capital requirements based on available data and models developed by Norges Bank. Generally, our procedures for approximating exposures and calculating risk parameters are in line with the Basel II requirements described in section 2. However, as it is not possible to reproduce the banks' risk profile completely, we need to incorporate some proxies for additional Basel II capital requirements on exposures which are not identified in our data set.

3.1 Data

The data we use to calculate capital requirements according to the Basel II framework are drawn from the Statistics on enterprises, the Statistics on households, and the Bank Statistics. The statistics on enterprises, the SEBRA-database, provides annual financial statements for individual companies starting in 1988. The number of enterprises submitting their financial records to the database is up from 80.000 in 1988 to 140.000 in 2007.

We use tax return data from all Norwegian households. This gives us data for more than two million households per year. Data on standard living costs are mainly from the National Institute for Consumer Research.

The Bank Statistics from Statistics of Norway provides detailed data on each of the Norwegian saving and commercial banks and on branches and subsidiaries of foreign banks in Norway. Information on individual borrowers of each bank is not available, but the volumes of loans can be allocated to sectors and industries. Using this type of loan classification we can combine data from the banks' balance sheets with detailed annual data on individual enterprises and households along the sector/industry dimension.

3.2 Projection of Basel II exposures

Exposures to the corporate sector are approximated based on data from the Bank Statistics and the Statistics on enterprises. Loans to the corporate sector accounted for 28 % of the

assets in the Norwegian banking sector by the end of 2007. In the bank model the corporate loan portfolio is composed of nine different industries.[5]

Data on total sales for each enterprise makes it possible to identify the loans within each of the nine different industries as corporate exposures, retail exposures and SME exposures. While all enterprises with total sales less than 2 million NOK are assumed to be retail exposures, all enterprises with total sales exceeding 400 million NOK are assumed to be *corporate exposures*. The remaining enterprises are assumed to be *SME exposures*. This is in accordance with the CRD where enterprises with total sales less than 50 million Euros, equivalent to around 400 million NOK, can be classified as SMEs. Based on this assumption, 12.8 percent of the loans to the enterprise sector by the end of 2007 were corporate exposures, 38.6 percent were SME exposures and 48.7 percent were other retail exposures. We shall assume that this distribution of exposures to corporates, retails and SMEs within each of the nine industries are identical for the largest Norwegian banks (and remains the same over the simulation period). Given this assumption it is possible to calculate capital requirements for corporate, retail and SME exposures for the individual banks.

Exposures to the households are approximated based on data from the Bank Statistics. *Residential mortgage loans* (including home equities lines of credit) accounted for 35 percent of the assets in the Norwegian banking sector by the end of 2007. The remaining retail exposures, i.e. total loans to the retail market less residential mortgages and other retail exposures, are assumed to be *qualifying revolving retail exposures*. 4 percent of the Norwegian banking sector's assets are classified as qualifying revolving retail.

Bank exposures and *sovereign* exposures are identified in the Bank Statistics. While bank exposures were 6 percent of the assets in the Norwegian banking sector by the end of 2007, sovereign exposures were less than 1 percent. *Equity* includes all assets posted as long-term shareholdings in the Bank Statistics. Equity exposures accounted for less than 1 percent of the assets in the Norwegian banking sector.

[5] Primary industries, Property management, Commercial services, Mining and manufacturing, Oil and gas, Shipping abroad, Other transport, Construction and Retail trade, hotel and restaurant.

Off-balance sheet exposures and Eligible purchased retail and corporate receivables are not identified in the Bank Statistics. Thus, capital requirements for these exposures are not calculated.

In the simulations below, the time path of exposures to each sector and industry will be projected by the set of models used in the Norges Bank stress testing exercises. The loan growth of the nine industries in the corporate portfolio is taken from the enterprise model. The growth in the residential mortgage exposures and qualifying revolving retail exposures is taken from the macro model (see section 3.3). Other exposures are assumed to be growing at the same rate as the total loan growth.

3.3 Projection of Basel II risk parameters

We apply the advanced IRB approach across the board. The Norwegian IRB banks have only adopted the IRB approach for parts of their holdings. While the share of IRB exposures to total exposures of DnB NOR was 38 percent at end 2007, the IRB share of Nordea Bank Norge was 54 percent. However, the Norwegian IRB banks are in the process of extending the IRB approach to their entire portfolios as set out in the Basel II framework.

We apply a set of models in order to project the relevant risk parameters. Projections of key variables from a macro model, i.e. credit growth, lending rates, loan losses, wages, gross domestic product, inflation, house prices and housing investments, are being used as input in an enterprise model, a bank model and a household model. The macro model is an equilibrium correction model for the Norwegian economy and comprises relationships that are central when analysing financial stability. For a more detailed review of the relationships in the macro model, see Andersen and Berge (2008).

The *PDs for loans granted to the enterprises*, i.e. Corporate, SME and Other retail exposures, are taken from an estimated model that predicts PDs for each industry (the SEBRA model). The SEBRA model provides the probability of bankruptcy as a generalised logistic function of accounting data indicators representing earnings, liquidity, financial strength, industry, age and size of the company. See Bernhardsen (2001) and Bernhardsen and Larsen (2007) for a more detailed description of the SEBRA model.

Projections from the macro model are used to project the financial statement of each firm over the simulation period. Bankruptcy is assumed to be the only event producing defaults. The procedures are described in detail by Bernhardsen and Syversten (2008), who also documents the results of a back testing exercise. When the actual development in macro variables is used, projections of loan losses five years ahead starting from any year between 1988 and 2003 were shown to perform fairly well at the aggregate level.

In simulations of *PDs for bank exposures*, we employ a risk index for Norwegian banks (see Andersen, 2008). The PD for bank exposures is set equal to the average probability of failure as predicted by the risk index for the five largest Norwegian owned banks and the largest foreign owned subsidiary (Nordea Bank Norge). These six banks held 59 percent of the assets in the Norwegian banking sector by the end of 2007.

The parameters of the bank risk index have been estimated on the basis of quarterly data between 2000 and 2005. The risk index represents the PD for individual banks and is based on indicators of the banks' capital adequacy, earnings, liquidity, credit risk and concentration risk. A bank model is employed to project the indicators of the risk index. The PDs of banks are then computed by the risk index. For a more detailed description of the bank model, see Andersen and Berge (2008).

The *PDs for Sovereign exposures* are set equal to the average PD reported in the 5th Quantitative Impact Study (QIS 5) by Basel II banks included in CEBS Group 1[6]. The PDs for sovereign exposures are assumed to be constant.

The *PDs for the residential mortgage loans and qualifying revolving retail exposures* are approximated based on the households' financial margins predicted by a model for households. The financial margin is defined as the household income minus taxes, interest payments, repayment of debt and standard living costs. The financial margin should serve as a reasonable measure of the households' debt-servicing capacity. For a discussion of households' margins, see Vatne (2006, 2007).

[6] CEBS Group 1 banks are banks located in a country which are part of the Committee of European Banking Supervisors, have Tier 1 capital in excess of 3 billion Euro, are diversified and internationally active.

In forward projections of the household sectors' financial margins, repayment of debt is assumed to be linear over 20 years. Standard living costs are taken from the National Institute for Consumer Research and depend on key characteristics of the household. The PDs for Retail Mortgages and Qualifying Revolving Retail are assumed to be proportional to the share of household debt held by households with a negative financial margin. In addition, these PDs are calibrated according to the QIS 5 study and the average Basel II parameters reported by the Norwegian banks. Thus, our PDs are initially set equal to the PDs reported by the Basel II banks and then assumed to change with the households' debt-servicing capacity.

The *LGD*s *on corporate exposures, SMEs, bank exposures, sovereign exposures and small firms* defined as retail exposures are taken from a model estimated by Bernhardsen and Larsen (2007). They found that the LGD can be projected with reasonable accuracy by using a simple dynamic model where the main explanatory factor is changes in commercial property prices. [7] This is not surprising as banks' lending to enterprises is often secured against property. According to the estimated model, a 10 percent drop in commercial property prices leads, cet. par., to an increase in the LGD of around 11 percentage points. Loss given default tends towards a constant level of 35 percent over time. According to the CRD, the LGDs used for the IRB capital calculation cannot be less than this long-run default-weighted average.

The *LGD*s of residential mortgage loans and qualifying revolving retail exposures are initially set equal to the average LGD of the QIS 5 study, i.e. 16.1 and 55.0 percent respectively. However, these LGDs are assumed to be changing over the simulation period in line with the LGD from the estimated model for enterprises.

The *EAD*s of all on-balance sheet exposures are measured gross of provisions. The effects of on-balance sheet netting are not taken into account. The possibility of additional drawings on credit lines is indirectly incorporated in the predicted loan growth. The EAD estimates are therefore of a PIT character. We do not have the data needed for calculating capital requirements on off-balance sheet exposures.

According to the advanced IRB approach the effective maturity *(M)* should be measured based on cash flow data. As data on cash flows are not identified in the bank statistics, we

[7] $LGD(t) = 0.085 + 0.76LGD(t-1) - 1.09\Delta\ln(\text{commercial property prices})$

apply the foundation IRB approach for measuring *M*. According to the foundation IRB approach *M* is 2.5 years for all exposures included in our estimates.

Due to limitations on data we apply the simple risk weight method[8] for calculating the capital requirements on *equity exposures*. As the share of equity holdings not publicly traded is not available in our data set, we apply a 350 % risk weight for all equity exposures. This is in line with the simple risk weight method under the market-based approach for equity exposures.

3.4 Projection of additional Basel II capital requirements

As it is not possible to reproduce the banks' risk profile completely, we need to incorporate some proxies for additional capital requirements on exposures which are not identified in our data set. Moreover, the calculated cyclicality in our analysis is not expected to be significantly affected by the fact that we do not cover every single risk exposures.

The capital requirement for *operational risk* is calculated by assuming that the (last reported) capital charge for operational risk is growing at the same rate as the gross income. Operational risk is not expected to be a source of increased procyclicality in the minimum capital requirements, as historical experiences indicate that operational risk actually tends to increase during economic upturns.

The calculation of capital charges for *market risk* should ideally be based on data which is not available in the Bank Statistics. Instead, we use the last reported capital charge for market risk at each bank. This capital charge is adjusted with the annual growth of the financial assets exposed to market fluctuations identified in the banks' balance sheets.

The additional Pillar II capital requirement[9] is approximated by multiplying the capital charge for all the identified exposures with the annual real GDP growth (Mainland Norway) from the

[8] Under the market-based approach, banks are permitted to use two different methods: a simple risk weight method or an internal models method. Under the simple risk weight method a 300% risk weight is to be applied to equity holdings that are publicly traded and a 400% risk weight is to be applied to all other equity holdings.

[9] Under the supervisory review process (Pillar II), supervisors should address whether the bank need to hold additional capital against credit risk concentrations, liquidity risk, interest rate risk in the banking book and other risks that are not, or not fully, covered in Pillar 1. Supervisors generally expect banks to operate above the minimum regulatory capital ratios and can require banks to hold capital in excess of the minimum. External factors such as business cycle effects and the macroeconomic environment should be considered. For a more detailed description of the Pillar II capital charge, see Basel

macro model. This ensures that the Pillar II capital charge reflects business cycle effects. However, a negative GDP growth will not result in any reductions in the Pillar I capital requirements. This is in line with the CRD which do not allow for any reductions in the Pillar I capital requirements.

The capital charge for the remaining exposures which are not identified in our data set, i.e. off-balance-sheet exposures, purchased receivables and exposures to foreign counterparts, and risk-reducing effects of guarantees and credit derivatives, are endogenously determined as a residual; the capital charge is equal to the difference between the latest Basel II capital requirements identified in the bank statistics and the sum of all the capital charges specified above. In simulations, we assume that the residual is growing at the same rate as the sum of all the capital charges specified above.

3.5 Our approach – pros and cons

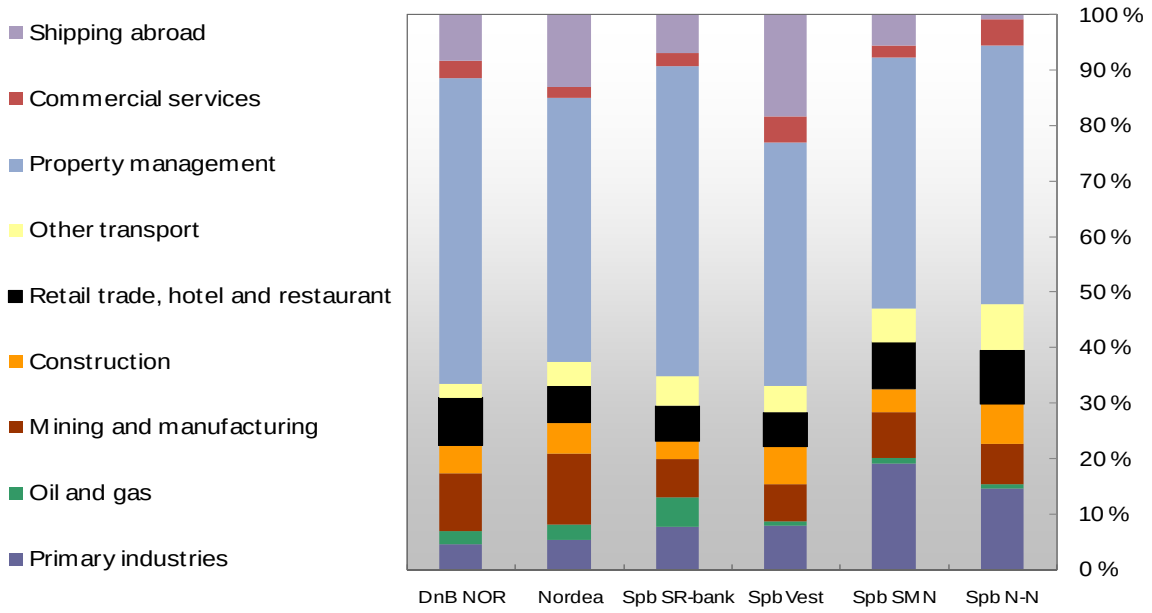
We assess cyclicality of Basel II capital requirements for the entire bank portfolio. The empirical literature normally only assess the cyclicality of Basel II capital requirements for a hypothetical credit portfolio or parts of an individual bank's assets, for instance the corporate portfolio. As opposed to the majority of the literature, we calculate Basel II capital charges on the banks' total loans to every sector and industry. Household exposures are separated into retail mortgages and qualifying revolving retail according to the Bank Statistics. For total enterprise loans to each of the nine different industries we distinguish between corporate exposures, SME exposures and retail exposures based on data on total sales for each enterprise. At this point we implicitly assume that all bank debt reported by the enterprises and households is extended by Norwegian banks. More importantly, we assume that the distributions of exposures to corporates, retails and SMEs are identical for the banks included in our analysis. This assumption may be strong as the share of corporate exposures is arguably lower for minor banks having limited lending capacity[10]. However, the distribution of exposures to corporates, retails and SMEs is not expected to differ substantially between the banks included in our analysis.

Committee on Bank Supervision (2006b)

[10] Under the Codified Banking Directive, large exposures are limited to a maximum share of a bank's own funds.

Bank exposures and sovereign exposures are reported in the Bank Statistics. By specifying bank portfolios in these dimensions we arrive at 31 different risk groups. Thus, we take into account that different banks have different exposures to industries, see Chart 1.

Chart 1 The shares of loans to different industries for Norway's five largest banks[11] and Nordea Bank Norge. Percentage of total loans to the enterprise sector. 2008 Q4



DnB NOR has the highest exposure to the property management sector both in relative and absolute terms. Sparebank 1 Nord-Norge and Sparebank 1 SMN have a substantially higher share of loans to the primary industries than the other banks. While Sparebanken Vest has the largest relative exposure to the shipping industry, Sparebank 1 SR-bank has the largest relative exposure to the oil industry. In this way we are able to differentiate the quality of borrowers between the banks to some extent. This approach diverges from the majority of the literature which calculate capital requirements of a representative portfolio, i.e an artificial bank, based on market information.

We measure credit risk with respect to loans to different sectors and industries without a direct reference to a bank-specific client base. Aggregate bankruptcy probability reveals information only on the average quality of borrowers from specific sectors and industries, and therefore only reflects the idiosyncratic risk for each bank due to its specialisation in particular groups of borrowers. These risk measures do not take into account the variation in

[11] DnB NOR, Sparebank 1 SR-bank, Sparebanken Vest, Sparebank 1 SMN and Sparebank 1 Nord-Norge.

bankruptcy probabilities within sectors and industries. Some banks may end up with less credit-worthy borrowers than others due to lower risk aversion or poorer risk management.

One potential disadvantage of using average risk parameters is that the capital requirement formula is not linear, but concave. Thus, feeding the capital requirement formula with average risk parameters may create some potential bias in our approximation. However, according to the definition of exposure classes and our approach to approximating exposures, 52 percent of the assets owned by the Norwegian banking sector were retail exposures by the end of 2007. According to the CRD, a retail exposure "must be one of a large pool of exposures, which are managed by the bank on pooled basis". Furthermore, the CRD underlines that "For each identified pool of retail exposures, banks are expected provide an estimate of the PD and LGD associated with the pool". In Norwegian regulations, banks estimating PDs for individual borrowers with statistical models can set the PD associated with the pool equal to the unweighted average of these PDs. Consequently, our calculation of capital charges based on average risk parameters for different risk groups probably serve as a reasonable approximation. However, errors may still arise from applying average risk parameters if the distribution of PDs, LGDs and EADs is not stable through the economic cycle.

We estimate the risk parameters for each portfolio based on a set of models different from those frequently applied in the literature. Typically the empirical literature assesses the cyclicality of Basel II by using either rating transition matrices or market indicators of PD, as a proxy for an IRB bank's rating system. The other risk parameters are normally left constant. Contrary to most other studies, we allow for cyclicality in LGDs. Several studies argue that the LGDs are likely to be affected by the economic cycle, se for example Altman et al. (2005) and Dierick et al. (2005). Finally, we indirectly assume that the EAD is affected by the cycle. EADs may increase as borrowers make more use of their loan commitment limits during an economic downturn. The possibility of additional drawings on credit lines is indirectly incorporated in the predicted loan growth.

We project the risk parameters based on detailed data on the Norwegian enterprise, household and banking sectors. This data set probably includes more relevant information for calculating Basel II capital requirements than the market indicators used in several of the previous simulation studies. Market liquidity effects, herd behaviour and several other mechanisms in the capital market may produce substantial variation in market indicators that is not related to

the borrowers' probability of default. Moreover, market indicators are only available for a fraction of the banks' borrowers.

Finally, we analyse both the cyclicality of capital positions and the cyclicality of Basel II capital requirements at the same time. Ultimately, it is the cyclicality in the capital adequacy, which is determined by both the capital positions and the capital requirements, that matters. The macroeconomic effects of Basel II will depend on how the banks' capital buffers are affected by the business cycle. Thus, we also compare the cyclicality of the capital positions to the cyclicality of the capital requirements.

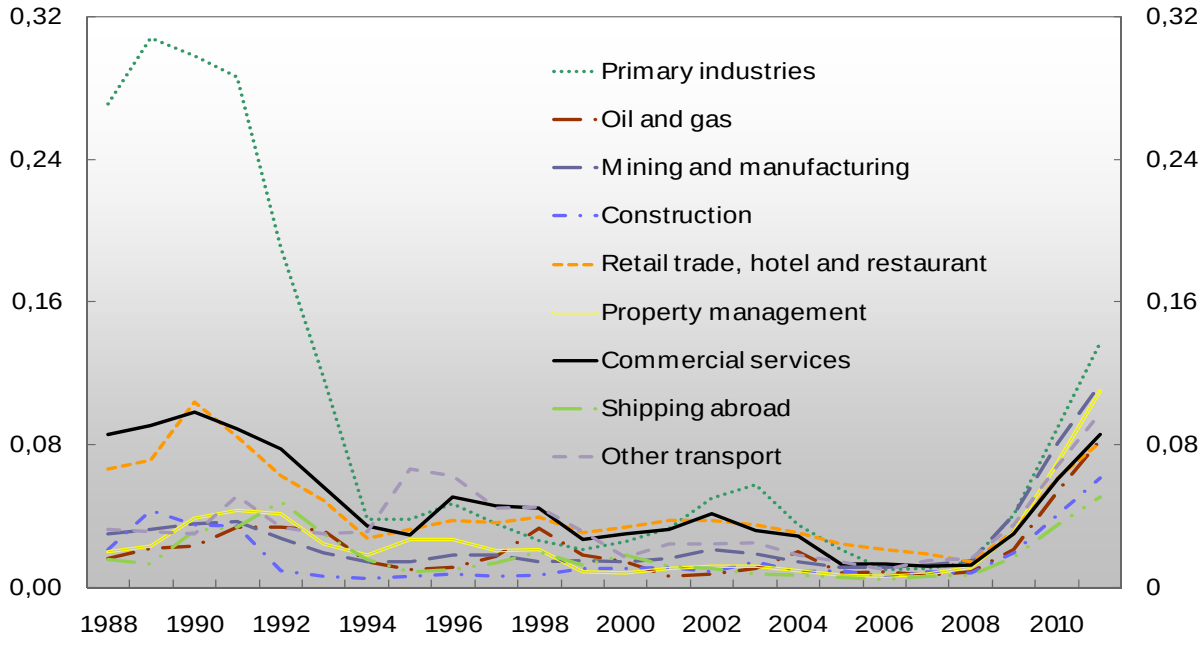
4. Simulations on the Basel II capital requirements and capital positions

An important part of Norges Bank's surveillance work is to analyse how economic shocks might affect banks' financial positions. The profitability and capital adequacy of the five largest Norwegian owned banks and Nordea Bank Norge are stress tested regularly on a semi-annual basis. Limiting the analysis to these six banks can be justified from the fact that failures of smaller banks will not have any systemic impact. The gain from including minor banks is not considered worthwhile, as including these requires substantial work.

Based on the procedures outlined in section 3 we calculate Basel II capital requirements for the six banks in the stress scenario of the Norges Bank Financial Stability Report 2008/2. In this stress scenario a severe shock occurs from 2008. The scenario is produced for the years 2009-2011. A weakening of households' confidence in their own financial situation and a downturn of the Norwegian economy leads to a sharp fall in house prices. Consumer price inflation increases as a result of both higher domestic price pressures and increased imported inflation. Moreover, we assume that banks' risk-willingness declines in pace with heightened global liquidity and credit risk. With higher consumer price inflation, the interest rate rises rapidly over the next two years to curb inflation. Lower house prices and higher bank lending rates result in lower corporate and household credit demand and weaker economic growth compared with the baseline scenario. GDP growth is negative in two of the three years. Weaker macroeconomic developments and higher bank lending rates reduce borrowers' debt-servicing capacity. This produces loan losses of 2.6 percent of total loans at the end of the projection period.

Initially, we employ our models to calculate PIT estimates of PDs and LGDs based on the stress scenario. Next, these risk parameters are combined with the EADs and Ms and the Basel II formula to compute the capital requirements. Historical data and projections of the PDs are displayed in chart 2-4. Chart 2 displays the annual share of non-performing loans in different industries since 1988. The stress scenario PDs projected by the SEBRA model are also included in the chart.

Chart 2 The share of non-performing loans in different industries. Shares of total loans to the enterprise sector. PD projections for 2008 – 2011. Percent



The PDs increase substantially during the last years of the simulation period and reach the highest level since the Norwegian banking crisis. The increase in the PDs from 2008 to 2011 differs from 456 percent (retail trade, hotel and restaurant) to 875 percent (property management).

The share of household debt held by households with a negative financial margin is reported in Chart 3 below. As outlined in section 3.3, we assume that the PDs for the residential mortgage loans and qualifying revolving retail exposures develop in line with this share. The share of household debt held by households with a negative financial margin has been falling rapidly since 1989. However, according to the household model the share is increasing in 2007 and 2008.

Chart 3 The share of household debt held by households with a negative financial margin. Percentage of total loans to the household sector. Projections for 2008 - 2011

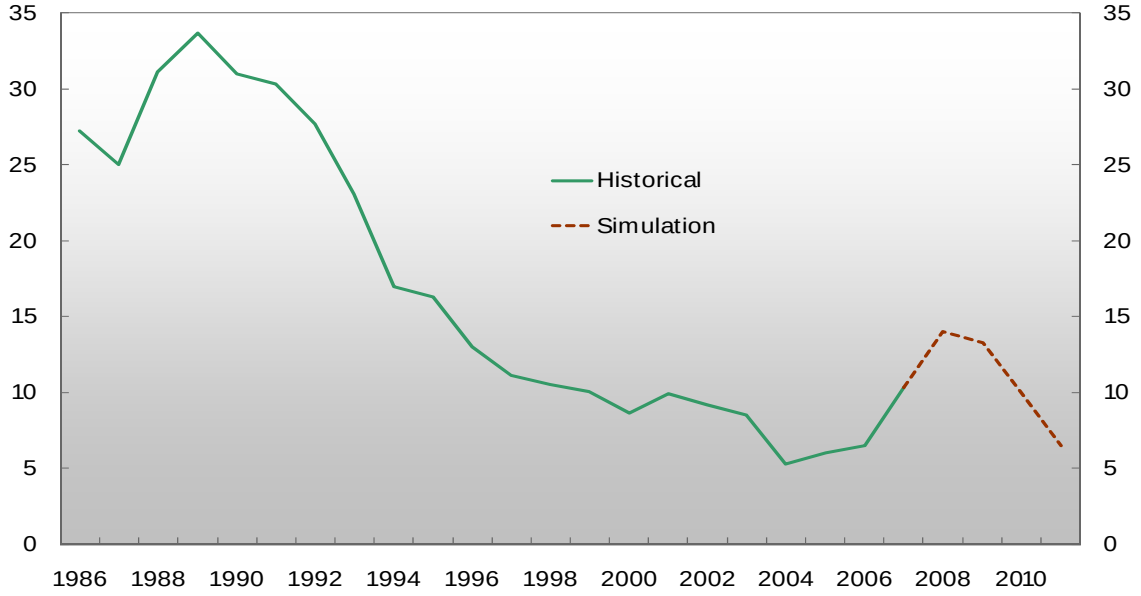


Chart 4 displays the average probability of liquidity or solvency problems for the five largest domestically held banks and Nordea Bank Norge. The probability of liquidity or solvency problems is extracted from the risk index for Norwegian banks. The mean probability of liquidity or solvency problems was 65 percent in 1991, at the height of the Norwegian banking crisis. In the stress scenario this probability increases rapidly during the simulation period and is 24 percent in 2011.

Chart 4 Probability of liquidity or solvency problems for Norway's five largest banks and Nordea Bank Norge. Projections for 2008 - 2011

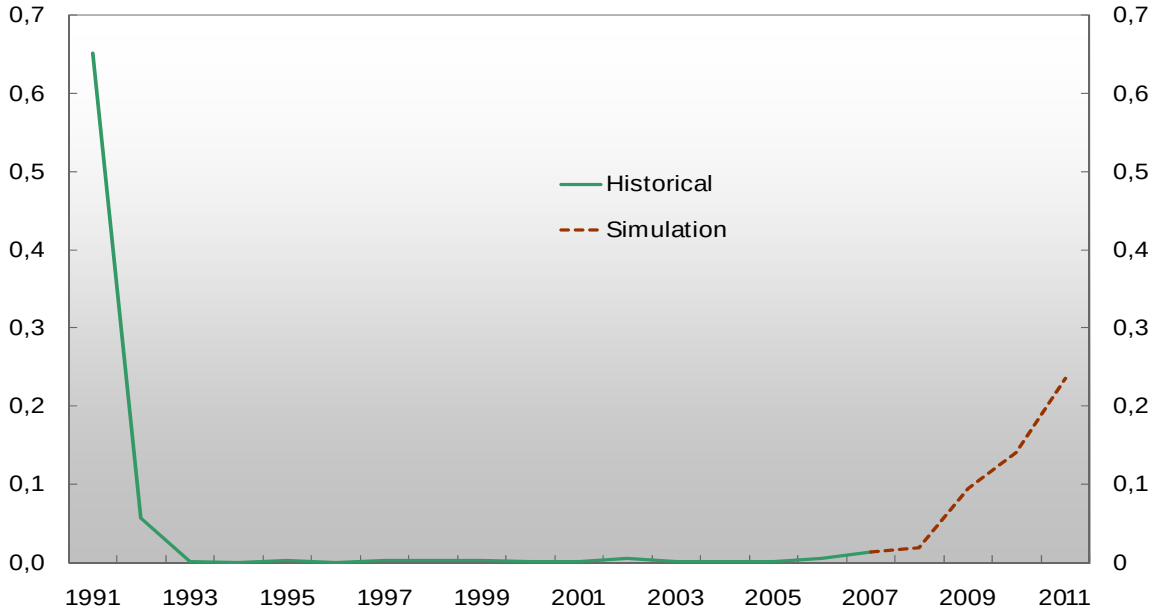
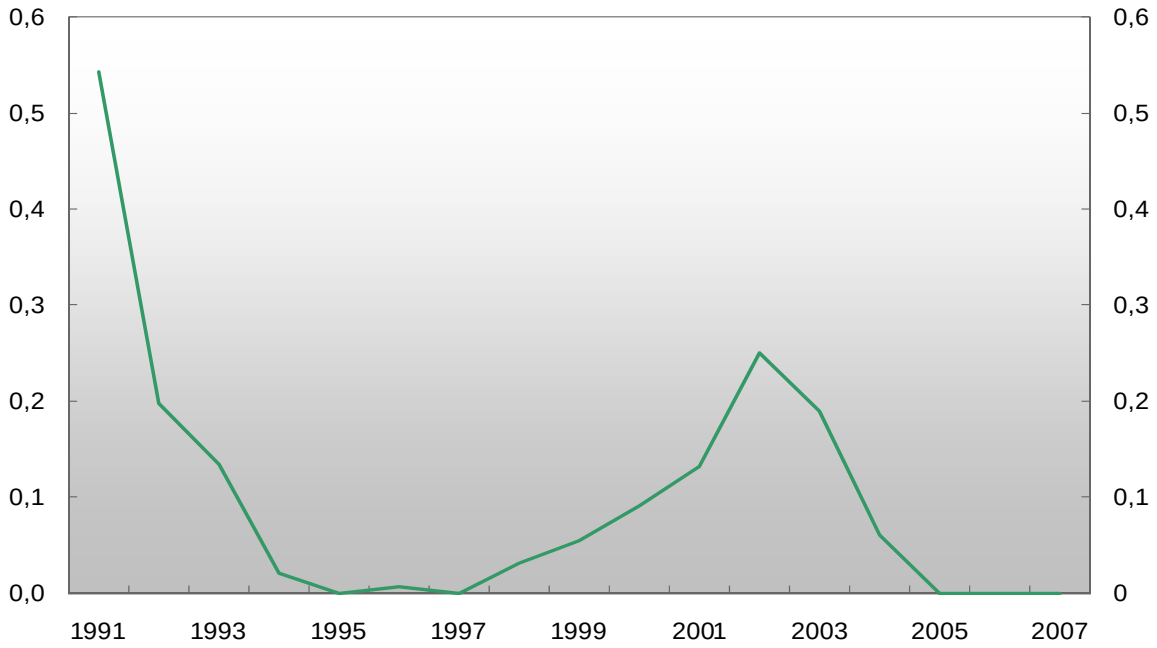


Chart 5 below displays the loan-loss ratio. This ratio is equal to the historical LGD. Towards the end of the previous banking crisis, i.e. in 1991, the loan-loss ratio was 54 percent. In 2002 the loan-loss ratio peaked at 25 percent.

Chart 5 The loan-loss ratio. Percentage of total defaulted loans.



4.1 PIT Basel II capital requirements

We initially calculate PIT capital requirements. According to Catarineu-Rabell et al. (2003) many banks consider their rating systems as more PIT than TTC in nature. The main reason for this is the difficulty of obtaining sufficiently long data series to apply TTC systems. This is especially the case for recently established banks. In addition, banks prefer to use recent default data which is regarded as more relevant to the current situation. This will especially be the case if the stock of non-performing loans has been falling during recent years. For instance, as a transitional arrangement the Financial Supervisory Authority of Norway allows banks to employ the advanced IRB approach in 2008 and the foundation IRB approach in 2008 and 2009 even if the historical observation period is no longer than two years.[12] This may have been done to allow for a level playing field. Finally, constructing a TTC system is technically challenging, because structural variables that are used to classify borrowers also vary with the cycle. Altogether, these facts strongly indicate that calculating PIT capital requirements is relevant.

[12] See § 49-2 in the capital requirement regulations for Norwegian financial institutions (2006): FOR 2006-12-14 nr 1506.

The average PDs and LGDs included in our calculation of PIT Basel II capital requirements are reported in Table 1 in the appendix. The 0.03 percent floor is not binding in any single case. The LGDs are not allowed to be less than the average LGDs, which are assumed to be equal to the average LGDs reported in the QIS 5. This assumption is in line with the Basel II requirement that LGD estimates should reflect economic downturn conditions.

We find that total Basel II capital requirements grow significantly faster than the Basel I capital requirements, see Table 1. The Basel II risk-weighted assets increase by 202 percent during the simulation period. In 2011 the total Basel II risk-weighted assets for the six banks are 184 percent higher than the Basel I risk-weighted assets. The largest relative difference between these two figures for a single bank is 201 percent. These results support the hypothesis that the Basel II capital requirements might rise substantially in a recession, as credit risk materialises and borrowers are downgraded. The results also highlight the fact that risk can easily be underestimated if measured over short periods and on data that do not capture a complete credit cycle.

Table 1 Risk-weighted assets for the five largest Norwegian banks and Nordea Bank Norge. Millions of NOK. 2008 – 2011

	Sep 2008	2008	2009	2010	2011
Reported Basel II risk-weighted assets	1295	0	0	0	0
Operational Risk	67	56	57	59	63
Market Risk	46	50	49	48	48
Pillar II	21	25	0	0	10
Retail mortgages	124	206	466	453	300
Qualifying revolving retail	24	24	35	30	19
Bank	157	186	545	693	682
Sovereign	4	4	7	8	7
Corporates	57	68	156	232	249
SME	151	180	408	605	654
Other retail	108	129	288	368	376
Equities	67	68	66	65	65
Residual	469	566	1211	1492	1436
Total Basel II risk-weighted assets	1295	1563	3289	4054	3911
Basel I risk-weighted assets	1479	1461	1412	1383	1377

As reported in Table 1, the Basel II risk-weighted assets increase substantially, especially for Bank exposures, Corporates, SMEs and Other retail exposures. The main driver behind the accelerating capital requirements on bank exposures is the increase in the PD from the risk index for banks driven by deteriorating earnings and falling capital adequacy ratios. In

addition, the LGDs increase rapidly during the simulation period as property prices fall by almost 50 percent. This sharp fall is an important driver behind the increase in the total capital requirements.

The share of household debt held by households with a negative financial margin peaks in 2008 at 14 percent in 2008, and then falls to 13.3 percent in 2009 and below 10 percent in 2010 and 2011. This reduces the capital requirements on retail mortgages and qualifying revolving retail during the last years of the projection period.

4.2 TTC Basel II capital requirements

According to the Basel II framework the banks are urged to use a TTC rating systems. In order to calculate TTC PDs we combine historical data with projections of the PDs. The data employed to calculate TTC PDs is displayed in Charts 2-4. As in Benford and Nier (2007), we set the TTC PDs equal to the five-year-moving average PDs. We also calculate TTC Basel capital requirements based on ten-year-moving average PDs. In addition, we apply five- and ten-year-moving average LGDs. The historical LGDs are assumed to be equal to the average LGDs reported in the QIS 5.

The risk parameters included in the TTC calculation of Basel II capital requirements are reported in the Tables 2 and 3 in the appendix. The PDs still increase rapidly during the simulation period. When the ten-year-moving average is applied, the increase in the PDs during the simulation period differs from 25 percent (retail trade, hotel and restaurant) to 191 percent (property management). The increase in the PDs based on the five-year-moving average differs from 88 percent (retail trade, hotel and restaurant) to 439 percent (property management). The 0.03 percent floor is not binding in any single case.

The five- and ten-year-moving average LGDs also increase substantially. When the ten-year-moving average is applied, the increase in the LGDs during the simulation period differs from 17 percent (qualifying revolving retail) to 102 percent (retail mortgages). The increases in the LGDs are naturally somewhat higher when the five-year-moving average is employed.

Tables 4 and 5 in the appendix report the TTC calculated risk-weighted assets for the different exposures. Interestingly, the increase in the TTC Basel II risk-weighted assets is still sizeable. The Basel II risk-weighted assets, based on the ten-year-moving average, increase by 75

percent during the simulation period. In 2011 the Basel II risk-weighted assets based on the ten-year-moving average are 65 percent higher than the Basel I risk-weighted assets. The difference is 141 percent when the five-year-moving average is applied.

These results reveal that banks adopting TTC rating systems may still experience substantial cyclicality in their Basel II capital requirements. The calculated increases in the Basel II capital requirements are higher than the increases documented by empirical studies like Kashyap and Stein (2004) and Saurina and Trucharte (2006). While our analysis produce increases in the Basel II capital requirements in the range of 75 percent (TTC) to 202 percent (PIT), the capital requirement calculated by Kashyap and Stein (2004) increased by 30-90 percent. However, Benford and Nier (2007) documented increases in the Basel II capital requirements across the economic cycle more in line with our findings.

4.3 Simulations on the capital positions and the Basel II capital adequacy

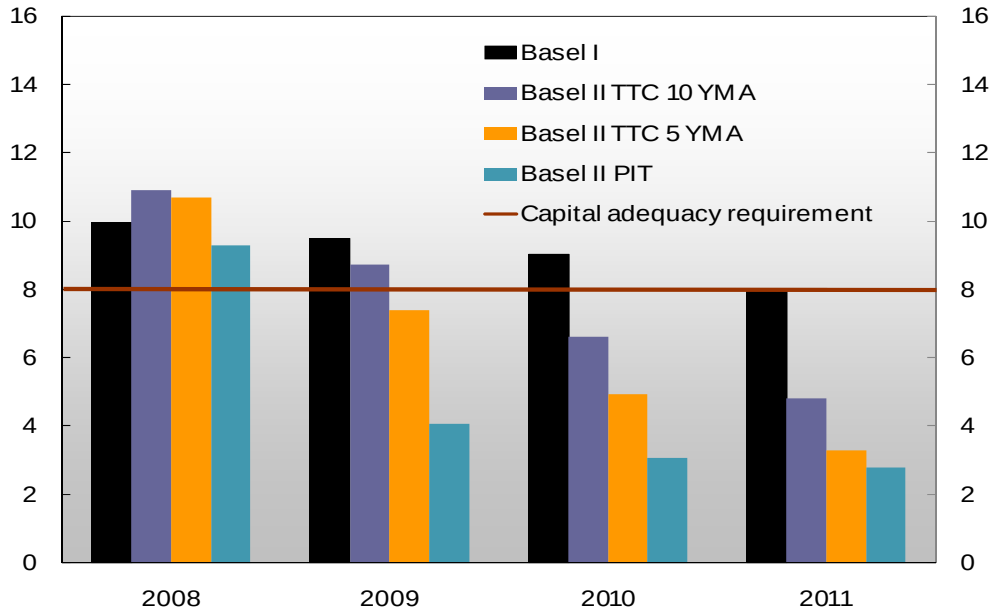
Ultimately, it is the cyclicality in the capital adequacy that matters. Thus, the macroeconomic effects of Basel II will depend on how the banks' capital buffers are affected by the business cycle. In the bank model total provisions affect the regulatory capital as the regulatory capital is endogenously determined by the profit net of losses and after taxes and dividends.[13]

Chart 6 displays the average capital adequacy ratio for the six banks calculated with the Basel I approach, the Basel II PIT approach and the two Basel II TTC approaches. With constant risk weights (Basel I) the capital adequacy of the six banks falls only just below the required level of 8 percent in 2011 unless new capital is raised. The reported Basel I capital adequacy ratio is only affected by changes in the capital position as we assume no sizeable portfolio shifts during the projection period. In the recession scenario, negative results in 2009, 2010 and 2011 reduce the capital position by 25 percent from 2008 to 2011. Consequently, the Basel I capital adequacy ratio falls from 10.0 percent in 2008 to just below 8.0 percent in

[13] Under Basel II, the difference between total provisions and total expected losses must be deducted from regulatory capital when expected losses exceed provisions. 50 % of the deduction must be made from the Tier 1 capital and 50% from the Tier 2 capital. Expected losses associated with equity exposures under the PD/LGD approach and securitisation exposures are not included in the sum of total expected losses. Total provisions include specific provisions, partial write-offs and general provisions. We assume that total provisions equal total expected losses.

2011. This demonstrates that changes in the capital position may affect the capital adequacy substantially.

Chart 6 Capital adequacy in the five largest domestically held banks and Nordea Bank Norge. Percents of risk-weighted assets.



We find a negative co-movement between capital positions and Basel II capital requirements. Consequently, with the PIT Basel II approach the capital requirements of the six banks are violated already in 2009. The Basel II PIT capital adequacy ratio falls from 9.3 percent in 2008 to 2.8 percent in 2011. Thus, the added cyclical pressure on bank capital positions caused by Basel II PIT capital requirements is of a larger magnitude than the pre-existing effect under Basel I.

With the TTC Basel II approaches the added cyclicality in the capital adequacy ratio is still sizeable. Even if the six banks employ TTC Basel II capital requirements based on ten-year-moving average PDs, they violate the capital requirements during the two last years of the projection period.

One explanation behind the small difference in the cyclicality of TTC and PIT capital requirements may be the fact that the capital requirements formula is concave. Thus, the effect on the capital charge of an 800 percent increase in the PDs is not eight times the effect of a 100 percent increase in the PDs. In addition, the PDs based on moving averages increase substantially during the simulation period, see tables 2 and 3 in the appendix. Loan losses are

often unexpected and tend to increase rapidly. Surprisingly high loan losses affect the risk parameters even if the historical observation period is ten years. Thus, Basel II may introduce significant cyclicality in the capital requirements even when the banks have access to default data over a full decade.

However, the cyclicality in the Basel II capital requirements can be effectively contained if the historical observation period is sufficient long and includes economic downturn conditions. We finally apply twenty-year-moving average PDs and LGDs, based on the data displayed in Chart 2-4, in order to cover the previous banking crisis. As reported in Table 6 in the appendix, the risk parameters based on the twenty-year-moving average is fairly stable. Several PDs are actually falling during the simulation period as the previous banking crisis is given lower weight. Thus, in 2011 the TTC Basel II risk-weighted assets, based on the twenty-year-moving average, are only 8 percent higher than the Basel I risk-weighted assets, see Table 7 in the appendix. The TTC Basel II risk-weighted assets, based on the twenty-year-moving average, do not exhibit any significant cyclicality during the simulation period.

5. Conclusion

While the new capital adequacy framework, Basel II, aims to make the banks' minimum capital requirements more sensitive to the underlying risk of the assets, it may also introduce an additional source of procyclicality in the banking sector. Higher capital requirements and falling capital adequacy ratios in recessions may induce banks to tighten their credit standards which, in turn, may amplify the economic downturn. This concern has been intensified by the ongoing financial crisis.

In this paper we analyse the cyclicality of capital positions and the cyclicality of Basel II capital requirements based on a point-in-time rating system and two versions of a through-the-cycle rating system. A bank model developed to stress-test financial stability is combined with bankruptcy probabilities from an enterprise model, from a risk index for banks and from a household model to analyse the cyclicality of the Basel II capital adequacy for Norwegian banks.

Our analysis demonstrates the cyclical nature of Basel II. Based on a recession scenario for the Norwegian economy, we document a substantial increase in the calculated Basel II capital requirements even when the banks employ a through-the-cycle rating system where the risk parameters are based on a ten-year observation period. At the same time, bank capital

deteriorates as the banks record high losses on loans and securities. Hence our analysis highlights the concern that Basel II may introduce an additional source of procyclicality in the banking sector.

After the introduction of Basel II, capital adequacy may not only fall during recessions due to deteriorating capital positions, as with the previous Basel I framework, but also due to higher capital requirements. The added cyclical pressure on bank capital positions caused by Basel II may be of a larger magnitude than the pre-existing effect under Basel I.

Falling capital adequacy ratios may induce banks to tighten their credit standards by cutting back on lending or increasing lending margins. This could especially be the case if the banks are not able to cut dividends, raise new equity or subordinated debt (at normal costs), or sell other assets. Empirical research suggests that the overall response is likely to involve a reduction in the loan growth. This may, in turn, amplify the economic downturn. This effect can be particularly strong in the Norwegian economy where the share of loans to SMEs and household, which do not have perfect access to non-bank financing, is quite high.

During the ongoing financial crisis, banks have already been cutting back on lending due to liquidity and solvency problems. The share of non-performing loans is increasing and the banks are recording higher loan losses. The models employed in our analysis indicate that this will produce higher PDs and LGDs. The EADs may also increase as borrowers utilize their credit line limits during economic downturns. The outcome of higher risk parameters is higher capital requirements. Thus, Basel II may create even larger problems for banks with deteriorating capital positions and solvency problems during the ongoing financial crisis. However, the cyclicality in their Basel II capital requirements can be effectively contained if the historical observation period is sufficient long and includes economic downturn conditions.

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Appendix

Table 1 PIT risk parameters

	2008		2009		2010		2011	
Exposure	**PD**	**LGD**	**PD**	**LGD**	**PD**	**LGD**	**PD**	**LGD**
Bank	0,0195	0,406	0,0952	0,737	0,1412	0,827	0,2358	0,720
Sovereign	0,0013	0,406	0,0013	0,737	0,0013	0,827	0,0013	0,720
Retail Mortgages	0,0120	0,262	0,0114	0,627	0,0085	0,744	0,0085	0,657
Qualifying Revolving Retail	0,0369	0,558	0,0350	0,852	0,0262	0,915	0,0172	0,787
Enterprises								
Primary industries	0,0149	0,406	0,0410	0,737	0,0898	0,827	0,1372	0,720
Oil and gas	0,0089	0,406	0,0212	0,737	0,0542	0,827	0,0827	0,720
Mining	0,0151	0,406	0,0405	0,737	0,0805	0,827	0,1137	0,720
Construction	0,0079	0,406	0,0194	0,737	0,0406	0,827	0,0615	0,720
Retail trade, hotel and restaurant	0,0147	0,406	0,0319	0,737	0,0619	0,827	0,0818	0,720
Shipping abroad	0,0067	0,406	0,0165	0,737	0,0352	0,827	0,0508	0,720
Other transport	0,0164	0,406	0,0352	0,737	0,0681	0,827	0,0978	0,720
Property management	0,0113	0,406	0,0311	0,737	0,0701	0,827	0,1099	0,720
Commercial services	0,0124	0,406	0,0297	0,737	0,0607	0,827	0,0858	0,720
Equities	350 % Risk weight		350 % Risk weight		350 % Risk weight		350 % Risk weight	

Table 2 TTC risk parameters. Five-year-moving average PDs and LGDs

	2008		2009		2010		2011	
Exposure	**PD**	**LGD**	**PD**	**LGD**	**PD**	**LGD**	**PD**	**LGD**
Bank	0,0086	0,361	0,0274	0,438	0,0553	0,534	0,1011	0,608
Sovereign	0,0013	0,361	0,0013	0,438	0,0013	0,534	0,0013	0,608
Retail Mortgages	0,0120	0,181	0,0143	0,274	0,0154	0,391	0,0154	0,490
Qualifying Revolving Retail	0,0369	0,552	0,0439	0,612	0,0472	0,685	0,0473	0,732
Enterprises								
Primary industries	0,0185	0,361	0,0197	0,438	0,0334	0,534	0,0588	0,608
Oil and gas	0,0107	0,361	0,0110	0,438	0,0201	0,534	0,0348	0,608
Mining	0,0128	0,361	0,0181	0,438	0,0319	0,534	0,0524	0,608
Construction	0,0082	0,361	0,0102	0,438	0,0166	0,534	0,0276	0,608
Retail trade, hotel and restaurant	0,0223	0,361	0,0224	0,438	0,0299	0,534	0,0419	0,608
Shipping abroad	0,0058	0,361	0,0078	0,438	0,0138	0,534	0,0231	0,608
Other transport	0,0147	0,361	0,0182	0,438	0,0289	0,534	0,0465	0,608
Property management	0,0086	0,361	0,0128	0,438	0,0254	0,534	0,0461	0,608
Commercial services	0,0159	0,361	0,0161	0,438	0,0256	0,534	0,0401	0,608
Equities	350 % Risk weight		350 % Risk weight		350 % Risk weight		350 % Risk weight	

Table 3 TTC risk parameters. Ten-year-moving average PDs and LGDs

	2008		2009		2010		2011	
Exposure	**PD**	**LGD**	**PD**	**LGD**	**PD**	**LGD**	**PD**	**LGD**
Bank	0,0058	0,356	0,0150	0,394	0,0290	0,442	0,0523	0,479
Sovereign	0,0013	0,356	0,0013	0,394	0,0013	0,442	0,0013	0,479
Retail Mortgages	0,0120	0,171	0,0124	0,218	0,0126	0,276	0,0126	0,326
Qualifying Revolving Retail	0,0369	0,551	0,0382	0,581	0,0388	0,618	0,0373	0,641
Enterprises								
Primary industries	0,0282	0,356	0,0301	0,394	0,0365	0,442	0,0469	0,479
Oil and gas	0,0112	0,356	0,0115	0,394	0,0154	0,442	0,0230	0,479
Mining	0,0149	0,356	0,0175	0,394	0,0241	0,442	0,0338	0,479
Construction	0,0097	0,356	0,0106	0,394	0,0136	0,442	0,0186	0,479
Retail trade, hotel and restaurant	0,0288	0,356	0,0289	0,394	0,0316	0,442	0,0360	0,479
Shipping abroad	0,0089	0,356	0,0093	0,394	0,0110	0,442	0,0149	0,479
Other transport	0,0196	0,356	0,0200	0,394	0,0251	0,442	0,0324	0,479
Property management	0,0095	0,356	0,0118	0,394	0,0179	0,442	0,0278	0,479
Commercial services	0,0242	0,356	0,0245	0,394	0,0276	0,442	0,0329	0,479
Equities	350 % Risk weight		350 % Risk weight		350 % Risk weight		350 % Risk weight	

Table 4 Risk weighted assets for the five largest Norwegian banks and Nordea Bank Norge based on five-year-moving average PDs and LGDs. Millions of NOK. 2008 – 2011

	Sep 2008	2008	2009	2010	2011
Reported Basel II risk-weighted assets	1295	0	0	0	0
Operational Risk	67	56	57	59	63
Market Risk	46	50	49	48	48
Pillar II	20	21	0	0	8
Retail mortgages	124	142	236	351	441
Qualifying revolving retail	24	24	29	34	37
Bank	120	127	214	319	456
Sovereign	4	4	4	5	6
Corporates	55	58	74	111	157
SME	145	154	196	290	409
Other retail	103	109	142	209	272
Equities	67	68	66	65	65
Residual	521	547	738	1031	1351
Total Basel II risk-weighted assets	1295	1360	1806	2522	3313
Basel I risk-weighted assets	1479	1461	1412	1383	1377

Table 5 Risk weighted assets for the five largest Norwegian banks and Nordea Bank Norge based on ten-year-moving average PDs and LGDs. Millions of NOK. 2008 – 2011

	Sep 2008	2008	2009	2010	2011
Reported Basel II risk-weighted assets	1295	0	0	0	0
Operational Risk	67	56	57	59	63
Market Risk	46	50	49	48	48
Pillar II	20	20	0	0	6
Retail mortgages	124	134	172	218	252
Qualifying revolving retail	24	24	25	27	27
Bank	102	106	163	216	282
Sovereign	4	4	4	4	5
Corporates	58	61	67	86	109
SME	154	161	178	225	285
Other retail	110	115	128	163	203
Equities	67	68	66	65	65
Residual	519	535	624	764	920
Total Basel II risk-weighted assets	1295	1335	1532	1877	2266
Basel I risk-weighted assets	1479	1461	1412	1383	1377

Table 6 TTC risk parameters. Twenty-year-moving average PDs and LGDs

	2008		2009		2010		2011	
Exposure	**PD**	**LGD**	**PD**	**LGD**	**PD**	**LGD**	**PD**	**LGD**
Bank	0,0432	0,353	0,0460	0,373	0,0507	0,396	0,0299	0,414
Sovereign	0,0013	0,353	0,0013	0,373	0,0013	0,396	0,0013	0,414
Retail Mortgages	0,0120	0,167	0,0112	0,191	0,0104	0,219	0,0104	0,243
Qualifying Revolving Retail	0,0369	0,550	0,0344	0,566	0,0318	0,584	0,0289	0,596
Enterprises								
Primary industries	0,0833	0,353	0,0700	0,373	0,0596	0,396	0,0522	0,414
Oil and gas	0,0172	0,353	0,0172	0,373	0,0187	0,396	0,0211	0,414
Mining	0,0190	0,353	0,0194	0,373	0,0216	0,396	0,0255	0,414
Construction	0,0128	0,353	0,0116	0,373	0,0119	0,396	0,0132	0,414
Retail trade, hotel and restaurant	0,0417	0,353	0,0398	0,373	0,0376	0,396	0,0375	0,414
Shipping abroad	0,0157	0,353	0,0158	0,373	0,0160	0,396	0,0169	0,414
Other transport	0,0311	0,353	0,0313	0,373	0,0332	0,396	0,0356	0,414
Property management	0,0191	0,353	0,0195	0,373	0,0211	0,396	0,0244	0,414
Commercial services	0,0428	0,353	0,0398	0,373	0,0379	0,396	0,0378	0,414
Equities	350 % Risk weight		350 % Risk weight		350 % Risk weight		350 % Risk weight	

Table 7 Risk weighted assets for the five largest Norwegian banks and Nordea Bank Norge based on twenty-year-moving average PDs and LGDs. Millions of NOK. 2008 – 2011

	Sep 2008	2008	2009	2010	2011
Reported Basel II risk-weighted assets	1295	0	0	0	0
Operational Risk	67	56	57	59	63
Market Risk	46	50	49	48	48
Pillar II	24	24	0	0	5
Retail mortgages	124	131	140	152	159
Qualifying revolving retail	24	24	23	22	21
Bank	197	203	212	230	206
Sovereign	4	4	4	4	4
Corporates	71	73	73	81	92
SME	185	192	192	212	242
Other retail	131	136	137	152	172
Equities	67	68	66	65	65
Residual	355	364	370	398	417
Total Basel II risk-weighted assets	1295	1326	1324	1422	1494
Basel I risk-weighted assets	1479	1461	1412	1383	1377