Financial Stability Paper No. 3 – December 2007

Monitoring cyclicality of Basel II capital requirements

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The use of credit ratings to set capital requirements under Basel II represents an important change to the way banks are regulated. While encouraging better risk management by banks, it also raises the possibility that capital requirements might vary with economic conditions, creating risks to the stability of the financial system. This paper offers some evidence on the likely magnitude of these effects. It then sets out a framework that will be used by the Bank and FSA to monitor Basel II capital requirements. The Bank is particularly interested in possible implications of cyclical variability in capital requirements under Basel II for the UK banking sector in aggregate, while the FSA's focus is the capital adequacy of individual banks. The paper finally suggests that the industry, as well as market participants, can play a part in avoiding potential unintended consequences of Basel II — through careful capital planning by banks, and scrutiny, by market participants, of the outputs of banks' rating systems.

1 Introduction

The major change implied by 'Basel II', which will apply to all UK banking operations from 2008, is that capital requirements will be much more closely tied to risks, as measured by credit ratings. At a minimum, banks will have to apply the Standardised Approach (SA) to Basel II, where capital requirements are based upon agency ratings. More advanced banks will be permitted to use the Internal Ratings Based (IRB) approaches, where requirements are based upon the outputs of banks' own rating systems. While the anticipation of a move towards Basel II has encouraged banks to invest further in the measurement of risks *ex ante*, Basel II may also affect the way the banking system responds to a crystallisation of risks *ex post*. In particular, if (agency or internal) credit ratings are sensitive to economic conditions, then under Basel II capital requirements may fall in an upturn and rise in recessions. This may, in turn, increase the sensitivity of the supply of credit to economic conditions (procyclicality).

Section 2 provides an overview of the rationale for Basel II and the way the potential for increased procyclicality may arise under it. Section 3 reviews existing evidence and presents some new calculations on how banks' capital requirements might behave over time under Basel II. Section 4 describes how the UK authorities intend to monitor Basel II, and Section 5 offers some thoughts on how market participants might interpret and react to the revised requirements. Section 6 concludes.

2 Basel II and procyclicality — an overview

Unlike other bank liabilities, capital can be used to absorb losses. Minimum capital requirements set a basic level of resilience against losses and help protect a bank against insolvency. Internationally agreed minimum standards for capital requirements have existed since the first Basel Accord of 1988, 'Basel I'.

Under Basel I, capital requirements for credit risk exposures are set purely on the basis of the type of portfolio: a fixed risk-weight is applied to each type of exposure, and banks are required to maintain a ratio of capital, after deductions, to total risk-weighted assets of 8%. A portfolio of qualifying sovereign exposures attracts a risk-weight of 0%, exposures to banks, and qualifying non-bank financial institutions, a risk-weight of 20%, the retail mortgage portfolio a weight of 50%, and corporate as well as unsecured retail portfolios (such as credit cards) a weight of 100%.

The lack of risk sensitivity in Basel I led to a concern that this framework was increasingly being undermined by regulatory arbitrage, such as the incentive to securitise low-risk assets, but to retain high-risk exposures, both within and across these risk buckets.(1) In response, the revised, Basel II, framework for

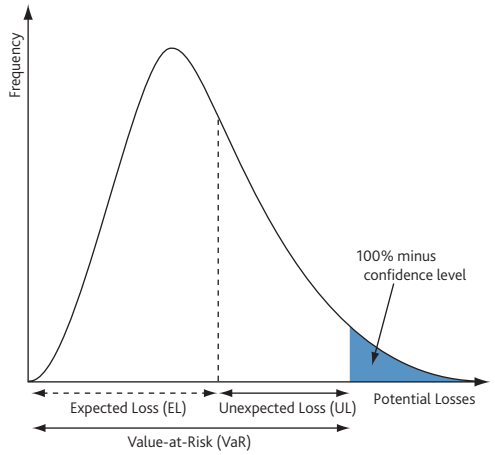
(1) One of the deficiencies of Basel I that will be addressed by Basel II is the treatment of undrawn lines. For any type of portfolio, undrawn commitments with a maturity of less than one year carry no capital charge under Basel I. As discussed in the October 2007 *Financial Stability Report* (*FSR*), this appears to have provided incentives for banks to provide liquidity facilities and other credit enhancements to special investment vehicles (SIVs) and asset-backed commercial paper (ABCP) programmes off the banks' balance sheet.

capital standards introduces greater risk sensitivity of capital requirements, while aiming to maintain international consistency in capital regulation.

Under Basel II, capital requirements will be determined not only by the type of portfolio but also, to achieve greater risk sensitivity, by a credit rating assigned to each borrower within the portfolio. For banks on the Standardised Approach, external (agency) ratings will be used to determine capital requirements; for banks on the IRB approaches, banks' own internal ratings systems will be used. All EU-incorporated banks will have to comply with these revised capital requirements for credit risk from 1 January 2008 and will, at a minimum, need to satisfy capital requirements under the Standardised Approach.(1) However, all of the major UK banks(2) plan to adopt the IRB approaches.

While banks are free to build their own models to assign ratings to exposures within the constraints of supervisory review, the mapping from ratings to capital requirements is hardwired in Basel II. A regulatory formula aims to set requirements to ensure that stressed credit losses over a one-year period do not exceed a bank's capital — a Value-at-Risk approach. This stressed level of losses can be decomposed into the level of credit losses that is expected to occur on average, the Expected Loss (EL), and a peak level of losses above EL expected to be exceeded with only a small probability, the Unexpected Loss (UL), as shown in **Chart 1**. Firms may offset the EL component with provisions,(3) but must hold capital against UL, and any EL that is not offset by provisioning. The ability to offset EL with provisions allows a bank to set aside a portion of current income to cover the losses it expects to occur over one year; however Basel II capital requirements do not recognise the loss-absorbing capacity of future income.

Chart 1 Value-at-Risk model for credit risk under Basel II IRB approaches



Source: BCBS (2005).

The EL and UL components are calculated through the following formulae:

$$EL = EAD \cdot PD \cdot LGD \quad (1)$$

$$UL = 8\% \cdot RWA_{credit} = EAD \cdot LGD \cdot f(PD, \rho, q, M) \quad (2)$$

These include six key parameters: exposure at default (*EAD*), loss given default (*LGD*), probability of default (*PD*), a correlation factor (ρ), set by regulators as a function of borrower type, a desired one-year probability of solvency (q), set equal to 99.9%, and the remaining maturity of the loan (M). f is a regulatory formula that takes some of these parameters as inputs.(4)

The UL formula's main function is to transform an estimate of a borrower's average (across all economic conditions) PD into a conditional PD, given stressed (at the 99.9% level) economic conditions.(5) The IRB formulae expect, therefore, parameter estimates that are stable over time as inputs. If the assumptions behind the formulae are correct, the output is a capital requirement sufficiently large that a bank is only expected to become insolvent once every 1,000 years.(6) In practice though, the output of the formula has been scaled(7) by the Basel Committee on Banking Supervision (BCBS) so that capital requirements of the G10 banking system as a whole are, in aggregate, the same as under Basel I.

Under the Capital Requirements Directive (CRD), banks on the Advanced IRB (AIRB) approach are required to generate internal estimates for EAD and LGD, together with PD and M. In the United Kingdom, banks on the Foundation IRB (FIRB) approach are required to estimate an exposure's PD and expected maturity (M) themselves, with regulators setting the remaining parameters. An exception applies to retail exposures, where there is a single approach with both FIRB and AIRB banks generating internal estimates for EAD, LGD and PD.

The supervisory review process requires that estimates are used for business and not just for regulatory purposes. This

(1) The Capital Requirements Directive came into effect on 1 January 2007. Provisions in that Directive allow some banks to operate under Basel I capital requirements for a transitional period until 1 January 2008. All BCBS member countries, including the United States, plan to implement Basel II, though to a different timetable. For the transitional period in which not all BCBS member countries might yet have implemented Basel II, supervisors have come to agreements on how to deal with banks that might be active both in and outside the EU.
(2) Membership of the major UK banks group is based on the provision of customer services in the United Kingdom, regardless of the country of ownership. The following financial groups, in alphabetical order, are included: Alliance & Leicester, Banco Santander, Barclays, Bradford & Bingley, HBOS, HSBC, Lloyds TSB, Nationwide, Northern Rock and RBS.
(3) Only general provisions are recognised, up to a limit, as Tier 2 capital under Basel I, and the standardised approach to Basel II. Under the IRB approaches all provisions attributable to IRB-rated exposures (including specific provisions) may be used to offset EL. Surplus provisions (those in excess of EL) may be counted as Tier 2 capital up to a limit of 0.6% of credit risk-weighted assets. A shortfall of provisions is deducted, 50% from Tier 1 capital and 50% from Tier 2.
(4) A non-technical explanation of the Basel II IRB formulae can be found at www.bis.org/bcbs/irbriskweight.pdf.
(5) There is no such mapping provided for LGD. Here, firms are expected to estimate a 'downturn' LGD, and EAD, corresponding to stressed economic conditions.
(6) Gordy (2003) demonstrates how the IRB formulae can be derived from the large-portfolio asymptotic behaviour of a Merton model with a single common risk factor, 'economic conditions'.
(7) In May 2006, the Basel Committee decided to maintain a scaling factor of 1.06, applied to credit risk-weighted assets. See www.bis.org/press/p060524.htm.

can produce a tension between the stable parameter estimates that the IRB formulae expect, and the kind of inputs useful for business processes. Economic capital models used in active portfolio management may wish to use a 'full-information' or 'point-in time' (PIT) estimate of the UL associated with an exposure, that is conditional on all available information, including current economic conditions. PIT rating systems may also be more appropriate inputs for ratings-based pricing models. By definition, a rating system that produces stable parameter estimates — a 'through-the-cycle' (TTC) rating system — cannot be aligned with such a full-information rating system. A survey of large US banks by Treacy and Carey (1998) found that almost all banks had chosen to assign ratings based on current economic conditions. But even where banks adapt their rating systems to be more TTC following the implementation of Basel II, it is not clear this would produce completely stable inputs. Rating agencies purport to rate TTC; however, empirical studies of the behaviour of their ratings over time find strong evidence that agency ratings are cyclical, with more downgrades being observed in recessions, eg Amato and Furfine (2003).

Any cyclicality of rating systems implies that credit risk capital requirements under Basel II may be too low from the perspective of the desired solvency standard (ie the long-run probability of solvency, eg 99.9%) during economic upturns,(1) and too high relative to the same standard in a downturn. And any such deviation from the desired solvency standard through time will be more pronounced the closer banks' rating systems are to a PIT system, and less pronounced under a TTC system. Further, a slackening of regulatory constraints in good economic conditions, and tightening in adverse conditions, might lead to greater instability in the provision of credit. Low requirements in times of economic expansion might contribute to credit booms. Rising capital requirements in recessions, at the same time that banks' capital is reduced through increased write-offs, may lead to a tightening in the terms and conditions governing the supply of credit to the wider economy. Such shifts in loan supply might manifest themselves in a number of ways: banks might shorten maturities, increase their demands for collateral and increase the price of new loans. They might also refuse to roll over existing credit and exercise early foreclosure on non-performing loans. A systemic tightening in credit supply may in turn increase financial pressures on companies and households and deepen, or prolong, a downturn.

The credit risk requirements discussed above make up the majority of banks' minimum capital requirements under Basel II. In addition, Basel II introduces an explicit capital requirement for operational risk and amends the calculation of the requirement for market risk to bring the treatment in line with the revised rules for credit risk in the banking book. The overall requirement continues to be expressed as a ratio of actual capital, after deductions, to total (credit, market, and operational) risk-weighted assets of 8%. This minimum required capital ratio makes up what is known as 'Pillar 1' of Basel II. The Basel II framework also contains guidance on the supervisory review of banks' risks and risk management procedures, which can result in supplementary capital requirements under Pillar 2. For example, Pillar 1 requirements relate entirely to the bank's asset side and do not take into consideration any liquidity mismatches between banks' assets and liabilities. But under Pillar 2 supervisors may give this some consideration in the overall assessment of risks. The framework finally requires banks to disclose certain elements of their risk profile to the market at large (Pillar 3). The potential for supervisory review (Pillar 2) and disclosure requirements (Pillar 3) to help address concerns about more volatile capital requirements under Basel II will be discussed in more detail in Section 5, below.(2)

3 Simulation evidence

While the use of banks' internal ratings in Basel II has the potential to make capital requirements more cyclical, there is as yet no direct evidence on the behaviour of these internal ratings systems in practice and hence on the possible magnitude of this effect. Market intelligence gathered by the Bank suggests that a number of the major UK lenders expect that the outputs of both their retail and corporate rating systems will vary with the economic cycle to some extent. In advance of Basel II's introduction, a number of simulation studies have attempted to estimate the likely amplitude of variation in Basel II capital requirements, given assumptions on how banks' rating systems might behave as economic conditions change. This section reviews studies examining the behaviour of rating systems for corporate borrowers, and provides some new simulation evidence for retail exposures based on UK data.

(a) Corporate portfolios

A growing body of literature has employed simulation approaches to estimate the likely magnitude of the cyclical variations in Basel II capital requirements for corporate portfolios. Typically these simulation studies track the rating for a representative portfolio of exposures using either rating transition matrices, or market indicators of PDs, as a proxy for an IRB bank's rating system. Studies based on market price Merton models(3) of default, such as Moody's KMV, are often classified as describing a PIT rating system. Simulation studies based on rating agency transition matrices are often classified as being more TTC. These studies then map changes in PDs to changes in capital requirements and hence estimate how

(1) As insufficient allowance is taken of weaker conditions elsewhere in the economic cycle.
(2) A more general discussion of Basel II disclosure requirements can be found in the October 2007 *FSR*.
(3) Merton models use market measures of the level and volatility of companies' share prices to estimate the likelihood that the value of a company's equity will fall to zero, resulting in the company defaulting on its debt. See Merton (1974).

Table A Studies that simulate the peak to trough variation of Basel II capital requirements for corporate portfolios

Study	Country	Time period considered	Based on: Agency ratings	Based on: Market-based ratings
Segoviano and Lowe (2002)	Mexico	3/1995–12/1999	16%–70%	–
Catarineu-Rabell, Jackson and Tsomocos (2003)	US, Europe	12/1990–12/1992 recession	15%–18%	8%–53%
Kashyap and Stein (2004)	US, Europe, Rest of world	12/1998–12/2002	32%–43%	3%–83%

References are set out in full on page 13.

capital requirements might vary over a business cycle. **Table A** summarises the results of some recent simulation studies based on corporate portfolios. Most simulations show significant and sizable cyclical behaviour of requirements. Not surprisingly, cyclicality is found to be considerably larger under assumptions of a PIT rating method than under a TTC method; but it is sizable even under TTC assumptions. Both estimates of cyclicality vary markedly. Differences in simulation estimates are due both to differences in the detail of the method and differences in the country and time period considered. These differences are surveyed in detail in Kashyap and Stein (2004).

(b) Retail portfolios

Bank loan portfolios typically contain both corporate and retail (ie household sector) exposures. *A priori*, there is little reason to expect retail defaults, and hence a 'point-in-time' estimate for retail PDs, to be any less cyclical than corporate defaults. Shocks to interest rates, unexpected shocks to income, due to unemployment or reduced real earnings growth, or unexpected shocks to the market value of physical collateral will restrict the ability of households to service or roll over debt and may increase retail defaults. Despite this, the literature has so far focused almost exclusively on the corporate portfolio. We extend the literature by considering the likely cyclicality of rating systems for the retail mortgage portfolio.

For the United Kingdom, the Council of Mortgage Lenders (CML) provides a long time series of data on retail mortgage arrears back to 1982 and therefore covering a full economic cycle. Using these data, we simulate the PDs that banks' internal rating systems would have assigned to mortgage exposures over this period, under a number of different assumptions. To draw inferences from these arrears data for the PD on a mortgage, and the behaviour of capital requirements over time, we first need a mapping from arrears to defaults. To be consistent with the Basel II definition of default to be applied by the UK Financial Services Authority to retail exposures, we define a default to have occurred when the obligor is past due by more than 180 days (6 months). The CML provides data on the stock of mortgages half to one year (6–12 months), and more than a year (>12 months), in arrears at the end of each half-year. The ratio of the current number of mortgages 6–12 months in arrears to the number of mortgages performing in the previous period gives the current period's default rate on the Basel II past-due measure.(1) It follows that an annual default rate (the horizon used in Basel II) can be constructed by dividing the total flows into default over the past year, as measured by the number of accounts that are 6 to 12 months in arrears, by the average number of performing accounts in the previous year:

$$DR_t^{Annual} = \frac{Arrears6-12_t + Arrears6-12_{t-1}}{0.5 \cdot (NumberPerf_{t-1} + NumberPerf_{t-2})} \qquad (3)$$

Chart 2 plots this annual default rate on UK retail mortgages. The rate increased by 270% between 1989 and 1992. To translate this figure into the equivalent rise in the Basel II capital requirement for retail mortgage exposures, we assume a LGD of 15% throughout(2) and that banks match their expected loss (EL) with provisions at all points in time. When expected losses are offset by provisions, then the percentage Basel II capital requirement for a mortgage is simply the product of 8% (the minimum capital ratio) and the Basel II mortgage risk-weight (which, under the IRB approach, is a function of a loan's PD and LGD). If banks used the contemporary annual default rate as their estimate of PD on a retail mortgage, the 270% increase in PD would have translated into a 120% increase in capital requirements for retail mortgage exposures (**Chart 3**).

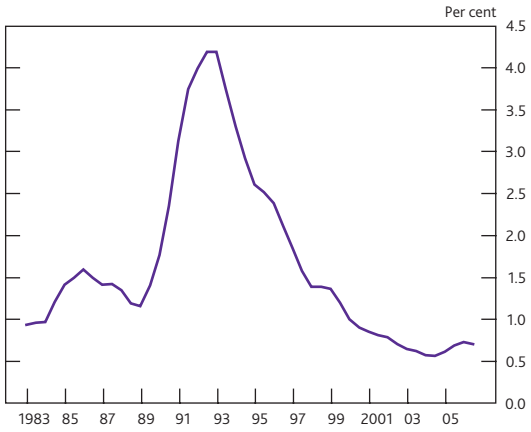
Linking the Basel II capital requirement to the actual annual default rate is equivalent to using a PIT rating system. In order to get a sense of how a more TTC system might behave in aggregate we construct two alternative models of mortgage defaults. The first builds on the error correction approach used by Whitley, Windram and Cox (2004) and is described in Box A on page 8 in more detail. This approach enables a long-run 'equilibrium' mortgage default rate to be estimated at each point in time, but allows the predicted default rate to vary from this equilibrium value in the short run. To abstract from these short-run dynamics, we use the predicted long-run equilibrium mortgage default rate as a measure of a TTC PD. Our second TTC model simply uses a moving average of annual default rates.

Using a rating system implied by the long-run relationship in the error correction model for the mortgage PD dampens the

(1) This assumes that mortgage exposures are not written off prior to a mortgage spending six months in arrears. Since we observe a large stock of mortgages that are more than twelve months in arrears in each period it looks reasonable to assume we are capturing mortgages before they are written off.

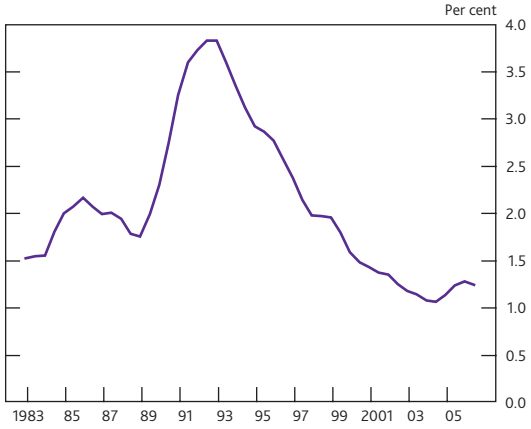
(2) In recessions, LGD is likely to increase. Banks are therefore encouraged to use a 'downturn estimate' of LGD that is stable through time. The average LGD assigned to retail mortgage exposures by UK banks was found to be 14% in the 5th Quantitative Impact Study, available at: www.fsa.gov.uk/pubs/international/QIS_5_Results_Complete.pdf.

Chart 2 Annual mortgage default rate (per cent)



Source: Council of Mortgage Lenders.

Chart 3 'Point-in-time' mortgage capital requirements (UL)

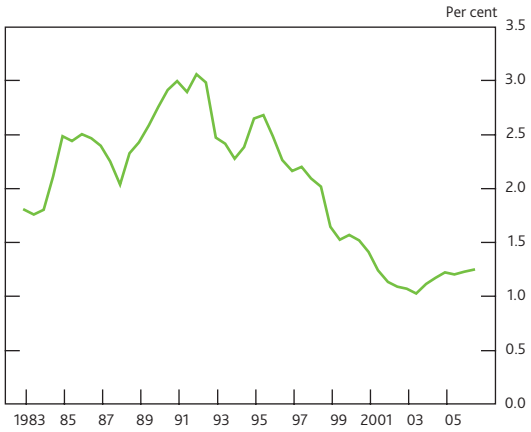


Source: Bank calculations.

range of fluctuations in capital requirements considerably, but still leaves a series which is fairly volatile (**Chart 4**). These fluctuations are driven by the impact of mortgage income gearing, undrawn housing equity and unemployment on the TTC measure of the mortgage PD. All three variables are important in explaining the long-run equilibrium default rate (and hence our TTC PD) and it seems likely that such variables would be useful for a bank attempting to apply TTC ratings to a cross-section of individual borrowers. However, our simulations demonstrate that, in aggregate, these variables fluctuate with the macroeconomic environment. Hence, though such a rating system might be useful for distinguishing between the credit qualities of individual borrowers, it might also carry the property that aggregate ratings will fluctuate over time.

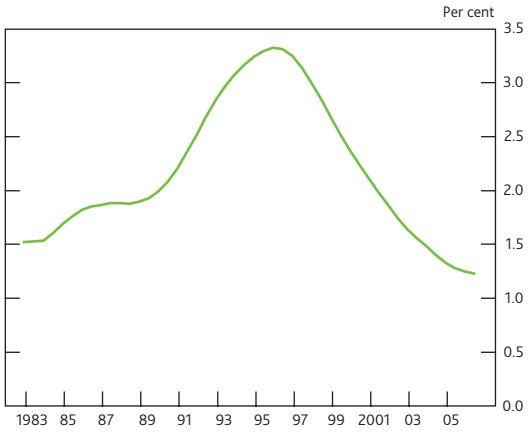
We next consider the effect of adopting a simpler TTC system, where we use a long-run moving average of historical mortgage default rates over the past five years as a proxy for the PD used in firm's IRB rating systems (**Chart 5**). We set the averaging period to five years to correspond to the five-year minimum data history requirement for the Basel II retail IRB approach. Under this moving average TTC system the

Chart 4 'Through-the-cycle' mortgage capital requirements



Source: Bank calculations.

Chart 5 Smoothed 'PIT' mortgage capital requirements



Source: Bank calculations.

Table B Variations of mortgage capital requirements under different rating systems, 1983–2006

	Rating system		
	PIT	Smoothed PIT	Error correction (TTC)
Min to max	300%	170%	202%
Cyclical downturn (1989 to 1992)	120%	42%	23%

Note: Min to max variation is calculated as the percentage increase in requirements from the minimum of the series to the maximum. Cyclical downturn is calculated as the percentage increase in requirements from 1989 to 1992.

Source: Bank calculations.

variation in capital requirements is also lower than the pure PIT, but again, quite substantial.(1) **Table B** compares the results of the three different approaches. This shows that variability under all approaches can be sizable.

Saurina and Trucharte (2006) also consider the cyclicality of capital requirements for retail exposures, using a panel of

(1) The backward-looking nature of the rating system also results in the peak in capital requirements lagging the peak in mortgage defaults by several periods.

Box A
A simple model for UK retail mortgage default rates

Motivated by Whitley, Windram and Cox (2004), the following determinants of the long-run level of the mortgage default rate are tested: *Equity*, the level of undrawn equity, defined as one minus the ratio of household mortgage debt to housing wealth; *Gearing*, the ratio of mortgage interest payments to household disposable income (a measure of income gearing); and *UN*, the unemployment rate. We test all three of these variables, and the level of mortgage defaults, for stationarity and are unable to reject the null hypothesis of a unit root in each case. The short-run dynamics are determined by movements in the level of economic activity relative to trend (*Gap*), as well as changes in the variables in the long-run relationship. Our preferred specification for the error correction model is shown below.

$$\Delta \ln(DR_t) = \underset{(0.00)*}{0.34}\,\Delta \ln(DR_{t-1}) - \underset{(0.04)*}{3.78}\,\Delta(Gap_{t-1}) -$$
$$\underset{(0.00)*}{8.81}\,\Delta \ln(Equity_t) - \underset{(0.00)*}{0.20}\,ECM_{t-1}$$

$$\text{where } ECM_t = \ln(DR_t) -$$
$$\underset{(0.05)*}{0.531}\ln(UN_t) + \underset{(0.00)*}{0.991}\ln(Gearing_t) - \underset{(0.00)*}{8.561}\ln(Equity_t) - \underset{(0.11)*}{0.95}$$

Adj. R2: 0.86 Durbin-Watson: 1.87 No. of observations: 44.

* Figures in parentheses correspond to p-values.

A long-run, or cointegrating, relationship between mortgage default rates, income gearing, unemployment and undrawn equity is suggested by the negative and significant coefficient on the error correction term, ECM_{t-1}. All three of these variables have the expected effect on the rate of mortgage defaults. A 1% increase in mortgage income gearing — which would make servicing mortgage debt more burdensome — eventually increases the default rate by 1%. A 1% increase in the unemployment rate — which will tend to increase the proportion of the population servicing mortgage debt with no current employment income — increases the default rate by 0.5%. A 1% fall in the level of undrawn equity relative to housing wealth — a proxy for both the cost to the homeowner of defaulting on a mortgage and the net worth of the household sector — eventually increases the proportion of defaults by 8.6%. Though the coefficient on undrawn equity looks large compared to that on unemployment and income gearing, the standard deviation of undrawn equity is over ten times lower than that of unemployment and income gearing. The three variables are thus of similar importance in explaining movements in defaults over the sample period.

In the short run, the mortgage default rate can deviate from this equilibrium, though it tends towards the level predicted by the long-run relationship. The coefficient of 0.2 on ECM_{t-1} suggests that disequilibrium is resolved with a half-life of just over three periods ie one and a half years. Short-run macroeconomic fluctuations move the mortgage default rate away from equilibrium. A 1% fall in GDP relative to trend (1% decrease in the output gap) increases mortgage defaults by 3.8%. At an initial default rate of 1%, such a shock to output would therefore increase the mortgage default rate to 1.04%. Changes in undrawn equity also have an immediate, short-run impact. A 1% fall in undrawn equity immediately increases mortgages defaults by 8.8%. This is very similar in size to the long-run relationship, indicative of a much quicker adjustment of mortgage defaults to changes in housing market conditions than to either changes in unemployment or income gearing. Neither changes in unemployment nor changes in income gearing were found to have any impact on the short-run dynamics.

borrowers from the Spanish Credit Register. As their data set contains detailed microeconomic data on a wide cross-section of around three million borrowers, they are able to estimate the PD for individual borrowers based on borrower-specific information. They also find that average PIT estimates for mortgage PDs vary widely across the cycle, supporting our results for the United Kingdom. The resulting capital requirements in their PIT rating system vary from a minimum 0.85% to a maximum 2.93%, a range of 245%. This compares with the range of 300% for a PIT rating system based on UK mortgage data. Saurina and Trucharte (2006) also consider TTC ratings. When the state of the economy, as measured by GDP growth, is held constant, capital requirements vary from a minimum of 1.84% to a maximum of 2.87%, a range of 56%. They note that their proxy for a TTC rating system is affected by both structural and cyclical changes — some of the structural variables that are used to classify borrowers (default and delinquency credit history, undrawn lines of credit available) also vary with the economic cycle. Again, this illustrates the practical problems of constructing a TTC rating system.

A comparison with the size and composition of UK banks' balance sheets can help put these cyclical variations in capital requirements into perspective. Survey results suggest that mortgage and corporate portfolios will make up around 10% and 30% respectively of large, 'Group 1', UK banks' risk-weighted assets under Basel II.[1] An increase in

(1) See FSA (2005). Group 1 banks are those banks with more than €3 billion Tier 1 capital, broadly corresponding to the major UK banks group. Other portfolios contributing to banks' risk-weighted assets are unsecured retail (20%), small and medium-sized enterprises (7%), bank (7%) and sovereign (1%), the trading book (7%), operational risk (9%), and related entities (10%).

risk-weighted assets of around 40% for the mortgage portfolio, and 40% for the corporate portfolio — corresponding broadly to the variation in TTC ratings systems over the early 1990s recession — would therefore increase a bank's risk-weighted assets, and therefore capital requirements, by around 20%, assuming no change in the risk-weights of other portfolios.(1) This cyclical effect would, of course, be larger if capital requirements for other portfolios were affected. It would be smaller for a milder recession scenario than that considered here. It would be larger under the same scenario, were banks to use PIT ratings systems.

Under Basel II then, banks' risk-weighted assets, and therefore capital requirements, might rise in a recession scenario as credit risk materialises and borrowers are downgraded. In this scenario, banks may also experience increased losses on lending associated with higher household, or corporate, defaults that may reduce profits and ultimately actual capital. Haldane *et al* (2007) describe how losses arising from household defaults could, in a scenario modelled on the early 1990s recession, result in household credit losses equivalent to 6%–16% of major UK banks' Tier 1 capital. Were retained profits on performing loans insufficient to absorb this loss, this would then lead to a reduction in actual capital. Adverse corporate credit conditions might result in corporate credit losses equivalent to 10%–21% of major UK banks' Tier 1 capital in that same scenario. And a global economic slowdown, that combines the corporate and household stress scenarios and is calibrated to resemble, in terms of severity, the early-1990s UK recession might result in credit losses (relative to base profits) equivalent to 40% of major UK banks' Tier 1 capital.

Where banks' capital ratios are under pressure — both from losses and from an increase in requirements — banks can respond in a number of ways. They might cut regular dividends in order to increase Tier 1 capital through higher retained earnings. If that were not sufficient, banks might issue new shares, though this might prove costly during a period when the banking sector is under stress. Alternatively, banks could attempt to rebuild their margins, by raising the prices they charge on existing lending. If these actions were not sufficient to rebuild capital ratios, banks might more aggressively cut back on new lending, thereby reducing their capital requirements, for example by tightening non-price terms and conditions on new loans.

It is difficult to quantify *ex ante* the effect on behaviour along all of these dimensions. But empirical research suggests that the overall response is likely to involve a reduction in loan growth (Nier and Zicchino (2005)). Moreover, this study found that the strength of the response to loan growth is non-linear and depends on the capital cushion available to absorb losses. If capital buffers are low (overall and relative to the required capital) banks cut their lending by more than if capital buffers are ample. This suggests that in a scenario where banks are under pressure both through losses sustained and through an increase in requirements, the reduction in lending is likely to be amplified.

4 Official monitoring

Section 3 documented how the use of banks' internal ratings for credit risks might lead to capital requirements that vary significantly with cyclical conditions under Basel II. Depending on the magnitude of this variation, there is a risk that the lower capital requirements during economic upturns might undermine capital adequacy, or that the higher requirements during downturns might lead to reductions in aggregate credit supply that could have adverse systemic consequences. In response to these risks, the Bank and the FSA intend to monitor the behaviour of Basel II capital requirements as the majority of UK banks start applying the IRB approaches from 2008. As set out in the April 2007 *FSR*, in parallel with the domestic monitoring exercise, international monitoring is being conducted both at the EU and G10 (Basel) levels.

Table C summarises the framework through which Basel II capital requirements are applied. Minimum capital requirements can be expressed as the summation of 8% of total risk-weighted assets and deductions. These deductions include the excess of expected losses over provisions — the 'regulatory calculation difference' (RCD). The core objective of the Bank's and the FSA's monitoring will be to isolate, and attempt to explain those fluctuations in capital requirements that arise from banks' internal rating systems. While these rating systems drive both the regulatory calculation difference (EL minus provisions) and credit risk-weighted assets (UL), it is credit risk-weighted assets that make up the largest share of banks' total capital requirements. For most portfolios, average PDs are small relative to stressed PDs and therefore the regulatory formula generally produces EL amounts that are small relative to UL (8% of risk-weighted assets).(2)

The second panel of **Table C** demonstrates how credit risk-weighted assets can be decomposed into total credit exposure (a balance sheet size effect), the exposure shares of specific portfolios (such as corporate, mortgage, other retail, banks, etc — a portfolio composition effect) and the average risk-weight for each portfolio (an IRB ratings effect). Under Basel I, risk-weights for a given portfolio were fixed. It is the IRB ratings effect, which may vary across portfolios, as well as across banks, that is the novelty of Basel II.

To pick up the impact of internal ratings for credit risk on the volatility of capital requirements, the monitoring exercise will

(1) The major UK banks are currently well capitalised, with Tier 1 capital ratios (of Tier 1 capital to risk-weighted assets) of around 8%, and such an increase in risk-weighted assets would reduce this ratio to around 6.5%, still well above regulatory requirements (of 4%).
(2) Examples where expected losses are larger than unexpected losses, might include the credit card portfolio and portfolios of loans that are in default.

Table C Outline of Basel II Pillar 1 capital requirements for an IRB bank

Required capital: $Capital \geq 8\% \cdot RWA + Deductions + RCD$

Required capital ratio: $\frac{Capital - Deductions - RCD}{RWA} \geq 8\%$

Decomposition of risk-weighted assets:[a]

$$RWA = RWA_{credit} + RWA_{op} + RWA_{mkt}$$

$$RWA = Exp_{credit}\left[\sum_i \frac{Exp_i}{Exp_{credit}} \cdot \frac{RWA_i}{Exp_i}\right] + RWA_{op} + RWA_{mkt}$$

$$RWA = Exp_{credit} \cdot \left[\sum_i Share_i \cdot RW_i\right] + RWA_{op} + RWA_{mkt}$$

Balance sheet size effect; Portfolio composition effect; **IRB ratings effect**

where: *RCD* = Regulatory calculation difference, the difference between provisions, and expected losses. Excess provisions may only be recognised up to a limit of 0.6% of credit risk-weighted assets.

RWA = Total (ie credit, market and operational) risk-weighted assets.

Exp = Total exposures (including notional exposure to market and operational risks).

$Share_i$ = Exposure share of portfolio *i* (relative to total credit exposures).

RW_i = Average risk-weight of portfolio *i* (*RWA* per credit exposure).

Definitions:

Capital: Total Tier 1, 2 and 3 capital, before deductions.

Deductions: Supervisory deductions from (Tier 1, 2 and 3) capital other than the regulatory calculation difference.

Regulatory calculation difference: The difference between total expected losses and total eligible provisions.

Exposures: For credit risk these are defined as the exposure at default, after taking into account credit risk mitigation (eg collateral) and 'credit conversion factors' (eg future draw-downs on committed lines of credit). This is in line with the definition of exposures used in FSA regulatory reporting.

(a) For brevity we group counterparty credit risk within market risk-weighted assets here, and abstract from any additional risk-weighted assets that may arise from large exposures.

focus on the average capital requirements for credit risk. These can usefully be viewed as a weighted average of average risk-weighted assets per unit of exposure at the portfolio level, with the weights being the exposure shares for each portfolio (corporate, mortgage, etc):

$$\frac{8\% \cdot RWA^{credit}}{EXP^{credit}} = \sum_{PF} \frac{Exposures_{PF}}{EXP^{credit}} \times \frac{8\% \cdot RWA_{PF}}{EXP_{PF}}$$

Where a change in ratings increases the average risk-weight assigned to a particular portfolio, risk-weighted assets overall will increase in proportion to that portfolio's size and, absent changes in provisioning, there will be greater deductions from capital arising from the regulatory calculation difference.

Comparison of movements in these average risk-weights with changes in the actual default experience for various types of borrower can allow a quantification of the sensitivity of internal rating systems to credit conditions. For example, the correlation between the realised aggregate corporate or mortgage default rate with average risk-weights assigned to those exposures might be tracked. Over time, this will enable an assessment to be made of how Basel II capital requirements might behave under stressed conditions, contributing to an understanding of the resilience of banks to stressed conditions under the Basel II regime.

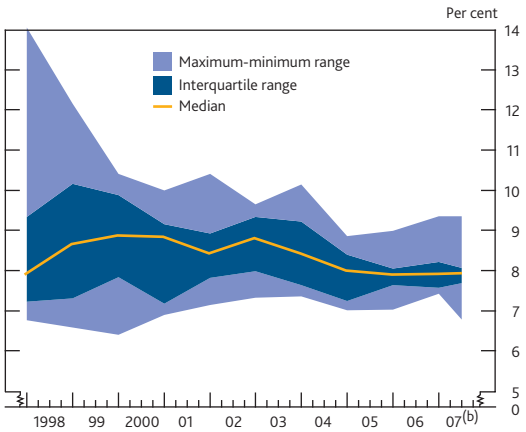
The Bank also plans to monitor the impact, if any, that changes in required capital have on actual capital and lending. This monitoring can draw on two additional sources of information. First, the Bank, through its monetary statistics, has detailed monthly information on the quantity of new bank lending. Second, the recently launched Bank of England Credit Conditions Survey contains questions asking banks about the impact of various factors on their loan supply (see Driver (2007)).

The Bank intends to publish the results of the monitoring exercise in future stand-alone articles, as well as in future *FSRs*, as part of its periodic assessments of the risks to and resilience of the UK financial system.

5 Market response to Basel II capital requirements

Under Basel I, banks have held a large buffer of capital over and above minimum regulatory requirements. For example, for the past decade, actual Tier 1 capital ratios for the major UK banks have fluctuated within a range of 6%–14%; significantly above the 4% Basel I minimum (**Chart 6**).

Chart 6 Major UK banks' Tier 1 capital ratios[a]



Sources: Published accounts and Bank calculations.

(a) All ratios reported on a Basel I basis.
(b) 2007 H1 figure.

These 'buffers' of capital above supervisory requirements can be explained in two ways. The first appeals to banks' capital planning motive. Banks may hold a 'voluntary' buffer of capital above requirements in order to manage the risk that negative shocks to earnings causes capital to fall below the regulatory minimum. Milne and Whalley (2001) demonstrate how banks with franchise value will build up a buffer of capital above the regulatory minimum to avoid the cost associated

with such a breach. Section 5 (a) below discusses how Basel II impacts on this capital planning motive for holding a buffer. A second explanation for the buffer is the effect of market discipline. Banks may be forced to maintain higher capital ratios than the regulatory minimum in order to maintain their external credit ratings and therefore to control the costs of wholesale funding. Nier and Baumann (2006) provide empirical evidence that stronger market discipline results in banks holding larger capital buffers, all else equal. Section 5 (b) discusses how market discipline might operate under Basel II.

(a) Capital planning under Basel II

One factor that might inhibit the ability of a bank to comply with capital requirements is an unexpected deterioration in economic conditions resulting in losses and therefore a reduction in actual capital. Under Basel II, it has been shown that, in addition, capital requirements themselves are likely to be more sensitive to economic conditions. This may change the size of the buffer of capital banks need to hold above current regulatory requirements in order to manage the risk that they fail to meet regulatory requirements in the future. Banks may need to stress the inputs to internal rating systems in order to evaluate the sensitivity of their rating systems to economic conditions and consider how a recession might impact on their ability to meet capital requirements. Though banks are able to manage their capital requirements and ratios by raising new capital, or securitising assets in benign conditions, these capital planning tools may not be available in such stressed circumstances. As a result a bank may be forced to cut back on new lending, and to decline to roll over maturing loans to existing borrowers, in order to comply with capital requirements.

From the point of view of the bank such actions result in reductions to its earnings and can damage its reputation with clients. Banks therefore have some private incentive to avoid this kind of outcome by maintaining a sufficient buffer of capital to allow them to continue to provide financial services across a range of economic conditions. However, if a deterioration in economic conditions resulted in widespread problems in meeting capital requirements (perhaps reflecting a widespread adoption of rating systems that are sensitive to the economic cycle), then individual banks might not suffer reputational damage from cutting back on lending to the same extent. Further, costs associated with a systemic reduction in credit provision (such as a disruption to financial stability or an exacerbation of an economic downturn) are likely to be external to any individual bank's lending decisions. For these reasons, there is a risk that the buffers of capital banks hold under Basel II will be insufficient from a public policy perspective. To address this risk, the FSA will therefore, as part of its supervisory review (Pillar 2) process, require banks to run stress tests that can be used to 'assess the effect of certain specific conditions on its total capital requirements for credit risk' and to 'assess the firm's ability to meet its capital requirements for credit risk… during all stages of the economic cycle and during an economic recession such as might be experienced once in 25 years'.(1)

(b) Market discipline under Basel II

Rating agencies and security analysts have historically attached some weight to Basel I capital ratios (actual capital relative to RWA) when assessing a bank's solvency. However, the lack of risk sensitivity in the Basel I framework can mean that two banks with very different levels of risk might have similar RWA and would thus be subject to the same Basel I capital requirement. Basel II improves on this situation by producing a capital requirement that is more closely aligned to the risks to which a bank is exposed.

However, different banks might use different approaches to constructing internal ratings systems under Basel II and therefore credit risk may not be measured consistently across banks. There is a risk that this might undermine the usefulness of Basel II capital ratios for peer comparison. **Table C** describes how the impact of internal ratings on capital ratios can be isolated from effects such as balance sheet size and portfolio composition. Under Pillar 3 of Basel II, banks will be required to disclose the average risk-weight that their IRB rating systems assign to exposures to the corporate, residential mortgages and other retail portfolios, as well as details of the rating system used to rate borrowers. These ratings impact on both the denominator (through risk-weights) and numerator (through Expected Loss amounts) of the capital ratio. When comparing a bank's capital ratio with its peers, rating agencies and analysts should also examine the average risk-weights that are applied to credit exposures and assess whether a bank is rating conservatively. Where banks have a similar business mix in a particular portfolio, their average risk-weights should also be similar. And if a bank appears to the market to be rating less conservatively than its peers, the market should demand a higher ratio of actual relative to required capital.

A similar principle needs to be applied over time. Where a bank's risk-weights appear to be fairly sensitive to economic conditions, the market should expect it to aim for a higher capital ratio in benign conditions when regulatory requirements are low, so that it is able to cope with any rise in requirements that would occur were conditions to deteriorate.

6 Conclusion

The use in Basel II of ratings to set capital requirements, while improving on the risk sensitivity of requirements, and encouraging better risk management, introduces the risk that

(1) See the FSA's Prudential Sourcebook for Banks, Building Societies and Investment Firms (BIPRU), 4.3.30R. Available online at: http://fsahandbook.info/FSA/html/handbook/BIPRU/4/3.

capital requirements may vary excessively with economic conditions. In response, the Bank and the FSA have set up a system to monitor the behaviour of aggregate Basel II requirements, and to identify shifts in requirements that might mean either that the capitalisation of the banking system is undermined during periods of strong economic growth, or that the ability of the banking systems to continue to provide financial services is impaired during periods of weak economic growth. But the industry, as well as market participants need also play their part in avoiding potential unintended consequences of Basel II — through careful capital planning by banks, and scrutiny, by market participants, of the outputs of banks' rating systems.

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