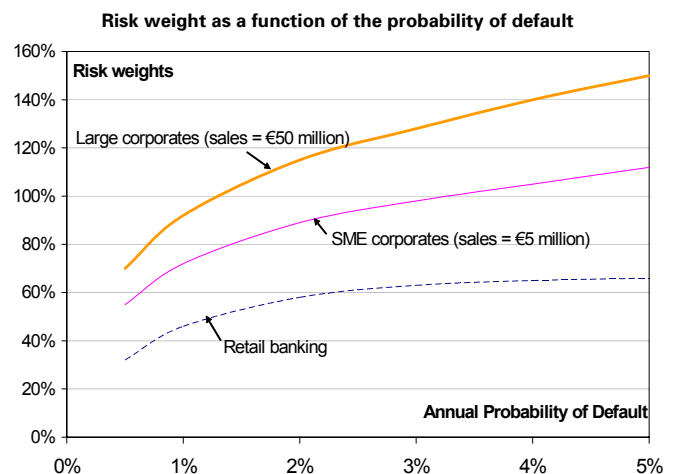




## Examining the impact of Basel II on the supply of credit to SMEs

- To safeguard against credit risk and prevent a systemic crisis, banks must comply with prudential regulations requiring them to hold a certain amount of capital for each loan granted. The Basel II Capital Accord has reformed the procedures for calculating regulatory capital - which now increases with borrower risk - as part of efforts to strengthen the stability of the international banking system. Basel II was implemented in Europe through Directive 2006/49/EC, which is currently being transposed in France.
- Basel II is designed to ensure that small and medium-sized enterprises (SMEs), which are theoretically riskier than big firms, are not hindered from accessing credit. Given the same probability of default (PD) and loss given default (LGD), bank loans to SMEs are subject to lower capital requirements than claims on larger firms (cf. chart). SME risk is highly idiosyncratic (linked to industry, local and human specific factors that banks can diversify by pooling a large number of claims on SMEs in their loan portfolios). The capital requirement for SME claims is estimated to be some 30% lower compared with Basel I.
- However, regulatory capital varies significantly with credit risk. This should encourage banks to price in closer accordance with company risk - something they do to a relatively small extent in France today. The observed dispersion of loan pricing is indeed far lower than the level that would have been expected if banks were lending to riskier-than-average firms and passing on the cost of risk in their margin.
- **By fostering a more risk-sensitive approach to bank's pricing, Basel II could bring pricing more in line with costs, ultimately improving the supply of credit to SMEs.**

This study was prepared under the authority of the Treasury and Economic Policy General Directorate and does not necessarily reflect the position of the Ministry of the Economy, Finance and Industry.



Source: Feri and DGTPE

*A risk weight of 100% corresponds to the Cooke ratio. This is the foundation internal ratings-based (IRB) approach.*

## 1. Impact of Basel II on SME-related regulatory capital requirements

### 1.1 From Basel I to Basel II

Set up in 1974 by the central bank governors of the G10 countries, the Basel Committee assigned itself the task of devising rules to strengthen the stability of the international banking system. Since achieving this goal meant first and foremost reducing the risk of bank failures, the Committee initially concentrated on credit risk and set a minimum level of capital that banks had to set aside to cover loan losses.

The Basel I Accord, which was designed to meet this objective, consisted of a set of recommendations put forward by the Committee in 1988. The main recommendation involved establishing the Cooke ratio, which required credit institutions to hold regulatory capital equal to at least 8% of their total loan commitments. In practice, under this rule, banks were required to finance at least €8 of every €100 loaned out of their own capital, while the remaining €92 could come from other sources of financing, such as deposits, borrowings and interbank financing.

The Cooke ratio was adjusted in the mid-1990s to include the management of off-balance sheet risks, such as those linked to derivatives. However, the ratio proved insufficient. One-size-fits-all prudential treatment for all loan commitments failed to capture the broad diversity of credit risk. Furthermore, Basel I concentrated on banks' credit risk, ignoring operational risk.

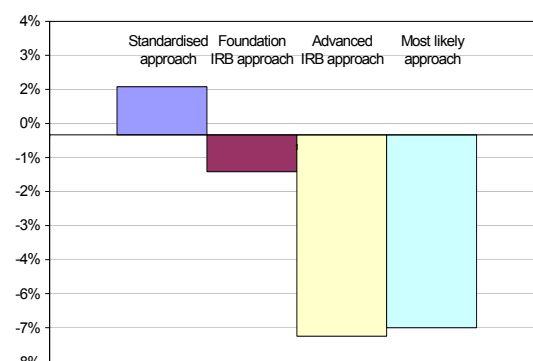
As a result, the Basel Committee reformed its prudential requirements by publishing the Basel II Accord in June 2004. Directives 2006-48 and 49 of 14 June 2006 introduced Basel II into European legislation, and Member States are in the process of transposing the Accord into domestic legislation and regulations.

Basel II has three pillars<sup>1</sup>. The first contains a set of quantitative regulatory provisions and makes banks' regulatory capital more sensitive to actual risk. Specifically, Basel II provides formulas for calculating regulatory capital that contain three main variables. Depending on the approach selected by banks, the first two of these variables - probability of default (PD) and loss given default (LGD) - are either calculated by the banks or derived from ratings provided by authorised external rating agencies. The third variable, which is the correlation R between the idiosyncratic risk peculiar to a loan and a systematic risk factor<sup>2</sup>, is defined on an ad hoc basis by the Basel Committee.

The coefficients used in the Basel II formulas to determine regulatory capital and correlations are the result of quanti-

tative studies conducted in all the countries affected by Basel II<sup>3</sup>.

Chart 1: reduction in regulatory capital compared with Basel I



loan portfolios of internationally active banks from G10 countries other than the US  
Source: QIS5.

### 1.2 Different approaches offered under Basel II

Banks can choose between two main types of approaches when risk weighting loans to determine the associated capital requirements (which have increasing risk sensitivity):

- **The external ratings-based or standardised approach**, where the regulator assigns risk weights based on ratings provided by authorised external credit assessment institutions<sup>4</sup>.
- **The internal ratings-based (IRB) approach, where banks rely on their own internal estimates of risk components to determine regulatory capital. This approach is based on measuring expected losses (EL) and unexpected losses (UL). Risk weight functions only include UL-only<sup>5</sup>.** There are two IRB variants:
  - The foundation (FIRB) approach, where banks are responsible for calculating the PD on each exposure but must use a supervisory value for LGD.
  - The advanced (AIRB) approach, where banks calculate not only the PD, but also three other variables included in the regulatory capital formula, namely LGD, exposure and maturity.

The largest banks are expected to adopt the AIRB approach. This should enable them to achieve substantial capital savings, in return for establishing systems that will ultimately result in better risk selection (cf. Chart 1).

(1) Pillar 2 improves domestic supervisory review processes. Pillar 3 strengthens market discipline, notably banks' financial disclosure requirements.

(2) Idiosyncratic risk is the specific risk associated with a given claim. It is linked to the peculiar characteristics of that claim (the health of an SME's senior manager, for example) and contrasts with systematic or macroeconomic risk, which affects all the claims in a category (e.g. the risk of a surge in oil prices).

(3) The most recent of these studies (QIS5) was released in June 2006.

(4) If the data do not allow this, the capital charges provided for under Basel I continue to apply.

(5) Because EL are provisioned elsewhere.

### 1.3 Given equivalent levels of risk, the Basel II formulas result in lower regulatory capital requirements for claims on SMEs

Basel II separates claims on SMEs into two categories: claims of less than €1 million are classified under retail banking, while claims of over €1 million are classified in the corporate portfolio.

The regulatory capital requirements for retail exposures and claims on SMEs treated as corporates are reduced by around 30% and 15%-20% respectively compared with claims on large companies displaying similar PD and LGD values. Table 1 shows that the regulatory capital charges for retail loans and credits to low-risk (risky) medium-sized and large companies will decline (increase) under Basel II. Moreover, these changes will be amplified if the bank uses the more sophisticated approach.

**SME loans receive special treatment as a precautionary measure designed to ensure that these companies are not overly penalised in terms of access to bank credit and to address the biases in the Basel II formulas.** This specific treatment is expressed in the formula for correlation R (cf. Box 3), in which correlation

is a decreasing function of PD and an increasing function of sales. Accordingly, correlation is lower for claims on SMEs. The presence in a portfolio of a claim that is weakly correlated with systematic risk enhances diversification, reducing overall risk and hence the associated regulatory capital requirements.

This choice is open to criticism from a theoretical perspective, but it has been empirically validated by several studies of portfolios of claims on internationally active corporates<sup>6</sup>. The assumption of a decreasing relationship between PD and the correlation with systematic risk is justified by the fact that a high PD essentially reflects idiosyncratic risk that in principle is independent from systematic risk.

However, studies carried out on country-level<sup>7</sup> and sector portfolios<sup>8</sup> find an increasing relationship, which, conversely, appears to suggest that a high PD means greater exposure to systematic risk.

This assumption nevertheless seems justified given the necessary simplifications implied by the Basel II formulas, which ignore certain elements particularly significant for SMEs:

**Table 1: Table 1: FIRB and AIRB risk weights<sup>a</sup>**

	LGD	SME								
		Retail			Corporate (sales=5M€)			Corporate (sales>=50M€)		
		40%	50%	70%	40%	50%	70%	40%	50%	70%
PD=0,5%	FIRB	32%			55%			70%		
	AIRB	28%	36%	50%	49%	61%	86%	62%	78%	109%
PD=1%	FIRB	46%			72%			92%		
	AIRB	41%	51%	72%	64%	80%	112%	82%	102%	143%
PD=2%	FIRB	58%			89%			115%		
	AIRB	52%	64%	90%	79%	99%	138%	102%	128%	179%
PD=3%	FIRB	63%			98%			128%		
	AIRB	56%	70%	98%	87%	109%	152%	114%	142%	199%
PD=4%	FIRB	65%			105%			140%		
	AIRB	58%	72%	101%	93%	117%	163%	124%	156%	218%
PD=5%	FIRB	66%			112%			150%		
	AIRB	59%	73%	103%	100%	124%	174%	133%	167%	233%

a. A risk weight of 100% corresponds to the Cooke ratio.

Source: "International Convergence of Capital Measurement and Capital Standards: A Revised Framework. Complete Version, BIS, June 2006.

Interpreting the table: a loan to an SME with sales of under €5 million and a PD of 1% will receive a risk weight of 72% under the FIRB approach, and a 64% (80%, 112%) weight under the AIRB approach if LGD is 40% (50%, 70%).

#### Box 1: Credit risk

Credit risk is the risk to the bank that a borrowing company will be unable to repay a loan under the initial terms. It is measured by computing the average expected loss, which is obtained for a given time horizon by multiplying the company's probability of default (PD) over the period by the percentage of the claim that will not be recovered, or loss given default (LGD).

Basel II uses a broader PD definition than that initially used by the Banque de France, which equated default with legal default, i.e. with the initiation of legal proceedings. To align itself more closely with the Basel II definition, under which default is considered to have occurred if an obligor is past due more than 90 days on an obligation or is unable to pay its credit obligations, the Banque de France introduced the notion of failure in addition to that of default. The failure category includes companies that are in legal default and companies with a payment rating of 9, which designates companies with reported payment incidents plus severe cash flow difficulties and compromised solvency. Payment ratings are issued by Banque de France analysts and measure the regularity of a company's payments.

If a company is unable to repay its entire obligation at the due date, the bank suffers a loss on the unsecured portion, which it covers with provisions. It covers the unexpected portion with its capital.

- (6) Cf. "The Empirical Relationship between Average Asset Correlation, Firm Probability of Default and Asset Size", J. Lopez, *Federal Reserve Bank of San Francisco*, 2002.
- (7) For an analysis of French data, see "The Credit Risk in SME Loans Portfolios : Modeling Issues», Pricing, and Capital Requirements", M. Dietsch and J. Petey, *Journal of Banking and Finance*, 2002.
- (8) "Asset Return Correlation and Basel II : the Case of Automotive Lease Portfolios", L. Duchemin, M.P. Laurent and M. Schmit, *Sohay Business School Working Paper*, 2003.

- Claims on SMEs introduce a significant diversification effect, since their risk is essentially idiosyncratic (e.g. human- or sector-related). The Basel II formula, which do not factor in correlations between the claims in a portfolio, may therefore underestimate the reduction in risk that results from holding a claim on an SME.
- The PD of a claim on SME is theoretically more volatile than that of a large company's. The Basel II formulas not take account of PD time variability. As a result, the correlation between the PD and systematic risk tends to be underestimated<sup>9</sup>, with the PD declining at the peak of the cycle and vice versa, especially in the case of claims on SMEs.

#### **1.4 On average, the regulatory capital requirements for portfolios of SME claims held by banks should decline**

**Studies simulating the capital charges applicable to SME loan portfolios concur that there will be an overall reduction for these portfolios.** France's banking commission, the Commission Bancaire, carried out a simulation involving the entire portfolio of bank loans to SMEs<sup>10</sup>. It estimated the average risk weight at 90.4%

under the revised standardised approach, 71.4% under the FIRB approach, and 67.4% under the AIRB approach (compared with 100% under Basel I). The latest EU simulations, which were published in June 2006 (QIS5), are consistent with these findings.

This average decline in capital charges stems essentially from loans classified under retail banking. According to the QIS5 findings, the capital charge for a portfolio of SME retail loans is 22% lower than Basel I under the revised standardised approach, 50% under the FIRB approach and 48% under the AIRB approach<sup>11</sup>.

However, there is no such consensus on the change in charges for claims on SME corporates. This change is harder to forecast because it is more dependent on the composition of bank portfolios. One study<sup>12</sup> of a portfolio of more than 200,000 claims on French SMEs using data from the Banque de France's central credit register and FIBEN database shows that if portfolios are invariant, the introduction of Basel II would result in risk weights of more than 100% for most of the portfolios comprising claims on SMEs treated as corporates<sup>13</sup>, regardless of the approach chosen.

## **2. Potential effects of Basel II on the supply of credit to SMEs**

### **2.1 The change in regulatory capital resulting from Basel II will probably affect banks' economic capital and hence their approach to supplying credit**

**Optimal economic capital, as determined by each bank, is higher on average than regulatory capital.** In the UK, between 1998 and 2002 economic capital was, on an individual basis, 50% higher on average than the level set by the UK's Financial Services Authority (FSA)<sup>14</sup>. In France, too, Tier 1 capital, which includes the highest-rated financial instruments, seems to be well above the regulatory minimum of 4% set by Basel II for this category<sup>15</sup>.

Banks maintain high Tier 1 ratios because they want to obtain a good rating that will enable them to finance themselves at a lower cost. In practice, each bank uses its own definition for economic capital, which represents a trade-off between the contrasting cost and risk requirements of stakeholders (like rating agencies and shareholders) and reflects the sophistication of the methods used by the bank to estimate the risk on its exposures.

Even if economic capital is currently higher than regulatory capital, an increase in the second may mechanically cause the former to rise. The rating agencies use regulatory capital as a benchmark and banks may attempt to partly maintain the gap between regulatory and economic capital in an effort to hold onto their rating and obtain attractive financing terms. Economic capital, though is also determined by other strategic factors, such as mergers and acquisitions, and this may mitigate the impact of Basel II.

The changes to banks' economic capital as a result of Basel II could affect the supply of credit by banks, particularly towards SMEs, which display highly variable risk. Specifically, the fact that capital charges on different loans vary to differing extents should lead to differences in the corresponding margins earned by banks. Based on their refinancing costs, banks could therefore modify the way they allocate credit supply.

(9) Hamerle, Liebig et Rösch, *ibid*.

(10) "Le Traitement des Engagements sur les PME dans Bâle II (CP3)", *Commission Bancaire Bulletin No. 30 of April 2004*. M. Dietsch and A. Tisseyre ("Bâle II et les PME: Prospective sur les Conditions d'Accès au Crédit des PME", *Revue Banque, No. 669*, May 2005) obtain comparable results.

(11) These reductions are averages calculated for the 18 EU countries selected for the study plus Bulgaria and Norway. They concern Group 1 banks, i.e. banks that are internationally active on several markets and have capital of over €3 billion. The main French banks fall into this category.

(12) "Le Traitement des Engagements sur les PME dans Bâle II (CP3)", *Ibid*.

(13) Conversely, risk weights would be lower than 100% for most of the portfolios containing SME retail loans.

(14) "What Determines how much Capital is held by UK Banks and Building Societies?" I. Alfon, I. Argimon et P. Bascuñana-Ambròs, *FSA Occasional Paper 22*, 2004.

(15) According to Fitch Ratings, all the major French banks had Tier 1 ratios of over 8% at end-2004. Tier 2 financial products are subject to an average requirement of 8%. See "No Fears for Tears - An Analysis of French Banks' Capital", *Fitch Ratings, June 2005*.

## 2.2 Basel II should encourage banks to price loans on a more risk-sensitive basis

In France, when banks price loans, they take relatively little account of the riskiness of the company. The observed dispersion of credit pricing is far narrower than the level that could have been expected if banks were lending to relatively risky companies and passing on the cost of risk in the loan interest rate (see Box 2).

Low and relatively uniform pricing may therefore prevent risky companies from obtaining bank credit. Banks compensate for low returns on loans with large mark-ups on other bank products that risky companies cannot access because of the uncertainty surrounding their long-term survival.

**Basel II could change this practice and make loan pricing more risk-sensitive.** According to a US study<sup>16</sup> the cost of a loan with a PD of 10% would increase by 200 basis points (bp)<sup>17</sup> under an advanced approach, compared with Basel I. However, the cost of loans to low-risk SMEs would decline only to a limited extent (up to 50 bp for a loan with a PD of 0.03%).

**Loan pricing spreads resulting from Basel II should be smaller than existing spreads in banks' EL costs (which represent the risk premium).** Under the advanced approaches, the price spread attributable solely to the new regulatory capital requirements is estimated at around 50 bp between a low-risk SME with sales of less than €5 million and a three-year PD of 4%, and a comparable risky company (PD of 15%)<sup>18</sup>. As a comparison, the observed difference in risk premiums amounts to 270 bp.

**In sum, by fostering more risk-sensitive pricing, Basel II could help align bank pricing with costs. This might mean that risky companies could be less excluded from credit than they are under the current system of relatively uniform pricing, ultimately improving credit supply.**

## 3. Potential procyclical effects

### 3.1 The Basel II formula could in theory make the capital adequacy ratio more volatile...

Basel II could make capital charges more procyclical compared with Basel I, because the denominator of the new capital adequacy ratio is now sensitive to economic conditions. In the event of a recession, the sum of weighted assets should theoretically increase in response to the higher PD, and, in the case of the AIRB approach, the

## 2.3 The coexistence of banks adopting different approaches might prompt institutions to specialise based on borrower's risk

Insofar as the IRB approaches under Basel II lead to greater differentiation of risk, which favours low-risk companies, Basel II could lead to competitive distortions by encouraging banks that have adopted an external ratings-based approach to focus on the riskiest loans, leaving the rest of the market to others. However, banks have developed scoring techniques that should enable them to identify risky high-margin loans, and this could limit the competitive distortions caused by the adoption of different approaches.

The problem is unlikely to arise in France, since almost all of the main banks seem to be gravitating towards either the FIRB or AIRB approach. For the most part, the French banks meet the size requirements of an IRB system.

By contrast, in the United States, Basel II could accentuate existing specialisations. Compared with community banks, large US banks assign a significantly smaller share of their credit supply to SMEs<sup>19</sup>.

In addition, SME lending by large banks is concentrated on low-risk SMEs that are big enough to be rated under internal scoring systems. Conversely, community banks entertain more individual relationships with their debtors, which gives them a competitive advantage on the credit market for younger and riskier businesses. The adoption of different approaches by these two types of banks is therefore likely to further accentuate specialisation in the United States, without necessarily affecting the aggregate supply of credit to SMEs. For the time being, only large US banking corporations are supposed to adopt Basel II, while the remaining 8,000 community banks remain subject to Basel I or to an improved version known as Basel IA.

higher LGD. This effect would be partly offset by the smaller increase or the decline in loan volumes.

Regulatory capital could be significantly more procyclical under Basel II compared with Basel I. The cyclical reversal between 1998 and 2002 caused capital charges to go up. The increase would have been even greater under Basel II calculation methods than it was under Basel I. Merely switching to Basel II would have increased the charge by

(16) "Loan Pricing under Basel Capital Requirements", R. Repullo et J. Suarez, 2004, *Journal of Financial Intermediation*.

(17) The model assumes fierce competition between banks and also assumes that banks reflect the entire change in their regulatory capital in their economic capital.

(18) See previous calculation and "Firms' access to bank credit", *Tresor-Economics No. 7, January 2007*. A simple calculation using a Capital Asset Pricing Model also estimates that the cost of a loan to an SME with sales of under €5 million goes up by 50 bp under the FIRB approach when the firm's one-year PD increases from 0.5% to 5%. This calculation uses a long-term risk-free rate of 3.5%, a market risk premium of 6% and a beta of 1.25.

(19) «Potential Competitive Effects of Basel II on Banks in SME Credit Markets in the US», A. Berger, *Board of Governors Of the Federal Reserve System*, 2004.

between 35% and 45% for a portfolio with an invariant composition over the period of US and European investment grade or non-investment grade claims (cf. Box 2).

If the increased procyclicality of regulatory capital is reflected in the procyclicality of credit supply, there is a danger that SMEs lending might be especially affected. For one thing, SMEs might see their PD increase more sharply following a deterioration in business conditions, because they are less able to withstand shocks. For another, SMEs generally find it harder to access bank credit and might be the first to be squeezed out if supply is curtailed.

### 3.2 ... but in practice banks already display a procyclical behaviour pattern that has little to do with capital charges

When economic conditions are unfavourable, banks tend to tighten their loan terms, reducing supply by more than the downturn in demand, and/or by modifying the composition of their claim portfolio.

Several studies have shown that under Basel I banks tended to reduce their supply of credit in the event of a cyclical reversal. In the United States, between 1989 and 1997, a 1% increase in capital requirements caused a 5.5% reduction in loan growth<sup>20</sup>.

This procyclical aspect of the credit supply appears to exist irrespective of the method used to calculate regulatory capital. In other words, there was a relationship between the risk "measured" by Basel II regulatory capital and lending activities before the new capital adequacy ratio was introduced. A simulation carried out using French data between 1993 and 2001 retrospectively constructed capital requirements under the Basel II FIRB approach and showed that there was indeed a relationship between capital requirements and loans granted, but that this relationship did not become significant until after four quarters<sup>21</sup>.

### 3.3 Several ways of reducing the procyclicality of regulatory capital have been examined as a result

Several technical proposals have been discarded:

- Countercyclical dynamic provisioning might have made the numerator less procyclical. However research on Basel I demonstrated that this procyclical element was not significant<sup>22</sup>.
- Smoothing risk weights based on economic expectations was ruled out because this would have worked counter to the risk differentiation targeted by Basel II.

#### Box 2: Company risk and loan pricing

The risk associated with a company and that company's ability to meet its financial commitments are estimated using statistical scoring methods that factor in the firm's age, size, sector of activity and financial ratios. These techniques yield a rating that sums up the risk associated with a given company.

Banks compute their own internal ratings. Specialised agencies like Moody's, Standard & Poors' and Fitch also rate large companies, and the Banque de France, too, compiles ratings, especially for SMEs. These ratings are used to calculate the risk premium, which is the difference between the interest rate at which a given company may take on debt, and the risk-free rate. The bank works out the risk premium when extending a loan. The risk premium on a bond is reflected in the market price. The premium compensates for the average expected loss of the lender on the claim.

In the case of a bank loan, the cost of risk theoretically built into the price of the loan may vary considerably, potentially exceeding 1,000 bp. In practice, loan pricing remains in a far narrower range of around 250 and 150 bp for small short- and medium-term loans, based on the difference between the first and the ninth deciles of the distribution of observed interest rates<sup>a</sup>. This suggests that banks do not pass on the full cost of risk or lend only to relatively low-risk companies.

The risk premium on a bond also varies significantly with the rating assigned by the main rating agencies. Borrowers that qualify as "investment grade" are deemed to be low risk and get the highest ratings, i.e. long-term ratings of BBB- or greater from Standard & Poors' and Baa3 and higher from Moody's. Riskier borrowers come under the speculative category and are rated lower than BBB- and Baa3.

The risk premium on a bond is also called the spread and corresponds to the difference between the cost of credit for an AAA rated borrower and a riskier borrower. In 2006, average credit spreads stood at around 60 bp (300 bp) for investment grade (speculative) private borrowers in Europe.

a. These intervals are computed from the Banque de France's survey of the cost of business credit in third-quarter 2006.

(20) "Evidence on the Response of US Banks to Changes in Capital Requirements", C. Furfine, BIS *Working Paper* N°88, 2004.

(21) "Exigences de Capital et Cycles Économiques : Une Etude Empirique sur les Données Françaises", V. Oung, *Bulletin de la Commission Bancaire*, n°28, April 2003. The authors use data from the central credit register and Banque de France scores.

(22) See for example "Bâle II: Un peu, Beaucoup (ou pas du tout) Procyclique?", F. Béranger and J. Téiletche, *Flash CDC IXIS*, November 2003.

## Box 3: Basel II formulas for calculating regulatory capital charges and correlations for SMEs under IRB approaches

### 1. Asymptotic single risk factor model

The Basel II formulas estimate the amount of regulatory capital associated with an exposure that will cover unexpected loss in 99.9% of cases. The corresponding threshold of the claim's value, the Value-at-Risk (VaR), is estimated using an asymptotic single risk factor model.

The model takes into account only the correlation between the idiosyncratic risk of an exposure and the systematic risk, ignoring correlations between the idiosyncratic risks of different claims in a portfolio. It is based on the assumption that idiosyncratic risks tend to cancel themselves out when a portfolio is made up of many small exposures. It therefore applies to diversified portfolios, in accordance with one of the objectives of the Basel Committee, which is to encourage banks to diversify their assets.

### 2. Basel II formulas

*Regulatory capital formulas:*

The single risk factor model defines regulatory capital  $K$  as the difference between expected loss and  $VaR(\tau)$ . The value of an exposure  $Z_i$  is defined as a linear combination of two independent Gaussian variables: the systematic risk factor  $x$  and idiosyncratic risk<sup>a</sup>  $\varepsilon_i$ . The degree of exposure to systematic risk is written  $w$ .  $Z_i$  is defined by:

$$Z_i = wx + \sqrt{1-w^2} \varepsilon_i$$

PD is the average probability on a one-year horizon that the value of the exposure will fall below  $\tau$  which corresponds to the "acceptable" level of systematic risk, i.e.:

$$PD = Pr(Z_i \leq \tau) = \Phi(\tau)$$

where  $\Phi$  is the distribution function of the standard normal distribution. Default therefore occurs when :

$$Z_i \leq \Phi^{-1}(PD(x)), \text{ where } \varepsilon_i \leq \frac{\Phi^{-1}(PD) - wx}{\sqrt{1-w^2}}$$

The PD conditional on systematic risk,  $PD(x)$ , is defined implicitly, as follows :

$$PD(x) = \Phi\left[\frac{\Phi^{-1}(PD) - wx}{\sqrt{1-w^2}}\right]$$

The Basel II formulas use this definition, adding maturity adjustments<sup>b</sup> for large corporates and a risk-based reduction for retail exposures. Further, correlation  $w^2$  is replaced by  $R^2$ , which is defined on an ad hoc basis in the formulae given below. All the variables in the following formulas are a function of systematic risk  $x$ .

- For retail exposures:

$$K = LGD * \Phi\left(\frac{1}{\sqrt{1-R^2}} \Phi^{-1}(PD) + \frac{R}{\sqrt{1-R^2}} \Phi^{-1}(0,999)\right) - PD * LGD$$

- For exposures involving SMEs classified as corporates:

$$K = \left[ LGD * \Phi\left(\frac{1}{\sqrt{1-R^2}} \Phi^{-1}(PD) + \frac{R}{\sqrt{1-R^2}} \Phi^{-1}(0,999)\right) - PD * LGD \right] \times \frac{1 + (M - 2,5) * b(PD)}{1 - 1,5 * b(PD)}$$

where :

- $b(PD) = (0,11852 - 0,05478 * \log(PD))^2$  is a maturity adjustment
- $M$  is the average maturity of exposures.

*Correlation formulas:*

The correlation formulas are calibrated to ensure that aggregate regulatory capital is unchanged from Basel I and that there are no threshold effects resulting from the special treatment for SMEs.

- For retail exposures:

$$R^2 = 0,03 * \frac{1 - e^{-35 * PD}}{1 - e^{-354}} + 0,16 * \left[ 1 - \frac{1 - e^{-35 * PD}}{1 - e^{-35}} \right]$$

- or exposures involving SMEs classified as corporates:

$$R^2 = 0,12 * \frac{1 - e^{-50 * PD}}{1 - e^{-50}} + 0,24 * \left[ 1 - \frac{1 - e^{-50 * PD}}{1 - e^{-50}} \right] - 0,04 * \left[ 1 - \frac{S - 5}{45} \right]$$

where  $S$  denotes the company's annual sales, which are assumed to be between €5 million and €50 million.

- Correlation  $R$  is equal to  $corr(Z_i, Z_j)$ . It does not depend on idiosyncratic risk because the Gaussian variables that capture it are independent.
- The decision to adjust for maturity reflects the intuitive notion that, on the one hand, risk increases with loan duration and, on the other, the likelihood that the PD will deteriorate increases when the PD is low to start with and the maturity of the exposure is large. These factors suggest that regulatory capital should increase with maturity.

- Having the probability of bank failure (set at 0.01%) vary as a function of economic conditions might have limited the adverse effects of capital scarcity<sup>23</sup>, but might also have encouraged banks to take on excessive risk<sup>24</sup>.
- However, under the European Directive that incorporates Basel II, the new ratio will be regularly tested for procyclicality. Also, the Accord's second pillar provides for regular crisis simulations and allows supervisors to require a bank to reduce its risks or to increase its reserves if economic capital is deemed too low<sup>25</sup>. However, the impact on procyclicality of requiring economic capital to be greater than regulatory capital will depend on the size of the surplus required by the supervisor, which is not specified in the Accord, and on the methods used to simulate crises.

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(23) "Cyclical Implications of the Basel II Capital Standards", A. Kashyap and J. Stein, *Economic Perspectives*, 2004.

(24) Banks would have less reason to monitor their risks if regulatory capital requirements were reduced when economic conditions deteriorate.

(25) There are also arrangements to cap the reduction in capital requirements of banks that adopt an IRB approach.

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