Capital Requirements for SMEs under the Revised Basel II Framework

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Abstract

This article reviews the final changes in the Benchmark Risk Weight Function of the Basel-II proposal as of June 2004. A special focus is directed to the impact of the proposed changes to the segment of Small and Mid-Sized Enterprises (SME). One of the main objectives of the recalibration of the IRB approach was to relieve capital requirements for these institutions. We further provide a comprehensive survey of empirical findings on the relationship between the asset correlation and the model parameters probability of default (PD) and firm size. We find that neither the level of asset correlation nor the assumed relationship between correlation and probability of default as it is assumed in the capital accord can be observed in the market. In a final case study we investigate the implications of changes in regulatory capital on credit spreads for SMEs.

Keywords: Basel Capital Accord, SMEs, Capital Requirements, Asset Correlations

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1 Introduction

The first pillar of the new Basel-II regulatory framework embeds the concept of risk based capital requirements, the so-called IRB (internal-ratings-based) approach. Under this approach the amount of capital a bank is required to hold in order to cover potential future losses, is no longer a fixed percentage as in the first accord but determined by a more refined system. To cite the third consultative document of the Basel capital accord (BIS, 2003):

"The IRB approach is based on measures of unexpected losses (UL) and expected losses (EL). The risk-weight functions produce capital requirements for the UL portion whereas the Expected losses are treated separately".

The measure of UL is in its turn a measure of risk. The most prominent risk measure in the industry is Value at Risk (VaR) which was introduced by JP Morgan in the 1990s. One can loosely speak of Value at Risk as the amount of capital which can be lost within the next year, if the next year is a really bad one. Value-at-Risk is the 95% quantile of the loss distribution and can therefore be quantified as the amount of capital that is lost, if an even worse outcome only had less than a 5% chance. To calculate VaR a model for the determination of the loss distribution of a bank’s portfolio is needed. An industry-wide used class of models are the so called one factor models which will be described in more detail later. The Basel committee has adopted the concept of VaR as the main risk measure. However, its measure for UL is not a pure implementation of VaR but relies on VaR as its foundation. The functions in the IRB approach were developed on the basis of survey and model-based evidence and are in that sense an interpolation of empirical and mathematical research.

In section 2 we present the main input variables and the derivation of the benchmark risk weight function that is used for calculation of the required capital for a loan portfolio in the Basel approach. In section 3 we review the calibration and the changes in the BRW function from the perspective of capital requirements for SMEs. Concentrating on the assumed relationship between PD, firm size and asset correlation, several empirical studies of the parameters and the changes of the IRB functions in the Basel capital accord will be discussed in section 4. Section 5 provides a case study about the impact of the IRB proposal on the credit conditions for German SMEs.
Figure 1: VaR(95%) and EL. A worse outcome than the VaR(95%) is a loss in the shaded region.

Section 6 summarizes the results.

2 The IRB approach - Risk Components, Key Elements and the Benchmark Risk weight function

In this section we give a brief overview of the main ideas and input parameters of the IRB approach for corporate exposures in the new Basel Capital Accord. We further illustrate the one-factor model that is used for derivation of the so-called benchmark risk weight function in the IRB approach. The Internal Rating Based approach relies - in opposite to Basel I or the basic Standardised Approach of Basel II - heavily upon a bank’s internal assessment of its counterparties and exposures.

2.1 Key elements and Risk Components

According to the consultative document, the IRB approach has five key elements:
1. A classification of the exposures by broad exposure type.

2. For each exposure class, certain risk components which a bank must provide, using standardized parameters or its internal estimates.

3. A risk-weight function which provides risk weights (and hence capital requirements) for given sets of these components.

4. A set of minimum requirements that a bank must meet in order to be eligible for IRB treatment for that exposure.

5. Across all exposure classes, supervisory review of compliance with the minimum requirements.

The capital charge for the exposures then depends on a set of four risk components (inputs) which are provided either through the application of standardised supervisory rules (foundation methodology) or internal assessments (advanced methodology), subject to supervisory minimum requirements.

Probability of Default (PD): All banks – whether using the foundation or the advanced methodology – have to provide an internal estimate of the PD associated with the borrowers in each borrower grade. Each estimate of PD has to represent a conservative view of a long-run average PD for the grade in question and has to be grounded in historical experience and empirical evidence. The preparation of the estimates, the risk management processes, and the rating assignments that lay behind them have to reflect full compliance with supervisory minimum requirements to qualify for the IRB recognition.

Loss Given Default (LGD): While the PD – associated with a given borrower – does not depend on the features of the specific transaction, LGD is facility-specific. Losses are generally understood to be influenced by key transaction characteristics such as the presence of collateral and the degree of subordination. The LGD value can be determined in two ways: In the first way – respectively under the foundation methodology – LGD is estimated through the application of standard supervisory rules. The differentiated levels of LGD are based upon the characteristics of the underlying transaction, including
the presence and the type of collateral. The starting point is a value of 50% for most unsecured transactions whereas a higher value of 70% is applied to subordinated exposures, but the percentage can be scaled to the degree to which the transaction is secured. If there is a transaction with financial collateral, a so-called haircut methodology is used.\textsuperscript{2} In the advanced methodology LGD – which is applied to each exposure – is determined by the banks themselves. Thus, banks using internal LGD estimates for capital purposes are able to differentiate LGD values on the basis of a wider set of transaction and borrower characteristics.

**Exposure at Default (EAD):** As with LGD, EAD is also facility-specific. Under the foundation methodology, EAD is estimated through the use of standard supervisory rules and is determined by the banks themselves in the advanced methodology. In most cases, EAD is equal to the nominal amount of the exposure but for certain exposures – e.g. those with undrawn commitments – it includes an estimate of future lending prior to default.

**Maturity (M):** Where maturity is treated as an explicit risk component, like in the advanced approach, banks are expected to provide supervisors with the effective contractual maturity of their exposures. Where there is no explicit adjustment for maturity, a standard supervisory approach is presented for linking effective contractual maturity to capital requirements.

After introducing the input parameters of the IRB approach we will now briefly describe how the benchmark risk weight function in the new accord can be derived based on a so-called one-factor credit risk model.

### 2.2 Derivation of the Benchmark Riskweight Function

In credit risk models the discrete event of default is often modelled with a random variable $Y$ which follows a Bernoulli law. This means that $Y$ can take on either 0 or 1 where we assume that $Y = 1$ indicates that the firm defaults.

Since the seminal work of Merton in 1972, the so-called structural models using the value of the firm as input variable for determining default proba-

\textsuperscript{2}A separate set of LGD values is applied to transactions with real estate collateral.
bilities are very popular in credit risk management. In a Merton-style model a firm is said to default if the value of the total assets drops below a certain threshold $D$, the contractual value of its obligations. The probability of default thus becomes

$$P(Y = 1) = P(V < D).$$

The idea of a company defaulting if the value of its assets falls below a threshold $c_i$ is also used in the derivation of the credit Value-at-Risk model of the Basel committee. Let therefore be $Z_{i,t}$ the asset change of company $i$ within a time interval $t$. In the so-called one-factor models, e.g. (Belkin et al., 1998) $Z_{i,t}$ is considered to have a Gaussian distribution with mean 0 and variance 1. This variable can be decomposed in the following way:

$$Z_{i,t} = \sqrt{\rho} X_t + \sqrt{1 - \rho} \varepsilon_{i,t}$$  

$X_t \sim N(0,1)$  

$\varepsilon_{i,t} \sim N(0,1)$ \hspace{1cm} (2.1)

The interpretation is that the random effect of the asset value of borrower $i$ is a combination of a systematic risk factor $X_t$ which affects all borrowers, and an idiosyncratic risk factor $\varepsilon_{i,t}$ affecting only borrower $i$. $\sqrt{\rho}$ is often called the factor loading of the systematic risk factor and is interpreted as the sensitivity against systematic risk. Put mathematically it is simply the square root of the correlation coefficient of the asset value process with the systematic factor.

As it is shown in (Vasicek, 1997), the probability of default can now be formulated as

$$P(Y_{i,t} = 1) = P(Z_{i,t} < c_i) = \Phi(c_i)$$ \hspace{1cm} (2.2)

This is the unconditional default probability. If the outcome of the systematic risk factor was known, we could calculate the conditional probability of default

$$P(Y_{i,t} = 1|X_t = x) = P(Z_{i,t} \leq c_i|X_t = x)$$

$$= P(\sqrt{\rho} X_t + \sqrt{1 - \rho} \varepsilon_{i,t} \leq c_i|X_t = x)$$

$$= P(\varepsilon_{i,t} < \frac{c_i - \sqrt{\rho} x}{\sqrt{1 - \rho}}|X_t = x)$$

$$= \Phi\left(\frac{c_i - \sqrt{\rho} x}{\sqrt{1 - \rho}}\right)$$
\( \Phi \) denotes the cumulative standard normal distribution function. Having modelled the probability of default for an individual loan, we now have to establish a model for a whole loan portfolio. Consider a Portfolio consisting of \( n \) loans to different borrowers where each borrower’s probability of default is modelled as described above. We further assume that all borrowers have the same default threshold \( c \). Then conditional on the state of the economy \( X = x \), the probability of having \( k \) defaults in the portfolio is binomially distributed.

\[
P \left( \sum_{i=1}^{n} Y_{i,t} = k \right| X_t = x \right) = \binom{n}{k} (p(x))^k (1 - p(x))^{n-k} \quad (2.3)
\]

\[
p(x) = \Phi(c - \sqrt{\rho x}) / \sqrt{1 - \rho}
\]

Using the law of iterated expectations the probability of \( k \) defaults is the expected value of the conditional probability of \( k \) defaults:

\[
P \left( \sum_{i=1}^{n} Y_{i,t} = k \right) = \int_{-\infty}^{\infty} P \left( \sum_{i=1}^{n} Y_{i,t} = k \right| X_t = x \right) \phi(x) dx = 
\]

\[
= \int_{-\infty}^{\infty} \binom{n}{k} \left( \phi \left( c - \frac{\sqrt{\rho x}}{\sqrt{1 - \rho}} \right) \right)^k \left( 1 - \phi \left( c - \frac{\sqrt{\rho x}}{\sqrt{1 - \rho}} \right) \right)^{n-k} \phi(x) dx \quad (2.4)
\]

Having described the theoretical model of defaults, we will now investigate how these equations are linked to the Basel IRB framework. As it was mentioned above the IRB functions are based on the Value at Risk measure. In this section we presented a method to calculate the loss distribution, which is needed to calculate VaR. With the probability of \( k \) defaults in a homogenous portfolio of size \( n \) given in equation (2.4), the cumulative loss distribution function of the portfolio is

\[
P \left( \sum_{i=1}^{n} Y_{i,t} \leq m \right) = \sum_{k=0}^{m} \int_{-\infty}^{\infty} \binom{n}{k} (p(x))^k (1 - p(x))^{n-k} \phi(x) dx. \quad (2.5)
\]

Thus, to determine for example the Value-at-Risk at the 99.9\% level one would need to compute \( P^{-1}(0.999) \). This is tedious work and will have to be done numerically. Fortunately, VaR can be approximated efficiently in
one-factor models. The most prominent article is due to (Gordy, 2002) and provides a portfolio-invariant rule for capital charges at the level of a single loan and thus the foundation of the Basel IRB function.

Let $\alpha_{0.999}$ denote the adverse 99.9% quantile of the state of the economy $X_t$, meaning that a worse outcome of the systematic risk factor only has a 0.01 percent chance. Since $X_t$ is standard normally distributed with small values of $X_t$ being unfavorable to a firm, $\text{VaR}(99.9\%) = \Phi^{-1}(0.001)$. Conditional on this bad state of the economy, the probability of default for an individual loan is:

$$P(Y_{i,t} = 1|X_t = \alpha_{0.999}) = \Phi\left(\frac{c_i - \sqrt{\rho}\Phi^{-1}(0.001)}{\sqrt{1 - \rho}}\right)$$

and the expected loss on the loan is:

$$E[L_{i}]|X_t = \alpha_{0.999}] = LGD \cdot \Phi\left(\frac{c_i - \sqrt{\rho}\Phi^{-1}(0.001)}{\sqrt{1 - \rho}}\right)$$

(2.6)

Gordy shows in his work how the sum of these expected conditional losses approaches the true $\text{VaR}(99.9\%)$ of the whole loan portfolio.$^3$

The threshold $c_i$ can be determined from the PD of the respective loan in the following way:

$$PD_i = P(Y_{i,t} = 1) = P(Z_{i,t} < c_i)$$

Since $Z_{i,t} \sim N(0, 1)$ it follows that

$$PD_i = \Phi(c_i) \Leftrightarrow \Phi^{-1}(PD_i) = c_i$$

(2.7)

Taken together (2.6) and (2.7) yield the core of the Basel IRB function to determine the regulatory capital charge on a single loan. With the fact that the standard normal distribution is symmetric around the origin we get:

$$E[L_{i}]|X_t = \alpha_{0.999}] = LGD \cdot \Phi\left(\frac{\Phi^{-1}(PD_i) + \sqrt{\rho}\Phi^{-1}(0.999)}{\sqrt{1 - \rho}}\right)$$

(2.8)

This can be considered as the core of the benchmark risk weight function in the new Basel capital accord. We will now take a look at the calibration of this function with focus on its effect on capital requirements for small and medium sized enterprises (SMEs).

$^3$For the needed regularity conditions and the exact type of convergence we refer to (Gordy, 2002)
3 Calibration of the Benchmark Risk Weight Function

3.1 The January 2001 Consultative Document

In the previous section we introduced the key risk factors according to the Basel committee and illustrated the derivation of the benchmark risk weight function. According to the second consultative document (CP2) the risk weighted assets (RWA) should be calculated using the formula:

\[
RWA = \min \left[ \frac{LGD}{50} \cdot K(PD) \cdot (1 + b(PD) \cdot (M - 3); 12.5 \cdot LGD \right] \quad (3.1)
\]

Obviously next to the probability of default \(PD\) also the factors Loss Given Default \(LGD\) and maturity \(M\) enter the calculation of risk weighted assets. The factor \(b(PD)\) is a maturity adjustment and \(K(PD)\) the calibrated benchmark risk weight function.

Especially in the advanced IRB approach maturity is treated as an explicit risk component. The sensitivity of a loan’s end-of-horizon value to a credit quality deterioration short of default is dependent on its maturity. As a consequence, maturity has a substantial influence on economic capital within so-called mark-to-market (MTM) models, with longer-maturity loans requiring greater economic capital. The schedule of maturity adjustment factors was based on an underlying MTM calibration approach. The calibration of \(b(PD)\) according to the committee was a smooth functional relationship between \(PD\) and \(b(PD)\):

\[
b(PD) = \frac{0.0235 \cdot (1 - PD)}{PD^{0.44} + 0.047 \cdot (1 - PD)}. \quad (3.2)
\]

Further, the calibrated benchmark risk function was of the form

\[
K(PD) = 976.5 \cdot \Phi \left( \frac{\Phi^{-1}(PD) + \sqrt{0.20} \cdot \Phi^{-1}(0.995)}{\sqrt{1 - 0.20}} \right) \cdot \left( 1 + 0.047 \cdot \frac{1 - PD}{PD^{0.44}} \right) \quad (3.3)
\]
It is easy to see that the parameter for the asset correlation was set to \( \rho = 0.2 \) for all loans while the quantile for Value-at-Risk calculation was set to the 99.5% level. Further the above expression consisted of three separate factors. The first term 976.5 was a constant scaling factor to calibrate the \( K(PD) \) to 100% for \( PD = 0.7\% \) and \( LGD = 50\% \). The second term \( \Phi(1.118 \cdot \Phi^{-1}(PD) + 1.288) \) represented the sum of EL and UL and was associated with a hypothetical, infinitely-granular portfolio of a one-year loan having a LGD of 50%, based on the idea of the one-factor model as it was described in the previous section. The last factor \( (1 + 0.047 \cdot (1 - PD)/(PD^{0.44})) \) was an adjustment to reflect that the benchmark risk weights for corporates were calibrated to a three-year average maturity.

![Figure 2: (Benchmark) Risk Weights as a Function of PD](image)

A graphical depiction of IRB risk weights according to the January 2001 consultative document for a hypothetical corporate exposure having an LGD equal to 50% without an explicit maturity dimension is presented in figure 2. Some exemplary risk weights for given PD according to the second consultative document are presented in table 3.1. It should be noted that there is a minimum risk weight of 14.1 based on a 0.03%-floor which was imposed for PD values by the committee. The floor is due to the committees evaluation of banks difficulties in measuring PDs adequately. Further the risk weights were capped at 625% which corresponds to a PD of exactly 17.15%.
<table>
<thead>
<tr>
<th>PD (in %)</th>
<th>BRW (in %)</th>
<th>PD (in %)</th>
<th>BRW (in %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.03</td>
<td>14.1</td>
<td>1.0</td>
<td>125.0</td>
</tr>
<tr>
<td>0.05</td>
<td>19.1</td>
<td>2.0</td>
<td>192.4</td>
</tr>
<tr>
<td>0.1</td>
<td>29.3</td>
<td>3.0</td>
<td>246.0</td>
</tr>
<tr>
<td>0.2</td>
<td>45.1</td>
<td>5.0</td>
<td>331.4</td>
</tr>
<tr>
<td>0.4</td>
<td>69.9</td>
<td>10.0</td>
<td>482.4</td>
</tr>
<tr>
<td>0.5</td>
<td>80.6</td>
<td>15.0</td>
<td>588.0</td>
</tr>
<tr>
<td>0.7</td>
<td>99.8</td>
<td>20.0</td>
<td>668.2</td>
</tr>
</tbody>
</table>

Table 1: Exemplary Benchmark Risk Weights for Corporate Exposures according to the second consultative document of January 2001.

3.2 Criticism of the IRB Approach

The suggestions of the IRB approach of the second consultative document were subject to extensive discussions. Especially small and medium-sized companies (SMEs) were afraid of higher capital costs for banks that would lead to worse credit conditions for these companies. Also the desired incentive character of the IRB approach for banks was very questionable, since risk weights in many cases were rather higher for the IRB approach than for the STD approach. There was a clear tendency in the IRB approach of assigning lower risk weights to companies with a very good rating and much higher risk weights to such companies with a rating worse than BB-. Since especially SMEs could rarely obtain a rating in one of the first three categories, according to CP2 banks would have to hold a higher amount of capital for such companies. Therefore, especially small and medium sized companies and companies with a rating in the speculative grade area were afraid to suffer from higher capital costs for the banks that would be passed down to the companies.

Another questionable issue was the assumed linear relationship between maturity and the assigned risk weights of the second consultative document.

Comparing the assigned Risk Weights to actually observed spreads in the market, one could find that for high rated bonds credit spreads rise - maybe even in a linear relationship - with longer maturities. This behavior matches the model of the Basel committee where higher risk weights are assigned to
exposures with longer maturities. However, especially for lower rated bonds market credit spreads do not show a positive correlation with maturity. For $Ba$ rated bonds the spreads are constant while for single $B$ rated bonds the spreads fall from year one. The reason for the falling credit spreads in lower rating categories can be explained empirically by the fact that as the threat of default recedes, risk neutral investors require a smaller yield spread to compensate them for expected default loss. This market behaviour of credit spreads was not incorporated in CP2. Even worse, many SMEs were afraid that due to higher risk weights for long-term loans, banks could even refuse to make such contracts anymore.

The problems and criticism mentioned above was also confirmed by so-called quantitative impact studies (QIS) conducted by banks for the Basel committee. According to a study for several of the G10 major banks the capital requirements would have been between 6% and 14% higher. Therefore, the goals of the accord to keep the overall capital unchanged were not satisfied. Thus, obviously to match the goals set by the committee there was need for a revision of some features in the accord - especially for the BRW function in the IRB approach that should provide an incentive for banks to refine their risk management procedure.
3.3 Changes in the final version of the IRB approach

Due to the severe criticism of the second consultative document there were several changes in the Basel Capital Accord until in June 2004 the final version of the framework (BIS, 2004) was published. In this section we will illustrate some of the changes in the final version with respect to the effect on capital requirements especially for SMEs.

3.3.1 Treatment of SMEs

One of the major criticisms was the treatment of more risky loans or companies especially small and medium-sized companies (SMEs). Generally, SME borrowers are defined as companies with less than Euro 50 Million in annual sales - thus, e.g. in Germany more than 90% of the companies will fall into this class. In recognition of the different risks associated with SME borrowers, under the IRB approach for corporate credits, banks will now be permitted to separately distinguish loans to SME borrowers from those to larger firms.

Banks that manage small-business-related exposures in a manner similar to retail exposures will be permitted to apply the less capital requiring retail IRB treatment to such exposures, provided that the total exposure of a bank to an individual SME is less than Euro 1 Million. Such exposures are then treated the same way as credits to private customers. The committee assumes that this should result in an average reduction of approximately ten percent across the entire set of SME borrowers in the IRB framework for corporate loans.

Furthermore, several changes in the benchmark risk weight function that will be described later were especially designed to reduce regulatory capital for exposures to SMEs.

3.3.2 Changes in the Maturity Adjustment term

A second criticised drawback was the assigned maturity adjustment in CP2 - especially the linear relationship between maturity horizon and the assigned risk weights for more risky loans. In the IRB foundation approach now all exposures will now be assumed to have an average maturity of 2.5 instead of 3 years.

Additionally, in the advanced IRB approach in recognition of the unique characteristics of national markets, supervisors will have the option of ex-
empting smaller domestic firms from the maturity framework. In this framework smaller domestic firms are defined as those with consolidated sales and consolidated assets of less than Euro 500 Million. If the exemption is applied, those firms will be assumed to have an average maturity of 2.5 years, as under the foundation IRB approach.

For firms with sales greater than Euro 500 Million in the advanced IRB approach the maturity adjustment will be included according to the factor

\[
\frac{(1 + b(PD) \cdot (M - 2.5))}{1 - 1.5b(PD)}
\]

with

\[
b(PD) = (0.11852 - 0.05478 \log(PD))^2.
\]

The denominator in the fraction can be interpreted as an adjustment to the average maturity of 2.5 years while the numerator is the maturity adjustment based on the PD of the exposure and its maturity.

<table>
<thead>
<tr>
<th>PD</th>
<th>M=1</th>
<th>M=2</th>
<th>M=2.5</th>
<th>M=3</th>
<th>M=4</th>
<th>M=5</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.03%</td>
<td>1.00</td>
<td>1.604</td>
<td>1.906</td>
<td>2.208</td>
<td>2.811</td>
<td>3.415</td>
</tr>
<tr>
<td>0.05%</td>
<td>1.00</td>
<td>1.501</td>
<td>1.752</td>
<td>2.002</td>
<td>2.504</td>
<td>3.005</td>
</tr>
<tr>
<td>0.10%</td>
<td>1.00</td>
<td>1.392</td>
<td>1.588</td>
<td>1.784</td>
<td>2.177</td>
<td>2.569</td>
</tr>
<tr>
<td>0.50%</td>
<td>1.00</td>
<td>1.223</td>
<td>1.334</td>
<td>1.446</td>
<td>1.669</td>
<td>1.892</td>
</tr>
<tr>
<td>1.00%</td>
<td>1.00</td>
<td>1.173</td>
<td>1.260</td>
<td>1.346</td>
<td>1.520</td>
<td>1.693</td>
</tr>
<tr>
<td>5.00%</td>
<td>1.00</td>
<td>1.091</td>
<td>1.136</td>
<td>1.182</td>
<td>1.272</td>
<td>1.363</td>
</tr>
<tr>
<td>10.00%</td>
<td>1.00</td>
<td>1.066</td>
<td>1.099</td>
<td>1.132</td>
<td>1.197</td>
<td>1.263</td>
</tr>
<tr>
<td>15.00%</td>
<td>1.00</td>
<td>1.053</td>
<td>1.080</td>
<td>1.107</td>
<td>1.160</td>
<td>1.214</td>
</tr>
<tr>
<td>20.00%</td>
<td>1.00</td>
<td>1.046</td>
<td>1.068</td>
<td>1.091</td>
<td>1.137</td>
<td>1.183</td>
</tr>
<tr>
<td>25.00%</td>
<td>1.00</td>
<td>1.040</td>
<td>1.060</td>
<td>1.080</td>
<td>1.120</td>
<td>1.160</td>
</tr>
<tr>
<td>30.00%</td>
<td>1.00</td>
<td>1.036</td>
<td>1.054</td>
<td>1.072</td>
<td>1.108</td>
<td>1.143</td>
</tr>
</tbody>
</table>

Table 2: Maturity Adjustment in the June 2004 Version of the Basel Capital Accord (factors in comparison to an exposure with a one-year maturity).

Table 3.3.2 shows the exemplary maturity adjustments compared to a one-year maturity of an exposure. Obviously for exposures with higher default
probabilites the effect of the maturity is much smaller than for higher rated exposures. This points out the intention of the Basel committee to avoid extremely high benchmark risk weights and thus, capital requirements for exposures to SMEs with longer maturities.

3.3.3 The refined BRW function

As a consequence of the fair comment on the risk weight function assigned in the IRB approach the Basel committee imposed a refined BRW function. The modified formula relating probability of default, asset correlation, firm size and maturity to capital requirements differs from the formula proposed in the second consultative document in several ways.

The formula in the second consultative document incorporated an implicit assumption that asset correlation for all exposures is equal to 0.20. The new formula assumes that asset correlation declines with PD and decreases with the size of the firm according to the following relationship:

$$\rho(PD) = 0.12 \cdot \left( \frac{1 - e^{-50PD}}{1 - e^{-50}} \right) + 0.24 \cdot \left( 1 - \left( \frac{1 - e^{-50PD}}{1 - e^{-50}} \right) \right) - \left( 1 - \min\{50, \max\{S, 5\}\} - 5 \right) \cdot 0.04$$

(3.6)

Ignoring the adjustment for the size of the company, for the lowest PD value the asset correlation equals 0.24 and for the highest PD value it is equal to 0.12. Additionally, between 0 and 0.04 can be subtracted from the value of the asset correlation according to the size of the company. For companies with a turnover of Euro 5 Million or less the assumed asset correlation is reduced 0.04 while for companies with a turnover greater than Euro 50 Million there is no reduction of the assumed asset correlation at all. Inbetween there is a linear relationship. Since the topic of asset correlations will be treated more extensively in the next sections we will only present exemplary correlations for several combinations of PD and turnover in table 3.3.3. Again the intention of the Basel committee to reduce benchmark risk weights for exposures to SMEs with higher PDs is obvious.

Another major change is that there is no explicit scaling factor in the formula anymore. Also the confidence level that was implicit in the formula has been increased from 0.995 to 0.999, to cover some of the elements previously dealt with by the scaling factor. This value enters then the main formula
Table 3: Model Asset Correlations for different combinations of PD and company size S measured in turnover, compared to the CP2 formula.

<table>
<thead>
<tr>
<th>PD</th>
<th>CP2</th>
<th>S = 5</th>
<th>S = 15</th>
<th>S = 25</th>
<th>S = 50</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.03%</td>
<td>0.2</td>
<td>0.20</td>
<td>0.21</td>
<td>0.22</td>
<td>0.24</td>
</tr>
<tr>
<td>0.05%</td>
<td>0.2</td>
<td>0.20</td>
<td>0.21</td>
<td>0.21</td>
<td>0.24</td>
</tr>
<tr>
<td>0.10%</td>
<td>0.2</td>
<td>0.19</td>
<td>0.20</td>
<td>0.21</td>
<td>0.23</td>
</tr>
<tr>
<td>0.50%</td>
<td>0.2</td>
<td>0.17</td>
<td>0.18</td>
<td>0.19</td>
<td>0.21</td>
</tr>
<tr>
<td>1.00%</td>
<td>0.2</td>
<td>0.15</td>
<td>0.16</td>
<td>0.17</td>
<td>0.19</td>
</tr>
<tr>
<td>5.00%</td>
<td>0.2</td>
<td>0.09</td>
<td>0.10</td>
<td>0.11</td>
<td>0.13</td>
</tr>
<tr>
<td>10.00%</td>
<td>0.2</td>
<td>0.08</td>
<td>0.09</td>
<td>0.10</td>
<td>0.12</td>
</tr>
<tr>
<td>15.00%</td>
<td>0.2</td>
<td>0.08</td>
<td>0.09</td>
<td>0.10</td>
<td>0.12</td>
</tr>
<tr>
<td>20.00%</td>
<td>0.2</td>
<td>0.08</td>
<td>0.09</td>
<td>0.10</td>
<td>0.12</td>
</tr>
<tr>
<td>25.00%</td>
<td>0.2</td>
<td>0.08</td>
<td>0.09</td>
<td>0.10</td>
<td>0.12</td>
</tr>
<tr>
<td>30.00%</td>
<td>0.2</td>
<td>0.08</td>
<td>0.09</td>
<td>0.10</td>
<td>0.12</td>
</tr>
</tbody>
</table>

for the capital requirement. Capital requirements and risk-weighted assets are related in a straightforward manner. With the given confidence level and $\Phi^{-1}(0.999) = 3.090$, the resulting formula is the following:

$$ RWA_i = K(PD, \rho) \cdot 12.5 \cdot EAD $$

(3.7)

with

$$ K = LDGD \left[ \Phi \left( \frac{\Phi^{-1}(PD) + \sqrt{\rho} \Phi^{-1}(0.999)}{\sqrt{1-\rho}} \right) - PD \right] \cdot \frac{1 - b(PD)(M - 2.5)}{1 - 1.5b(PD)} $$

(3.8)

Again $\Phi$ denotes the cumulative standard normal distribution function. The total risk weighted assets are simply the sum over all individual values.

The effects of the changes in the benchmark risk weight function are illustrated in figure 4. Recall that one objective of the changes was to reduce the burdens which the IRB approach would bring to the sector of small and mid-sized enterprises. Firms in this segment usually have a very low rating, this can be seen in Fig 5. in section 5. Moving from a fixed capital charge of 8% to the IRB approach from the January proposal yielded a steep risk
weight curve. It resulted in heavy capital charges, especially for borrowers in lower rating categories. The new version of the BRW function shows, how the risk weights have been reduced significantly for borrowers with PDs above 1.0% (at this PD level one usually refers to loans as being in the non-investment grade, i.e. BB and below).

3.3.4 Expected, Unexpected Losses and the Required Capital

Finally, a novelty in Basel II is the calibration of the risk weights only to unexpected losses. Therefore, in equation (3.8) the expected loss is subtracted:

\[
UL = LGD \cdot \Phi\left(\frac{PD_i - \Phi^{-1}(0.999)}{\sqrt{1-\hat{\rho}}}\right) - \frac{EL + UL}{EL} 
\]

Thus, for the first time the required capital is based only on unexpected losses and not the sum of expected plus unexpected losses. This also leads to a reduction of the regulatory capital. One concern that has been identified in the committee’s prior impact surveys has been the potential gap between the capital required under the Basel I approach, the standardized, foundation and advanced IRB approaches. To overcome this gap, the committee decided to alter the structure of the minimum floor capital requirements in the revised
accord. Under the new approach, there will be a single capital floor for 2006-2009 following implementation of the new accord. This floor will be based on calculations using the rules of the existing accord. Beginning year-end 2006 and during the first years following implementation, IRB capital requirements for credit risk together with operational risk capital charges cannot fall below 95% of the current level required in 2007, 90% in 2008 and 80% in 2009 of the capital requirements based on the old regulations.

We conclude that the capital requirements for the various exposures in the final document have been designed to be consistent with the committee’s goal of neither significantly decreasing nor increasing the aggregate level of regulatory capital in the banking system. The main focus in the final changes of the benchmark risk weight function of the IRB approach was the treatment of small and medium sized enterprises. From this angle one can conclude that the final version of the capital accord gives banks dealing with such companies a much better position than earlier versions. In the following section we will have a special focus on the calibration of the asset correlation parameters.

4 Model Parameters and their Impact

This section investigates the adequacy of the new Basel capital accord from the perspective of asset correlation. Again, a special focus is set on SMEs, where the results of several empirical studies are compared to the relationship suggested by the Basel committee. Further the implications on capital requirements for banks dealing mainly with SMEs will be analysed.

As we summarized in the previous sections, the Basel risk weight function for corporates is based on a one-factor model imposing strong restrictions on the parameters. The asset correlation is not to be estimated by the banks but is hardwired as a function of the probability of default (PD) and the size of the borrower. The issue of how to define firm size is nontrivial; here the total turnover of a borrower serves as a proxy for this quantity.

We will now discuss economic arguments that support the assumption that asset correlation is dependent on size and probability of default. At first we address the influence of firm size.

The interpretation of the one factor model is that the value of the total assets are controlled by a systematic factor and an idiosyncratic one. A higher correlation of certain assets implies a high correlation with the systematic
risk factor.
The Basel II Risk Weight Function implies that, conditional on a certain PD, SMEs possess a smaller asset correlation. This is supported by the argument that large firms can be thought of as being a portfolio of small ones. This means that large firms are usually better diversified, so their idiosyncratic risk would be smaller compared to their systematic risk. If two companies of different size have the same PD, it follows that the larger one has a higher exposure to the systematic risk factor in the one-factor model.

A second argument is the so called "business sector argument". Business sectors that are known to be very cyclical and thus more dependent on the systematic risk usually show a higher percentage of large companies. Considering size unconditional of the business sector can therefore lead to the conclusion that firm size is a strong indicator of asset correlation even though it is merely a proxy for a business sector. This would be consistent with data from the "Institut für Mittelstandsforshung" which is presented in table 4. The sectors "manufacturing" through "automotive" are all known to be cyclical and do indeed possess a smaller amount of SMEs. Whereas the other three sectors consist to a higher degree of small and medium enterprises.

Thirdly, according to (Bernanke et al., 1996) there is an effect known as the "financial accelerator". In their framework endogenous developments in credit markets work to propagate and amplify shocks to the macroeconomy. The key mechanism involves the link between "external finance premium" and the net worth of the potential borrower (i.e. the total value of their assets). They define the external finance premium to be the difference between the cost of funds raised externally and the opportunity cost of funds internal to the firm. This difference arises due to informational asymmetries in the credit market. Their model implies an inverse dependency on the borrowers’ net worth which means that the higher the value of the borrower’s net assets, the lower the finance premium. The authors expect that the impact of such a higher premium will be stronger the more a corporate borrower has to rely on bank loans. Larger firms have better access to capital markets and are more able to circumvent this problem. However SMEs will be very vulnerable in this respect. This means that due to the financial accelerator SMEs are more exposed to macroeconomic shocks and will have a higher asset correlation in the one-factor model.

(Kalckreuth, 2001) suggests that the credit channel (capital markets, banks
<table>
<thead>
<tr>
<th>Business sector</th>
<th>Percentage of SMEs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturing</td>
<td>15.6%</td>
</tr>
<tr>
<td>Construction</td>
<td>17.6%</td>
</tr>
<tr>
<td>Automotive</td>
<td>15.4%</td>
</tr>
<tr>
<td>Transport &amp; Communication</td>
<td>31.7%</td>
</tr>
<tr>
<td>Health &amp; Financial Services</td>
<td>27.4%</td>
</tr>
<tr>
<td>Other Public &amp; Personal Services</td>
<td>42.1%</td>
</tr>
</tbody>
</table>

Table 4: Distribution of German SMEs over business sectors.

or other) plays a subordinated role in Germany due to a strong house-bank relationship (especially for SMEs). Therefore the effect of the financial accelerator could be significantly smaller in Germany.

In summary, the two first arguments support the hypothesis of a decreasing relationship of $\rho$ with firm size, whereas the financial accelerator opposes this.

Concerning the dependence of asset correlation on PD there seems to be little literature that has dealt with this issue on a theoretical basis. First empirical evidence on a relationship between PD and the asset correlation parameter emerged after the second quantitative impact study (QIS-2), which was initiated in April 2001. Since, several authors have addressed this issue for the various credit markets. The first major change in the current accord to Risk-weight functions came in reaction to this second quantitative impact study. The January 2001 proposal had the asset correlation set to a fixed 20%. In the light of the results they initiated a more targeted study which is known as QIS-2.5. In this study (often referred to as the November proposal), the asset correlation was modified to make $\rho$ a function of the PD and the VaR was changed to 99.9%.

$$\rho(PD) = 0.10 \left( \frac{1 - e^{-50PD}}{1 - e^{-50}} \right) + 0.20 \left( 1 - \frac{1 - e^{-50PD}}{1 - e^{-50}} \right)$$

(4.1)

So the correlations were in between 20% and 10%. The reasons for this change were severalfold. Partly the changes are motivated model-theoretically, as described for the dependence of the asset correlation on size, others are due to macroeconomic and political reasoning.
One objective was to mitigate pro-cyclical effects induced by the new accord. Changing the asset correlation in this way should help to achieve that goal. To see this, we suppose that a downturn in the business cycle took place resulting therein that the non-defaulted borrowers of a bank will be downgraded by the internal rating system. This forces the bank to hold more capital against its current loan portfolio. Since raising new capital is more expensive in these adverse conditions, a bank will be forced to cut back on its lending activities. Thereby it is contributing to a worsening of the situation.

This effect was more severe in the CP2 January 2001 proposal, because firms that are moved to higher PD values are still assigned the same asset correlation parameter. In the CP3 proposal from November 2001 the asset correlation would decline and thus alleviate this effect.

Rösch examines the pro-cyclical effects of the CP3 proposal, compared to the one from January 2001 and Basel I. In a simulation study on historical data his findings are that the capital charge changes such that they will even be more cyclical in the November 2001 proposal. Of course this is not to be attributed to the effect described above but to the fact that the VaR was changed to 99.9%.

4.1 Equity vs Asset Correlation

Before we compare the results that researchers have found for the various markets, we will briefly discuss the relationship between equity and asset correlations. Since the introduction of the CreditMetrics model, it has been industry practice to use equity correlations as a proxy for asset correlations. But since most firms are not traded, especially SMEs, one has to device means to extend the observed equity correlations to non-traded firms. In CreditManager, the software provided by CreditMetrics, correlations are logistically regressed on market capitalization. With that technique the correlation with the systematic factor is determined using the market capitalization of a firm in the inverse of the fitted logistic function. To extend this concept for the use with SMEs, (Hahnenstein, 2004) explores how the book value of total assets can be used instead of the market capitalization. His findings do not suggest the use of this method to determine equity correlations for non-traded firms. Not only is it difficult to infer equity correlations for all firms in a market, the results of Servigny and Renault (2002) question the accuracy of this ap-
approach altogether. Comparing empirical default correlations and the inferred default correlations from equity, they find a prohibiting low dependency between these quantities. They attribute this to the fact that equity prices and their returns reflect many factors such as changes in risk aversion in the equity markets and liquidity effects.

4.2 Empirical Evidence on the Asset Correlation

Lopez (2002) finds empirical evidence that supports the hypothesis of a decreasing relationship between asset correlation and probability of default. His estimates show that this effect is stronger the larger the firm is. For firms that fall into the SME category his estimates indicate no significant dependence. Deviant from the Basel-II methodology he uses the book value of total assets as a proxy for firm size instead of the turnover. These facts could account for the discrepancies to the results of other researchers which we will discuss now.

Dietsch and Petey (2002, 2004) provide comprehensive results for SMEs in the German and French market. Their evidence does not suggest a negative relationship between PD and $\rho$ as it is laid out in the Basel-II functions. For the relationship with firm size measured in turnover, they find some support for a decrease of $\rho$ with firm size. Hamerle et al (2003, 2004) have made strong use of additional explanatory variables within a model. It turns out that the inclusion of these regression variables reduce the estimates for $\rho$ significantly. To give an example: They use default data from the U.S market and the rating system of Standard and Poor’s. For the BB grade the model without regression variables produces an estimate of 6.04% compared to a 0.67% when the Federal Reserve Funds Rate is included as a one year lagged variable. This enormous increase in precision can be explained by the fact, that the business cycle is reflected in macroeconomic quantities. Therefore, the inclusion of these figures will increase the fit of the model drastically. The given estimates for $\rho$ are non-monotone in the rating categories and do therefore not support the Basel-II assumptions.

Another empirical study (Rösch, 2002b) examines the effect of the business cycle on correlations in a one factor model. In his work he makes extensive use of explanatory variables in a framework as it is described in the previous sections. He uses the same database of the German market as Hamerle and Düllmann and finds that correlations can be significantly diminished through the introduction of proxy variables for the business cycle. Though he does
not specifically address the issue of a PD relationship with the asset correlation, his findings are still relevant at this point. This is because in some sectors he includes lagged values of the default rates for the respective sector. As described before, the estimates for the parameters of these variables can be interpreted as explaining parts of the correlation with the common risk factor. When compared to the other included regression variables for a certain sector, the lagged default rates showed smaller standard errors and were all positive. This strongly contradicts the Basel-II assumption of a decreasing $\rho$ with PD.

Finally, (Düllmann & Scheule, 2003) provide the most sophisticated empirical study of the effects of PD and firm size on the asset correlation. Their findings reject a clear relationship of $\rho$ on PD, too, and do also support a decreasing relationship of $\rho$ with decreasing firm size.

In their model setup they include a macro-economic variable in form of a business climate index and a borrower specific credit score. They discuss the use of several different estimators, their efficiency and small sample properties.

### 4.3 Conclusion on the empirical findings

Recent research provides clear evidence of a relationship between firm size and asset correlation for a one factor model, as it is specified in the Basel Capital Accord. Here the term ”relationship” is chosen intentionally since it has not been clarified whether this relationship stems from the fact that the size adequately represents a firm’s dependence on the unobserved state of the economy. The inclusion of figures such as the total turnover, credit scores or other firm specific quantities in a regression model provide the methods to test the significance of these parameters against each other. To find out whether firm size is merely a proxy for a business sector, one can use the regression framework as it is outlined here, to statistically test the explanatory power of the *turnover* against sector specific variables. Further the results provide evidence that the asset correlation increases with the probability of default. This contradicts the assumptions imposed by the IRB risk weight functions.

With respect to the macro-economic concerns regarding pro-cyclicality we would like to point out results from (Rösch, 2002) and (Rösch, 2002b).
He identifies two drivers, that are responsible for the changes in regulatory capital charge. The first one is the actual default risk that changes with the business cycle. This changes the rating grade for a firm in a loan portfolio through the new PD estimates as it was previously described. The second driver is what he calls transition risk. This is the risk that firms in the loan portfolio move to different rating grades from one period to the other. In simulations on historical data with the Standard and Poor’s empirical rating transitions, Rösch found that the effect of the transition risk had been reduced through the changes in the asset correlation. But the default risk had a much higher impact on the change in capital charges. Therefore, the decreasing relationship between ρ and PD does counteract pro-cyclicality, but the impact is significantly smaller than the impact of the change in the VaR quantile. He suggests, that to adequately reduce the cyclical effects of this regulation, the VaR quantile should be determined according to the business cycle. (Kashyap & Stein, 2004) pursue this idea from a macro-economic perspective and arrive at a similar conclusion.

Given that the major part of the cyclical effect is indeed due to the changing default risk one will seek to efficiently forecast these changes. From the econometrics of financial time series we know that models that account for seasonality can effectively reduce the volatility. The caveat in applications to default risk is the small data basis. But even though there is not much historical data on defaults, there exists a huge literature on the business cycle in the field of macroeconomics. (Rösch, 2002b) shows how a properly regressed model can be used to forecast the default business cycle using lagged values of observed macro-economic variables. We think that future research should continue in this direction, and exploit the already existing models for the business cycle. Merging these results could yield more accurate forecasts for default rates not only on the one year horizon. This would thus provide banks with the means to optimize their capital structure with respect to the changes in capital charges, anticipated in this way.

5 Case study

Examining a typical German SME portfolio as that of the KfW Mittelstandsbank depicted in Fig. 5, we see that the almost half of all firms have a rating
of BB or BB+. To see how credit conditions can change for these firms, we conduct the following case study. Based on simplified calculations, it demonstrates how credit spreads can change due to Basel-II. Assume loans with the properties in Table 5.

<table>
<thead>
<tr>
<th>EAD</th>
<th>LGD</th>
<th>Rating Class</th>
<th>PD</th>
<th>Maturity (M)</th>
<th>Firm Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>50</td>
<td>AAA</td>
<td>0.01%</td>
<td>4 years</td>
<td>45</td>
</tr>
<tr>
<td>100</td>
<td>50</td>
<td>BB</td>
<td>1.2%</td>
<td>4 years</td>
<td>45</td>
</tr>
<tr>
<td>100</td>
<td>50</td>
<td>B</td>
<td>7%</td>
<td>4 years</td>
<td>45</td>
</tr>
</tbody>
</table>

Table 5: Examplary properties for loans.

In the old accord this would induce a capital charge of 8%, meaning that the own funds to be held against this exposure would be 8 compared to 92 in borrowed funds. For the borrower rated B, the risk weight changes to 201.667% in the IRB approach. The bank would have to hold $100 \cdot 0.08 \cdot 2.01667 = 16.133$ of own funds against 83.866 of borrowed funds. Further assume a ROE for the bank of 15% and the bank’s internal credit cost of 5%, leaving a net ROE of 10%. With the required equity this adds a margin
of \(10\% \cdot 16.133 = 1.61\). Now suppose a handling charge of 0.25\% and a Risk Premium of 3.5\%, this yields a credit interest rate of 10.36\% for the firm. Compared to an interest rate of 9.55\% under the old accord. These calculation are summarized for different rating grades in table 5.

<table>
<thead>
<tr>
<th>Rating Grade</th>
<th>Standard Approach</th>
<th>IRB Approach</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AAA</td>
<td>BB</td>
</tr>
<tr>
<td>EAD</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Risk Weight</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>(\Rightarrow) Own Funds</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>(\Rightarrow) Borrowed Funds</td>
<td>92</td>
<td>92</td>
</tr>
<tr>
<td>ROE</td>
<td>15%</td>
<td>15%</td>
</tr>
<tr>
<td>Credit cost</td>
<td>5%</td>
<td>5%</td>
</tr>
<tr>
<td>net ROE</td>
<td>10%</td>
<td>10%</td>
</tr>
<tr>
<td>(\Rightarrow) net cost of equity</td>
<td>0.8</td>
<td>0.8</td>
</tr>
<tr>
<td>Assumed Handling charges</td>
<td>0.25%</td>
<td>0.25%</td>
</tr>
<tr>
<td>Risk Premium (Spread)</td>
<td>0.1%</td>
<td>1.0%</td>
</tr>
<tr>
<td>Interest Rate</td>
<td>6.15%</td>
<td>7.05%</td>
</tr>
</tbody>
</table>

Table 6: Exemplary calculations for different loans and ratings.

From table 5 we can see how the spreads widen for the riskier loans. Based on similar calculations the Deutsche Bundesbank estimated the effects of the new regulation on the changes in the credit spreads for the different size segments of the German market.

For the January proposal (table 5) the credit spread between small and large firms may widen by 1.5\% on average. In the November (table 5) proposal the spread between large and small widens by only 1\% on average, so it can be seen how the transition to the asset correlation function from Eq.(4.1) brought ”regulatory relief” for the segment of SMEs. The final version reduces the capital charges even further as it can be seen from Fig.4.
<table>
<thead>
<tr>
<th></th>
<th>PD</th>
<th>RW</th>
<th>Cap. Requ.</th>
<th>Spread</th>
<th>Δ Spread</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small Firms</td>
<td>2%</td>
<td>128%</td>
<td>10.2%</td>
<td>1.53%</td>
<td>+0.33%</td>
</tr>
<tr>
<td>Medium sized Firms</td>
<td>1.3%</td>
<td>110%</td>
<td>8.8%</td>
<td>1.32%</td>
<td>+0.12%</td>
</tr>
<tr>
<td>Large Firms</td>
<td>0.2%</td>
<td>48%</td>
<td>3.8%</td>
<td>0.57%</td>
<td>−0.62%</td>
</tr>
</tbody>
</table>

Table 7: Changes in Credit spreads under a January 2001 compliant IRB system.

<table>
<thead>
<tr>
<th></th>
<th>PD</th>
<th>RW</th>
<th>Cap. Requ.</th>
<th>Spread</th>
<th>Δ Spread</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small Firms</td>
<td>2%</td>
<td>128%</td>
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<td>1.53%</td>
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<tr>
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<td>1.32%</td>
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</tr>
<tr>
<td>Large Firms</td>
<td>0.2%</td>
<td>48%</td>
<td>3.8%</td>
<td>0.57%</td>
<td>−0.62%</td>
</tr>
</tbody>
</table>

Table 8: Changes in Credit spreads in under a November 2001 compliant IRB system.

6 Conclusion and Future Work

We found that based on the various changes in the final version of the Basel Capital Accord especially for SMEs capital requirements were substantially decreased in the IRB approach. The Basel committee therefore followed the fair criticism towards the second consultative document that was received from theory and practise.

Considering the assumed relationship between probability of default and asset correlation throughout several empirical studies, the estimated correlations have been much lower than those imposed by the Basel-II IRB approach. This fact does not lead to a direct criticisms of the proposed risk weight functions since we have seen how macro- and micro-prudential perspectives played an important role in the considerations of the Basel committee.

One reason for the observed small correlations will be that all studies were
conducted on very large, quasi exhaustive databases for the respective market. A bank’s loan portfolio can be interpreted as a sample from this space and thus as a random variable which will exhibit deviations. Therefore the true VaR of an individual bank can be much higher than that of the portfolios of the whole German market. It is therefore the aim of a regulatory framework to control the maximum VaR for all sample portfolios over the whole sample space. This justifies the higher asset correlations imposed by the committee.

Another, very important aspect is what is frequently referred to as model risk. In VaR applications tail statistics are much more important than statistics for parameters that control the large central body of a distribution. Therefore, significant estimates of model parameters such as the correlations, means or variances do not necessarily indicate a good model choice. Especially in a gaussian setup, estimates of correlations are not sensitive with respect to the tails of the distribution. To model portfolio distributions with heavier tails one does not have to give up the structure of an unobservable common risk factor and an idiosyncratic component. Changing the distributional assumption of these factors can produce portfolio distribution with heavier tails. Research, as that of (Frey & McNeil, 2003), gives important insights on these issues and proposes several alternative modelling possibilities.

The conclusions that the KfW\(^4\) draws from these changes are that SMEs will have to improve their creditworthiness and actively maintain a good house-bank relationship. They will have to professionalize their management in this respect and improve on the issue of transparency. This could lead to an improved flow of information between banks and SMEs and reduce their finance premium.

\(^4\)Kreditanstalt für Wiederaufbau. A German financial Group that is sponsored by the Government. A group member is the KfW Mittelstandsbank, a bank which supports German SMEs.
References


