Basel II - Credit risk

Background

To protect depositors and the financial system overall, the 1998 Capital Accord ("Basel I") placed restrictions on the exposure a bank could have in relation to its capital (see Capital Required for a simple illustration of how to calculate capital requirements for a non-financial firm). In other words, it restricted how much a bank could lend in total with the goal to decrease the probability that, in an extreme downturn of the economy, depositors would lose their money and (since banks often lend to other banks) the banking system would collapse (i.e. systematic risk).

The links to the Capital Required software specific models are provided here:

[Capital_required]
[Capital_required]

Basel II comprises three mutually reinforcing pillars:

• Pillar 1: The Minimum Capital Requirements (the part we will focus on);
• Pillar 2: The Supervisory review – about the dialogue between banks and their supervisors;
• Pillar 3: About the disclosure requirements.

Pillar 1 says that the Capital Ratio, defined as below, should be no less than 8%:

Capital Ratio = Capital a bank has available / Risk-weighted assets  ≥ 8%

Because the 1998 Capital Accord took a relative unsophisticated view of the risk-weighted assets, the Basel Committee is now in the process of developing a more sophisticated risk sensitive framework, called Basel II. In Basel II the risk-weighted assets will explicitly include three types of risk:

1. Credit Risk (new treatment under Basel II)
2. Market Risk (in 1996, an amendment was made to the treatment of market risk)
3. Operational Risk (newly introduced in Basel II)

In this section, we will focus on Credit Risk. Basel II gives banks the freedom to choose from three distinct options for the calculation of credit risk and three others for operational risk. For credit risk, they are:

1. The Standardised Approach;
2. The Foundation Internal Ratings Based (IRB) approach;
3. The Advanced IRB approach.

The Standardised Approach makes use of external credit assessments to determine the weightings and to calculate the total risk-weighted assets. In this section, we will focus on the Internal Rating Based approaches (second and third method) of the credit risk approach, since they include an internal risk assessment of the company. The primary inputs to the risk-weighted asset calculations, are:

1. Probability of Default (PD) – measures the likelihood that the borrower will default over a given time horizon;
2. Loss Given Default (LGD) – measures the proportion of the exposure that will be lost if a default occurs;
3. Exposure At Default (EAD) – measures the amount of the facility that is likely to be drawn if a default occurs.

The EAD depends on the insurance and hedging activities of the bank (they will be left out of this example; see Integrated Risk Management for an example of this). Banks will have to categorize their risk assets into risk classes, and for each class estimate the probability of default (PD) and the expected loss given default (LGD).
The links to the Integrated Risk Management software specific models are provided here:

Integrated_Risk_Management
Integrated_Risk_Management

Example

Relevance

In this example, which is based on the BIS working paper of Altman et al. (2002), we look at a very important assumption about credit risk, i.e. the relationship between the PD and the LGD. In other words, if macro-economic factors increase the PD (e.g. during a recession), does the LGD stay the same, go up or go down. It is often thought that if the PD goes up, the LGD will go up too. Most credit models currently used assume no relationship between the two variables. In this example, we will examine the effect of this assumption on estimates of credit risk models, such as expected (average) losses and VaR – 99%.

Situation

You are working for a bank that has a portfolio of 25 loans (see graph below), ranging from $1,000 to $15,000 and belonging to seven different rating grades with long-term (historic) probability of default (PD) levels ranging from 0.5% to 5% (of course, banks would normally have much larger portfolios of loans, but this example in only meant for illustration purpose).

The short term PD is, however, influenced by a macro-economic factor, $x_1$, that is equal to all loans (with weight $w_1$ equal to 50%) and an idiosyncratic (random) factor $x_2$, unique for every loan (with $w_2$ equal to 50%), such that:

$$ PD_{\text{short}} = PD_{\text{long}} \times (w_1 x_1 + w_2 x_2) $$

The two weights $w_1$ and $w_2$ always have to add up to 100%, i.e. $w_2 = 1 - w_1$. Both factors $x_1$ and $x_2$ are modeled as Exponential (1) distributions [same as Gamma (0, 1, 1) distributions, see section Gamma distribution] that have a mean of one. An Exponential distribution was assumed since it is highly skewed to the right, representing the situation that default probabilities (PD’s) are low most of the time but sometimes, during rare/extreme situations, can increase dramatically.

Three scenarios

Scenario 1. Assume that the LGD is deterministic; 30% for all borrowers
**Scenario 2.** Assume the LGD is stochastic but uncorrelated with the probability of default PD. Use a Beta (9, 21, 1), which results in a mean LGD of 30% (see section on Beta Distribution).

**Scenario 3.** Assume there is a perfect rank order correlation (see Rank Order Correlation) between the macro-economic background factor, $x_t$, and the LGD.

**Question**

What are the losses and their distribution parameters under the three different scenarios?

**Results**

The solution to this example is provided in the following spreadsheet: Basel II.

The resulting distributions of the losses of the portfolio are shown in the figure (which represents a situation with 250 loans) and the table (with 25 loans) below. Although there is no real difference between scenario 1 and 2, the expected losses and the unexpected losses (VaR) under scenario 3 are considerably higher.

**Distribution of Losses under the three scenarios**

![Distribution of Losses under the three scenarios](image)

Table 1. Main results under the three scenarios

<table>
<thead>
<tr>
<th>LGD modelled according to approach</th>
<th>Scenario 1</th>
<th>Scenario 2</th>
<th>Scenario 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expected loss</td>
<td>$1,459</td>
<td>$1,460</td>
<td>$1,510</td>
</tr>
<tr>
<td>95% VaR</td>
<td>$6,037</td>
<td>$6,307</td>
<td>$6,749</td>
</tr>
<tr>
<td>99% VaR</td>
<td>$9,140</td>
<td>$9,760</td>
<td>$10,446</td>
</tr>
<tr>
<td>99.5% VaR</td>
<td>$10,569</td>
<td>$11,281</td>
<td>$12,085</td>
</tr>
<tr>
<td>99.9% VaR</td>
<td>$12,963</td>
<td>$14,135</td>
<td>$15,633</td>
</tr>
</tbody>
</table>

**Conclusion**
This relatively simple exercise illustrates that the relationship between the PD and the LGD is very important to estimate credit risk. If in reality PD and LGD are both driven by some common (e.g. macro economic) forces and therefore are correlated, not only the expected but also the unexpected losses (VaR) in most portfolio credit risk models, will have been seriously underestimated if the correlation is ignored!

The links to the Basel II software specific models are provided here:

Basel_II
Basel_II