Measurement of the Credit Risk

Lecturer Dănuţ CULEŢU, Ph.D.
,,Andrei Şaguna” University of Constanta

Andreea Gabriela BALDAC, Ph.D. Student
,,Artifex” University of Bucharest/Academy of
Economic Studies Bucharest

Alexandru URSACHE, Ph.D. Student
Academy of Economic Studies Bucharest

Abstract
Credit risk should, in general, be considered as a component of market risk, as explained in previous pages. However, the methods of analysis of this type of risk are more extensive than those used in the case of market risk just as a result of difficulties information may be obtained and the period of time as long as an investor (an individual, a company, the bank) must make reference. Loss of credit risk is usually calculated as the difference between the current value of the portfolio and its value at a given moment in the future.

Key words: credit risk, methods of analysis, capital market, statistical methods.

Over time, investors on the capital market, but especially banks, have realized that credit risk is one of the most important risks which may affect return on investments, whether it is about acquisitions of securities or loans granted to companies of the market. As a result, have been developed a number of models for the determination of this type of risk. These models will be analyzed in sub-section which follows. We will examine both models used by banks and investors on the capital market, as well as models used on many occasions by the banks.

Credit risk should, in general, be considered as a component of market risk, as explained in previous pages. However, the methods of analysis of this type of risk are more extensive than those used in the case of market risk just as a result of difficulties information may be obtained and the period of time as long as an investor (an individual, a company, the bank) must make reference.

The basic idea from which must be switched on in the analysis of the credit risk is analysis on the entire portfolio of securities held (if we are to
analyze a risk to which it is exposed an investor on the capital market) or customers financed (if we are talking about banks). For a better estimate of this type of risk, analysts must consider various categories of customers, depending on the industry in which activates, geographical location, etc., on the basis of this idea, over time we have developed a number of methods for the determination of the credit risk as outlined below.

Loss of credit risk is usually calculated as the difference between the current value of the portfolio and its value at a given moment in the future. Most of the times are used two models for determining the current value and the value of a portfolio. First model is based on paradigm 'defaulting' and the second on paradigm 'marking to the market'.

Inability payment shall relate to loss occurs as a result of the entry to your company's insolvency, which causes an inability acetseia to honor its payment obligations. Unlike the inability of payment, the marking to the market takes into account and other changes in the company in question which causes degradation company rating, even if it does not lead to the default. Usually, for this time of analysis is used Monte Carlo simulation, watching potential changes the rating for each company in portfolio.

There are many statistical methods for the determination of the credit of credit. We will begin by presenting the best-known methods for the calculation of the probability of default of a company to move later models more complicated, developed in major items in the industry.

1. **The default using Scoring statistical methods**

Using this method, the analyst is not necessarily interested in the degree of default intensity in how to return to the initial status, as well as the likelihood that a company will between the defaulting. Thus, it uses the regression model which is based on the variables of interest in the company's activity in the analysis. Probability of default depends on the outcome of this regressions.

For the application of this model, it is considered the company at the end of a specific period of time \( T \). Status company, noted with \( S \) may take the value of 1 if the firm has entered the defaulting at the end of the period \( T \) or the value 0 otherwise. In other words, for each company in part, the probability of default is

\[
P(S = 1| x_1, \ldots, x_k) = p(x_1, \ldots, x_k), \text{ where } p \text{ is 0 or 1.}
\]

If using a probability logistics for the determination of the probability \( p \),
\[ P(S = 1 \mid x_1, \ldots, x_n) = \frac{\exp(\alpha_0 + \beta_1 x_1 + \ldots + \beta_n x_n)}{1 + \exp(\alpha_0 + \beta_1 x_1 + \ldots + \beta_n x_n)} , \]

which means that, if \( l(x) = \log\left(\frac{x}{1-x}\right) \), then

\[ l(P(S = 1 \mid x_1, \ldots, x_n)) = \alpha_0 + \beta_1 x_1 + \ldots + \beta_n x_n \]

In case we analyze two companies with vectors covariante \( x^i \) și \( x^j \) and with their probability of default \( p^i \) și \( p^j \), then

\[ \log \frac{p^j / (1 - p^j)}{p^i / (1 - p^i)} = \beta (x^i - x^j) \]

Coming back to defining the likelihood of default as \( p \), which may take the value 0 or 1 as described above, the probability of default of the company is calculated using the following regression:

\[ P = \prod_{i=1}^{n} \left( \frac{\exp(\alpha + \beta x^i)}{1 + \exp(\alpha + \beta x^i)} \right)^{p_i} \left( \frac{1}{1 + \exp(\alpha + \beta x^i)} \right)^{1-p_i} \]

The resulting probability of default of the company in the analysis.

2. The default using Scoring discriminating analysis

Press and Wilson, in their work since 1978, have developed a model for determining the probability of default of a company using discriminant analysis. They used two samples with normal distribution companies, a sample that have probability of default 0 - \( E_0 = (x_0^i, \ldots, x_0^n) \) and a sample of the probability of default 1 – \( E_1 = (x_1^i, \ldots, x_1^n) \).

If in the model shown above company caused characteristic probability to default, in this model probability of default is the date and on the basis thereof shall be determined regression variables values representing the basic features of the company. Purpose of the method which will be described below is to determine if a company new tested will have the characteristics of a company that shall enter into default or of a company which will survive.
Environments of the two samples are noted $\mu^0$ and $\mu^1$, and their multivariate normal densities $\phi_0$ and $\phi_1$. Whether a new company to belong to group $i$ is $u_i$. $c(0 \mid 1)$ shall mean the cost encountered in the case in which a company which will enter the default is classified in category for companies that will survive, and $c(1 \mid 0)$ this means vice versa.

Likelihood that a company will be classified in category wrong (within the category $E_0$, she should be considered to be part of the category $E_1$), it is calculated as follows:

$$p(0 \mid 1) = \int_{E_i} \phi_j(x) dx \text{, where } i \text{ and } j \text{ may take the values 0 or 1.}$$

At the same time the estimated cost as a result of an incorrect classification is calculated as:

$$u = u_i p(0 \mid 1) c(0 \mid 1) + u_j p(1 \mid 0) c(1 \mid 0)$$

In order to minimize the cost of mis-classification, use this function:

$$f(x) = x' / \sum (\mu^0 - \mu^1) - \frac{1}{2} (\mu^0 - \mu^1)' / \sum (\mu^0 - \mu^1)$$

If

$$K = \frac{u_1}{u_0} \frac{c(0 \mid 1)}{c(1 \mid 0)} \text{, then,}$$

analysis must be allocated to company group of companies $E_0$ if $f(x) \geq \log K$ and group $E_1$ if $f(x) \prec \log K$.

Trouble is encountered in using this model is that normal distribution is not realistic for many of the variables used in characterised as companies. Another impediment is that this model does not have the ability to determine how long a company will survive given its characteristics used in the model.

With respect to the model scoringului analysis using the default discriminating, an example is the model used by Altman in his book of 1968, hereinafter called Z-scores:

$$f(x) = 0.012X_1 + 0.014X_2 + 0.033X_3 + 0.006X_4 + 0.999X_5 \text{, where}$$

$$X_1 = \text{fond de rulment/active totale;}$$
$$X_2 = \text{profit nedistribuit/active totale;}$$
\[ X_3 = \frac{EBIT}{active \; totale}; \]
\[ X_4 = \frac{capitaluri \; proprii \; la \; valoarea \; de \; piata}{datorii \; totale}; \]
\[ X_5 = \frac{CA}{active \; totale}. \]

The values according to which is to be determined probability of default are:
\[ f(x) > 2.99 \] – safe area
\[ 1.81 < f(x) < 2.99 \] – uncertain area
\[ f(x) < 1.81 \] - area businesses with high risk of default

Another model used in numerous analyzes of the risk of default is the default scoringului model estimated for private companies. How is this the case all companies listed on the Bucharest Stock Exchange (BVB), the model is worth being referred to and used in the chapters that follow.
\[ f(x) = 0.717X_1 + 0.847X_2 + 3.107X_3 + 0.420X_4 + 0.998X_5 \]

\[ X_1 = \frac{active \; curente - datorii \; curente}{active \; totale}; \]
\[ X_2 = \frac{profit \; net}{active \; totale}; \]
\[ X_3 = \frac{operational \; profit}{active \; totale}; \]
\[ X_4 = \frac{capitaluri \; proprii}{datorii \; totale}; \]
\[ X_5 = \frac{CA}{active \; totale}. \]

The values according to which is to be determined probability of default are:
\[ f(x) > 2.9 \] – safe area
\[ 1.23 < f(x) < 2.9 \] – uncertain area
\[ f(x) < 1.23 \] - area businesses with high risk of default

These models can be used by using six-monthly financial statements, as they are published by the companies. Usually their publication shall be carried out with a delay of 3-5 months. Companies are obliged to publish their annual financial statements by the end of May and on the six-monthly until the end of August. As a result, regression above will use data that are not recent and any amendments to the financial data of a company may impacta their ability to continue to carry on their activities in the future.
3. Probability of default determined based on convincing

In the book on credit risk, David Lando presents a method for the determination of the risk of default based on hazard. It has built a model based on probability of default of companies in a sample. Considering a sample of \( N \) companies, their probability of default at the time \( t \) it is expressed as being \( p(t, \theta) \), where \( \theta \) it is a parameter of interest of all companies in the sample.

Firms in the sample are to be achieved over the entire period of analysis, \( T \). Category C includes companies which have emerged over the period of analysis in the sample as a result of other events than cessation of, and in the category of companies D included are those companies which have entered into default until such time \( T \). Also, \( S(t, \theta) \) is the possibility of the survival of companies up to the time when \( T \). Thus, the likelihood of the occurrence of default is:

\[
\prod_{i \in D} p(t_i, \theta) \prod_{i \in C} S(t_i, \theta)
\]

We believe, also, cemeteries \( h(t, \theta) \), and likelihood of default at the time \( t \) of a company which has been included in the category for companies that do not ceased their activity during the period of analysis, as

\[
h(t, \theta) = \frac{p(t, \theta)}{p(t, \theta) + p(t + 1, \theta) + ...},
\]

And the relationship between hazard and the likelihood of default before time \( t \) is:

\[
p(t, \theta) = h(t, \theta) \prod_{s \leq t} (1 - h(s, \theta))
\]

Thus we can obtain probabilities of default for each of the categories C and D, as follows: \( h(t, \theta) \prod_{s \leq t} (1 - h(s, \theta)) \) for the companies included in category D;

\[
\prod_{s \leq t} (1 - h(s, \theta)) \text{ for the companies included in category C.}
\]

If we define \( d_i \) as number of companies which have entered into default until such time \( t \) și \( r_i \) as number of companies as possible to enter the default at the time \( t \), atunci \( r_i - d_i \), Companies will survive at the time \( t \).

Thus, cemeteries, and likelihood of default will be
\[ h_i = d_i / r_i \]

Of course that the methods described above are only some of the many types of statistical measurement of the credit risk. How literature is impressive as regards the subject under discussion, we believe that models described at the time will be sufficient for the practical application of this Phd works.

The purpose of this chapter was to outline clearly what is the definition of the credit risk, what are the special features of the securities on the Romanian market for credit risk. Also, presentation regulations on the banking market is particularly important to emphasize importance of international authorities granted subject in question.

On the basis of models presented in previous pages, investors may cause losses to which they are exposed and can implement procedures for management of the portfolio in such a way that credit risk to be improved to a large extent, As long as they understand the importance of this risk and its impact on profitability portfolio held.

4. **Probability of default determined on the basis of the rate of hazard time calculated continuously**

This way for the determination of the probability of default is applied more easily than previous versions. For guidance on the use of this model, there is a need for a variable \( \tau \) representing the default of a company, with continuous density \( f(\cdot) \). Thus, the probability of default is determined as:

\[
P(\tau \leq t) = F(t) = 1 - S(t) = \int_0^1 f(s)dx, \text{ where } S \text{ represents probability of survival.}
\]

Random rate and the probability supravietire are calculated after relations:

\[
\begin{align*}
    h(t) &= \frac{f(t)}{1 - F(t)} = \frac{f(t)}{S(t)} = -\frac{d}{dt} \log S(t) \\
    S(t) &= \exp\left(-\int_0^1 h(s)ds\right)
\end{align*}
\]

As a result,
\[ P(\tau \leq t + \Delta t | \tau > t) = \frac{P(\tau \leq t + \Delta t | \tau > t)}{P(\tau > t)} = 1 - \exp \left( - \int_{t}^{t+\Delta t} h(s)ds \right), \] having regard

that the limit:

\[ \lim_{\Delta t \to 0} \frac{1}{\Delta t} P(\tau \leq t + \Delta t | \tau > t) = h(t) \]

where \( h(t) \) is the possibility of incapacity for payment of action in a short period of time.

**Bibliography**


