

RISK MANAGEMENT FOR SUSTAINABLE GROWTH

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Abstract

Sustainable development refers to the fulfilment of human needs through simultaneous socioeconomic and technological progress. This kind of progress is dependent upon continued economic, social, cultural, and technological progress, but in order to achieve this status careful attention should be paid to preservation of the resources. In the process mentioned an adequate risk management plays an important role and could not be neglected. This evidence allows coming to the conclusion that sustainable development could be achieved through consideration of risks, uncertainties, and information and knowledge imperfections. The phenomenon of risk plays a ubiquitous role in finance and insurance as well as in economics, since it is involved in nearly all financial and economic activities. It is worth to mention that each financial and economical crisis leads to insights and affirmation that we now recognize the causes, but on the other hand the question about appropriate risk management is asked very seldom, and now even after the subprime crisis we do have the same ritual - improvement of methods and tools, while no evaluation of the existing approach is done. The aim of the paper is to give a survey of the development status of the Solvency II process. The approach has been motivated by the recent developments in the insurance and finance business, where risk management and risk measures have become crucial to calculate capital requirements. The article gives an overview, analysis and evaluation of the methods that are currently available in practice.

Key words: sustainable development, risk management, Solvency II

Introduction

In recent years, risk management (see e.g. [1, 2]) and also appropriate and adequate risk measures (see e.g. [3]) have gained importance due to Basel II requirements in the banking world and due to the current discussions about appropriate risk measures to be used for the computation of capital requirements in the Solvency II process in the insurance businesses.

Risk management at the present time is used to optimize the solvency capital of a business. The aim is to determine a company-wide solvency capital value, which quantifies the risk of business activities. Therefore, the risks have to be summarized in a risk measure. Usual risk measures are variance, standard deviation, Value at Risk, Expected Shortfall, Lower Partial Moments and other risk measures. It is often assumed that the risks are stochastically independent, although e.g. many insurance risks are heavily dependent in the tails.

Companies providing financial services have to compute premiums that are adequate to its risks. Therefore, the premium is a risk measure in general. In the insurance business, there are two applications of risk measures: the calculation of premium rates for the underwriting and of risk capital requirements for solvency (calculation of size of solvency capital). A proper premium rate enables a company to operate smoothly

while making reasonable profits for its shareholders, and the capital requirements ensure that the risk of insolvency remains acceptable.

After Chernobyl, Russian crisis, the E-business Hype, the Enron and Worldcom scandal, and now even after the subprime crisis we have the same ritual as every time after crisis – discussion about improvement of methods and tools, while no evaluation of the existing approach is done. The aim of the paper is to give a survey of the development status of the Solvency II process. The approach has been motivated by the recent developments in the insurance and finance business, where risk management and risk measures have become crucial to calculate capital requirements.

The aim of the current paper to give an overview about the development of Solvency II and to provide an analysis of risk measures used in practice (in particular Value at Risk is going to be discussed) in order to answer the question, if there is a necessity for new risk management approach or pre-crisis risk management system is still satisfactory.

1. Solvency II – Brief Overview

Over the past years, risk management and risk measures have gradually more gained importance. There is no doubt that managing risks is supposed to optimize the administration of the

scarce capital of security in a way that on the one hand the risks are covered, but on the other hand the least possible capital of security is kept. The aim of this procedure is to define a corporation-wide objective criterion to determine the capital of security, which quantifies the risk of business activity. Therefore, the complex risks have to be reduced to a one-dimensional risk measure.

Solvency II has been initiated by the European Community, and it will introduce a new solvency regime which will be characterized by an integrated risk management approach. In 2001 the European Commission started this project in order to review the European framework for the prudential supervision of insurers, and Solvency II Framework Directive was presented

in July 2007, Europe wide implementation is scheduled to be completed by 2011 (follow [4]). Solvency II has a number of objectives, whereby the protection of policyholders is one of the most significant. While previous regulatory action regulated the industry on the product level to protect the policyholders, the focus has been shifted to the level of capitalization. But as there is no commonly accepted expression of risk in the financial statements – and therefore there is no possibility to rely on „general level“ capital requirements and specific regulation is needed.

The overall architecture of Solvency II (European Commission (2003)) follows a three – pillar structure (follow figure 1) and is analogous to Basle II in the banking sector.

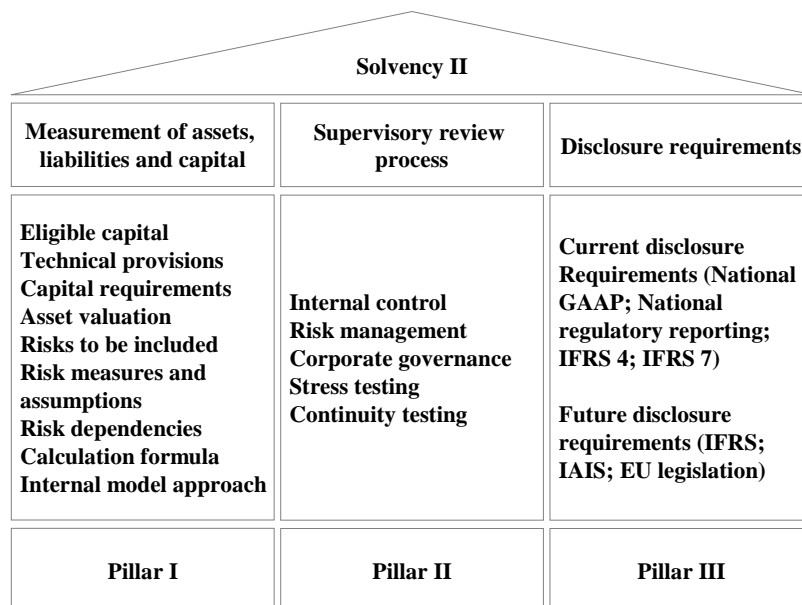


Fig. 1. Solvency II tree – pillar structure

The **first pillar** includes the risk-based quantitative capital requirements, which are calculated by a standard model or a more detailed, specified internal model. Solvency II divides the capital requirements in two levels: the minimum capital requirements designate the „level of capital below which an insurance undertaking’s operations present an unacceptable risk to policyholders. If an undertaking’s available capital falls below the minimum capital requirements, ultimate supervisory action should be triggered“ (Committee of European Insurance and Occupational Pensions Supervisors (2005)). The Solvency Capital Requirements is the amount of capital, to which we will refer as economic capi-

tal, reflects the required capital to meet all obligations over a specified time horizon.

The **second pillar** reflects the qualitative risk management. Its key elements are the control of internal risk models, governance processes, stress tests or the quality of risk mitigation.

The **third pillar** stands for disclosure and transparency to reinforce the market mechanisms and risk-based supervision.

The basic concept of Solvency II have been developed so far, however, the details are not yet worked out. The aim of the European Commission is the commencement of the new solvency regulations in the year 2010 – 2011. And that is the first problem on the field on risk man-

agement - international and national regulations adaptation process takes too long period of time, but fast changing business environment can not wait too long for the new requirements or mechanisms that are supposed to prevent crisis.

The requirements for a standard model in the Solvency II framework are complex. The function of the model is to optimize the present equity capital, to use the equity capital under yield return-risk-aspects and to deposit sufficient capital to cover the taken risks. The aim is to create an easy standard model which is transparent for the supervisory authority and needs only a few parameters.

Furthermore, the model should evaluate all basic risks in the company homogeneously and should measure all basic risks through one quantitative factor, so that two periods or two businesses can be compared. However, the model can only be an early indicator and can not re-

place a detailed inspection. This idea should be taken into consideration while discussing the sufficiency of the international risk models.

The development of risk orientated supervision and solvability systems began several years ago in the Netherlands, Great Britain, Switzerland and Germany. Even though Switzerland is not a member of the European Union there is a necessity to include also this system in the comparison, while this particular country plays an important role on the financial market and in the business environment.

The following table (see Table 1) presents main differences in the system among different European countries mentioned. It is worth to point out that Value at Risk is one of the mainly used risk measures, and that is why it is necessary to pay attention to this risk measure and evaluate it.

Table 1. Comparison of the systems among different European countries

Criteria	Germany	Netherlands	Great Britain	Switzerland
Valuation 1. Assets: 2. Liabilities:	1. Market Value 2. Market Value and/or Best Estimate	1. Market Value 2. Best Estimate	1. Market Value 2. Best Estimate	1. Market Value 2. Best Estimate
Minimum and target levels	Minimum Capital Requirements Solvency Capital Requirements	European Union rules Solvency Capital Requirements	Minimum Capital Requirements Enhanced Capital Requirement	Minimum Capital Requirements Solvency Capital Requirements
Solvency classification 1. based on risk factors 2. based on scenarios	1. yes 2. no	1. yes 2. yes	1. yes 2. Minimum Capital Requirements	1. n/a 2. yes
Confidence level	99,5%	99,5%	99,5%	99,0%
Risk measure	Value at Risk	n/a	Value at Risk	Expected Shortfall
Time horizon (in years)	One year	One year + multi	One year	One year
Internal models	Strongly recommended	Recommended	Recommended	Strongly recommended

2. Value at Risk

One of the most popular risk measures is the Value at Risk (VaR), which is used due to regulatory reasons in finance and in the insurance businesses. In the literature the Value at Risk is also called „Monetary at Risk“ or „Capital at Risk“. The Value at Risk is a one - sided and monetary as well as future oriented and risk adjusted performance measure, which corresponds to the percentile principle of the premium principles for insurance businesses.

The study of literature leads to the conclusion that many different definitions of VaR exist, which could be explained as a result of the inaccuracy of authors, as they do not make a distinction between lower and upper Value at Risk.

In order to solve this problem let define the Value at Risk as the ε - quantile with $\varepsilon = 1 - \alpha$, where α is a probability of default.

Before taking further steps in the discussion about VaR some words should be mentioned about quantiles. Let $X \in Z$ be a real valued ran-

dom variable and $\varepsilon \in (0;1)$. If q satisfies the following inequalities, then it could be called a ε - quantile:

$$\begin{aligned} P(X < q) &\leq \varepsilon \\ P(X > q) &\leq 1 - \varepsilon \\ P(X < q) &\leq \varepsilon \leq P(X \leq q) \end{aligned} \quad (1)$$

The lower ε - quantile of X (usually defined as an occurring loss to the value that is monetary expressed) is to be defined as:

$$q_\varepsilon(X) = \inf\{x \in \mathfrak{R} | F_X(x) \geq \varepsilon\} \quad (2)$$

where R is a real space and F – cumulative distribution function of X . In the similar way the upper - quantile of X could be defined:

$$q^\varepsilon(X) = \inf\{x \in \mathfrak{R} | F_X(x) > \varepsilon\} \quad (3)$$

and therefore, q is a ε - quantile in case the following inequity is satisfied:

$$q_\varepsilon(X) \leq q \leq q^\varepsilon(X) \quad (4)$$

For further information regarding this inequality follow considerations provided by [9].

The following part of the paper is going to discuss VaR - risk measure. Let X be a real-valued random variable with $X \in Z$ and F – the cumulative distribution function of the risk X and finally $\alpha \in (0;1)$ - be a confidence level.

Taking into consideration the idea about lower and upper risk measure mentioned in the second part of the current paper; the lower VaR is given by the following equations and it is the lower $(1 - \alpha)$ - quantile of X :

$$\begin{aligned} VaR_\alpha(X) &= q_{1-\alpha}(X) = \inf\{x \in \mathfrak{R} | F_X(x) \geq 1-\alpha\} \\ &= \inf\{x \in \mathfrak{R} | P(X \leq x) \geq 1-\alpha\} \\ &= \inf\{x \in \mathfrak{R} | P(X > x) \leq \alpha\} \\ &= \inf\{x \in \mathfrak{R} | P(X \geq x) > \alpha\} \\ &= F_X^{-1}(1-\alpha) \end{aligned} \quad (5)$$

The upper VaR is given by the following equation and is the upper $(1 - \alpha)$ - quantile of X :

$$\begin{aligned} VaR^\alpha(X) &= q^{1-\alpha}(X) = \inf\{x \in \mathfrak{R} | F_X(x) > 1-\alpha\} \\ &= \inf\{x \in \mathfrak{R} | P(X \leq x) > 1-\alpha\} \\ &= \inf\{x \in \mathfrak{R} | P(X > x) < \alpha\} \\ &= \sup\{x \in \mathfrak{R} | P(X \geq x) \geq \alpha\} \end{aligned} \quad (6)$$

The advantages of Value at Risk are simplicity, wide applicability and universality. As it was already mentioned VaR is the most widely used risk measure in financial institutions for market risk and credit risk due to historic and regulatory developments.

Risk managers can control the default risk via the use of Value at Risk. However, the Value at Risk also possesses some serious weaknesses. The Value at Risk as a risk measure is heavily criticized for not being subadditive in general; see also the discussion by Embrechts et.al. [10] and by McNeil et.al [1].

In capital market models in most of the cases the normal distribution is used, which is a member of the elliptical distribution family. That is why it is an idealized situation, where all portfolios can be represented as linear combinations of the same set of underlying elliptically distributed risks. Thus, the Expected Shortfall and the Value at Risk are affine functions of mean and standard deviation. Therefore, it is possible to come to the conclusion that the Value at Risk provides the same information about the tail loss as the Expected Shortfall does.

In the elliptical world everything is proportional to the standard deviation which in turn is subadditive. Therefore, in the normal world both Value at Risk and Expected Shortfall are subadditive for $0.5 < \alpha < 1$. The following theoretical example shows that this is no longer true outside the elliptical world.

Suppose that the risks X_1 and X_2 follow a Pareto distribution, each having density function like:

$$f(x) = \frac{1}{2(\sqrt{1+x})^3}, x \geq 0 \quad (7)$$

and with shape parameter $\lambda = 1/2$ and form parameter $\beta = 1$. The cumulative distribution function is given by:

$$F(x) = 1 - \frac{1}{\sqrt{1+x}}, x \geq 0 \quad (8)$$

Then the density g and cumulative distribution function G of the aggregated risk $S = X_1 + X_2$ can be computed in the following case, among others: X_1 and X_2 are independent risk, then:

$$g(z) = \frac{z}{(2+z)^2 \sqrt{1+z}} \sim \frac{1}{\sqrt{1+z}^3} \quad (9)$$

$$G(z) = 1 - 2 \frac{\sqrt{1+z}}{2+z} \text{ for } z \rightarrow \infty$$

From the cumulative distribution functions the aggregated loss could be expressed as following for $0 < \alpha < 1$:

$$\text{VaR}_\alpha = \frac{4}{\alpha^2} - 2 - \frac{2}{1 + \sqrt{1 - \alpha^2}} \quad (10)$$

$$\sim \frac{4}{\alpha^2} - 4 (\alpha \rightarrow 0)$$

The VaR for both X_1 and X_2 is given for $0 < \alpha < 1$ by:

$$\begin{aligned} \text{VaR}_\alpha(X_1) &= \inf \{x | F_{X_1}(x) \geq 1 - \alpha\} = \\ &= \inf \{x | P(X_1 \leq x) \geq 1 - \alpha\} = \\ &= \frac{1}{\alpha^2} - 1 \end{aligned} \quad (11)$$

$$\begin{aligned} \text{VaR}_\alpha(X_2) &= \inf \{x | F_{X_2}(x) \geq 1 - \alpha\} = \\ &= \inf \{x | P(X_2 \leq x) \geq 1 - \alpha\} = \\ &= \frac{1}{\alpha^2} - 1 \end{aligned} \quad (12)$$

The following graph (Figure 2) shows the VaR_α for the example above: the first curve (see Figure 1 – left curve) is identically with the curve of the sum $\text{VaR}_\alpha(X_1) + \text{VaR}_\alpha(X_2)$; the second curve (see Figure 2 – right curve) is equivalent to the aggregated loss (equation 10).

It is obvious that the risk measure Value at Risk violates the property of subadditivity in general. Example shows that it is more „dangerous“ to have two independent Pareto distributed risks in the same portfolio instead of having the two identical ones.

Therefore, a serious disadvantage is that Value at Risk does not consider the structure of the distribution of aggregate losses. Additionally, the risks at the tail of the distribution are not considered and therefore an underestimation of risks may appear.

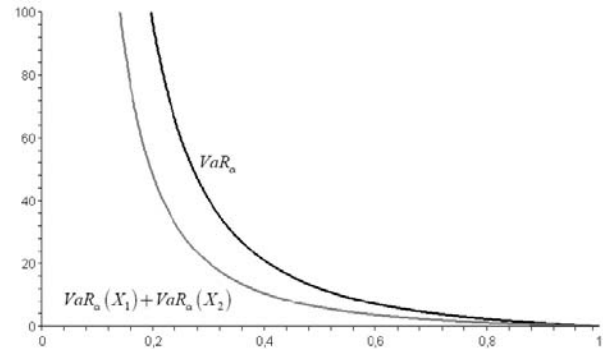


Fig. 2. Comparison of Value at Risk for two independent risks – theoretical example

Thus, the Value at Risk does not consider the question of „how bad is bad“ (follow considerations by Artzner et. al. [11] or Dhaene et al. [12]). The Value at Risk is only related to a frequency estimate of a high claim. Therefore, it does not say anything about the severity (conditional expected loss) when that (rare) loss happens.

However, in the insurance business distributions of the elliptical distribution family are usually not used. Therefore, it is necessary to consider the property of subadditivity.

Let understand subadditivity as mathematical equivalent of the diversification effect. For a subadditive risk measure, portfolio diversification always leads to risk reduction, while for a non-subadditive risk measure it may happen that the diversified portfolio requires more solvency capital than the original one. Several examples and references about this topic can be found by [13].

Another disadvantage is the absence of continuity of the Value at Risk as a function of the level α for a fixed risk X .

The Value at Risk as a quantile function is only continuous from the right. Therefore, it is possible that for slightly different confidence levels one obtains highly different values for the Value at Risk.

However, this disadvantage can be corrected by calculation of the Value at Risk for many levels. At high divergence of the confidence levels it is useful to regard economic considerations in the calculation of solvency capital.

Hence, it is possible to say that the use of Value at Risk as risk measure requires caution and there is the necessity to look for other possibilities for other risk measures.

Conclusions

Over the past years, risk management and risk measures have increasingly gained importance. Managing risks is supposed to optimize the administration of the scarce capital of security in a way that on one hand the risks are covered and on the other hand the least possible capital of security is kept.

The aim is to define a corporation-wide objective criterion to determine the capital of security, which quantifies the risk of business activity. Therefore, the complex risks have to be reduced to a one-dimensional risk measure.

The insurance supervisor's task is to ensure that the interests of the policyholders are protected and the security of the underwriters is guaranteed. Therefore, rules for a sufficient capital of security as well as associated methods of risk management have to be fixed.

The current paper gave the overview of the development status of the Solvency II process. The approach has been motivated by the recent developments in the insurance and finance business, where risk management and risk measures have become crucial to calculate capital requirements.

The article discussed main issues and evaluated the method – Value at Risk that is currently used in practice. Several disadvantages of the approach have been discussed and in conclusion it is worth to say that new risk management tool is needed (that was indirectly proved by the current financial crisis).

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