RISK MANAGEMENT FOR SUSTAINABLE GROWTH. DO WE NEED A NEW APPROACH?

Jekaterina Kuzmina
BA School of Business and Finance, Latvia

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. In the process mentioned an adequate risk management plays an important role. This evidence allows coming to the conclusion that sustainable development could be achieved thorough consideration of risks, uncertainties, and information and knowledge imperfections 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 after the subprime crisis 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 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. McNeil et.al. (2006); Gruendel and (2005)) and also appropriate and adequate risk measures (see e.g. Artzner et.al. (1999)) 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 Perlet 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 and Expected Shortfall are 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.

Solvency II – Mail Stones of the Development Process

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 Eling (2007)). 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 and is analogous to Basle II in the banking sector. 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 capital, 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 management - 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 replace 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 thought 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 Among 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

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 ε = 1 – α, 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 Є Z be a real valued random variable and ε Є (0;1). If q satisfies the following inequalities, then it could be called a ε – quantile:

$$P(X < q) \leq \varepsilon$$
$$P(X > q) \leq 1 - \varepsilon \qquad [1]$$
$$P(X < q) \leq \varepsilon \leq P(X \leq q)$$

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

$$q_{\varepsilon}(X) = \inf\{x \in \Re \mid F_X(x) \geq \varepsilon\} \qquad [2]$$

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:

$$q^{\varepsilon}(X) = \inf \{x \in \Re | F_X(x) > \varepsilon\} \quad [3]$$

and therefore, q is a - 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 Delbaen (2002). The following part of the paper is going to discuss VaR - risk measure. Let X be a real-valued random variable with X Є Z and F – the cumulative distribution function of the risk X and finally α Є (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 – α) – quantile of X:

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

The upper VaR is given by the following equitation and is the upper (1 – α) – quantile of X:

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

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.(2002) and by McNeil et.al. (2006). 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 < α < 1. The following theoretical example shows that this is no longer true outside the elliptical world. Suppose that the risks X1 and X2 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 λ = ½ and form parameter β = 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 = X1 + X2 can be computed in the following case, among others: X1 and X2 are independent risk, then:

$$g(z) = \frac{z}{(2+z)^2\sqrt{1+z}} \sim \frac{1}{\sqrt{1+z}^3}$$
$$G(z) = 1 - 2\frac{\sqrt{1+z}}{2+z} \text{ for\_} z \to \infty \qquad [9]$$

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

$$\mathrm{VaR}_{\alpha} = \frac{4}{\alpha^2} - 2 - \frac{2}{1+\sqrt{1-\alpha^2}}$$
$$\sim \frac{4}{\alpha^2} - 4(\alpha \to 0) \qquad [10]$$

The VaR for both X1 and X2 is given for 0 < α < 1 by:

$$\mathrm{VaR}_{\alpha}(X_1) = \inf \{x \mid F_{x1}(x) \geq 1-\alpha\}$$
$$= \inf \{x \mid P(X_1 \leq x) \geq 1-\alpha\} \qquad [11]$$
$$= \frac{1}{\alpha^2} - 1$$

$$\mathrm{VaR}_{\alpha}(X_2) = \inf \{x \mid F_{x2}(x) \geq 1-\alpha\}$$
$$= \inf \{x \mid P(X_2 \leq x) \geq 1-\alpha\} \qquad [12]$$
$$= \frac{1}{\alpha^2} - 1$$

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. Thus, the Value at Risk does not consider the question of “how bad is bad” (follow considerations by Artzner et. al. (2002) or Dhaene et al. (2004)). 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 Langmann (2005). 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.

Expected Shortfall

In the context of Solvency II a discussion resulted on how to quantify the actuarial risk using a qualified risk measure. The Expected Shortfall (ES) is the "smallest" useful coherent risk measure above VaR. The Expected Shortfall became increasingly popular in connection with Solvency II. The Expected Shortfall is also called Conditional Value at Risk, Tail Value at Risk or Average Value at Risk, which refer to the same risk measure. However, there is a necessity of paying attention on how the authors define the risk measure in their papers. That is why the current part is going to start with definition. Let α Є (0;1) be a fixed confidence level and X Є Z be a risk within $E(X^{+}) < \infty$, then the Expected Shortfall ES at level α of X is given by:

$$ES_{\alpha} = ES_{\alpha}(X) = E\left(X \middle| X \geq VaR_{\alpha}(X)\right) = \frac{1}{\alpha}\int_{0}^{\alpha} VaR_{u}(X)du \qquad [13]$$

The ES equals the arithmetic average of the Value at Risk over all risk levels up to α (for more details follow Acerbi (2004)). Attention should be paid to the fact that Expected Shortfall and the different versions of Tail Conditional Expectation do not give the same result in general. The relations between the different versions are examined in detail in Langmann (2005). The Expected Shortfall is a coherent risk measure, that could be proved as following: positive homogeneity and the translation invariance follow directly from the positive homogeneity and the translation invariance of Value at Risk and the linearity of the integral. Fix α Є (0;1) and X Є Z with equation [13] we come to the conclusion that:

$$\begin{aligned} &ES_{\alpha}(\lambda X) = \lambda ES_{\alpha}(X)\_\_for\_\_\lambda \geq 0 \\ &ES_{\alpha}(X + c) = ES_{\alpha}(X) + c\_\_for\_all\_c \in \Re \end{aligned} \qquad [14]$$

The monotonicity can be derived as follows: let X≤Y for some X, Y Є Z. Then by monotonicity of the Value at Risk we get:

$$\int_{0}^{\alpha} VaR_{u}(X)du \leq \int_{0}^{\alpha} VaR_{u}(Y)du --> ES_{\alpha}(X) \leq ES_{\alpha}(Y) \qquad [15]$$

The subadditivity of the Expected Shortfall can be proved with a modified indicator function:

$$\begin{aligned} &1^{\alpha}_{[X \geq x]} = \left\{1_{[X \geq x]}; 1_{[X \geq x]} + \frac{\alpha - P(X \geq x)}{P(X = x)} 1_{[X = x]}\right. \\ &P(X = x) = 0; P(X = x) > 0 \end{aligned} \qquad [16]$$

Let Y Є Z with $E(Y^{+}) < \infty$ and S= X+Y, then to complete the proof of the theorem the following could be done:

$$\begin{aligned} &\alpha * (ES_{\alpha}(X) + ES_{\alpha}(Y) - ES_{\alpha}(S) = \\ &= E\left(X1^{\alpha}_{(X \geq VaR\alpha(X))} + Y1^{\alpha}_{(Y \geq VaR\alpha(Y))} - S1^{\alpha}_{(S \geq VaR\alpha(S))}\right) = \\ &= E\left(X(1^{\alpha}_{(X \geq VaR\alpha(X))} - 1^{\alpha}_{(S \geq VaR\alpha(S))}) + Y\left(1^{\alpha}_{(Y \geq VaR\alpha(Y))} - 1^{\alpha}_{(S \geq VaR\alpha(S))}\right)\right) = \\ &= E\left(X(1^{\alpha}_{(X \geq VaR\alpha(X))} - 1^{\alpha}_{(S \geq VaR\alpha(S))}) + E\left(Y(1^{\alpha}_{(Y \geq VaR\alpha(Y))} - 1^{\alpha}_{(S \geq VaR\alpha(S))}\right)\right) \geq \\ &\geq VaR_{\alpha}(X)E(1^{\alpha}_{(X \geq VaR\alpha(X))} - 1^{\alpha}_{(S \geq VaR\alpha(S))}) + VaR_{\alpha}(Y)E(1^{\alpha}_{(Y \geq VaR\alpha(Y))} - 1^{\alpha}_{(S \geq VaR\alpha(S))}) = \\ &= VaR_{\alpha}(X)(\alpha - \alpha) + VaR_{\alpha}(Y)(\alpha - \alpha) = 0 \end{aligned} \qquad [17]$$

The key advantage of the Expected Shortfall compared to the Value at Risk is that the Expected Shortfall does not only describe but also quantifies the fact of insolvency. Consequently, the Expected Shortfall considers the interests of policy in a stronger sense. However, the interests of shareholders are weaker considered in comparison to the interests of policy holders. This risk measure is the coherence of this risk measure in comparison to the Value at Risk. Furthermore, the Expected Shortfall is continuous with respect to the confidence level α and, hence, produces only little differing values for little modifications of the confidence level.

However, it does not only possess advantages. Expected Shortfall only reflects losses exceeding Value at Risk and therefore is sensitive mainly to extreme events. Hence the following problems are possible: (1) ES is calculated as the expected value of all worst losses. However, this ignores that every unlikely event will happen sooner or later given enough time. Therefore, the size of the losses will eventually exceed the existing solvency capital; (2) it reacts sensitively to an adjustment of the distributions, which is a problem, because often no sufficient data for extreme events is available; (3) the difference between Value at Risk and Expected Shortfall is in general large, and the additional capital invested compared to the Value at Risk only gives a small increase of the secured return period of $1/\alpha$. Hence, the gap between Value at Risk and Expected Shortfall, being a financial strain to the insurance business, is in practice disproportionably high compared to its gain and, therefore, not acceptable; (4) ES can be seen as the average loss above therefore, one justification of its use is the law of large numbers. However, this is not reasonable from an economic point of view, as insolvencies are singular events. Due to this perception, from an economical point of view, the use of this measure may lead to absurd risk capital allocations. Therefore, in the usual case risks are not reserved adequately.

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 and Expected Shortfall 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).

References

1. ACERBI, C. (2004) Coherent Representations of Subjective Risk-Aversion. In: Szegö, G. (Ed.): Risk measures for the 21st century. Wiley Finance Series. Chichester: John Wiley & Sons, Ltd.
2. ARTZNER, P., DELBAEN, F., EBER, J.-M. AND HEATH, D. Coherent Measures of Risk. Mathematical Finance. 1999 9(3), p. 203 – 228
3. ARTZNER, P., DELBAEN, F., EBER, J.-M. AND HEATH, D. (2002) Coherent Measures of Risk. In: Dempster, M. A. H. (Ed.): Risk Management: Value at Risk and Beyond. Cambridge University Press., p. 145 – 175
4. CONSULTATION PAPER NO. 4. Draft Answers to the European Commission on the First Wave of Calls for Advice in the Framework of the Solvency II Project. [online] [accessed 15 August 2009]. Available from Internet: <http://www.ceiops.org>
5. CONSULTATION PAPER NO. 7. Draft Answers to the European Commission on the Second Wave of Calls for Advice in the Framework of the Solvency II Project. [online] [accessed 15 August 2009]. Available from Internet: <http://www.ceiops.org>
6. CONSULTATION PAPER NO. 9. Draft Answers to the European Commission on the Third Wave of Calls for Advice in the Framework of the Solvency II Project. [online] [accessed 15 August 2009]. Available from Internet: <http://www.ceiops.org>

7. DESIGN OF A FUTURE PRUDENTIAL SUPERVISORY SYSTEM IN THE EU. Recommendations by the Commission Services. [online] [accessed 15 August 2009]. Available from Internet: <http://www.ceiops.org>
8. DELBAEN, F. (2002) Coherent Risk Measures on General Probability Spaces. In: Sandmann, K. and Schönbucher, Philip J. (Eds.): Advances in finance and stochastics: essays in honour of Dieter Sondermann. Berlin: Springer Verlag, p. 1 – 37
9. DHAENE, JAN L. M., VANDUFFEL, S., TANG, Q., GOOVAERTS, MARC J., KAAS, R. AND VYNCKE, D. (2004) Solvency capital, risk measures and comonotonicity: a review. Working Paper. Katolieke Universiteit Leuven
10. ELING M. (2007) The Solvency II Process: Overview and Critical Analysis. Risk management and insurance review 1, p. 69 – 86
11. EMBRECHTS, P., MCNEIL, ALEXANDER J. AND STRAUMANN, D. (2002) Correlation and Dependence in Risk Management: Properties and Pitfalls. In: Dempster, M. A. H. (Ed.): Risk Management: Value at Risk and Beyond. Cambridge University Press, p. 176 – 223
12. GRÜNDL, H. UND PERLET, H. (2005) Solvency II & Risikomanagement – Umbruch in der Versicherungswirtschaft. Gabler Verlag
13. LANGMANN, M. (2005) Risikomaße in der Versicherungstechnik: Vom Value-at-Risk zu Spektralmaßen – Konzeption, Vergleich, Bewertung. Diplomarbeit an der Carl von Ossietzky Universität Oldenburg
14. MCNEIL, A. J., FREY, R. AND EMBRECHTS, P. (2006) Quantitative risk management concepts, techniques and tools. Princeton University Press

About the author

Mc. Jekaterina Kuzmina
Doctoral Student
BA School of Business and Finance
Risk Management, Portfolio Management
E-mail: jekaterina_kuzmina@yahoo.de