CONDITIONAL RISK MEASURE MODELING FOR LATVIAN INSURANCE COMPANIES

JEKATERINA KUZMINA,
BA School of Business and Finance, Latvia

GAIDA PETTERE PH.D.,
IRINA VORONOVA, PH.D.
Faculty of Engineering Economics and Management
Riga Technical University, Latvia

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Abstract: Due to the current economical situation on the Latvian market insurance companies are forced to consider other possibilities of income generation. One of such opportunities could be seen in cash flows from investment operations, while managing stocks' portfolios. The process of portfolio management is tightly connected with adequate risk management. In the current paper we have used copula approach for estimating portfolio's conditional risk measures and though to contribute to the discussion about appropriate risk management in the insurance companies.

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Introduction

Latvian Insurers' Association data shows that in the first half of 2009 Latvian insurance market (both for life and non-life insurance companies) decreased by 22.6% in comparison to the same period of the previous year, and the forecast for the next period is negative. Due to the current economical situation on the local market insurance companies are forced to consider other possibilities of income generation. One of such opportunities could be seen in cash flows from investment operations, while managing stocks' portfolios as the global equity market is recovering. The process of portfolio management is tightly connected with adequate risk management. We strongly believe that multidimensional copula models allow determining risk measures with the least violation number in the back-testing, provides the investors to allocate the minimum regulatory capital requirement in accordance with Solvency II. The topic of the copula approach in the portfolio management was already discussed in several papers (e.g. Ozun and Cifter (2007) used copula models for estimating portfolio Value at Risk), while we are going to use the approach for estimating portfolio's conditional risk measures and though to contribute to the discussion about appropriate risk management in the insurance companies. In the current paper we are going to show the possibility of estimation several risk measures with copula models while describing the approach on the base of test portfolio built of three stock indices: CAC 40 - French stock market index; ATX - Austrian traded index; SBF 120 - Paris stock exchange index.

Latvian insurance market: new challenges and possible solutions

Unfavorable economic situation on the global and local market negatively influenced insurance companies. Latest data shows that in the first half of 2009 Latvian non-life insurance market decreased by 21% (while the amount of gross claims paid decreased only by 4%) and life insurance market - by 27% (while the amount of gross claims paid in the same period increased by 52%) in comparison to the equal period of the previous year. Experts of the industry and companies` management are expecting further decrease of the total market volume and earnings, and are warning about market consolidation in the short-term time period. In the challenging market environment the insurance companies are forced to look for other opportunities of profit generation.

According to the Latvian Law (2009) companies providing insurance services are allowed to invest up to 5% of their technical reserves securities, excluding Latvian and OECD country's securities. In the previous periods insurance companies were building conservative portfolios while mainly investing in government bonds and keeping only small amount of shares. Favorable market performance on the European equity market in the last months as well as the strong rally in the high beta sectors makes institutional investors to consider about investing in equities as far as European equity market is recovering, but prices are still lower to enter the market.

While deciding about investment in equities or other asset classes, it is to be considered that the process of portfolio management is to be integrated in the risk management system in order to fulfill European and local regulatory requirements (Solvency II).

Risk management requirements

The ability of insurance companies to identify and manage risks as well as the efficient use of capital is becoming increasingly important in a highly competitive market environment. The concept of the Value at Risk has obvious structural similarities to the pillar 1 of the Solvency II concept, and if an insurance company chooses to apply internal risk measurement models, the management results can be immediately used for regulatory purposes, as Value at Risk gives a necessary amount of economic capital that is tied up in supporting the business. Value at Risk is an accepted measure of risk which has achieved the high status of being written into industry regulations.

However, it should be regarded that the measure is unstable and difficult to work with numerically when losses are not normally distributed, in such cases when loss distributions tend to exhibit so called fat tails. Moreover, Value at Risk fails to be coherent in the sense of Artzner et al. (1999). And a very serious shortcoming of this risk measure, in addition, is that it provides no handle to the extent of the losses that are beyond the amount indicated by Value at Risk. Indeed, it merely provides a lowest bound for losses in the tail of the loss distribution and has a bias toward optimism instead of the conservatism that ought to prevail in risk management. Due to the problems described in the last years an alternative risk measure - conditional Value at Risk - was determined in order to satisfy portfolio managers' requirements.

As it was already mentioned in the recent years a growing attention has been devoted to a clear treatment of the quantification of financial risks. Artzner et al. (1999) proposed in their work a set of advantageous axioms that every risk measure should satisfy, defining in such a way the class of coherent risk measures. Delbaen (2002) proved that, under a mild continuity assumption, every coherent risk measure can be represented as worst expected loss with respect to a given set of probabilistic models.

In our work we are going to use the following idea presented by Bion-Nadal (2004): a financial position on the market could be described by a bounded map defined on the set of different possible scenarios (Ω – set of scenarios). Let us consider a linear space χ of financial positions and a σ-algebra F on the space Ω, and denote EF the set of all bounded real valued (Ω;F) measurable maps. Let us assume that a probability measure P is given on the σ-algebra F, which is the case of partial uncertainty relevant to the market situation.

A mapping: $$\rho_F : \chi \rightarrow L^{\infty}(\Omega; F; P) \qquad (1)$$

is called conditional a risk measure to the probability space (Ω;F;P) if it satisfies the following conditions: monotonicity for all X, Y being part of linear space χ if X ≤ Y then ρF (Y) ≤ ρF (X); translation invariance for all Y being part of EF and all X being part of χ then ρF (X+Y) = ρF (X) – Y; multiplicative invariance for all X being part of χ, for all A being part of F ρF (X1A) = 1aρF (X).

Practical example: portfolio conditional risk modeling

In order to determine conditional risk measures we are building test portfolio consisting of 3 European equity indices: CAC 40 - French stock market index; ATX - Austrian traded index; SBF 120 - Paris stock exchange index and with following weights: w1 = 20%; w2 = 50% and w3 = 30% (please note that the question about appropriate asset allocation and weights is not a question discussed in the current paper). For this purpose we use Bloomberg data source and extract index values with a time period from June 2007 to June 2009.

In the next step the distribution function for each index is determined. Marginal distributions for stock indices price changes were checked using Kolmogorov test and they are: for CAC 40 – Gumbel (extreme value) distribution with $a = 0.655$ and $b = 0.089$; for ATX – Gamma distribution with $\lambda = 100$ and $\alpha = 65$; for SBF 120 - Gumbel (extreme value) distribution with $a = 0.45$ and $b = 0.148$. These data allow accomplishing data simulation with copula approach (normal copula used). Further considerations about the approach used are explained in the paper by Kollo and Pettere (2009).

In order to prove fitness of copula to data we built up one dimensional distributions from simulated and existing data in each coordinate plane using Genest, Rivest construction and found stochastic Kolmogorov test value (whereby X stands for CAC 40 - French stock market index; Y for ATX - Austrian traded index; Z for SBF 120 - Paris stock exchange index). Please note that test values' in each coordinate plane characteristics after 150 replications are as shown in the Table 1 (Kolmogorov critical value corresponding to 5% significance level is equal to 0.0823).

TABLE 1. KOLMOGOROV TEST VALUES AND THEIR CHARACTERISTICS

Characteristic of test value	X_Y plane	X_Z plane	Y_Z plane
№ of simulations	150	150	150
Mean	0.0758	0.0712	0.0801
Median	0.0733	0.0696	0.0788
Min	0.0586	0.0586	0.0586
Max	0.0989	0.0916	0.1172
Standard deviation	0.0085	0.0069	0.0103
Skewness	0.4875	0.4198	0.5842
Kurtosis	0.1845	0.0196	0.4416
Percentile 1%	0.0586	0.0586	0.0592
Percentile 99%	0.0989	0.0910	0.1156

In the next step the forecast of index values was made and "new" values based on historical data were gained. While comparing the results with real values we came to the conclusion that the error percentage showed an interval [-5.7; 10.9] for 150 replications of each index; that could be considered to be satisfactory result being aware of volatile market in the previous periods.

Based on the simulated index prices we have computed conditional risk measures. We define conditional mean (or conditional tail expectance) as:

$$\mu_C = E\left[X / X \le VaR_X(\alpha)\right], \quad (2)$$

where X is a vector of variables on which the condition of value being lower then conditional Value at Risk is determined.

We define conditional Value at Risk as conditional expected loss under the condition that it exceeds Value at Risk:

$$VaR_X(\alpha) = \sup\{x / P(X < x) \le \alpha\}, \quad (3)$$

where $\acute{\alpha}$ is probability of loss defined (for example 1%).

In order to be in compliance with risk measures determined in the Table 1 we are going to use also the following measures: variance or conditional second order central moment; conditional skewness and conditional kurtosis:

$$\sigma_C^2 = E\left[(X - E(X))^2 / X \le VaR_X(\alpha)\right], \quad (4)$$

$$A_C = \frac{E\left[(X - E(X))^3 / X \le VaR_X(\alpha)\right]}{\sigma_C^3}, \quad (5)$$

$$K_C = \frac{E\left[(X - E(X))^4 / X \le VaR_X(\alpha)\right]}{\sigma_C^4} - 3. \quad (6)$$

The purpose of building test portfolio was to proof that based on the data simulated and while using Excel (there is no need for using challenging mathematical calculations) it is possible to determine several risk measures in order to satisfy requirements of regulatory authorities and choose appropriate tools for risk management. Table 2 shows results of test portfolio's stochastic risk measures and their characteristics of descriptive statistics which are obtained after 150 replications.

TABLE 2. CONDITIONAL STOCHASTIC RISK MEASURES OF TEST PORTFOLIO AND THEIR CHARACTERISTICS

		Conditional Risk Measures:						
VaR (5%)		Mean	Variance	Standard deviation	Skewness	Kurtosis	Percentile 2.5%	Percentile 97.5%
		1 575.53	315.95	17.78	-0.27	0.13	1 538.84	1603.92
Characteristics:	Mean	2 270.37	253.16	15.91	0.07	-0.24	2 240.85	2 302.31
	Standard deviation	522.47	262.01	16.19	0.16	-0.27	492.32	552.27
	Skewness	1.02	0.03	0.16	0.47	-0.16	0.77	1.36
	Kurtosis	1.84	0.87	0.93	1.23	2.27	0.61	3.99
	Percentile 2.5%	1 490.10	433.07	20.81	-0.03	-0.13	1 454.76	1 529.72
	Percentile 97.5%	3 500.53	5 003.12	70.73	0.36	0.86	3 360.79	3 668.58

Conclusions

Current economical situation on the Latvian market forces insurance companies operating on the market to look for alternative profit generating opportunities, in order to reduce the gap between the amount of gross claims paid and net premiums received. One of such possibilities is seen in equity investment due to the current attractive possibilities on the global equity market: while the world economy is recovering, but prices are still lower to enter the market (European equity indices are trading 7% below the level before Lehman Brothers bankruptcy, while the stock indices in Emerging Markets are 10% above). It is to be considered that while investing in different classes of assets the management of the companies is to be in accordance with international and national requirements concerning appropriate risk management. In the current paper we have shown the algorithm of computation conditional risk measures in the copula approach framework and claim that the approach described is appropriate in order to satisfy regulatory requirements and internal risk management standards. Based on the practical example we came to the conclusion that the approach described can handle large number of instruments and scenarios, and while conditional Value at Risk management constraints can be used in various applications to bound percentiles of loss distributions, it is an adequate tool for risk management in insurance companies willing to enter equity market.

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