The "Value at Risk" Concept for Insurance Companies

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Abstract

The VAR concept is becoming the industry standard for risk management in banks active in trading. This presentation tries to show possible applications and conditions for the VAR-methods in insurance companies.

Résumé

La conception VAR (la valeur au risque) est le nouveau standard pour le management du risque dans le monde financier. Au cours de cette présentation on va élaborer quelques applications des méthodes du type VAR. En outre on va étudier les conditions sous lesquelles ces modèles peuvent être utiles pour des compagnies d'assurances.

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A. The Importance of Value-at-Risk for Insurance Companies

In times, of real time information worldwide it becomes easy for investors to compare the performance of financial institutions like banks, insurance companies and funds. Even less informed investors and clients are able to judge the performance of financial institutions by using the service of rating agencies, who give ratings not only on banks, but also on insurance companies and funds. Especially for insurance companies and investment funds efficient capital investments are the differentiating battle field on which competitors try to gain new clients. It becomes evident that the results of the capital investments influences the competitiveness and growth of financial institutions in the future.

In 1990 Harry M. Markowitz, one of the founders of modern portfolio theory, received the Nobel Price for Economics for his work. The basis of his work was to introduce risk into portfolio theory. Not only the expected return but also the risk of an investment becomes a decision criterion.
But what exactly is risk, how is it measured? As a measurement different variables are considered. So one can choose the probability that over a certain period of time a loss appears. In modern portfolio theory the standard deviation of the annual return has established itself as a measure of risk. This statistical term expresses the average deviation of an expected value.

In today's insurance companies risk is often measured by the amount of possible depreciation at the end of the year. This is somehow quantified by doing a rough scenario-analysis on the securities which have to be accounted by the lower of cost or market. Sometimes this method is accompanied by a so-called Gap Analysis which compares volumes between assets and liabilities, within different time buckets. All these methods have the disadvantage that they are not standardized and therefore, not usable to

compare competing companies. They normally do not give a good understanding of the real economic risks involved and by no means are they able to quantify the risk of complex portfolios which include options and correlation risks.

Methods which give a clear picture of market risks have been developed by large trading houses. In the last few years, the reason why they so quickly have become prominent in Europe, is the fact that the Bank for International Settlement in Basel (BIS) has proposed to cover market risks in banks with equity. The allowed methods to quantify market risks according to Basel are either some very standardized tables and scenario analysis' or some bank internal methods. A working group organised by the BIS has shown that mainly three different internal methods are presently used by trading houses. These are the Historical Simulation Method, the Variance-Covariance Method, and the Monte-Carlo-Method.

Internal Methods will become even more important when the European Capital Adequacy Directive will be revised in 1998. This already leads to the fact that Internal Models will be introduced into national laws by the national authorities in Europe who made it to their objective to get a tighter control on market risks of financial institutions.

Internal Methods measure market risk under normal market conditions by using historical market data to predict future market events. The so-called Variance-Covariance-Method measures the volatilities and correlations of market variables from historical price data and produces a statistical model based on these estimates. The Historical Simulation Method uses historical price observations directly to simulate future price changes. Using historical data to predict the future, makes the assumption that the future shows a

similiar type of behaviour with the past. It is strongly advisable to test this assumption frequently and to use stress testing in addition.

Stress tests look at possible price changes in asset values under given deterministic and prespecified scenarios. The user defines the market reactions, he wishes to study and the system calculates mark-to-market values for these outcomes. In stress testing one does not follow any historical or estimated rules or correlations, but uses history independent scenarios.

Internal Methods have the advantage that they compare various operations of different nature, since all portfolios and markets are reported on an equal measure. Stock market risks can be compared to bond portfolio risk or fx risk, and combined to give true portfolio risk. Further Internal Methods give the possibility to see true portfolio effects which are generated by the fact that the movements of market variables are correlated at various levels.

B. Standardisation by the Bank of International Settlement in Basel (BIS)

Within three years, from its first proposal in 1993 to its final draft in 1996, a market risk committee of the Bank of International Settlement in Basel has worked with international banks from different countries on standardizing the bank internal methods, so that the Value-at-Risk-results become comparable and therefore usable for the calculation of equity requirements.

Basel exclusively mentiones the three methods, Historical Simulation, Variance-Covariance and Monte-Carlo-Simulation, for fulfilling the requirements. To calculate the Value-at-Risk numbers, at least one year of daily historical data has to be used and the simulations have to assume a 10-day holding period of the investment portfolio. The requirement to use a 99%-confidence-interval means that out of the possible values of a portfolio

the point is marked where 99 % of all possible values have a better outcome and 1 % have a worse outcome. This point is compared with the actual value of the portfolio and the amount of loss defined with this procedure is the so-called 1 % Value-at-Risk level or the 99 % confidence interval. In other words there is a 1 %-probability that the value of the portfolio will decrease more than the loss obtained by the Value-at-Risk-level.

C. A short description of the Internal Models

1. The Variance-Covariance-Approach

The Variance-Covariance Method measures the standard deviations (volatility) and correlations of market variables (so-called risk factors) from historical price data. Each single position in a portfolio is attributed to a risk factor and the amount of stock in each risk factor is multiplied by its volatility. This resulting vector is then multiplied by the Covariance Matrix to give the value at risk of the entire portfolio. Multiplying the result by 2,33 scales the VAR from one standard deviation to a 99 % confidence interval (see appendix 1).

The Variance-Covariance-Matrix is the basis of these methods outlined. It summarizes the stochastic relationship between the various risk factors. Changes in volatilities of risk factors and their correlation coefficients give information about the effect one risk factor has on another risk factor.

The Variance-Covariance-Approach is an extension of Markowitz' portfolio theory. Markowitz developed portfolio theory only for linear pricing functions. Directly applying Markowitz' portfolio theory to option bearing positions requires a linear approximation of these pricing functions and thus neglects gamma effects. Regulators require that Internal Models from market risk

measurement include convexity risks. Different alternatives exist to accomplish this task. The easiest one is to calculate separately the convexity risk (gamma) and to add it to the calculated linear risk, known as Delta Plus Approach.

2. Historical Simulation

The Historical Simulation produces a list of profits and losses that a portfolio would have experienced if the current portfolio would have been held over predefined historical time periods. From the list of profit and losses the 1 % Value-at-Risk is determined by choosing the 1 % worst loss. Although this method is easy to understand it has certain draw-backs. Firstly it is focused on the historical paths of market movements. Secondly it is time consuming to recalculate the market value of each single position. This disadvantage can be solved by doing delta/gamma approximations for the recalculation of market values (appendix 2).

3. Monte-Carlo-Simulation

The Monte-Carlo-Simulation generates random numbers that are modified to have the distributions defined by historical data and the estimated volatilities and correlations. The model takes a set of possible values for each of the market variables during each simulation run and uses those values to calculate the corresponding prices for all positions. These simulations are repeated normally for 10.000 to 20.000 times, each simulation gives a representation of market-value.

Although the Monte-Carlo-Simulation takes a lot of computer time it is the most advanced method for quantifying risk since it does not depend on one historical time path (see appendix 3).

D. Implementation

1. Requirements

After the decision for VAR the institution must decide on which positions VAR is planned to calculate. The choices are either on single portfolios or company wide. This question is closely connected with the most difficult task for large houses to get the transaction data in a consistent manner. In addition, historical market data, evaluation formulae for all products traded and the implementation of at least one of the above mentioned Internal Methods is needed. Finally one must decide on what kind of reports are wanted and needed.

2. Transaction Data Base

In order to run a Value-at-Risk calculation on a portfolio, all transaction data of this portfolio have to be available in a consistent manner. The choices are either to use an existing inhouse data base or to buy from an external vendor a data base which includes already the description of the products traded or to use the shell of an open data base vendor. The decision criteria are complex and include points like the quality of the already existing transaction data base and its flexibility for a Value-at-Risk-calculation. Further one has to judge realistically the capacities of the inhouse EDP resources which are necessary to do inhouse developments. If one decides to buy a ready-to-use data base from an external vendor it is most advisable to look to software houses who offer derivative trading systems since their products normally offer the broadest choice of products within their data bases.

3. Market data

As mentioned above at least one year of daily market data is needed for each single risk factor an institution is trading in. Such a data base can be collected by oneself but one has to consider that it is not a trivial task to do. Especially when the number of risk factors is going into hundreds. It is more advisable to get this data from either professional data base vendors like DATA STREAM or REUTERS or from banks like DG BANK (via its GIS information systems) or JP Morgan who offeres these data on different computer networks.

4. Evaluation formulae

It is highly advisable that each institution knows exactly about the evaluation methods of all products traded. Therefore it should be a minor task to put these formulae together into the necessary software environment. Alternatively, like the above mentioned question of transaction data bases, derivative trading systems offer the widest choice of evaluation formulae for all possible products traded.

5. Models

At least one of the so-called Basel Inhouse Methods should be chosen and implemented in order to calculate Value-at-Risk. The first method to consider is clearly the Historical Simulation Method since it is easy to understand and to communicate to relevant groups in one's institution. No statistical assumptions are made and therefore explaining it needs no statistical background. Especially investment houses, like insurance companies who do not frequently trade and turnover their stock, can afford to

use the time consuming recalculation of each single position which is necessary in the Historical Simulation.

The Variance-Covariance-Method becomes very complex to implement, especially when option risks are included in the portfolio. Therefore this method is only advisable when option risks do not dominate and when quick and intra-day calculations are necessary.

The Monte-Carlo-Method clearly dominates the two other methods by the quality of information. But depending on the finess of the implementation it can become very time consuming and therefore not usable for intra-day calculations.

6. Reports

Especially for Value at-Risk reports it is essential to have not only one single number showing the Value-at-Risk with a 99 % confidence interval for the entire portfolio but to have at least an additional picture of the real distribution of the outcomes of all run scenarios. Also interesting are reports on other statistical values like largest portfolio loss or highest portfolio profit and predefined parameter or statistical stress test results.

E. Closing remarks

Introducing the Value-at-Risk concept into an insurance company, implementing the necessary software environment and starting to use consequently risk numbers to go with the reported return numbers might be a difficult but worthwile task to do. The concepts of modern portfolio theory which do not work without risk numbers and the tendency to use Value-at-Risk as an industry standard worldwide will force financial institutions to use

these numbers for their client reporting as well as their regulatory reporting. Any insurance company who is implementing Internal Models now will have a head start in this highly competitive business.

app. 1 VAR according to Variance-Covariance-Matrix

time series of historical market data

	10y bonds	7y bonds	5y bonds	. . .
29.12.95	6,32	6,07	5,33	
28.12.95	6,29	6,05	5,30	
27.12.95	6,25	6,01	5,25	
.	.	.	.	
.	.	.	.	

positions in portfolio

DM 20 MLN
7 % Pfandbrief
WKN 333 666

DM 10 MLN
Capped Floater
WKN 444 888

HFL 30 MLN
Bond

vector of 10day sensitivities

matrix of correlations

position per risk factor

$$2{,}33 \times \begin{bmatrix} s\,1 \\ s\,2 \\ s\,3 \\ \cdot \\ s\,n \end{bmatrix} \times \begin{bmatrix} c\,1{,}1;\ c\,1{,}2 \cdots \\ \cdots\cdots\cdots \\ \cdots\cdots\cdots \\ \cdots\cdots c\,n{,}n \end{bmatrix} \times \begin{bmatrix} p\,1, p\,2, \ldots . p\,n \end{bmatrix} \longrightarrow \text{VAR}_{B}$$

app. 2 VAR according to Historical Simulation

time series of historical market data				
	10y bonds	7y bonds	5y bonds	. . .
29.12.95	6,32	6,07	5,33	
28.12.95	6,29	6,05	5,30	
27.12.95	6,25	6,01	5,25	
.	.	.		
.	.	.		
.	.	.		

positions in portfolio

DM 20 MLN
7 % Pfandbrief
WKN 333 666

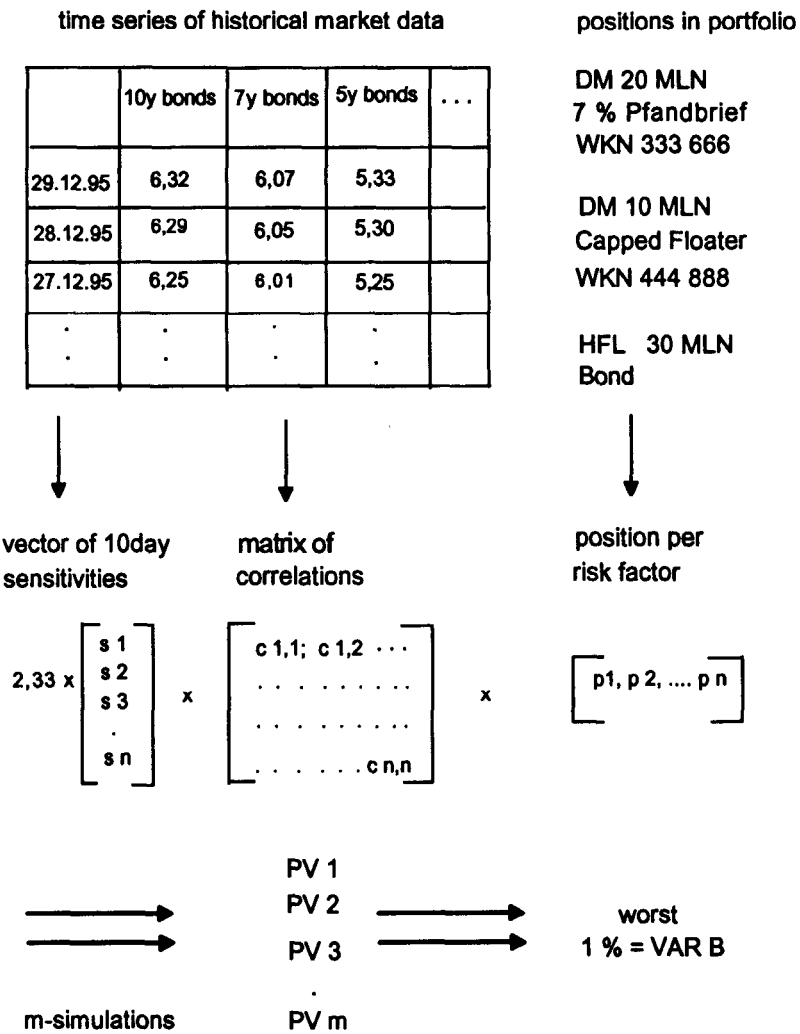
DM 10 MLN
Capped Floater
WKN 444 888

HFL 30 MLN
Government Bonds
.
.

Daily	Present Values	+ Present Value Changes
29.12.95	DM 2.450.579.200	- 1.100.000
28.12.95	DM 2.451.789.500	
27.12.95	.	
.	.	
.	.	
20.12.95	DM 2.452.985.400	
17.12.95	DM 2.451.679.200	

worst
1 % = VAR_B

app. 3 VAR according to Monte-Carlo-Simulation-Method



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