VaR (Value at Risk) for Insurance Risk- a simple model

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Abstract:

A large part of general microeconomic (in insurance) theory has been concerned with devising robust and analytically sound techniques for assessing the risk in insurance premium calculation. We need to address a simple actuarial risk pricing technique for quantifying a category of risk. As we know, volatility is an uncertainty of returns. So, how much an individual asset is likely to move with the general market and Value at Risk, our simple technical measure is the maximum loss (in the probabilistic sense) that is likely to be occurred in the immediate future for calculating the insurance pricing and we will show the parametric measure for the same.

Introduction:

Value at Risk (VaR), these days we also calculate for measuring insurance risk. Here we will first talk about Market Risk. Risk of "Loss" in "Value" of "Financial Assets" due to potential "adverse movement" of "market factors" like Interest Rates, Commodity Prices, Foreign Exchange Rates, Share Prices, insurance prices and the like is called Market Risk. The VaR is becoming the industry standard for risk management in banks active in trading. This presentation tries to show possible applications and conditions for VaR methods in share prices, commodity prices and Insurance/re insurance prices. Giving one example it can be understood easily. A Treasury Manager holds a portfolio of 5000 shares of GE with current value of $500,000 @ $500 a share. Markets crash tomorrow and shares fall to $100. He suffers a loss of $400,000.Another one example, A Company in India has borrowed $500,000 for expansion through ECB @ Rs. 40/$. He converts and gets Rs.20, 000,000. The rupee depreciates vs. the dollar to Rs.50/$. To repay the loan he has to shell out Rs.5, 000,000 extra. Similarly in Insurance and re insurance sectors, we can find risk of losses also.

Risk of Fluctuation happens in value due to Market Factors like interest rate, share prices, commodities, and forex rates. In India one of the biggest risks an Indian IT company faces is rupee appreciation which comes under market risk for forex rates changes. For all kind of market factors the various kind of losses would be defined at Value at Risk(VaR), For the Value at Risk the Assessment would be delivered like this showing one example , If you are going to a treasury manager who is holding your portfolio of $1 Billion in bonds and asks him or her about the chances of losses which in called as market risk, He or she would answer like, in 99% of the cases, over a 5 day horizon, we will not lose more than $200 million". This is the famous concept of VAR (Value at Risk) measure which was started by JP Morgan.

Value at Risk

Value at risk is a single, summary statistical measure of possible portfolio losses, which has been employed as an important input to chalk out the overall risk management solution of a business organization. Recently, VaR becomes the focus of attention of financial policymakers, regulators and researchers because its advantages in employing in institutional policymaking. The prime advantage of the VaR based strategy is akin to the advantage of using a single and sole indicator compared to handling multiple indicators for formulating a policy. Such strategy has serious policy implications for the determination of economic risk capital. As an insurance against the uncertainty of the net worth of the portfolio, the financial institution/bank could well hold an amount of risk less investments. 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. 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.

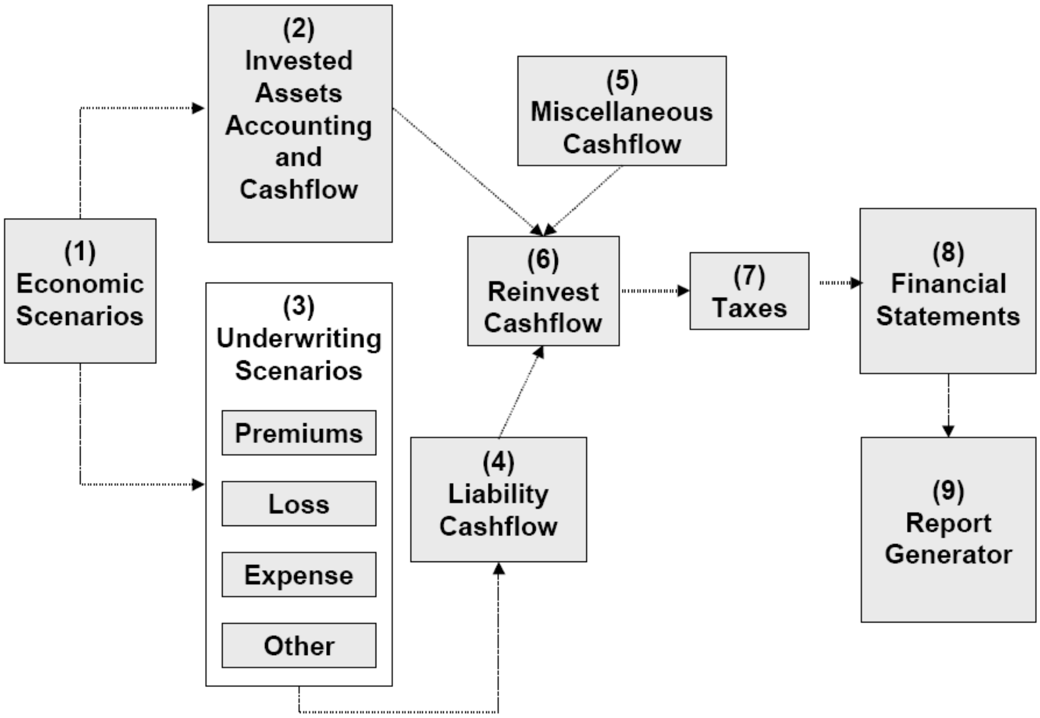
The so-called Variance-Covariance-Method measures the volatilities and correlations of market variables from historical price data and produces a statistical model based on these estimates. The Historical Simulation Method uses historical Price observations directly to simulate future price changes. Using historical data to predict the future makes the assumption that the future shows a similar type of behavior with the past. It is strongly advisable to test this assumption frequently and to use stress testing in addition. These are the Historical Simulation Method, the Variance-Covariance Method, and the Monte-Carlo-Method.

There are few points on VaR.

1. VaR is a measure of risk based on a probability of loss and a specific time horizon.
2. Key constituents of VAR are – Measurement Horizon, Confidence Interval, and Loss Distribution Type.
3. VAR tells us that the "Portfolio can lose a maximum of $ X over the next Y days with a confidence level of Z%"
4. VaR translates portfolio volatility into a dollar value and gives a measure of uncertainty through confidence level.

The Model:

The desire to grow the company's net worth to the greatest degree possible is only half of the story. The other half of the story is the potential drop in asset values inherent in pursuing a more volatile investment strategy. The more volatile the investment strategy, the greater the potential swings in both economic net worth and statutory surplus. As the company pursues its quest for enhanced net worth, the company must remain cognizant of how it is being viewed by the outside world. The company, through analyses of peer groups and through conversations with the different rating agencies, has developed a "targeted minimum capital" metric against which statutory surplus can be compared. (This threshold does not have to be equal to the level of capital needed to avoid regulatory oversight, i.e. twice the company's Authorized Control Level. It can be something of the company's choosing.) It is the company's objective to never have statutory surplus fall below this threshold.



Here in this flowchart, we see the Economic Scenarios is converted to two major units, one is invested Assets and other is underwriting scenarios which is included by premiums, loss, expense and other. These two stages go to reinvest cash flow. After this taxes gets included and gets financial statements. Once the financial statements get prepared it's used for report generator.

We would expect frictional cost families to give at least the following flexibilities insurance managers or actuary.

- Actuary should be able to translate the frictional cost function by a scalar, so that an addition of a constant (risk free) amount to the profit would not affect the frictional costs
- Actuary should be able to choose between risk tolerant cost functions that are more or less fiat but high, compared to risk adverse cost functions. A risk adverse cost function would have a lower minimum but would increase faster if ideal profits moved away from that minimum.
- There are many possible choices of frictional cost function families mat satisfy these criteria. Our chosen functions are of the form:

$$\theta(x) = \lambda \int_{-\infty}^{x} G(y)^{1-\lambda}\, dy + \int_{x}^{\infty} \left[(1-\lambda)G(y)^{-\lambda} + \lambda G(y)^{1-\lambda} - 1\right] dy$$

Where,

\# X is the ideal profit

\# θ is the frictional profit

\# λ is a risk loading parameter between 0 and 1, and is a determined by the overall level of Costa in the market . λ= 1 implies that all risk are priced at their maximum value.

\# Y is dummy integration variable

\# G(y) is a function which increases from 0 to 1 as moves from -∞ to ∞. The increase is not necessarily strict, nor continuous.

Concluded definition (Majumdar's insurance risk measure- 2007):

A loss (Lt) of a given insurance portfolio at time t may be defined as the difference between its value at time t and its value at time t-1. Therefore, Lt is a stochastic variable on (Ω, F) whose range is the real line, R. For a given subset (A) of R, a risk measure, Qt, can be defined as a real valued function on Lt Where $L_t \in A$

For the insurance measure we could apply generic measures of VaR:

Historical Simulation Method:

Lets make is simpler, and simply look at the following data: We need to look at last 100 days of actual daily change in interest rates

We won't make any assumptions on the distribution on interest rate. Assume that history is going to repeat itself based on the last 100 days. Rank over the last 100 days data of daily change in interest rate from lowest change to highest change. Choose the 99th values in the ranking. This is the 99% worst change in interest rate over 1 day. Assume this change is 0.02%. So new interest rate is 6.02%. Carry out a full valuation based on this change

Price of Bond (at 6.02%) = 100000/ (1+6.02%/2) ^20=55260
Change in price of bond = 55368-55260 = 108
VaR over 1 day horizon at 99% confidence level is (-108)
Note that in Delta-Normal-Gamma methods we never did full valuation

Monte Carlo Simulation Method:

Based on assumption of normal distribution of change in interest rates with mean 0% and standard deviation of 0.01%, simulate 1000000 scenarios of interest rate change over 1 day. It can be easier to mention the steps we need to follow.

- Step1: Draw random variable between (0,1)
- Step2: Map to cumulative frequency distribution of interest rate
- Step3: Choose interest rate change
- Step4: Perform full valuation
- Step5: Calculate change in value of bond
- Step6: Repeat steps 1 to 5, 1 million times. (You can't do it manually, unless you want this to me your life mission. This is done through computer models)

Based on the 1 million potential scenarios, we need to draw the frequency distribution of change in bond prices over 1 day and choose the at 99% confidence level point as VAR

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 worthwhile 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 ahead start in this highly competitive in insurance business.

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