# VAR: AN ALTERNATE MEASURE OF RISK

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## ABSTRACT

Value at risk is a statistical technique used to measure and quantify the level of financial risk within a firm or investment portfolio over a specific time frame. Value-a-Risk is an important and one of the most popular probability-based risk management tools for measuring and controlling market risks. In Industrial and financial sectors, this is considered as the important concept of risk measurement. The results produced by a VaR model are simple for all levels of staff from all areas of an organization to understand and at the same time they are quite reliable as well. Value at Risk has become such a popular tool within a short span of time and probably that is the biggest reason it has been adopted widely. This research paper is an attempt to discuss the concept of Value at Risk and the rationality behind using it. The researchers have also tried to explain important types of VaR.

**Keywords:** Value-at-Risk, Historical Simulation, Delta-Normal Method, Parametric VaR, Non-Parametric VaR, Correlation, Monte Carlo Analysis

## INTRODUCTION

A question that almost every investor who has invested or is considering investing in a risky asset asks at some point in time- "What is the most I can lose on this investment?" Value at Risk tries to provide an answer to this question, reasonably. In fact, it is misleading to consider Value at Risk, or VaR as it is widely known, to be an alternative to risk-adjusted value and probabilistic approaches. After all, it borrows liberally from both. If we accept the argument that risk matters and it affects fund managers and investors in making investment decisions, it follows logically that measuring risk is a critical first step towards managing it. This research paper covers the general description of VaR and the view of risk that includes its measurement. It also discusses the history of its applications and development. The study also covers various issues and questions related to the calculation of VAR and how researchers and analysts have tried to deal with them. At Last, the researchers try to find out how VaR fits into and is considered a safest risk measurement tool.

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Although the term "VaR" was not widely used before the mid-1990s, the origins of this measure of risk lie further back in time. The mathematics that underline VaR was by and large developed in the context of the modern portfolio theory by the legendary Harry Markowitz and few others. The efforts were directed towards a different end – constructing optimal portfolios for those investors who invest in equities. To be specific, the focus on market risks and the effect of the co-movements in these risks are central to how the value of VaR is computed.

## REVIEW OF LITERATURE

A large number of studies have been conducted on VaR. Although conflicting in many things, most of the researchers agree on one thing that there does not exist a single VaR model or a single approach that is optimal in all situations and all markets. There is no straightforward result, and it is not possible to establish a ranking among various models. The results are quite sensitive to the chosen probability level of VaR, the type of loss functions used, the period being normal or turbulent etc. Some researchers also established a trade-off between uncertainty and model sophistication. Some important studies related to VaR are as follows:

Lucas (2000) found that sophisticated risk models based on estimates of complete variance-covariance matrices fail to perform better than simpler univariate VaR models that require only volatility estimates. Bams and Wielhouwer (2000) drew similar conclusions that although sophisticated tail modeling results in better VaR estimates, but with more uncertainty. Supposing that the data-generating process is close to being integrated, the use of the more general GARCH model introduces estimation error, which might result in the superiority of EWMA. Christoffersen, Hahn and Inoue (2001) found that different models (EWMA, GARCH, Implied Volatility) might be optimal for different probability levels.

Berkowitz and O'Brien (2002) examined the VaR models used by six leading US financial institutions. Their results indicate that these models are in some cases highly inaccurate. Banks sometimes experienced high losses- much larger than their models predicted, which suggests that these models are poor at dealing with fat tails and extreme events. Lehar, Scheicher, and Schittenkopf (2002) found that more complex volatility models (GARCH and Stochastic volatility) are unable to improve on constant volatility models for VaR forecast, although they do for option pricing. Wong et al. (2002) concluded that while GARCH models are often superior in forecasting volatility, they consistently fail the Basel back test. Several journals investigated the issue of trade-off in model choice. Guermat and Harris (2002) found that EWMA-based VaR forecasts are excessively volatile and unnecessarily high when returns do not have conditionally normal distribution, but fat tail. This is because EWMA puts too much weight on extremes.

Caporin (2003) found that the EWMA compared to GARCH-based VaR forecast provides the best efficiency at a lower level of complexity. Brooks and Persand (2003) concluded that the relative performance of different models depends on the loss function used. However, GARCH models provide reasonably accurate VaR. Harmantzis, Miao, and Chien (2006) praised the EVT approach for dealing with extreme returns, which are characteristic for transitional markets. Wang (2010) used a mixture method to measure VaR using three stock index of Shanghai stock market and concluded that the mixture method is advantageous and accurate to calculate VaR of a portfolio.

## VAR: CONCEPT & HISTORICAL BACKGROUND

"Value at Risk measures the worst expected loss over a given horizon under normal market conditions at a given level of confidence" Jorion (2001). In simple words, we can say that, the Value at Risk measures the potential loss in value of a risky asset or portfolio over a given decided confidence interval. Thus, if the VaR on an asset is Rs.10 crores at one-month, 99% confidence level, there is an only a 1% chance that the value of the asset will drop more than Rs.10 crores over any given month. In its adapted form, the measure is sometimes defined more narrowly as the possible loss in value from "normal market risk" as opposed to all risk, requiring that we draw distinctions between normal and abnormal risk as well as between market and non-market risk. Value at Risk is most often used by commercial and investment banks to capture the potential loss in value of their traded portfolios from adverse market movements over a specified period; this can then be compared to their available capital and cash reserves to ensure that the losses can be covered without putting the firms at risk. What is the most amount of money we are willing to lose given a certain confidence interval and over a defined period of time is what Value at Risk is. A daily VAR calculation makes the most sense to measure the risk of a hedge fund given the leverage positions most hedge funds employ and the subsequent daily mark to market that must be reconciled with their futures positions.period of time for a decided confidence interval. Thus, if the VaR on an asset is Rs.10 crores at one-month, 99% confidence level, there is an only a 1% chance that the value of the asset will drop more than Rs.10 crores over any given month. In its adapted form, the measure is sometimes defined more narrowly as the possible loss in value from "normal market risk" as opposed to all risk, requiring that we draw distinctions between normal and abnormal risk as well as between market and non-market risk. Value at Risk is most often used by commercial and investment banks to capture the potential loss in value of their traded portfolios from adverse market movements over a specified period; this can then be compared to their available capital and cash reserves to ensure that the losses can be covered without putting the firms at risk. What is the most amount of money we are willing to lose given a certain confidence interval and over a defined period of time is what Value at Risk is. A daily VAR calculation makes the most sense to measure the risk of a hedge fund given the leverage positions most hedge funds employ and the subsequent daily mark to market that must be reconciled with their futures positions.

The VaR measures though came from the crises that beset financial service firms over time and the regulatory responses to these crises. The first regulatory capital requirements for banks were enacted in the aftermath of the Great Depression and the bank failures of the era when the Securities Exchange Act established the Securities Exchange Commission (SEC) in the United States of America and required banks to keep their borrowings below 2000% of their equity capital. Ten years thereafter, banks devised risk measures and control devices to ensure that they met these capital requirements. With the increased risk created by the advent of derivative markets and floating exchange rates in the early 1970s, capital requirements were refined and expanded in the SEC's Uniform Net Capital Rule (UNCR) that was promulgated in the USA in 1975, which categorized the financial assets that banks held into twelve classes, based upon risk, and required different capital requirements for each, ranging from 0% for short term treasuries to 30% for equities.

The first regulatory measures though were initiated in 1980 that led to the invention of Value at Risk, when the SEC tied the capital requirements of financial service firms to the losses that would be incurred, with 99% confidence over a thirty-day interval, in different security classes and historical returns were used to compute these potential losses. Although the

measures were described as haircuts and not as Value or Capital at Risk, it was clear the SEC was requiring financial service firms to embark on the process of estimating one- month 99% VaR and hold enough capital to cover the potential losses. At the same time, the trading portfolios of investment and commercial banks were becoming larger and more volatile, creating a need for timely risk control measures. Ken Garbade at Banker's Trust, presented sophisticated measures of Value at Risk in 1986 for the firm's fixed income portfolios, based on the covariance in yields on bonds of different maturities. So many financial service firms in the early 1990s had developed safety measures of Value at Risk, with wide variations on how it was measured. After numerous disastrous losses associated with the use of derivatives and leverage between 1993 and 1995, culminating with the failure of Barings, the British investment bank, as a result of unauthorized trading in Nikkei futures and options by Nick Leeson, a young trader in Singapore, firms were ready for more comprehensive risk measures. In the year 1995, J.P. Morgan provided public access to data on the variances of and covariances across various security and asset classes, that it had used internally for almost a decade to manage risk, and allowed software makers to develop software to measure risk. It is titled as the service "Risk Metrics" and used the term Value at Risk to describe the risk measure. In 1997, the U.S. Securities and Exchange Commission ruled that public corporations must disclose quantitative information about their derivatives activity. Major banks and dealers chose to implement the rule by including VaR information in the notes to their financial statements.

In the beginning of 1999, Worldwide adoption of the Basel II Accord gave further impetus to the use of VaR. VaR is the preferred measure of market risk. In the last ten years, Value at Risk has become the established measure of risk exposure in financial service firms and has started finding acceptance in non-financial service firms as well.This measure found a ready audience with commercial and investment banks, and the regulatory authorities overseeing them.

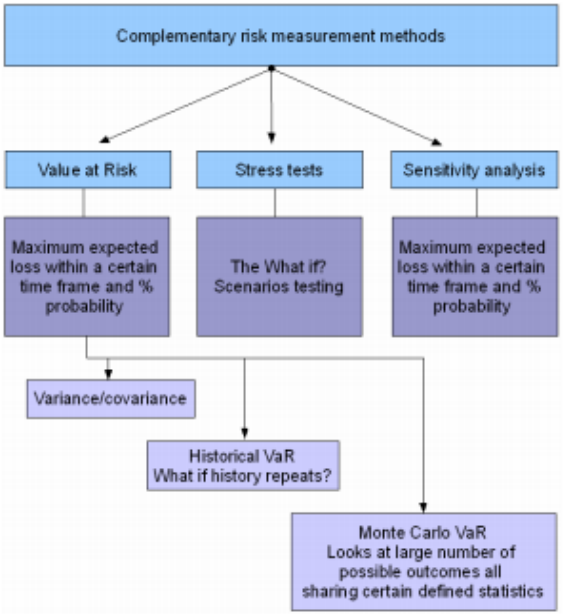


**Figure 1: Risk Measurement Methods**

***Source: James, T.: Energy Price Risk: Trading and Price Risk Management. Gordonsville, VA, USA: Palgrave Macmillan, 2003, p.132***

## TYPES OF VALUE AT RISK

There are two different measures of Value at Risk: Parametric Method and Non-Parametric Method. The parametric method consists of Delta-Normal Method and Monte Carlo Simulation, while not- Parametric Method consists of Historical Simulation.

The **Parametric VAR** (also known Covariance/Variance VAR) calculation is the common form used in practice with hedge fund managers. Two variables are required to calculate this VaR i.e. the mean and standard deviation of the portfolio. The biggest assumption that the managers using Parametric VAR make is that the returns from their portfolios are normally distributed. This is a vital assumption because it allows the manager to use the normal distribution as a proxy for expected returns. In addition to this, the returns are also assumed to be serially independent. In other words, no prior return should affect the current return. In reality, this assumption of return normality is proven to be quite risky. The strengths of this method is the simplicity of the calculations and the input data is easy to obtain.
The biggest weakness of this method is the assumption of normal distribution. Another problem with this method is the stability of both the standard deviation through time as well as the stability of the variance/covariance matrix in the portfolio. It is easy to depict how correlations have changed over time particularly in emerging markets and through contagion in times of financial crisis. Without appropriately adjusting the VAR calculation for these extreme events we are in fact corrupting the confidence intervals through which we are defining in our risk exposure.

**Historical VAR:** This methodology is much easier than the Parametric Value at Risk calculation. Here we are ranking all the past historical returns in terms of lowest to highest and computing with a predetermined confidence rate what the lowest return historically has been. It is a better methodology to use if we cannot determine the distribution of the return series. The simulated market states are produced by adding to the base case the period-to-period changes in market variables in the specified historical time series. The key assumption in the historical simulation is that the set of possible future scenarios is fully represented by what happened to a specific historical window. This methodology involves collecting the set of risk factor changes over a historical window: for example, daily changes over the last five years. The instruments in the portfolio are then repeatedly re-valued against each of the scenarios. The set of scenarios is assumed to be a good representation of all possibilities that could happen between today and tomorrow.

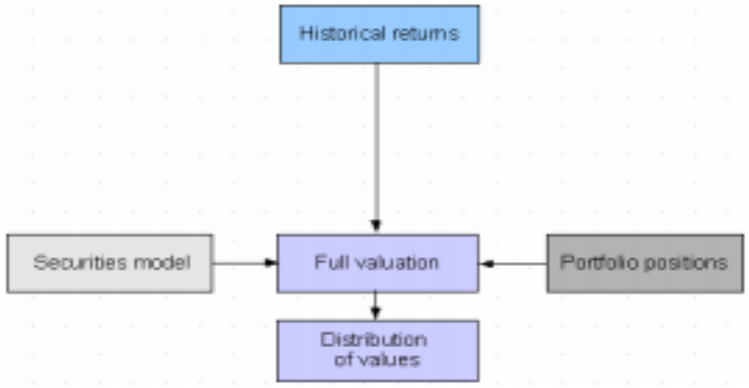


**Figure 2: Historical Simulation Method**

***Source: Jorion, P.: Value at Risk: The Benchmark for Controlling Market Risk. Blacklick, OH, USA: Mc Graw-Hill Professional Book Group, 2000, p.222.***

The main advantage of historical simulation is that it makes no assumptions about risk factor changes being from a particular distribution. Therefore, this methodology is consistent with the risk factor changes being from any distribution. Another important advantage is that historical simulation does not involve the estimation of any statistical parameters, such as variances or covariances, and is consequently exempt from inevitable estimation errors. The methodology is very easy to explain important audience, such as a corporate board of directors.

**Delta-Normal Method** is an analytic and parametric technique where the assumption is that daily geometric returns of the market variables are multivariate normally distributed with mean return zero. Historical data is used to measure the major parameters i.e. means, standard deviations, and correlations. When the market value of the portfolio is a linear function of the underlying parameters, the distribution of the profits is normal as well. VaR is computed by multiplying the vectors of first derivatives of the portfolio value with respect to the risk factor variables (the "deltas") by the specified covariance matrix, and then multiplying by a multiplier that depends on the normal distribution quantile point for the confidence level at which VaR is being computed. This method was first introduced by the JPMorgan's RiskMetrics™ system. The advantages of this method are its speed and simplicity, and the fact that distribution of returns need not be assumed to be stationary through time since volatility updating is incorporated into the parameter estimation. There are a number of criticisms attached to a delta-normal method. The existence of fat tails in the distribution of returns on most financial assets is the biggest problem in this method. The distribution of daily returns of any risk factor would in reality typically show a significant amount of positive kurtosis. This leads to fatter tails and extreme outcomes occurring much more frequently than would be predicted by the normal distribution assumption, which would lead to an underestimation of VaR (since VaR is concerned with the tails of the distribution).

**Monte Carlo VAR** method is a much more complex analytical tool and widely used in all the investment banks to calculate the value at risk where we try to map out any possible return scenario for our portfolio on a computer generated model. After running the model we would look at all the resulting return paths and then determine how much one could lose at a certain probability. While Monte Carlo VAR allows for an infinite number of possible scenarios where one is exposing himself/herself to huge model risks in determining the likelihood of any given path. In addition, the study includes more variables that could possibly alter the return paths, model complexity and model risks also increase in scale. Like Historical VAR, however, this methodology removes any assumption of normal distribution and thus if modeled accurately (not an easy task), probably would give the most accurate measure of the portfolio's true Value at Risk.

The Risk Metrics Monte Carlo methodology consists of three major steps: - Scenario generation, using the volatility and correlation estimates for the underlying assets in our portfolio, we produce a large number of future price scenarios in accordance with the lognormal models. We compute a portfolio value for each scenario. The simulation results are reported, either as a particular risk measure or portfolio distribution.

## CONCLUSION

VAR is a technique of measuring the financial risk associated with an asset or a portfolio over some definite time period. Its popularity stems from the ease of interpretation as a summary measure of risk and constant and dependable treatment of risk across different financial instruments. VAR is very often used as an estimate of the "maximum reasonable

loss" a company can expect to realize from all its financial exposures. VAR has received widespread appreciation and acceptability from industry as well as regulators. Various organizations have found that the benefits and uses of VAR make it an important and valuable decision support tool in a comprehensive risk management process.

The advantages of VaR as a measure of risk are well known and can't be overstated. VaR provides a consistent measure of risk across all types of markets and risk factors and in all types of positions. For example, a VaR value for an equity position can be meaningfully compared to a VaR value for a fixed income position if they have been computed by using same assumptions. Although this might seem so obvious now, there was no such measure that was in wide use, until VaR gained acceptance. For example, measures such as standard deviations were used for equities and duration and convexity were used for fixed income. Another very important advantage of VaR is that it can also take into account the interrelationships between various risk factors. This ability can range from making the use of simple correlations to making use of more understated and indirect relationships, depending upon the methodology that has been used. In addition to calculation and reporting of risk, VaR can also be used in a large number of ways in an organisation e.g. for deciding limits or risk targets at various levels, for allocating capital at various levels including firm-wide capital, for comparing risks of various deals before finalization, and for risk-adjusted performance measurement at different levels of the enterprise. It is important to understand and recognize that VaR is not merely a regulatory requirement, rather it can be very effectively used as a strategic tool.

## REFERENCES


1. Angelovska, J. (2010): *VaR based on SMA, EWMA and GARCH (1,1):Volatility models*, VDM Verlag Dr. Muler Gmbh & Co. KG
2. Berkowitz, J., O'Brien, J. (2002): How accurate are VaR models at commercial banks? *The Journal of Finance*, 52 (3), pp. 1093-1111.
3. Bernstein, Peter L. (1996): Against the Gods: The Remarkable Story of Risk. New York: John Wiley & Sons, Inc.
4. Boudoukh, J., Richardson M., Whitelaw F. R. (1998): The Best of Both Worlds: A hybrid Approach to Calculating Value at Risk, Risk, 11 (5), pp.64-67
5. Brooks, C., Persand, G. (2003): Volatility forecasting for Risk Management, *Journal of forecasting*, 22, pp. 1-22
6. Damodaran, Aswath. The Investment Principle: Risk and Return Models, *NYU Stern School of Business(*Source - *http://people.stern.nyu.edu/adamodar/pdfiles/acf3E/presentations/risk&ret.pdf)*
7. Caporin, M. (2003): The Trade Off Between Complexity and Efficiency of VaR Measures: A Comparison of Risk Metric and GARCH-Type Models. GRETA, working paper n.03.06
8. Jorion, P. (2001): Value at Risk, The New Benchmark for Managing Financial Risk, 2nd. ed., New York: McGraw Hill.
9. Lucas A. (2000): A note on optimal estimation from a risk management perspective under possibly miss specified tail behavior, *Journal of Business and Economic Statistics* No 18, pp. 31-39
10. Risk Metrics Technical Document 1995. JPMorgan/Reuters, Third Edition, New York.
11. Risk Metrics Technical Document 1996. JPMorgan/Reuters, Fourth Edition, New York.

12. Ping Wang, (2010): A Measuring Approach of Portfolio's VaR Based on APGARCH-EWMA Model, Information Processing (ISIP): Third International Symposium on Information Processing, pp.6-8.
13. Markowitz H. (1952): Portfolio Selection. *Journal of Finance*, 7, pp. 77-91.
14. Nylund, S. (2001): Value-at-Risk Analysis for Heavy-Tailed Financial Returns Helsinki University of Technology, Department of Engineering Physics and Mathematics.
15. Hull, J. C., White, A. (1998):, Incorporating Volatility Updating Into The Historical Simulation Method For Value At Risk, *Journal of Risk*, 1(1), pp.5-19.
16. Christoffersen, P., Hahn, J., Inoue, A. (2001): Testing and Comparing Value-at-Risk Measures, CIRANO, Paper 2001s-03.
17. Bams, D., Wielhouwer, L. J. (2001):: Empirical Issues in Value-at-Risk, Astin Bulletin, 31 (2), pp 299-317.
18. Alexander, C. (1996): Handbook of Risk Management and Analysis. New York: John Wiley and Sons.
19. Kupiec, P. H. (1995): Techniques for verifying the accuracy of risk measurement models. *The Journal of Derivatives*, 3, pp. 73–84.
20. Lehar, A., Scheicher, M., Schittenkopf, C. (2002): GARCH vs. stochastic volatility: Option pricing and risk management, *Journal of Banking Finance*, 26, pp. 323-345.
21. Duffie and Pan (1997), An Overview of Value at Risk.
22. Angelovska (2013), Managing Market Risk with VaR (Value at Risk)
23. Duke University's fuqua School of Business (2002) https://faculty.fuqua.duke.edu/~charvey/Teaching/BA453_2002/Satchmo/VAR.htm
24. Bratislava(2007), A comparison of Value–at–Risk methods for measurement of the financial risk.
25. Jorion, P.: Value at Risk: The Benchmark for Controlling Market Risk. Blacklick, OH, USA: Mc Graw-Hill Professional Book Group, 2000, p.222.
26. Graeme West: Risk Measurement for Financial Institutions. www.smealsearch.psu.edu/29776.html

Neves, Miller and Culp: CP Risk Management LLC, Value at Risk: Uses and Abuses, *Journal of Applied Corporate Finance,* P.26.