

VaR Applications: Setting VaR-based Limits

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Streamlining trading organizations and improving how capital is managed are areas of importance for many businesses. Value at risk can be applied in ways to improve both of these areas. This article suggests applying the VaR methodology to effectively set position and trading limits for businesses with commodity portfolios.

VaR as a Risk Measurement and Management tool

VaR provides a forward-looking analysis of the portfolio's risk profile in a comprehensive and consistent fashion. Looking at the historical risk adjusted returns of Long Term Capital Management, Barings, or Metallgesellschaft, it would have been nearly impossible to predict the large losses that they suffered. However, in most of the major derivatives debacles, a detailed analysis of their portfolio would have disclosed that the risks that were being taken were putting the institution's capital seriously at risk.

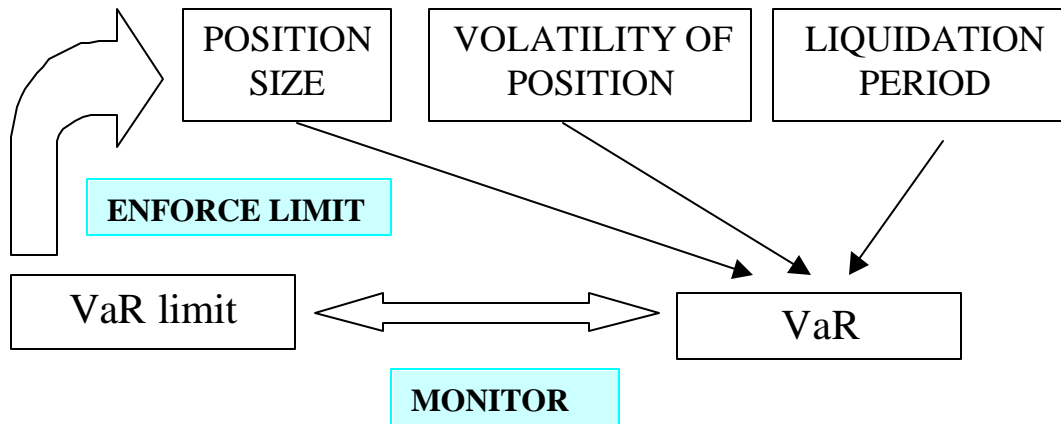
Implementing a VaR system is usually resource intensive, both in terms of software and personnel. The calculation can be labor and computationally intensive, as it requires a lot of information on a regular basis to describe the portfolio of the institution at any time and the state of the markets, which makes the generation of the number an onerous and expensive task. Once benefits start accruing from the implementation of VaR, the task is seen more positively. One of the most useful applications of VaR is to set position limits, which brings risk into the picture.

Risk avoidance is not an option for companies with natural positions in the underlying. As the energy markets deregulate worldwide, the unregulated entities are facing a situation which requires a new mindset: one seeing risk management as a survival-type of decision to compete in the marketplace. VaR is just one of many tools available for savvy risk managers. However, in order to maximize the benefits of having a VaR system in place, it should be used not only for risk measurement, but also for risk management. Setting VaR based position limits is a way to effectively use the information provided by the VaR analysis.

Typically, the limit structure of a trading book contains risk limits of stop-loss orders, position limits, nominal amount limits, or mark-to-market limits. By introducing VaR limits, we are being able to define the risk appetite of the firm and allocate capital to the different units.

It is not the position size, but the capital at risk that matters.

VaR must not exceed a set amount. The total VaR limit can be broken down into smaller components such as by desk or by trader.



The level at which the limit is set for each unit (trader, desk, business unit) should represent an allocation of capital reflecting that unit's appetite for risk tempered by the enterprise's total risk tolerance. The setting of risk limits often requires a change in thinking. The focus changes from maximizing gains to maximizing gains within risk parameters. Financially rewarding traders to generate higher risk-adjusted returns is one of the better means by which to implement this change in thinking.

This point deserves some further explanation. Typically traders are rewarded on the upside by their bonus. The upside reward is often substantial, while the consequence for poor performance is job loss. In weighing both the upside may have a higher weighting than the downside creating a condition in which traders take on too much risk to gain higher personal rewards.

One method for imposing constraints is to limit the size of a position. Traditional position limits have certain weaknesses that can be addressed by complementing them with risk-based limits

The main problems of traditional position limits are the following:

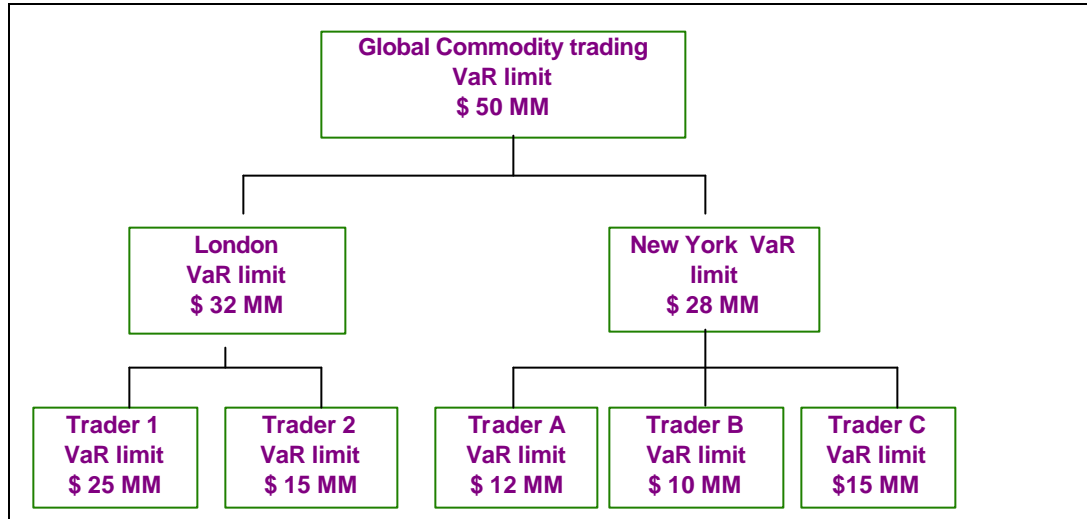
1. They are not directly comparable across units.
2. They do not incorporate leverage effects. A trader can increase her/his risk by taking positions in riskier assets such as longer-term debt or riskier equities, or by using positions requiring more leverage such as derivatives.
3. They do not incorporate diversification effects across units.
4. They may misrepresent the risk of derivatives portfolios.

The advantages of VaR position limits are

1. A VaR position limit is dynamic. It captures both changing market circumstances and the changing portfolio composition of each unit. VaR position limits both introduce the characteristics of the current portfolio and the expected variability of market risk factors.
2. VaR limits are easily communicated across the different levels of the organization, giving a good idea to management of how much could be lost with any particular position.
3. VaR incorporates leverage effects as well as position size effects.
4. VaR allows us to integrate risks across different markets and different instruments, and therefore offers a clear comprehensive view of risk in homogenous units.
5. VaR incorporates diversification effects within the portfolio. Regular position limits do not take into account the offsetting effects of having assets in the portfolio that do not move together.
6. VaR limits can be set across the different hierarchical levels of the organization, and therefore provide a basis on which to manage both the overall firm's risk and the risk of individual units. Due to the fact

that they take into account the interactions between the different units within each department, limits do not need to be additive and can incorporate diversification effects.

Trading Limits and Diversification

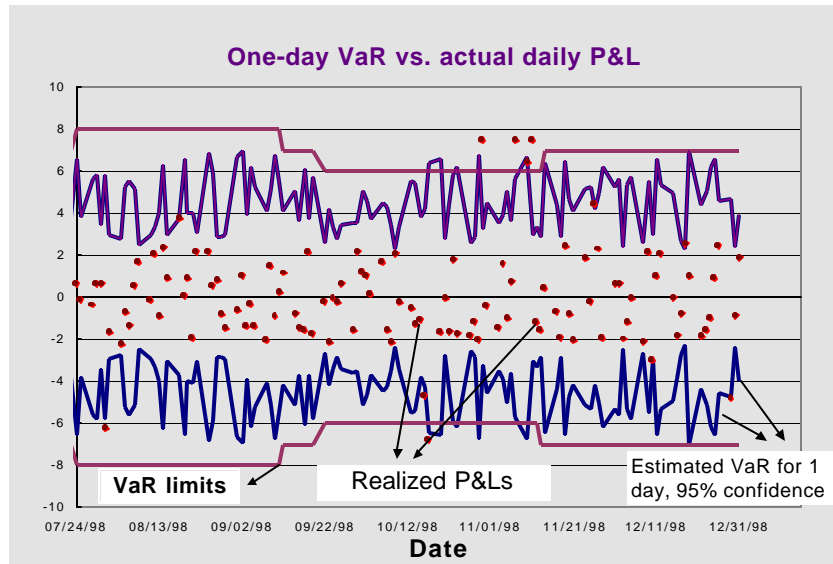


Putting VaR and Limits in a Historical Perspective

A VaR number in isolation may not offer enough information about the risk profile of a particular trader, book, or position. If we track variations in VaR through time, we would be able to measure the risk taken by the trader across time, instead of focusing on a single date.

We can combine the VaR numbers with the profits or losses experienced each day, and examine the cumulative losses. Several institutions penalize traders that are experiencing losses by reducing their VaR limits in an attempt to reduce the maximum exposure.

Variations of VaR and P&Ls through time



We can see the number of VaR violations, both in terms of limits, and in terms of realized P&L's.

By presenting results in a historical perspective, we can track actual P&Ls vs estimated VaR to determine validity of VaR model, and track VaR limit with actual VaR to determine whether a limit is being violated (early warning signals), and the frequency and severity of violations.

An area deserving further exploration is how VaR limits are related to estimations of returns.

What confidence interval and horizon should be chosen to set the VaR limit?

The choice of confidence interval is going to determine the VaR limit, and therefore, there will be a difference between setting a VaR limit at the 95% confidence level and a limit at the 99%.

It may be advisable to determine a VaR at the 95% (more statistically significant than the 99% level), and increase it by some adjustment factor.

Adding Liquidity into VaR limits

Several institutions measure the liquidity of positions and then adjust their VaR numbers by a "liquidity factor". One method of assessing liquidity is to divide the number of contracts traded each day for a given position by the number of contracts in your portfolio. For example, if 200 contracts are traded daily and the position to be liquidated has 50 contracts, the estimate for unwinding the position is four days. Holding a position equal to 50% of the daily volume traded would be difficult to unwind. Additionally, the daily volume can be used by looking at the volume for the last 6, 9, or 12 months, weighing the most recent month more heavily than the prior months. Another method for assessing liquidity is to keep track of the bid-ask spread for a contract and assume liquidity is drying up as the spread widens.

VaR can be adjusted for liquidity. For example, we could scale VaR depending on the number of days needed to liquidate a position by using the square root of time rule.

$$VaR_{adjusted} = VaR \times \sqrt{\text{days to liquidate}}$$

How many days does it take to liquidate a position?

Average volume over the last 6-12 months (possibly use some incremental weight giving more importance to recent volume)

Use a % of daily turnover (usually around 50%) to determine number of days (e.g. If our position is \$100 million, and the daily turnover is \$50 million, we would need 2 days to liquidate)

Enforcing VaR limits

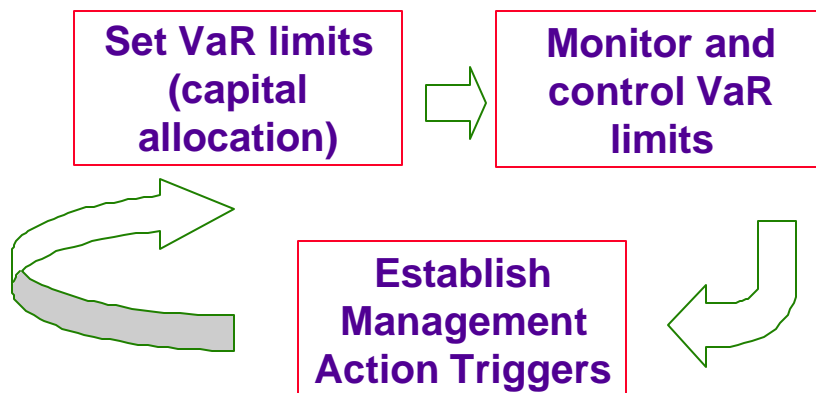
VaR limits serve as one piece of information, and cannot be the sole deciding factor. VaR numbers can jump due to large increases in volatilities, and it may not be optimal to adjust the portfolio to reduce the VaR number immediately. When volatilities increase suddenly and significantly, the risk manager may want to increase VaR limits for the short run, depending on the nature of the positions and the conditions of the market. Limits should have some degree of flexibility, as it may prove very costly to reduce or liquidate a position in certain circumstances

Setting limits is constrained by the ability to monitor the positions against the limit. If portfolios change frequently VaR should be calculated often and the limits monitored often. Intelligent controls can prevent instances such as the following: a trader's position is monitored at the close of business each day, but that trader is rewarded based on returns, so to get around the limits the trader speculates as a day trader closing out whatever positions were taken on earlier in the day. If successful the trader will make more money while staying within the limits, but the activity may be inconsistent with the overall strategy of the firm.

There are other ways to deal with exogenous shocks such as the volatility increase. One way is to have a range or set of VaR limits. If the VaR exceeds a certain limit but it is within a certain range, it can be seen as a warning for that trader to be careful and attempts should be made to reduce VaR in an orderly fashion. However, if the VaR enters into a higher range, the trader may be forced to act immediately to reduce VaR. This kind of limit can be thought of as a speed limit. If the speed limit is 55 mph (VaR limit), the trader may be allowed to go up to 65 or 75 mph under certain conditions, but if the trader exceeds 80 mph, then the trader should be strongly cautioned to reduce speed.

(Insert Chart with caption: This kind of limit setting strategy would allow a trader to adjust the portfolio composition in an orderly manner if there is a sudden change in market conditions.)

Establish one process for establishing risk limits and another for dealing with violations of those limits. The risk manager will determine the causes of the violation (changes in portfolio composition due to positions the trader put on, changes in market volatilities and/or correlations) and decide whether the VaR should be raised on a temporary basis or whether the trader should be forced to reduce the VaR of the portfolio. If VaR reduction is chosen the rate and extent of changes needs to be communicated to the trader.



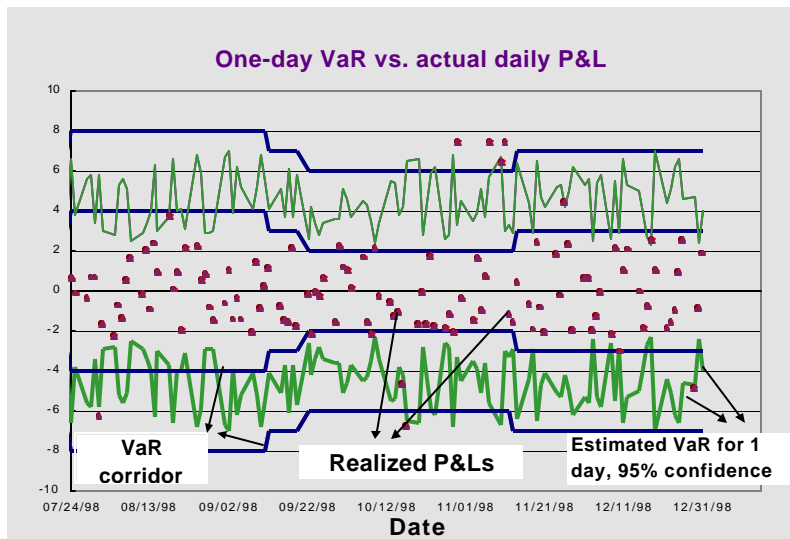
Risk Managers should measure, monitor, and report to senior management (independent role.) Setting management action triggers facilitates enforceability of VaR limits. Division managers should be involved in the process.

Traders may try to push the VaR limits and are likely to come up with reasons for why their limits should be raised. Risk managers can expect a litany of reasons for why a position cannot or should not be closed out. William F. (Billy) O'Connor, former chairman of the Chicago Board of Trade and then head of First Options Clearing Corporation illustrated several years ago how to deal with a trader and a position that was too risky. One of the traders clearing through Billy's firm exceeded his risk limits. Mr. O'Connor confronted the trader and explained the situation. The trader insisted he could not get out of the position. Mr. O'Connor took issue and promptly went into the pit where he traded out of the risky positions at market prices, much to the chagrin of the trader. Mr. O'Connor demonstrated two key points: excess risk would not be tolerated by the clearing firm and positions can be closed out even if doing so is expensive.

Risk managers will know how big a hit they will take if a position is closed out at market prices. They may have the luxury of unwinding a position gradually to incur less of a loss or taking offsetting positions. It is important for a risk manager to know the traders and be aware of how frequently each trader has violated the limit. Returns for each trader adjusted for risk give the risk manager essential information for making decisions on personnel and compensation issues.

Controlling the risk appetite: setting upper and lower VaR limits

One innovative investment committee recognizes that money is not generated without risk and so they set lower as well as upper risk limits for their investment manager. Risk boundaries such as this must be based on the institution's overall objectives.



At any point in time the VaR for a given unit may be well below the VaR limit set for that unit. If this situation is usually the case, then the limits for other units may be raised and that unit's limit may be lowered. This idea assumes the goal is to use capital to the best advantage of the organization as a whole.

VaR limits as a capital allocation mechanism

VaR limits can take an essential role in the capital allocation process as a risk control mechanism. The level of VaR limits for different units within the organization will affect future resource allocation and risk taking behavior.

VaR limits and controls are designed to affect risk taking behavior which is thought will maximize the firm's overall objectives. When setting VaR limits, it is important to know the consequences of the limits in the particular unit's risk taking behavior to make sure that they are consistent with the intended goals.

If the limit is seriously restricting the activities of any unit within the organization, it is likely that the traders will find ways to try to circumvent the limits in response to the institution controls.

A way to avoid this kind of conflict is decentralize risk controls, and have the managers at the various levels of the organization involved in the process.

A trader may change the composition of its portfolio to report a lower VaR number, and actually be increasing the risk of its portfolio in ways that will not be captured by VaR.

VaRdelta and Real-time VaR trading limits

We can introduce incremental VaR measures in setting position limits (VaRdelta and Component VaR) and therefore look at the contribution of each unit to overall VaR. That way, we can actually reduce overall portfolio risk by allowing traders whose positions are acting as a hedge of the organization to increase those positions.

Provided that (1) the portfolio does not change much over time and (2) the next trade is relatively small, then the VaRdelta vector provides a first order approximation that will tell us the incremental VaR of a trade. The incremental VaR calculation via VaRdelta is extremely fast, and may be conducted in real time. (It involves only a few microseconds of computer time.)

Combining VaR and stress test limits

Commodity businesses may want to borrow a technique used by banks. Several banks supplement VaR limits with "event risk" limits, i.e. risk of loss beyond the expected confidence level. These event risk limits are employed for portfolios that are particularly susceptible to extreme market-related valuation losses.

A current example may be portfolios with exposure to high power prices in the Midwest during the summer months. When the prices of hourly power in the U.S. soared last summer, energy companies found themselves at unforeseen levels of risk. This year the conditions may result in similar price behaviors. The effectiveness of a risk management system shows at those times

For such portfolios, VaR estimates should be reported with the results from stress tests to provide an analysis to senior management of the potential impact of adverse market moves on the firm's revenue. Stress tests should be conducted at the different levels of the firm (position, trader, desk, business unit.)

VaR limits for portfolios with Options

Options are one instrument type that has to be monitored and controlled frequently. Non-linear risks are frequently hidden in complex financial transactions and must be uncovered to be adequately captured for position management. Research shows that far out-of-the-money options tend to be overlooked in daily risk management. Analytic VaR may understate VaR for non-linear positions. Traders are clever and if they determine that options are underestimated in the VaR methodology used, it is reasonable to assume they will take on larger option positions. Monte Carlo VaR provides a better estimate for portfolios with non-linear positions.
Limit on total premiums paid per month/quarter...

Some institutions penalize the use of options by reducing the VaR limits to those positions (e.g. subtracting premiums paid or received from VaR limits, (unless delta neutral)

SUMMARY AND CONCLUSION

There are ways to incorporate VaR-based trading limits in order to capture effectively the risk
Several institutions are starting to introduce VaR based limits as a complement to other position limits.

We hope you can see how setting VaR limits can enable you to make a more efficient use of revenue. VaR calculation is resource intensive, and with relatively little additional input, useful reports can be generated. Risk management can be a creative, resourceful area, whose results contribute to the firm's profitability.

With the VaRdelta technology, it is possible to set real-time VaR-based trading limits, without the need to recalculate portfolio VaR. Trading organizations are already implementing VaR-based trading limits via the incremental analysis of candidate trades.

We must point out that VaR alone may not be a comprehensive measure of risk exposure, and therefore, VaR limits should complement other risk management techniques such as stress testing and scenario analysis.

We have shown that VaR is a very powerful tool to measure and manage risk, but not a goal in itself. It is the process that leads to the calculation of the VaR numbers, and the use of that information, which adds value to the risk management function, not just the VaR numbers themselves.