What ails market risk management?

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The recent debacles in the financial markets have resulted in a familiar call from the heads of several financial institutions – the need to overhaul and improve risk management. While this may sound like market risk management does not exist in these financial institutions, this is far from the truth.

Most investment banks, broker/dealers, large hedge funds, etc. have large market risk management teams involved in the production, analysis and the technology of market risk. These teams consist of highly qualified professionals, financial engineers and technologists who are paid very handsomely. With such large teams and the complex technology they use, a large bank can easily have a budget of tens of millions of dollars for the market risk analysis and management process.

The evolution of such extensive risk management teams is a relatively recent phenomenon. Even a dozen years ago risk management barely existed as a separate function in banks and as a separate science in modern financial methods and engineering. From a meager existence back in the mid-90's it quickly evolved to the point in which risk managers were crowned the new kings of Wall Street - they oversee traders and have the ability to cut or curtail positions; they are involved in modeling of products; selection and vetting of trading and risk systems and typically have a very short line to top management, independent of the trading desk hierarchy.

Then what happened? In most of the cases where large losses were taken by banks and hedge funds, the explanations have been partly due to a failure in risk management and controls. The recent SocGen losses caused by over $70b of unknown positions which accumulated over a year by a rogue trader, just epitomize this failure. Even with tens of millions spent on highly qualified staff and sophisticated systems, if banks cannot effectively analyze and manage their market risk, can they ever? Is this call for overhaul of risk management just another line that will lead to more of the same?

Not an easy question to answer – and at the risk of playing Monday morning quarterback, presented here are some of the issues that exist in the market risk management process and the changes that may help – although this is by no means exhaustive by any measure.

1. Risk Reporting vs. analysis
The market risk production process can be complex in most financial institutions. It requires processing risk calculations across all trading businesses, getting feeds from disparate systems, calculating consistent risk measures and then aggregating and reporting them. The reporting itself tends to be extensive, with reports for management, regulatory purposes, traders and limit monitoring. The result of this is that a vast majority of the time spent by risk teams is for the the actual "*production and reporting of risk numbers*". The effort spent in the daily "*process*" of risk management thus overshadows the effort in actual risk analysis.
Risk analysis is what leads to real risk management and discovery of market risk related issues. However most risk teams find not enough time for any kind of creative analysis and find themselves boxed into the *process* of risk management. This makes risk

management purely procedural as opposed to a balance of procedure, analytics and creative thinking.

2. VaR: bend the rules

Value at Risk (VaR) is the most prominently used measure for market risk. Developed as a method for consistent market risk measurement using statistically sound scenarios, VaR has an important place in market risk management, but at the same time can be grossly misused.

In general VaR is the expected loss of portfolio at some confidence level (typically 99%) which is calculated by valuing a portfolio under many different market rate scenarios. The scenarios can be generated using current market statistics (such as prices, volatility, correlations, etc) with an assumed distribution or through a Monte Carlo process, or they can be generated by using past prices to determine the scenarios (distribution thus determined by actual history). There are dozens of "tweaks" that have been made to this basic concept.

When using historical scenarios, about 2yrs of history has become the accepted norm. This is partly due of the need to balance the practical considerations of processing time for more scenarios. However 500 days is usually not enough. Markets commonly go through cycles that last several years, thus 2 years of scenarios may not capture enough of the potential market risk and may generate a skewed set of scenarios. In chart 1.1 and 1.2 below are the distribution of scenarios for the EUR-USD for the last 500 days and 1000 days. As the USD has been steadily falling for several years, the last 500 days of scenarios do not capture enough events of USD rising and is clearly skewed to a falling USD, while using 1000 days gives a better balanced scenario set. The difference in VAR between using 500 days and 1000 days in this case could be upwards of 10%. Increasing the duration of history will not necessary increase the actual VAR risk numbers, but will provide scenarios that are less skewed due to trending markets, which is preferable in any VAR calculation.

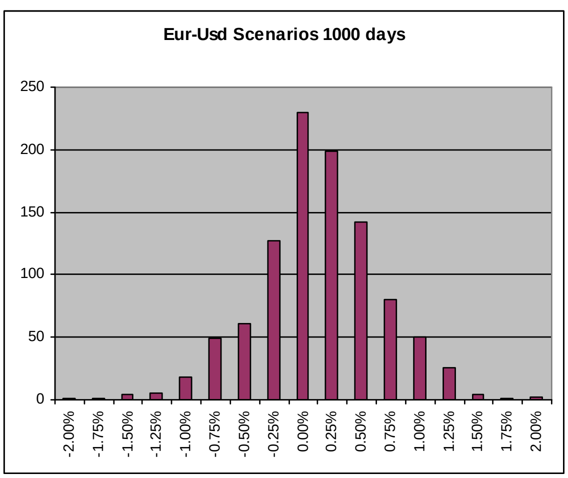

chart 1.1

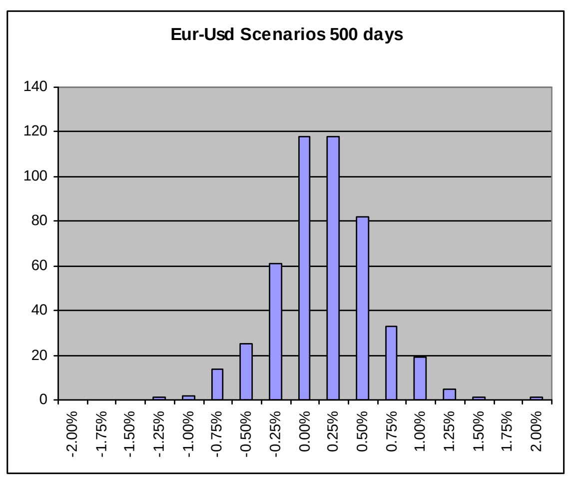

chart 1.2

Similarly, generating scenarios using current price volatility (standard deviations) and correlations, may result in scenarios that do not capture the risk of the market due to the volatility and correlations themselves being very volatile. As an example chart 2 below is the 60day standard deviation of credit spreads (using the "A" Communication &

Technology sector credit spreads) for a period of 18 months since the beginning of 2006. During the 3rd quarter of 2006, the standard deviation was only about 30%. If a 30% standard deviation was used during that period for the scenarios generation process, it would clearly result in smaller move scenarios and understate the VAR. The standard deviation prior to and after this period was clearly higher than 30%.

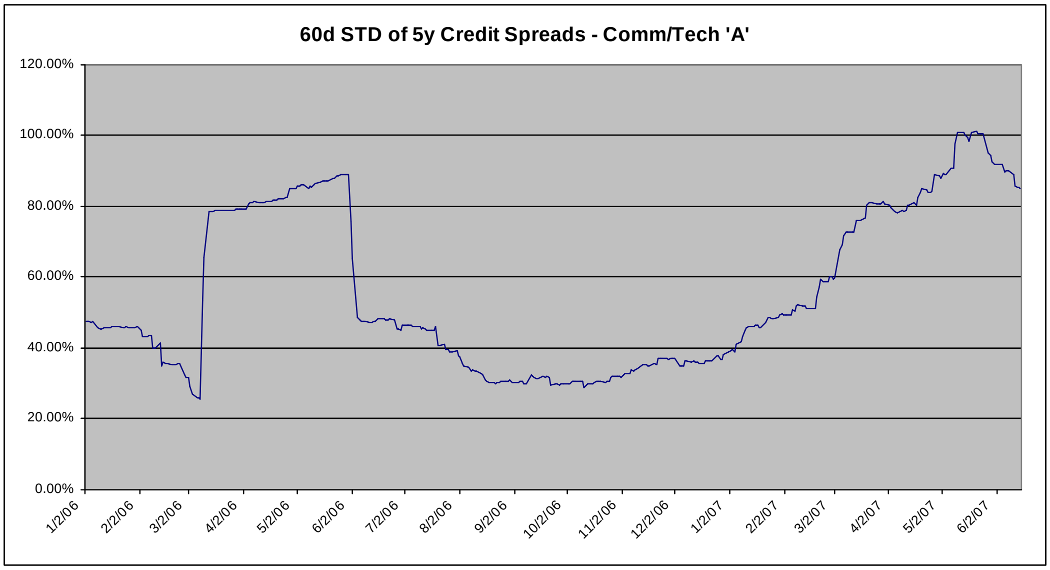

Chart 2

So risk departments need to bend the rules of statistics a bit – instead of using current standard deviations and correlations, possibly use a range or the worst case over some period. This will create scenarios that are more realistic, as opposed to the scenarios getting caught up in a lull in the market and thus understate the risk.

Another modification to the VaR process should be greater analysis of the P&L vectors from which VAR is determined. For example, it is important to analyze of the tails of the distribution of scenario generated P&L's as opposed to just picking out the 99th percentile number and calling it the VAR.
Below in table 1.0 is a simple hypothetical example - two portfolios, with similar net delta exposures, may generate the following worst case PL vectors (assuming the use of 500 days of historical scenarios).

Portfolio 1	Portfolio 2
-$5,000,000	-$7,500,000
-$4,500,000	-$6,750,000
-$4,000,000	-$6,000,000
-$3,500,000	-$5,000,000
-$3,000,000	**-$3,000,000**
-$2,500,000	-$2,750,000
-$2,000,000	-$2,500,000
-$2,000,000	-$2,500,000

Table 1.0

The 99th percentile VAR in both cases will be the 5th worst which will be a VAR of $3m. However the second portfolio clearly has a fatter tail in its PL distribution than the first portfolio, and thus is actually a riskier portfolio – which is not being captured in the VAR number. Simple solutions can solve such deficiencies – e.g. taking the average of several PL's around the 5th worst will incorporate the difference in the tails. Using 3 below and above, the VAR will be $3.07m vs. $4.07m and thus will capture the difference in risk of the portfolios.

3. Approximation is not a dirty word

Risk calculations are by definition an "estimate" of risk. Whether it is VaR or a stress test, it is an *estimate* of the P&L of the portfolio under some user defined or generated conditions. Since it is nearly impossible to predict the exact scenario the market prices will actually follow, the risk will always be an estimate.

However it is not uncommon for risk departments to spend enormous effort and resources on implementing risk calculations using the most accurate valuation models - at the expense of computation time. In addition many risk management departments have adopted a "full revaluation" approach for their calculations, which is computationally very intensive when valuing certain complex products.

Thus many risk departments would rather spend 10 hours of processing time on very extensive and expensive hardware architecture, using the most accurate models, rather than calculate approximate risk numbers in a fraction of that time. Given that the risk numbers are an estimate, it would be preferable to use approximation techniques that are 98%-99% accurate, but can reduce the "process time" dramatically and give more time for analysis. This will keep risk management departments results in greater sync with the producers of risk, i.e. the trading desks, and give them the ability to manage risk proactively rather than with large time delays.

As mentioned in Section 2 above, the use of a greater number of scenarios is preferable, which requires greater computational resources. By implementing faster approximation models, such resources will be freed up to do so. Similarly, as described in the next section, production of greater granularity of risk numbers is clearly required, which once again can be made possible by diverting processing bandwidth with the use of faster approximation models

Examples of such approximation and efficient techniques include use of sensitivity based P&L calculations as opposed to full revaluation; principal component analysis techniques for estimation of P&L; use of closed form type valuation models rather than simulation based models, etc.

4. Increase the granularity of risk calculations

We have all read the SocGen reports of how very large positions were not discovered by the risk control department since the trader booked fictitious positions that offset the risk of the actual positions.

It was actually not surprising that market risk management departments did not see this. It is very common for risk to be viewed at the netted overall "risk factor" level – in this case the level of the European stock markets. The position at SocGen had seemingly little to no net exposure. Even if the offsetting position was not fictitious, the incident highlights a problem in risk management. While risk *should* be looked at an overall basis, typically at the portfolio or desk level, risk also needs to be evaluated down to the position level. Clearly in this case the offsetting instruments were not exactly the same as the real one, otherwise it would have been caught several months ago as the bank would have had a reconciliation problem with the exchange. Thus the positions were large positions in distinct products that had offsetting market risk.

Market risk methods tend to ignore the liquidity risk inherent in different positions and focus on the net market risk. The assumption thus is that it will always be possible to unwind these positions efficiently and that these positions will only have small residual risk as the spreads between them will be stable. This is a common error is risk management. In addition to portfolio level risk factor numbers, risk management departments need to drill down and look at risk measures at the position level – be it VAR, stress or sensitivities.

In addition highly correlated market prices of common risk factors should be stressed independently as well. Case in point was Amaranth – their biggest bet was simply the March versus April futures on the same underlying product – natural gas. On a portfolio level they seemingly had little exposure to natural gas. However they had tremendous spread exposure and liquidity exposure – which would have been noticed only if the risk was evaluated down to the position level or if the futures were independently stressed. However treating multiple instruments on the same risk factor (e.g. futures) independently for risk calculations is easier said than done as it increases the number of risk factors (and degrees of freedom) in a portfolio. Once again this can only be achieved with fast, approximation tools available for risk managers who are focused on analysis rather than process.

5. Think like a trader, but don't think like your trader!

Risk managers should be able to think like traders, but not think the same as their own traders! Risk managers need to analyze positions with very different views of the markets and be able to imagine scenarios that are not necessarily realistic in the mind of their traders. Sure enough more market risk losses occur when the unimaginable occurs in the market!

6. Don't be dictated or bound by the models

Complex derivatives are valued by complex mathematical models that assume normality and non-arbitrage conditions as their inputs. For example most credit derivative models expect that credit spread curves are not so steeply inverted that they imply a negative forward default probability. Similarly exotic option models using the full volatility surface expect that the forward-forward volatility is non-negative.

While these conditions make sense and theoretically should not be violated, as they create an arbitrage opportunity – we have seen in practice such conditions may actually occur in the real market. Several credit spread curves became extremely negatively sloping temporarily last year. In the face of event risk we observed such steep volatility term structures that implied negative forward-forward volatility.

When such market conditions occur, many models tend to fail to value some positions, leading to the inability to measure risk. A common approach to alleviate this problem is to *tweak* the curves to bring them mathematically in-line and thus allow the models to not fail. Doing so is effectively making risk management bound by the models.

If the market prices are at some level, whether theoretically correct or not, risk management should not ignore them. When such conditions occur, if the bank has no position, then this is probably a trading opportunity- but if it does, then it cannot ignore the fact that there exists a liquidity issue in their positions. Modifying the market prices to fit to the model will just mask this risk.

In conclusion, by evaluating their processes; implementing more analytical tools; being creative in their methods and views and changing the focus to be being more analytical rather than procedural – financial institutions can make their market risk management team far more effective. Failure to do so will just leave them more open to be blind sighted by the next disaster.

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Abstract
The article explores some of the shortcomings in the market risk analysis practise at most financial institutions. It presents several ideas on how to improve the actual process of producing market risk numbers. It is focussed on the practical aspects of market risk management.

Keywords:
Market Risk, VAR, Scenarios, risk approximation