

Macro or Top-Down approach to VaR and Expected Tail Loss estimation

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In this article, we present a simple approach to VaR and Expected Tail Loss estimation based on analyzing the variability of profits and losses (P&L) for each risk-taking unit directly (e.g. trader, business unit, enterprise). In contrast with traditional approaches to VaR estimation based on simulating possible market conditions and revaluing the portfolio under those possible future states of the world, this approach is based on a “macro” or top-down analysis of realized P&Ls.

We will argue that this approach should be part of the arsenal of methods used by risk managers, and we will show how it can complement and in many cases improve the ability to forecast risk.

Traditional VaR methods or “bottom-up” approaches

Traditional simulation methods to calculate VaR and other risk measures use a bottom-up approach by taking each instrument in a portfolio, and recalculating its value under simulated market conditions for a set of risk factors or prices reflecting possible states of the world. This approach is conceptually sound, but in order to implement it, we need to make many assumptions about possible market behavior for each risk factor individually and jointly, and how the portfolio will react under those conditions.

The first generation of VaR models also assumes that the portfolio remains static (therefore ignoring possible exit strategies such as stop-losses or delta-neutral hedging), and usually don't take into account intra-day trades, transaction costs, liquidity and counter party risks. Firms using these models have found them useful as a risk measure, but due to the number of assumptions, their validity can sometimes be put to question.

Introducing Macro VaR

A complementary method that takes into account many of these shortcomings is to calculate VaR and other risk measures based on historical P&L series from different risk taking units. Recent empirical studies¹ have shown the importance of conducting a “macro” or “top-down” approach to VaR estimation by analyzing the P&Ls for each risk-taking unit directly. This approach can be run in parallel with traditional simulation based approaches, is simple to implement, and has a number of benefits that we outline throughout the article.

The analysis of historical returns and P&L fluctuations is one of the key components in the capital allocation process at any institution.

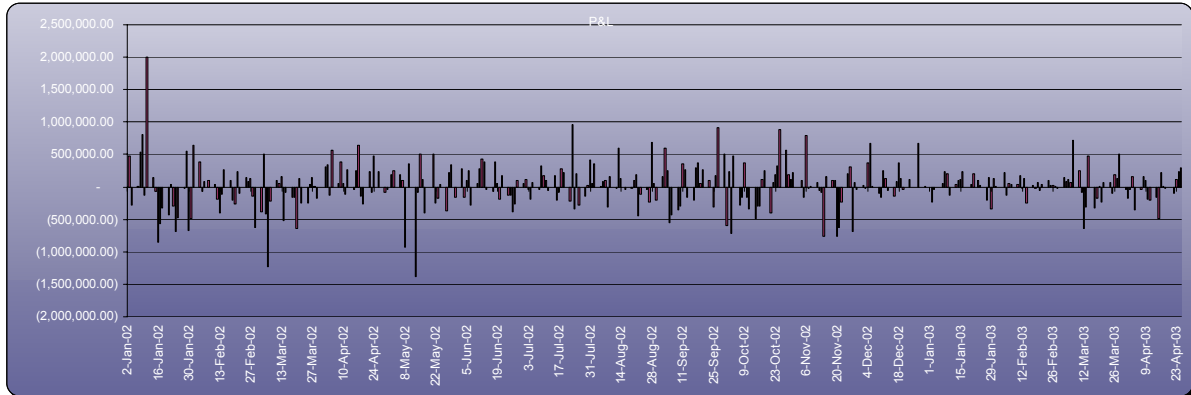
Mechanics of the Macro Approach

¹ See, e.g. Berkowitz and O'Brien (2002)

As we mentioned above, the approach is based on the study of the time series of P&L observations for a particular time period. The benefit of this approach is that it can capture P&L variability without the need of modeling the instruments of the portfolio and their exposure to certain market risk factors.

Basic steps to conducting a “macro” approach to VaR are as follows:

1. Provide a series of dates and P&L’s (or portfolio returns). Each P&L is treated as a scenario.

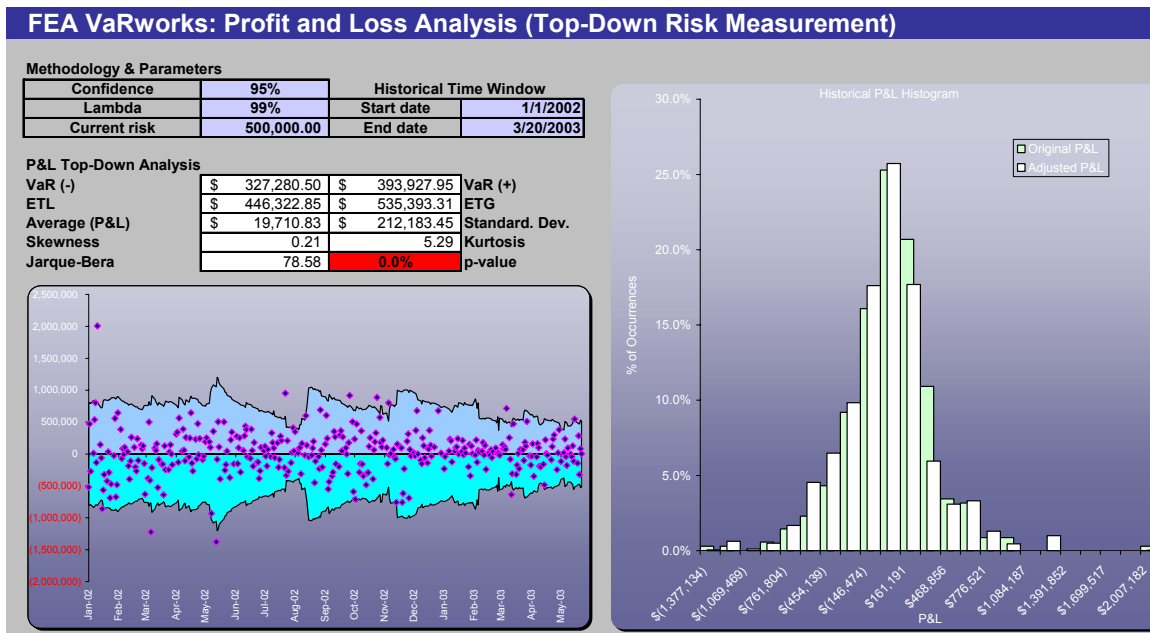


2. Determine historical window (and seasonality parameters) to be used.
3. Estimate the distribution of portfolio price changes or returns.
4. From this distribution of price changes, VaR, Expected Shortfall, and other risk measures can be calculated.

It should be noted, that by focusing exclusively on the analysis of historical performance, we are at risk of becoming captive by an immaterial past that offers little insight into what lies ahead. However, the good news is that we can “adjust” history in order to reflect current market conditions (e.g. based on implied volatility) and/or portfolio conditions (based on traditional VaR estimates; leverage ratios, etc.), that is, we can complement a backward looking analysis with relevant current information. Some of the enhancements to the pure historical analysis of P&L variability are presented below:

- Adjust the weighting of historical observations by applying exponentially weighted moving averages to weigh more recent returns more heavily, or by using seasonality adjustment methods if the risk profile changes considerably season by season. We can also introduce the results of stress tests weighted by modeler-assigned probabilities to reflect possible market changes and estimate the hypothetical profit or loss.
- Adjust the historical P&L values to reflect current risk conditions by using a volatility scaling adjustment in order to create scenarios consistent with the current level of risk of the portfolio (e.g. VaR, or some other measure of market risk that reflects current risk conditions).

For example, we can perform this adjustment by taking the ratio of historical VaR to the current one in order to “adjust” history. If P&L (t) is the realized P&L at time t and VaR (t-1) is the calculated VaR the previous period, we can rescale the P&L numbers for each period by multiplying them by the ratio of current VaR to the estimated VaR: $VaR(T)/VaR(t-1)$ to reflect the current level of risk in the portfolio. If the P&L on a particular day was \$5m with a \$10m VaR, and the current VaR is \$20m, the P&L would be re-scaled multiplying it by 2.



Benefits of top-down approach

- Uses actual MtM numbers rather than simulated ones, and therefore is more difficult to “game”. A trader would need to game the MtM system rather than the VaR model.
- Provides another tool in the arsenal of the risk managers at very little added cost.
- May provide better forecasts of day-ahead P&L variability more accurately than traditional VaR models
- Allows to automatically perform a backtest calculation, even if we do not have a series of VaR estimates.
- Includes intra-day trades, transaction costs, and other revenues and costs included in the P&L.

Limitations of the approach

- Uses only realized portfolio’s P&L. Markets and portfolios can change over the sample period.
- For portfolios for which we do not have enough price history, or which change substantially over time, simulation VaR methods may be more appropriate. We

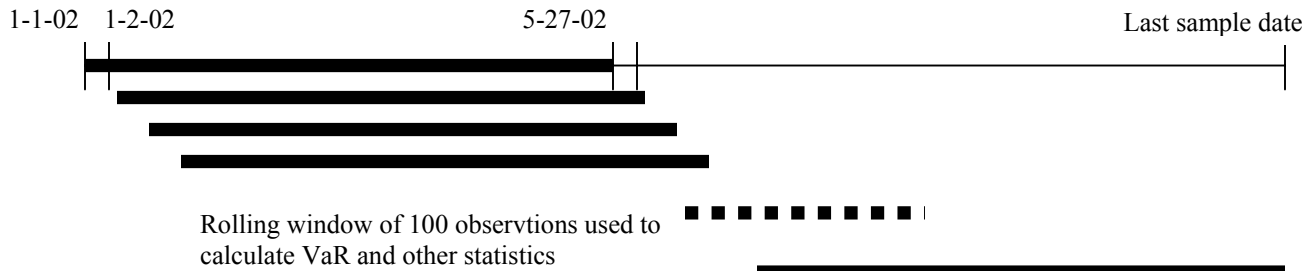
can compensate for this limitation by using some of the adjustment method mentioned above to reflect current risk conditions.

- Does not provide any information on the main contributors to portfolio risk.
- Does not capture long-term portfolio dynamics. The approach can be useful for short-term analysis, but may have severe limitations in modeling risk over long horizons. A bootstrapping approach could provide some light into long-term portfolio risk, but just by looking at past behavior, it may be risky to extract too many conclusions.

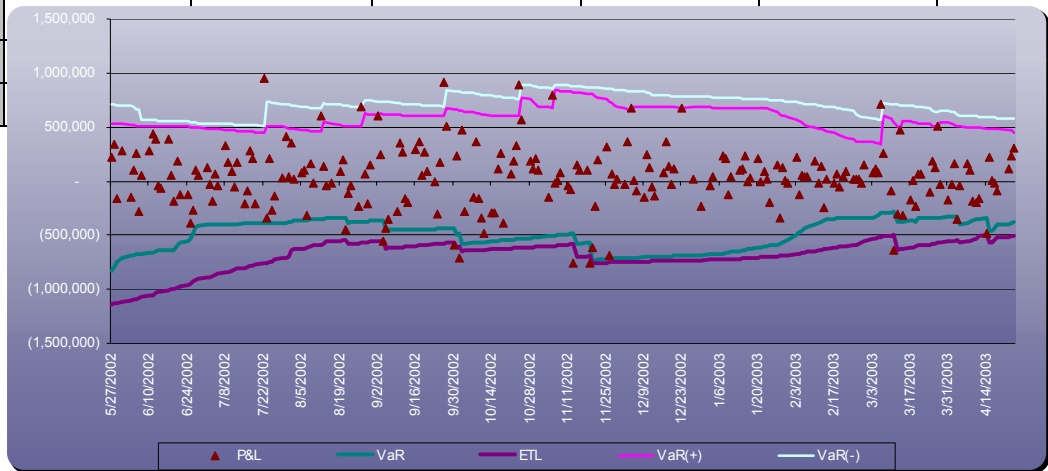
Rolling window VaR and ETL calculations

Another advantage of this approach is that we can calculate a time series of VaR, Expected Tail Losses and similar measures for the profit tail of the distribution from the history of P&Ls.

When firms implement a risk system, it usually takes months or years until they produce a reliable VaR number for the portfolio. Macro VaR numbers can be obtained quickly from historical P&L observations, and therefore, any institutions that has kept track of the evolution of P&L for different risk taking units can apply this approach immediately.



Date (t)	P&L (t+1)	VaR	ETL	VaR(+)	ETG
27-May-02	222,196	(834,441)	(1,141,517)	531,312	709,178
	340,426	(794,017)	(1,134,099)	529,636	705,443



We can easily test the accuracy of this type of analysis by applying traditional backtesting techniques to risk forecasts obtained using our macro approach. See Blanco and Oks (2004) for a more detailed description of the most commonly used backtests.

Macro VaR and prevention of “gaming” behavior

Many energy and commodity trading firms are replacing traditional position, volumetric and stop-loss limits with risk-based ones. Risk-based limits are designed to limit the level of risk taken by each risk-generating unit. In order for the limit structure to work, risk managers need to anticipate and prevent potential “gaming” behaviors on the side of the risk takers in order to reduce the reported risk of their positions. By analyzing the evolution of the P&L directly, risk managers should be able to identify changes in the risk profile of the risk-taking unit even if a VaR model fails to detect that change.

Conclusion

Tracking the variability of P&L directly provides risk managers with an alternative and/or complementary method of calculating VaR estimates which can be used as a check against risk estimates obtained from traditional VaR models. The “macro” approach can be very useful to determine changes in the risk profile that may not be captured by particular VaR methodologies (e.g. intra-day trades, modeling of complex instruments) and prevent gaming behavior by traders subject to risk-based limits.

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