

Enclosure 2

More on the use of different risk measures and choice of estimation variables

In the new draft rules for the management of the Government Pension Fund – Global, the Ministry of Finance proposes the introduction of Value at Risk and expected shortfall as new limits for the management of the Fund. Like expected tracking error, these are quantitative measures which entail a number of technical assumptions that can heavily influence the results. This enclosure looks at the various issues and analyses the implications of using actual portfolio data for the Government Pension Fund – Global.

Norges Bank agrees that extreme loss risk is an important part of a risk framework. In particular, expected shortfall may have a number of characteristics which make it a suitable measure for such a framework, and we use this measure extensively in our internal risk systems and risk analysis. However, the quality and stability of this measure will be very sensitive to the concrete technical specification of the model, and we will explain in the following how we view these challenges in the operational risk management of the Fund.

In principle, Value at Risk and expected shortfall are in the same family as tracking error (relative volatility). If we assume that the underlying processes are normally distributed (which we assume implicitly in using a parametric method), the relationship will be as illustrated in Chart 1. Value at risk, expected shortfall and tracking error will be a constant multiplier of one another and will not, therefore, introduce any additional information. The technical specification of the model will again have major implications for the level of tracking error and expected shortfall, but the relationship between them will be constant.

Chart 1: Tracking error (TE), Value at Risk (VaR) and expected shortfall with a normal distribution

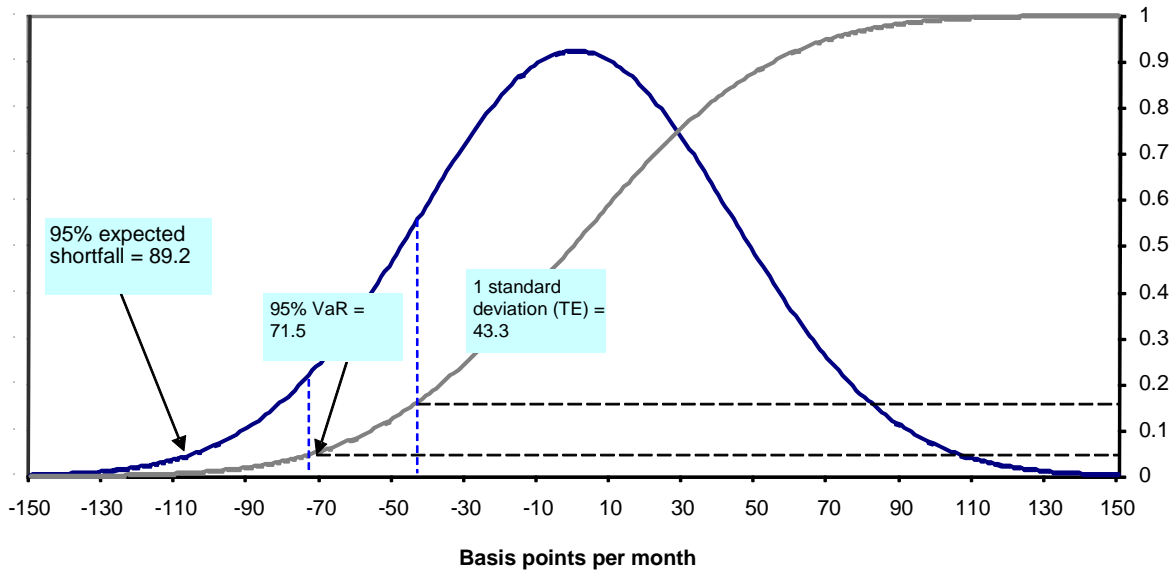
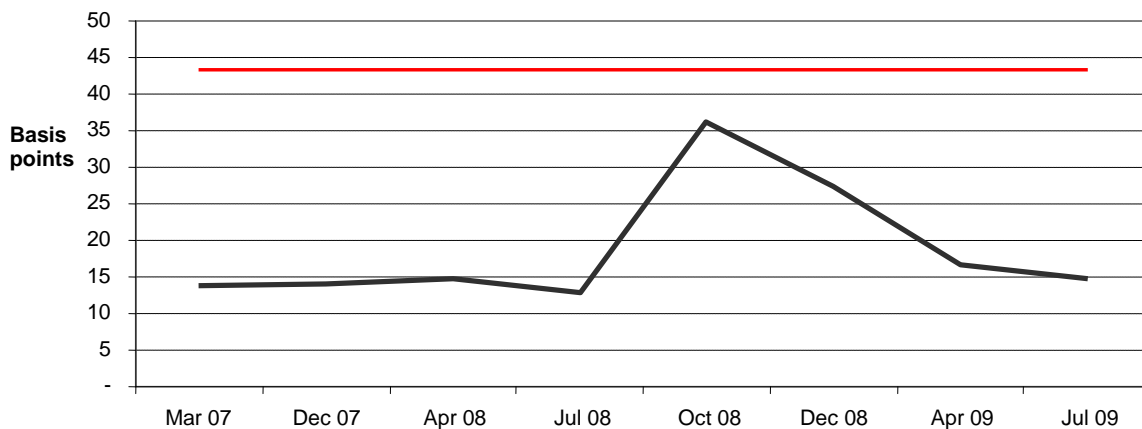


Figure 2 shows the level of tracking error with a parametric method, calculated using today's portfolio for various historical dates. The red line shows the limit issued by the Ministry converted into basis points per month. The reason why this chart does not show the breach of this limit that actually occurred in October 2008 is that here we are using today's portfolio, which has somewhat fewer positions than at that time.

Chart 2: Parametric tracking error

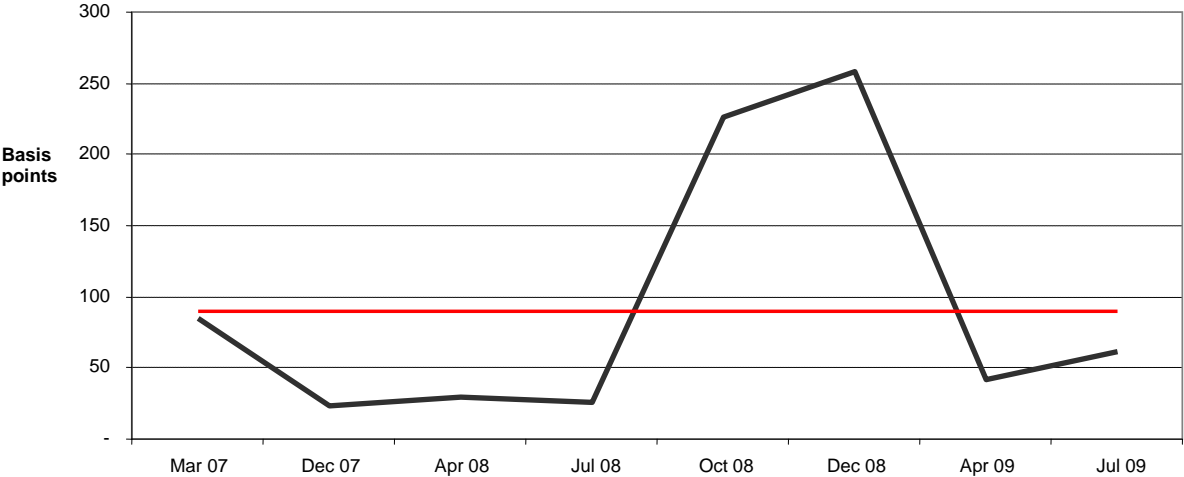


If Value at Risk and expected shortfall are to provide management information on top of that provided by tracking error, we need to use historical simulation instead of a parametric method, as the Ministry proposes in the draft rules. By historical simulation, we mean taking today's portfolio and calculating its value using new historical market prices at each estimation interval. The quality of a risk measure estimated using historical simulation is

critically dependent on there being good market prices for all instruments for every estimation interval.

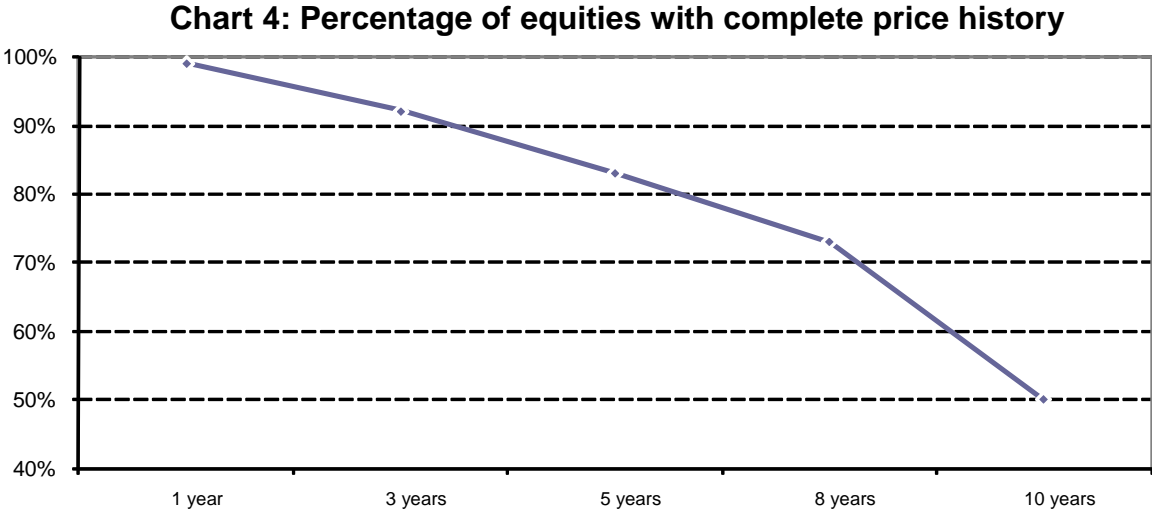
It is a known feature of time series in financial markets that the actual return distribution is not normally distributed, but has more frequent observations in the tails of the distribution than the normal distribution. If we assume that the quality of the historical simulation is good, Value at Risk and expected shortfall will, at high confidence levels, dominate tracking error over time and, in reality, become the effective constraint (if the limits for these risk measures are parametrically scaled as proposed by the Ministry). Depending on the estimation period and estimation interval used, the variability of Value at Risk and expected shortfall will also be higher than the corresponding figure for tracking error. Thus an additional uncertainty is introduced into the risk estimate, making its operationalisation more challenging. Chart 3 shows the level of expected shortfall with historical simulation, calculated using today's portfolio for various historical dates, in the same way as for tracking error using a parametric method in Chart 1. Here we have used the same estimation specification as when calculating tracking error. The red line shows the proposed limit from the Ministry of Finance.

Chart 3: Historically simulated expected shortfall



As there will be few, and often long, periods between extreme historical market observations, the estimation period for the estimation of Value at Risk and expected shortfall may, at high confidence intervals, be too long to have any predictive power. When the length of the estimation period is increased, the quality of the data will inevitably decrease, as the number

of instruments or securities with listed prices throughout the period will be smaller. This is illustrated in Chart 4.



The chart shows how many equities in today’s portfolio have historical prices once we increase the length of the estimation period. The past two years have seen extraordinary low levels of initial public offerings (IPOs). If we go back to the period 1998-2001, when there were extraordinarily high levels of IPOs, mostly related to technology and the Internet, an historically simulated expected shortfall has the potential to send out some very misleading management signals. In this case, the calculation of tracking error with a short estimation period would give much better signals about the change in the risk picture.

Historical simulation is, by and large, only well-suited to listed instruments with observable prices. For many fixed income securities, historical simulation is often performed by looking at the change in parameterised prices with generic price drivers such as yield curves and credit spreads, rather than at the prices of each individual instrument. This means that we often do not model instrument-specific conditions or liquidity effects. As the Fund’s benchmark index on the fixed income side is so extensive, there are no third-party suppliers of risk systems which can calculate a realistic historical simulation of expected shortfall as a single figure for the entire fixed income portfolio. An overall figure for Value at Risk and expected shortfall at an aggregated level for the Fund as a whole will therefore have very clear weaknesses in relation to the intention behind the use of historical simulation. Finally, qualitative interpretation of significance levels around a point estimate will be difficult, as the aggregation in itself makes the calculation less transparent.

The estimation of measures of extreme loss risk such as expected shortfall are resource-intensive for the benchmark index defined for the Government Pension Fund – Global. Due to the complexity of the benchmark index, Norges Bank makes a set of adjustments to the datasets, and we need to have different models for the different segments within the portfolio and perform the actual calculations outside our main risk system. Despite the level of customisation in this modelling, we must nevertheless include qualitative assessments, and it is difficult to aggregate the calculations into a “definitive” single overall figure at portfolio level.

In the wake of the financial crisis, there have been a number of reports attempting to draw conclusions from this extreme period, and many also provide concrete advice and recommendations as to how risk management can be improved. Several of these reports address specifically the use of aggregated model-based risk measures such as Value at Risk and expected shortfall. The Institute of International Finance writes in its report (2008):

The risk-management function should explicitly incorporate in its procedures the limitations of risk measures and models (e.g., VaR) that are used in the firm. Such limitations should be addressed by qualitative means, including expert judgement. Risk-management procedures should explicitly prevent dependence upon single methodologies.

The Senior Supervisors Group, comprising the regulatory authorities in France, Germany, Switzerland, the UK and the US, writes in its report (2008):

Most firms that avoided significant unexpected losses used a wide range of risk measures to discuss and challenge views on credit and market risk. These firms tended to use processes and measures that could be adjusted to reflect new circumstances, and they understood the limitations of individual risk measures.

UBS was one of the big international banks that had major problems when the financial crisis began in 2007, and was also one of the first to conduct a thorough review of internal factors that could provide reasons for these heavy losses. In an extensive report to shareholders (2008), it states, for example, that shortcomings in risk management were one of the main reasons, and in particular that the bank had placed too much faith in quantitative risk measures such as Value at Risk and stress tests which were based only on historical time series.

There have also been critical evaluations of model-based risk measures from academia. Jón **Danielsson** from the London School of Economics writes in “Blame the Models” (2008):

Having a number representing risk seems to more important than having a number which is correct.

Unfortunately, the reliability of such models decreases with complexity, so when we need the models the most they tend to be least reliable.

Aggregated VaR numbers for a big financial institution are essentially just random since model risk dominates.

We do, however, see increasing demands from supervisors for exactly the calculation of such numbers as a response to the current crisis.

References

Institute of International Finance (2008): *Final Report of the IIF Committee on Market Best Practices: Principles of Conduct and Best **Practice** Recommendations.*

Senior Supervisors Group (2008): *Observations on Risk Management Practices during the Recent Market Turbulence.*

UBS (2008): *Shareholder Report on UBS's Write-Downs.*

Danielsson, J. (2008): *Blame the Models.*