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MULTIVARIATE STUDENT'S T MONTE CARLO ESTIMATION OF VALUE AT RISK IN ENERGY PORTFOLIO

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OVERVIEW

The oil market is highly volatile [1] and in recent years the market has experienced two major shifts. First, demand for oil soared in following economic growth in newly industrialized countries, and secondly following the financial crisis of 2008 demand plummeted. For a risk manager of an energy portfolio these sudden changes in the market created difficulties when estimating risk, as the dependency on empirical data created estimates based on a normal market, while estimates were needed for a highly uncertain and negative market.

In addition to increased volatility in the market, the correlation of all products and assets tend to become more positive [2, 3] when experiencing a negative shift in the market. This increases the risk in a portfolio of long positions as the diversification advantages are reduced. Furthermore, it has been argued that a herding mechanism [4, 5, 6] amplifies this correlation, as market players follow the same strategies in order to avoid losses.

One of the most common approaches to estimate portfolio risk in most companies is Value at Risk (VaR) [7, 8], and also in petroleum companies. VaR defines the worst case scenario within a certain confidence level over a specified time horizon. It is a lower tail percentile for the distribution of profit and loss (P & L), and therefore the tails are essential when estimating VaR.

VaR has been criticized for underestimating risk [9], and it contributed to the increased risk seen in the financial as well as other sectors before the crisis. The underestimation may have been a result of the underlying distribution assumed for analytical approaches (normal assumption [9]), or the empirical distribution implied by a historical simulation.

In this paper we will use a multivariate student's *t* Monte Carlo simulation method to estimate VaR. Our method will be compared to an analytical approach with normal assumptions and the historical simulation which assumes an empirical distribution. The methods provide different approaches towards the tail distribution and will enable us to verify the necessity of a fat tail to include the risk of a portfolio.

Our analysis is divided into two periods. The first period include 500 days, from January 9th 2007 to 31st December 2008. The last 106 days (from 1st June 2008) were used as a stress test because of the high volatility experienced in this period.

METHODS

We will estimate VaR by a multivariate student's t Monte Carlo simulation method, and compare it to an analytical approach with normal assumption and the historical simulation which assumes an empirical distribution. The methods provide different approaches towards the tail distribution and will enable us to verify the necessity of a fat tail to include the risk of a portfolio. We will test the methods for conditional coverage of frequency and independence of tail losses [10].

RESULTS AND CONCLUSIONS

The results from our comparison of VaR estimation methods, suggests that heavier tails are needed to include the underlying risk, even in periods of normal growth. Although all

methods provide adequate cover in the full back test, only the student's t method is accepted in the stress-test period. The results are especially good at 3 degrees of freedom for the stress-test period, suggesting that a heavy tail is needed to cover more unlikely events. A risk management system should always include the possibility of a change in market volatility, and in order to avoid underestimation of risk, the methods including more uncertainty are the recommended methods for a long term risk management system.

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