Properties of the Value at Risk Estimate Using the Historical Simulation Methodology

A Research Project Submitted for the Degree of Master of Business

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1. Introduction

In its most general form, risk can be defined as the possibility an outcome will differ from expectations. This project is concerned with the quantification of market risk which results from the inherent volatility in the prices of financial assets and is of concern to banks and other financial institutions for two principal reasons. Firstly, a large proportion of the assets and liabilities of these types of firms are sensitive to changes in market prices. Secondly, there have been a number of high profile cases of significant losses caused by an inadequate appreciation of market risk. These factors have driven recent advances in quantifying and understanding Market Risk and one increasingly popular technique is known as Value-at-Risk (VaR).

Value-at-Risk is a relatively new concept originally developed for exchanges in their settlement operations and has advanced quickly since the late 1980's to become the leading measure of Market Risk in a majority of large banks and trading organizations. JP Morgan produced a standardized framework for the VaR calculation known as RiskMetrics in 1994 prompting an explosion in use by making the methodology and data freely available. A number of regulators, including the Reserve Bank of New Zealand, have advocated VaR as an appropriate risk measure.

A principle advantage of a VaR methodology lies in its simplicity. VaR is capable of providing a single number to express the market risk of a portfolio of financial instruments, a property that makes communication of such a complex exposure relatively simple. However, the greatest benefit of the technique lies in the structured analysis of exposures. It is this process of generating the VaR that delivers the benefit to an organization.

WestpacTrust have used the VaR technique since its earliest conception constantly changing and updating the methodology to reflect best practice in the industry. The bank currently perform this calculation but realize that there can be significant variation in the estimate depending on the various assumptions and underlying data used in the calculation. At present the bank relies on an intuitive understanding of how these various factors can influence the calculation but would prefer a quantitative solution. The principle aim of this project is to provide a framework enabling the Bank to gain a better understanding of the properties of the VaR estimate based on quantitative tools. Specifically, this process will involve an estimation of the error in VaR, an understanding of how the VaR estimate is affected by the underlying assumptions made and how other measures of market risk can be used to provide the trading risk management team with additional insights to the banks exposure.

Firstly, this research project will describe the different VaR techniques, their strengths and their weaknesses. One of these models will then be developed to calculate the VaR for WestpacTrust Financial Markets in Wellington. Finally, the properties of this VaR will be examined to understand the estimate and gain an
appreciation of the subjectivity in its calculation. Some recommendations to the Bank regarding their VaR methodology will form the conclusion to this report.

1.1 Definition

Value-at-Risk (VaR) can be defined as the maximum expected loss due to normal market movements over a specified interval of time within a certain confidence interval. A 95% one day VaR of $1000 means that a loss of greater than this will only occur, on average, once every 20 business days given normal market movements. The current portfolio is used to proxy the portfolio held over the specified interval of time, a factor that is probably a reasonable assumption for a one day VaR but not so for a one month VaR, especially for heavily traded portfolios. This simplicity of interpretation makes VaR an attractive and easy number to communicate. However, the disparity of techniques in calculation mean that the estimate of the actual VaR number may differ widely, a point that should be communicated to all users.

VaR measures a firm’s exposure to market risk – the risk associated with changes in the prices of financial assets and liabilities. The term risk factor will be used to define a specific risk: for example, if foreign exchange is being received today then the relevant risk factor is the foreign exchange rate.

The definition of the VaR estimate is also affected by the way in which the future values of the distribution are interpreted. This can be done in two distinct ways. Firstly, the expected portfolio outcome can be taken into account. This is done by calculating the VaR as the difference between the expected portfolio value at the end of the time horizon and the (say) fifth percentile. This approach takes into account the expected return of the portfolio over time thus the VaR includes the opportunity cost of any expected return. Secondly, the VaR can be found as the difference between today’s mark to market portfolio value and the (say) fifth percentile of the distribution of future portfolio values, thus the expected return is zero. The first method, or objective VaR, is predominately used for in-house risk measurement, as movements away from an expected return are, in effect, a loss. The second measurement or legal VaR is useful as a regulatory tool and for calculating the organization’s capital at risk. This project will consider both measurements by calculating the difference between the mean of the historical distribution and the mark to market value today.

1.2 Uses

VaR is predominately used as a measure of market risk for a portfolio of financial instruments. However the technique is general in nature and has been applied in many different ways including, performance assessment, credit risk analysis, regulatory capital requirements and limit establishment. This project will consider VaR as a measure of WestpacTrust’s exposure to market risk only although the bank does use VaR for some of these other purposes.

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1 Orange County, Barings Bank and Metallgesellschaft are a few of many organizations where a better understanding of market risk would have avoided huge losses.
10 References

