Monte Carlo simulation Value at Risk and PCA¹

Mária Bohdalová, <u>maria.bohdalova@fm.uniba.sk</u> Michal Greguš, <u>michal.gregus@fm.uniba.sk</u> Comenius University in Bratislava, Faculty of Management, Department of Information Systems, Odbojárov 10, Bratislava, 82005 Slovakia

Financial portfolios include many of risk factors, such as asset prices, interest rates, foreign exchange rates, commodity prices that affect the portfolios profit/loss. Risk factors are often very highly correlated therefore it is convenient to use principal component analysis to reduce the dimension of the risk factor space. Moreover, the construction of the principal components guarantees that they are uncorrelated, because they are generated by orthogonal eigenvectors. PCA is a technique for extracting a few key uncorrelated risk factors from a larger set of correlated risk factors. The ability of PCA to reduce dimensions, combined with the use of orthogonal variables for risk factors, makes this technique an extremely attractive option for Monte Carlo simulation. In highly correlated term structures of risk factors the replacement of the original risk factors by just a few orthogonal risk factors introduces very little error into the simulations, and increases the efficiency of the simulations enormously. In this paper the PCA in Monte Carlo simulation with multivariate normal and Student *t* Value at Risk (VaR) will be used.

Keywords: Principal Component Analysis, Value at Risk, Monte Carlo simulation

References

[1] *Alexander, C.* (2008). Market Risk Analysis, Volume II., John Wiley&Sons, Ltd., ISBN 978-0-470-99801-4(H/B)

[2] *Alexander, C.* (2008a). Market Risk Analysis, Volume III., John Wiley&Sons, Ltd., ISBN 978-0-470-99789-5(H/B)

[3] *Alexander, C.* (2008b). Market Risk Analysis, Volume IV., John Wiley&Sons, Ltd., ISBN 978-0-470-99788-8(H/B)

[4] *Cipra, T.* (2010). Financial and Insurance Formulas, Springer-Verlag Berlin Heidelberg, ISBN 978-3-7908-2592-3

[5] *Daripa, A. – Varotto, S.* (1998, October) Value at Risk and Precommitment: Approaches to Market Risk Regulation. In: *FRBNY ECONOMIC POLICY REVIEW*, p. 137-143

[6] *Penza, P. – Bansal, V. K.* (2001). Measuring market risk with Value at Risk. John Wiley&Sons, Ltd., ISBN 0-471-39313-4

[7] Tsay, R. S. (2010). Analysis of Financial Time Series. Third edition, John Wiley&Sons, Ltd., ISBN 978-0-470-41435-4

¹ The work on this paper has been supported by VEGA grant agency, grant numbers 1/0103/10 and 1/0279/11