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Journal of Banking & Finance 29 (2005) 927–958

Journal of BANKING & FINANCE

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Sensitivity analysis of VaR and Expected Shortfall for portfolios under netting agreements ☆

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Available online 29 September 2004

Abstract

In this paper, we characterize explicitly the first derivative of the Value at Risk and the Expected Shortfall with respect to portfolio allocations when netting between positions exists. As a particular case, we examine a simple Gaussian example in order to illustrate the impact of netting agreements in credit risk management. Collateral issues are also dealt with. For practical purposes we further provide nonparametric estimators for sensitivities and derive their asymptotic distributions. An empirical application on a typical banking portfolio is finally provided.

JEL classification: C14; D81; G10; G21; G22

Keywords: Value at Risk; Expected Shortfall; Sensitivity; Risk management; Credit risk; Netting; Collateral

☆ We thank G.P. Szegö and the referees for constructive criticism. We are grateful to Aubry Miens for having provided us the datebase. The second author by the Swiss National Science Foundation through the National Center of Competence: Financial Valuation and Risk Management (NCCR FINRISK). Part of this research was done when he was visiting THEMA and IRES. Downloadable at http://www.hec.unige.ch/professeurs/SCAILLET_Oliver/pages_web/Home_Page.htm.

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0378-4266/$ - see front matter
doi:10.1016/j.jbankfin.2004.08.007

1. Introduction

For risk management purposes, the evaluation of marginal impacts of current or new positions on risk measures and regulatory capital has been recognized as an important point (Garman, 1996; Jorion, 1997). In practice, this evaluation can be made through explicit estimators of the first order derivatives of some standard risk measures, such as the Value at Risk (VaR) and the Expected Shortfall (ES), with respect to portfolio allocations (Gouriéroux et al., 2000, hereafter GLS; Scaillet, 2004). Knowledge of the sensitivity is helpful in reducing the amount of computational time needed to process large portfolios since it avoids the need to recompute risk measures each time the portfolio composition is slightly modified (Kurth and Tasche, 2003; Martin et al., 2001; Martin and Wilde, 2002). Besides it allows decomposing global portfolio risk component by component, and identifying the largest risk contributions (Denault, 2001; Garman, 1997; Hallerbach, 2003; Tasche, 1999). These derivatives are also of particular relevance in portfolio selection problem (see Markowitz (1952) for portfolio selection in a mean–variance framework). They help to characterize and evaluate efficient portfolio allocations [1] when VaR and ES are substituted for variance as a measure of risk (GLS, 2000; Rockafellar and Uryasev, 2000; Yamai and Yoshiba, 2002b). In fact, numerical constrained optimization algorithms for computations of optimal allocations usually require consistent estimates of first order derivatives in order to converge properly.

Unfortunately, the results available up to now have fallen short of tackling the problem of netting. Clearly, this is an important omission since most financial positions with respect to one or several counterparties are netted in practice. Neglecting the impact of netting will bias the evaluation of marginal impacts of current or new positions on risk measures and regulatory capital, and will lead to inefficient allocations in portfolio selection problems.

Generally speaking, when trading partners agree to offset their positions or obligations, we say that there is netting. By doing so, they reduce a large number of positions or obligations to a smaller number of positions or obligations, and it is on this netted position that the two trading partners settle their outstanding obligations.

In the financial community, positions are most of the time netted inside standardized juridical contracts. Streamlining of documentation has taken place as a result of joint efforts by regulators and financial industry organizations. In 1990, the Bank of International Settlements (BIS) issued minimum standards for the design and operation of netting schemes, [2] while in 1991, the Federal Deposit Insurance Corporation Improvement Act (FDICIA) provided support for netting contracts among banks and other financial institutions. In 1992, the International Swaps and Derivatives Dealers (ISDA) issued its first version of the well-known "ISDA Master Agreement"

[1] A related topic is dynamic trading strategies under risk limits (Basak and Shapiro, 2001; Cuoco et al., 2001; Leippold et al., 2002).

[2] They are known as the Lamfalussy standards after the chairman of the Committee that wrote the report.