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COMPUTATION OF MARKET RISK MEASURES WITH STOCHASTIC LIQUIDITY HORIZON

GEMMA COLLDEFORNS-PAPIOL AND LUIS ORTIZ-GRACIA

Abstract. The Basel Committee of Banking Supervision has recently set out the revised standards for minimum capital requirements for market risk. The Committee has focused, among other things, on the two key areas of moving from Value-at-Risk (VaR) to Expected Shortfall (ES) and considering a comprehensive incorporation of the risk of market illiquidity by extending the risk measurement horizon. The estimation of the ES for several trading desks and taking into account different liquidity horizons is computationally very involved. We present a novel numerical method to compute the VaR and ES of a given portfolio within the stochastic holding period framework. Two approaches are considered, the delta-gamma approximation, for modelling the change in value of the portfolio as a quadratic approximation of the change in value of the risk factors, and some of the state-of-the-art stochastic processes for driving the dynamics of the log-value change of the portfolio like the Merton jump-diffusion model and the Kou model. Central to this procedure is the application of the SWIFT method developed for option pricing, that appears to be a very efficient and robust Fourier inversion method for risk management purposes.

Key words. Market Risk, Liquidity Risk, Stochastic Liquidity Horizon, Value-at-Risk, Expected Shortfall, Fourier Transform Inversion, Shannon Wavelets.

AMS subject classifications. 91G60, 62P05, 60E10, 65T60

JEL codes. G13, G32, C63

1. Introduction

The Basel Committee of Banking Supervision states in the consultative documents [3, 4] that *"the financial crisis exposed material weaknesses in the overall design of the framework for capitalising trading activities. The level of capital required against trading book exposures proved insufficient to absorb losses"*. Within the mentioned documents, the Basel Committee initiated a fundamental review of the trading book regime, beginning with an assessment of those things that went wrong. The revised standards for minimum capital requirements for market risk were recently established in [5].

The Committee has focused, among other things, on the two key areas of moving from VaR to ES and considering a comprehensive incorporation of the risk of market illiquidity. In regard to the first issue, a number of weaknesses have been identified with using VaR for determining regulatory capital requirements, including its inability to capture the risk in the tail. For this reason, the Committee has considered alternative risk metrics like, in particular, the ES, which measures the riskiness of a position by considering both the size and the likelihood of losses above a certain confidence level. The second issue relies on the importance of incorporating the risk of market illiquidity as a key consideration in banks' regulatory capital requirements for trading portfolios. The assumption that trading book risk positions where liquid, i.e., that banks could exit or hedge these positions over a ten-day horizon proved to be false during the recent crisis. As liquidity conditions deteriorated during the crisis, banks were forced to hold risk positions for much longer than originally expected and incurred in large losses due to fluctuations in liquidity premia and associated changes in market prices.

In its deliberations on revising the prudential regime for trading activities, the Committee has drawn on lessons both from the academic literature (see [2]) and banks' current and emerging risk management practices. One of the important messages from the academic literature on risk measurement in the trading book is that there are limitations of VaR models that rely on the use of continuous stochastic processes with only deterministic volatility assumptions. Introducing either

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