

# CVaR Variation Margin, Pricing and Hedging

J. G. López-Salas<sup>1</sup>, A. Agarwal<sup>2</sup>, S. De Marco<sup>1</sup>,  
E. Gobet<sup>1</sup>, F. Noubiagain<sup>3</sup>, A. Zhou<sup>4</sup>.

<sup>1</sup> Centre de Mathématiques Appliquées, École Polytechnique, Route de Saclay, 91128 Palaiseau cedex, France.

<sup>2</sup> Adam Smith Business School, University of Glasgow, Scotland.

<sup>3</sup> Département de Mathématiques, Université du Maine, Le Mans, France.

<sup>4</sup> CERMICS, École Nationale des Ponts et Chaussées, 77455 Marne-la-Vallée cedex 2, France.

The paradigm of linear risk-neutral pricing rules of financial contracts has changed in the last years, influenced by the regulators, and nowadays banks and financial institutions have to cope with posting collateral to the central counterparty (CCP, or clearing house) in order to secure their positions. Everyday, the CCP asks to each member to post a certain amount reflecting the exposure of their OTC contracts. The initial and variation margins correspond to deposit a collateral in order to cover a new contract, or to cover the daily change in market value of the contract. In this work, we aim at accounting for a non-linear phenomenon that occurs in practice. The deposit depends on the VaR (or CVaR) of the portfolio computed over 10 days, giving rise to a equation including a term depending on the law of the solution. We justify that this problem can be seen as a new type of anticipative BSDE. We derive stability estimates, existence and uniqueness results for the new type of BSDE and derive some approximations using non linear classical BSDEs. Then we propose some numerical schemes based on FD methods in dimension 1 and regression Monte-Carlo in higher dimensions.

Work supported by Chaire Risques Financiers from the Risk Foundation.