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## Multiple Risk Measures for Multivariate Dynamic Heavy–Tailed Models

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## Abstract

The dynamic evolution of tail-risk interdependence among institutions is of primary importance when extreme events such as financial crisis occur. In this paper we introduce two new risk measures that generalise the Conditional Value-at-Risk and the Conditional Expected Shortfall in a multiple setting. The proposed risk measures aim to capture extreme tail co-movements among several **multivariate** connected market participants experiencing contemporaneous distress instances. Analytical expressions for the risk measures are obtained under a parametric model that postulates a joint dynamic evolution of the underlying institutions' losses and gains. We consider a multivariate Student-t version of Markov Switching models as a robust alternative to the usual multivariate Gaussian specification, accounting for heavy-tails and time varying non-linear correlations. An empirical application to US banks is considered to show that our model-based risk measurement framework provides a better characterisation of the dynamic evolution of the overall risk of a financial system and a more complete picture of how the risk spreads among institutions.

KEYWORDS: Markov-Switching models, tail risk interdependence, risk measures, conditional Value-at-Risk, conditional expected shortfall, systemic risk.

## 1 Introduction

The recent global financial crisis originated by the US subprime mortgage bubble burst of August 2007 and the consequent downturn in economic activity leading to the 2008–2012 global recession, highlighted the strong negative impact of large scale collapse of financial institutions on other banks as well as on the real economy. After the failure of Bearn Stearns hedge funds on August 5th, 2007, the threat of total collapse of large financial institutions, and the consequent downturns in stock markets around the world, caused a worldwide increase in financial market volatility and a sudden tightening of the liquidity conditions. The spillover effect of a downturn in the financial system has been advocated as the main reason for massive public interventions and bailouts of distressed banks. Bank failures cause direct effects on the real economy because of their linkage to the manufactory industry through the credit mechanism and the significant role they play as financial intermediaries on the monetary

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