

# A New Copula Analysis of the EU Sovereign Debt Crisis

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The aim of this paper is to propose a new method to measure asymmetric correlation between the stock and government bond price returns of the five peripheral EU countries during the EU sovereign crisis. We find a strong dependence in the lower-tail of the stock-bond correlation in the early stage of the crisis, which can be interpreted a panic capital flight.

The correlation between the stock and bond price returns of the peripheral EU countries changed in the EU sovereign debt crisis. We consider the stock index and 10-year government bond price returns of the five EU countries after removing the effect of volatility change and serial correlation. In this paper we quantify the correlation asymmetry of the stock and bond returns of the five peripheral euro countries ( Greece, Ireland, Italy, Portugal, Spain) using a new time-varying asymmetric copula.

In the pre-crisis period (2006-2009) the sign of the correlation was negative. It changed to positive and the lower-left tail area had high "correlation" than in the upper-right tail area in the mid-crisis (2010-2013). In the post-crisis period (2014-2015) the asymmetry disappeared and the positive stock-bond correlation remained, suggesting that the government bonds were still unsafe assets

In order to analyze the time-varying correlations of the stock and government bond price returns in the crisis, we constructed a new asymmetric copula from a split normal distribution, namely a bivariate distribution consisting of two halved bivariate normal density functions with different correlation coefficients connected on the negative 45 degree line. The correlation coefficients of the underlying distribution are estimated by the particle filter method in a state space framework under the assumption that they independently follow random walk processes. The merit of using copula is that we can construct a joint distribution function with an arbitrary marginal distribution function and an arbitrary quantile dependence, which is an alternative concept to correlation.

For the ease of the computational burden, we estimated the standard deviation of the transition equation, which is essentially smoothness parameter, by maximizing the likelihood function approximated and interpolated by a thin plate spline regression method.