

Modelling dependence of interest rates, inflation rates and stock market returns

Hans Waszink AAG MBA MSc

Waszink Actuarial Advisory Ltd.

Sunnyside, Lowden Hill, Chippenham, UK

hans@hanswaszink.com

Abstract:

In the first part of this article, an approach to model the value of an outstanding, discounted liability under the impact of uncertain interest and inflation rates is discussed. Interest and inflation rates are modeled separately as time series to take into account autocorrelation. Subsequently, the dependence between interest and inflation is modeled using copulas. The goodness of fit of some copulas can be evaluated on the basis of historic data using a quantile plot. This is done for the Gumbel, Clayton and Independent copulas. The Gumbel copula, which gives the best fit, is then compared with the Normal copula to show that the two copulas are very similar with the parameters chosen. The distribution of the required reserve is shown under four different copula assumptions: comonotonicity, which represent the best case, countermonotonicity which represents the worst case, and the Gumbel and Normal copulas which represent more realistic scenarios.

The choice of copula has considerable impact on the higher percentiles of the required reserve, and the adopted approach is effective in selecting a suitable copula for the modelling of two underlying variables.

In the second part of the article, the application of copulas to the modelling of three dependent variables (interest, inflation and stock market return) is investigated. As the Clayton and Gumbel copulas only have a single parameter, they prove to be less suitable for the modelling of more than two dependent variables. The normal copula appears more suitable in this case as the dependence between each modelled variable can be set separately by a different parameter in the correlation matrix.

Keywords: copulas, dependence, autocorrelation, time series, stochastic modelling, goodness of fit, interest, inflation, stock market returns, discounting.