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Data

Our data consists of S&P 500 total return index, S&P 500 constituents' price time series, and the VIX index. The time series contain weekly data from the beginning of the 1990s. From S&P constituents we have included stocks that currently belong to the index, and the time series spans back to the beginning of the 1990s. Hence, our S&P 500 consists of only 177 stocks, and tickers are saved in the variable stock_names.

Assumptions

We conduct our studies and stress tests to an equally weighted portfolio, which means that our imaginary portfolio has 177 stocks, each with equal weight of 1/177= less than 1%. The data is cleaned and transformed to invariants, namely compounded returns for stocks.

The practice has two parts: flexible probabilities, and panic copula. Before these parts there is plenty of code to clean and visualize the data. In the beginning we also show the empirical copula of two stock invariants using the CMA.

In flexible probabilities we have conditioning according to the VIX index, for which we have defined a threshold of 27. Above this we consider the market to be in panic, and below it we are facing calm markets. We use three different methods to come up with flexible probabilities: "crisp", Gaussian kernel, and partial information kernel smoothing.

For panic copulas we tried to estimate the panic and calm market correlations from the historical observations of market invariants, and then construct correlation stress tests.

Results

Different CDFs for flexible probabilities can be seen in figure 1, where some basic statistics are shown graphically as well. In these stress tests we observe fatter tails, and more extreme values in the basic statistics. These results could give us reasonable idea of how the portfolio could perform in such events. Especially the distributions being fat-tailed is a wanted property for stress testing distribution.

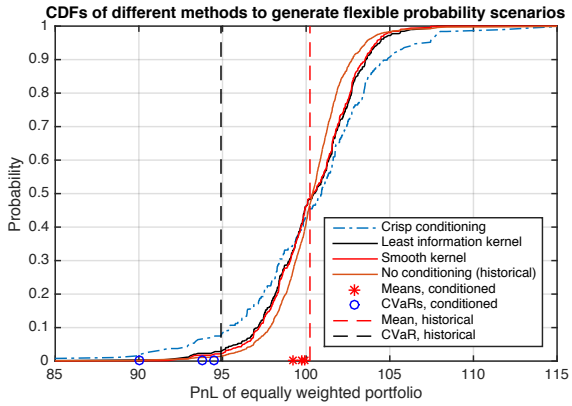

Figure 1 CDFs of flexible probability distributions

The results for panic copulas were not very interesting, since the correlations estimated for panic were actually quite modest. Using more extreme correlations and lower dimensional data we could perhaps have produced more interesting results. Here we actually observed that the historical scenarios have fatter tails than the panic copula, which was not expected. The panic copula yields more pessimistic results than the historical scenarios only when the CDF condition is very high: about 0.95, which means that the calm correlation is in use only in very good outcomes. Hence we conclude that the method for coming up with stress test correlations should be more sophisticated than the method used for this practice.