Index Development for a Market with Heavy-tailed Distributions

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In order to fully reflect the movements of prices or returns on financial assets, their distributions should be considered. However, they are often heavy-tailed and possibly skewed, and identifying them directly is not easy. To address this problem, we shall propose a statistical method of constructing a price index of a financial asset where the price distributions are skewed and heavy-tailed. Firstly, the Box-Cox transformation is applied where the parameter is determined by minimizing the AIC with respect to the original data. Then, the long-term trend of the distributions is estimated by fitting a new trend model with time-varying observation noises. The estimation is performed by applying state space modeling. Moreover, missing observations are automatically interpolated by the state space model. Finally, the index is defined by taking the inverse Box-Cox transformation of the optimal long-term trend. To show the effectiveness of our method, it will be applied to the sovereign Credit Default Swap market where the number of observations varies over time due to the immaturity. As a result, the worldwide spillover effects of the European debt crisis will be detected. Applying our method to the markets with insufficient information such as fast-growing or immature markets can be effective.

Key Words: Box-Cox transformation, financial crisis, time series analysis, time-varying variance