Dynamic Bayesian Network Analysis for Financial Risk Assessment

Shun Hin Chan

Department of information systems, business Statistics and operations management, The Hong Kong University of Science and Technology

Abstract

System risk refers to a breakdown of a financial system. To concept of "Too connected to fail" suggests that the interconnectedness play a main role in the systemic risk. A failure of a small part can trigger the failure of the other parts, eventually leads to a failure of the whole system. We aim to measure the sources and the flows of the market disturbances using the Bayesian networks, which consider the direction of the linkages among stocks such that we can model the flow of disturbances, as oppose to the popular undirected network approaches in the literature. Using Bayesian networks, the stocks can be ordered topologically, which allows us to measure the abovementioned sources of disturbance. We propose the order distance, which measures the change to the stock topological orders. Since the volatility is used as a signal of possible systemic risk events supported by the literature, we use the order distance to predict the absolute return, as a proxy of volatility, using the LASSO regression model, a regularization method to reduce overfitting. The empirical study using HSI stock data from 2008 to 2021 indicates that the order distance, as a summary statistics of the DAG, greatly improves the predictability on top of the summary statistics we can only obtained from undirected networks. The use of Bayesian network and the topological orders allows us to predict volatility more accurately and thus provides more accurate precautions of possible systemic risk events.

Keywords: Rolling-window analysis, Dynamic Network analysis, Bayesian networks, Topological orders, Order distance, Hang Seng Index, Financial market, Financial crisis, Financial contagion