

Granger Causality Analysis Based on Copula:

CFBA-2605 An Empirical Study of the Shanghai and Hong Kong Stock Markets

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Introduction or abstract

To overcome the limitations of the conventional Granger causality approaches in analyzing nonlinear and non-Gaussian time series data, this paper proposes a Granger causality analysis method based on Copula theory. This research presents the concept of the bivariate Copula-based sequences and formulates associated methods for estimation and statistical inference to investigate Granger causality from a distributional perspective. A new conditional independence test, known as the Copula-based chi-square goodness-of-fit test, was given by integrating the Copula model with the conventional Granger causality architecture. The proposed approach is applied to empirically examine the impact of the Shanghai-Hong Kong Stock Connect mechanism. The results show that the implementation of this initiative has triggered a structural shift in the causal interdependence and information transmission between the two stock markets.

Objectives

Building upon the theoretical framework established in [12], this study utilizes pair-Copula constructions to develop the notion of a bivariate Copula Dependence Series (CDS), explicitly denoted as CDS . We develop robust methods for estimating these sequences and conducting statistical inference. By bridging the gap between CDS and Granger causality, we construct a distribution-based framework for causal inference, shifting the focus from conditional moments such as mean or variance, emphasizing instead the entire conditional distribution. Given that independence testing plays a key role in this approach, we propose a new Copula-based chi-square goodness-of-fit test designed to assess conditional independence. Finally, we apply the proposed framework to examine the equity markets of Shanghai and Hong Kong. The empirical evidence demonstrates that the launch of the "Shanghai-Hong Kong Stock Connect" has triggered a fundamental structural shift in the causal relationships between these two financial centers.

Materials & Methods

We employ the Shanghai Composite Index to gauge the performance of the Shanghai market, while the Hang Seng Index serves as the benchmark for Hong Kong. Our analysis focuses on pairwise logarithmic returns collected from overlapping trading sessions between January 4, 2001, and July 25, 2019, totaling 4,300 observations. With the Shanghai-Hong Kong Stock Connect becoming operational on November 17, 2014, the time series is segmented into two periods: a pre-launch set (3,197 observations) and a post-launch set (1,103 observations). Numerical calculations were performed using the MATLAB platform, utilizing a standard 5% significance level for all hypothesis tests.

Results

we detect the following significant causal patterns at the 5% significance level:

- (1) The Shanghai-Hong Kong Stock Connect has modified the serial dependence of the Hang Seng Index, as indicated by a reduction in its optimal lag specification from 4 to 3.
- (2) Prior to the launch of the Shanghai-Hong Kong Stock Connect, the two markets exhibited mutual independence, with no significant Granger causality observed in either direction.
- (3) Following implementation, a distinct unidirectional causal relationship materialized, flowing from the Shanghai market to the Hong Kong market, whereas the reverse path from Hong Kong to Shanghai remained statistically insignificant.

Conclusion

This research presents a new framework for Granger causality analysis based on Copula theory. We suggest the concept of bivariate Copula dependence series and establish a robust framework for their estimation and statistical inference, facilitating causality analysis through the full joint probability distribution. By embedding the adaptability of Copula functions into the Granger causality framework, our method effectively overcomes the deficiencies of conventional linear models, particularly their failure to capture nonlinear relationships, asymmetric effects, and tail dependence. A major advancement lies in the development of a Copula-based chi-square goodness-of-fit test, which provides a reliable method for conditional independence without relying on restrictive distributional assumptions. Empirically, we applied this methodology to examine the integration between the Shanghai and Hong Kong stock markets surrounding the stock connect program. The results indicate that this liberalization initiative has significantly transformed the mechanisms of information transmission and reconfigured the causal relationship between the two exchanges.

References

The main reference questions are as follows:

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