Essays on Volatility and Dynamic Correlation with Applications to Financial Time Series

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https://hdl.handle.net/2324/4495991

出版情報：Kyushu University, 2021, 博士（経済学）, 課程博士
バージョン：

（様式３）

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論 文 名：Essays on Volatility and Dynamic Correlation with Applications to Financial Time Series
（ボラティリティと動的相関に関する研究）

区　　分：甲

論　文　内　容　の　要　旨

Among numerous factors affecting the market, researchers pay the hugest attention to the risk. Risk in the market is affected by the volatility of assets and interdependence between assets and it is essential for risk management, hedging, and asset allocation. We aim to constantly analyze the relationship among different assets and to predict future volatility from historical data more precisely and this research studies several financial data via implementing different methodologies, checking the robustness of results carefully.

In Chapter 2, we study the influence of frequencies of intraday data and distribution assumptions on the prediction of volatility. The realized variance (RV) proposed by Bollersslev et al. (2001) and the realized kernel (RK) introduced by Barndorff Nielsen et al. (2004, 2008) are known as estimators of true potential volatility calculated by high-frequency data. Hansen (2012) proposed the Realized General Autoregressive Conditional Heteroskedasticity (RealGARCH) model as a combination of traditional General Autoregressive Conditional Heteroskedasticity (GARCH) model and realized volatility estimators. On the other hand, there is little unified view of the predictive ability of the RealGARCH model. In our empirical study, we use the CNHJPY exchange rates data and focus on the forecast performance of the RealGARCH model. We consider the volatility measurements based on multiple different observation frequencies with various distribution assumptions on the volatility prediction. We find that for CNHJPY, the RealGARCH model outperforms traditional GARCH-type models in a volatility forecasting perspective, and the 20min based RV and the normal-inverse Gaussian distribution assumption may provide the best volatility forecast.

The following research subjects consider the multivariate situation. In Chapter 3, we survey the most important developments in measuring the dependence of multivariate financial time series. As the correlation between assets should be considered to be dynamic over the sample period, Engel (2002) and Tse and Tsui (2002) both develop the Dynamic Conditional Correlation (DCC) model which is capable to provide dynamic conditional correlations among assets. Cappiello, et al. (2006) extend the DCC model into an Asymmetric DCC (ADCC) model which permitting conditional asymmetries in correlation dynamics. However, the conditional correlation coefficient derived by these models can only measure the linear relationship. In this regard, the copula function (Sklar (1959)) is an excellent tool to capture nonlinear correlations and was first introduced into the financial data analysis by Frey and McNeil (2000) and Li (2000). We also discuss several tests of asymmetric dependence as well. We find that the asymmetric dependence may not universally exist in financial data, and we focus on investigating the asymmetric dependence in the following chapters.

In Chapter 4, we study the relationship among Asian stock markets with a t copula-based ADCC model. The main research questions are: do Asian stock markets have asymmetric interdependence, how financial crises affect market correlations. Our model considers both the asymmetry of the single asset's volatility and the asymmetry of the relationships between different assets. The empirical results show that the model without a copula cannot describe the asymmetry in joint distributions. We find that the Asian stock markets are highly dependent but among the overall 15 pairs of market indices, only 5 pairs indicate asymmetry in conditional correlations, which indicates that for other pairs, diversification may not benefit from the investment perspective. In addition, we investigate the change of the correlations in the volatile periods of Chinese markets over the last 20 years including the COVID-19 period in 2020. We find the evidence of contagion effect that the turmoil in the Chinese market will spread to other Asian markets, and not only the internal factors inside the financial market will lead to the increasing correlation but also the fluctuation caused by external factors such as the COVID-19 situation. However, compared to the COVID-19 situation in 2020, the similar disease SARS that happened in 2003 does not have led to a correlation increase.

In Chapter 5, we consider not only the t copula but also Archimedean copulas for modeling the dependence between assets as they can capture the nonlinear dependence well. We focus on studying the joint tail distributions, that is, we examine the dependence of assets when they encounter negative or positive shocks simultaneously. Empirical research is carried out on the analysis of the Asian stock markets and the cryptocurrencies data. For Asian stock markets, by considering the contagion effect as a nonlinear phenomenon, we find that when the Chinese market moves from a bullish state to a bearish state, all of the dependence and tail dependence coefficients with other markets will increase. As for the cryptocurrency, we find it does not have the autoregressive conditional heteroscedasticity effect, unlike traditional financial data. We find that though the t copula may best describe the joint distribution, a Clayton copula may better describe the joint lower tails.

In Chapter 6, we summarize our findings and discuss future work including the potential methods to handle cryptocurrencies.