Thesen zum Promotionskolloquium der Dissertation

High Dimensional Financial Engineering: Dependence Modeling and Sequential Surveillance

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von
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Outline

The dissertation contributes to areas of high dimensional financial engineering, especially in dependence modeling and sequential surveillance:

1. A review of state-of-the-art research proceeding of copula is given and a related application in financial engineering is performed to introduce the modern construction of multivariate distribution function.

2. The convex combination of copulae is proposed to improve the accuracy of pricing model of high-dimensional portfolio-like credit derivatives.

3. An `R` package "`EnergyOnlineCPM`" is developed for distribution-free sequential surveillance for multivariate independent statistical process.

4. A nonparametric multivariate statistical process control chart is devised to monitor high dimensional portfolios with no pre-knowledge and with online surveillance.

1 Copulae in High Dimensions: An Introduction

published in *Applied Quantitative Finance*, W. Härdle, C. Chen, L. Overbeck (Eds.). (2017), pp. 247-277. Springer-Verlag Berlin Heidelberg. (with O. Okhrin and A. Ristig)

- The bivariate copulas are introduced as a fundamental followed with the multivariate copulas which are the concentration in multivariate distribution modeling.

- Three main diverse multivariate dependence modeling tools are presented, including the hierarchical Archimedean copula, the factor copula and vine copula.

- Inference (estimation and test) for multivariate copulas including parametric and nonparametric routines, are presented.

- An empirical study of employing multivariate copulas in risk management is performed for Value-at-Risk computation and comparison.

2 A Comparison Study of Pricing Credit Default Swap Index Tranches with Convex Combination of Copulae

published in *The North American Journal of Economics and Finance*, Vol. 42C (2017) pp. 193-217. (with O. Okhrin)

- Convex combination of copulae is in first time employed in pricing the portfolio-like derivative, e.g. Collateralized Debt Obligation and Credit Default Swap Index.

- Many common used copulas including Gaussian, Student-t, Frank, Gumbel, Joe and Clayton copulas, are used to construct convex two combination of copulae, in order to explore the virtues like heterogeneous sector dependence and asymmetric tail-dependence.

- Two empirical studies with 125-dimensional data sets of Collateralized Debt Obligation and Credit Default Swap Index, clearly reveal that the performance of pricing using convex combination of copulae exceeds mainstream benchmark models.

3 `EnergyOnlineCPM`: An `R` Package for Nonparametric Multivariate Statistical Process Control

published in *The Comprehensive R Archive Network* in 2017. (with O. Okhrin)

- It is the first `R` package which concentrates on nonparametrical simultaneous monitoring of mean and covariance for multivariate statistical process.

- The energy discrepancy is employed in the package with default parallel algorithm for computation of permutation test. Real time tracking of computing process is provided.

- Since the package is already published in *The Comprehensive R Archive Network* (CRAN), hence the installation and document reference is convenient and user-friendly.

4 A Nonparametric Multivariate Statistical Process Control Chart for Financial Surveillance

submitted in 2017. (with O. Okhrin)

- A nonparametric control chart based on the change point model, for multivariate statistical process control (MSPC), is proposed.

- It is a nonparametric control chart, requiring no pre-knowledge of the data generating processes, needing only independent observations.

- It monitors the statistical process on covariance and mean simultaneously, not separately focusing on each one.

- It is designed for online detection (Phase II) of change point, which is central for real time surveillance of stream data.

- A simulation study comparing with three journal-published benchmark models and an empirical study using 5, 29, 90 dimensional data sets, show strong performance in simulation results and in financial turmoil detection for high dimensional portfolios.