Shrinkage for Gaussian and t Copulas in Ultra-High Dimensions

Stanislav Anatolyev* Vladimir Pyrlik†

CERGE-EI and NES CERGE-EI

July 2021

Abstract

Copulas are a convenient framework to synthesize joint distributions, particularly in higher dimensions. Currently, copula-based high dimensional settings are used for as many as a few hundred variables and require large data samples for estimation to be precise. In this paper, we employ shrinkage techniques for large covariance matrices in the problem of estimation of Gaussian and t copulas whose dimensionality goes well beyond that typical in the literature. Specifically, we use the covariance matrix shrinkage of Ledoit and Wolf to estimate large matrix parameters of Gaussian and t copulas for up to thousands of variables, using up to 20 times lower sample sizes. The simulation study shows that the shrinkage

*Address: Stanislav Anatolyev, CERGE-EI, a joint workplace of Center for Economic Research and Graduate Education, Charles University and the Economics Institute of the Czech Academy of Sciences, Politickych vězňů 7, P.O. Box 882, 111 21 Prague 1, Czech Republic; e-mail stanislav.anatolyev@cerge-ei.cz. This research was supported by the grant 20-28055S from the Czech Science Foundation.

†Address: Vladimir Pyrlik, CERGE-EI, a joint workplace of Center for Economic Research and Graduate Education, Charles University and the Economics Institute of the Czech Academy of Sciences, Politických vězňů 7, P.O. Box 882, 111 21 Prague 1, Czech Republic; e-mail vladimir.pyrlik@cerge-ei.cz.

estimation significantly outperforms traditional estimators, both in low and especially high dimensions. We also apply this approach to the problem of allocation of large portfolios.

KEYWORDS: Gaussian copula, t copula, high dimensionality, large covariance matrices, shrinkage, portfolio allocation

JEL CODES: C31, C46, C55, C58

HIGHLIGHTS:

- Methods of covariance matrix shrinkage are applied to estimate parameters of Gaussian and t copulas in ultra-high dimensions.
- Simulations illustrate dominance of shrinkage estimators over traditional copula estimators.
- The approach is applied for a large portfolio allocation problem with up to 3600 assets.