Hypothesis Testing on Linear Structures of High Dimensional Covariance Matrix

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Abstract: This paper is concerned with test of significance on high dimensional covariance structures, and aims to develop a unified framework for testing commonly-used linear covariance structures. We first construct a consistent estimator for parameters involved in the linear covariance structure, and then develop two tests for the linear covariance structures based on entropy loss and quadratic loss used for covariance matrix estimation. To study the asymptotic properties of the proposed tests, we study related high dimensional random matrix theory, and establish several highly useful asymptotic results. With the aid of these asymptotic results, we derive the limiting distributions of these two tests under the null and alternative hypotheses. We further show that the quadratic loss based test is asymptotically unbiased. We conduct Monte Carlo simulation study to examine the finite sample performance of the two tests. Our simulation results show that the limiting null distributions approximate their null distributions quite well, and the corresponding asymptotic critical values keep Type I error rate very well. Our numerical comparison implies that the proposed tests outperform existing ones in terms of controlling Type I error rate and power. Our simulation indicates that the test based on quadratic loss seems to have better power than the test based on entropy loss. We illustrate the proposed testing procedure by an empirical analysis of Chinese stock market data.