主 論 文 要 旨

論文題名　**On Robustness of Principal Component Analysis applied to Term Structure of Interest Rates**

ふりがな　　りゅう　ねんりん
学位申請者　LIU NIEN-LIN

主論文要旨

In this dissertation, the author studies the validity of the principal component analysis (PCA for short) applied to the term structure of interest rates. It is composed of four part, which are taken from Liu [14],[15], and Akahori and Liu [3],[4]. The term structure of interest rates is a stochastic process in a very high dimension. Many researchers as well as practitioners suspect that it can be decomposed into a few factors. The use of the principal component analysis (PCA) in the interest rate data analysis was in this sense very successful and it is actually commonly observed that the number of the factors is two--four. However, the analysis is implicitly performed by using a random walk hypothesis (RWH) on the spot interest rates, which is mathematically inconsistent with the no-arbitrage principle. The main aim of the present study is to account for this inconsistency as a mathematical challenge.

In the first part, empirical studies applying PCA on forward rates were done and it is reported that the number of factors of the forward rates are much greater than that of stylized belief. The result is striking since the RWH is consistent with no-arbitrage only when it is the one on forward rates. In short, the empirical results support the RWH on spot rates. In the second part, a limit theorem for the sample covariance matrix of the forward rate is established. The result shows that the number of the factors is at most twice greater than the one of the original random walk. This mathematical result rejects the RWH on spot rates. In the last part, the author generated dummy spot rate data by using dummy volatility matrices, dummy drift vector and Gaussian pseudo i.i.d. random vectors as driven noises. The results largely reconfirm the theoretical result, but we observed that if factors are many but concentrated on first several ones, then PCA applied to spot rates does not detect smaller factors while PCA applied to the forward rates detects most of the factors.