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High Dimensional Nonstationary Time Series Modelling with Generalized Dynamic Semiparametric Factor Model

(High dimensional) time series which reveal nonstationary and possibly periodic behavior occur frequently in many fields of science. In this article, we separate the modeling of high dimensional time series to time propagation of low dimensional time series and high dimensional time invariant functions via functional factor analysis. We propose a two-step estimation procedure. At the first step, we detect the deterministic trends of the time series by incorporating time basis selected by the group Lasso-type technique and choose the space basis based on smoothed functional principal component analysis. We show properties of this estimator under various situations extending current variable selection studies. At the second step, we obtain the detrended low dimensional stochastic process, but it also poses an important question: is it justified, from an inferential point of view, to base further statistical inference on the estimated stochastic time series? We show that the difference of the inference based on the estimated time series and "true" unobserved time series is asymptotically negligible, which finally allows one to study the dynamics of the whole high-dimensional system with a low dimensional representation together with the deterministic trend. We apply the method to our motivating empirical problems: studies of the dynamic behavior of temperatures (further used for pricing weather derivatives), implied volatilities and risk patterns and correlated brain activities (neuro-economics related) using fMRI data, where a panel version model is also presented.