

**Title:** Statistical Inference for ARMA Time Series via Moving Average Trend

**Abstract:** Maximum likelihood estimator (MLE) and Bayesian Information Criterion (BIC) order selection are examined for ARMA time series with slowly varying trend under a two-step scheme, to validate the well known detrending technique of moving average (Section 1.4, Brockwell and Davis 1991, Section 2.3, Shumway and Stoffer 2017). In step one, an enhanced moving average equivalent to local linear regression is fitted to the raw data with data-driven lag number, and subtracted from raw data to produce a sequence of residuals. The residuals are used in step two as substitutes of the latent ARMA series for MLE and BIC procedures. It is shown that with trend being second order smooth and lag number of the moving average correctly chosen, the two-step MLE is oracally efficient, i.e., it is asymptotically as efficient as the would-be MLE based on the unobserved ARMA series. At the same time, the two-step BIC consistently selects the orders as well. Simulation experiments corroborate the theoretical findings.

**Keywords:** Asymptotic normality; local linear estimator; maximum likelihood; moving average; oracle efficiency.