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The power of tests for weak stationary time series in finite samples: An empirical investigation

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Whether or not a time series is weakly stationary has long been a question of major interest in the field of time series analysis related to different scientific disciplines. A time series is considered as weakly stationary if the associated mean and covariance function do not vary with respect to time. That is to say, the original time series has statistical properties similar to those of the "time-shifted" series. Weak stationary time series can be sufficiently modelled, e.g. by means of so-called autoregressive moving average (ARMA) processes. In the case of non-stationary time series appropriate detrending procedures have to be performed prior to the analysis in order to transform the data to weakly stationary form.

According to the properties that weakly stationary processes exhibit homogenous variances, statistical inferences for weak stationarity can be carried out using variance homogeneity tests (e.g. two-sample β-test, multiple-sample Bartlett test). In addition, regarding a time series as an autoregressive (AR) process, the weak stationarity can be assessed by revising the existence of unit roots of the associated characteristic equation of the AR process. In the presence of unit roots, the analysed data are considered as non-stationary. The most famous autoregressive unit root tests are the augmented Dickey–Fuller test, the Phillips-Perron test, and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test. In this paper the power of stationarity tests is empirically investigated using a large amount of representative data simulated by means of autoregressive (integrated) moving average (AR(I)MA) processes. The test results are analysed based on statistical measures characterising the performance of a binary classification test, e.g. specificity (proportion of correctly identified null hypothesis) and sensitivity (proportion of correctly identified alternative hypothesis). The statistical analysis illustrates that the sensitivity of all investigated stationarity tests increases with increasing sample sizes. In comparison with the employed homogeneity tests whose specificity decreases with growing data volume, the specificity of the applied unit root tests remains at a high and constant level which corresponds very well to the specified probability of type I error α.