Long memory versus non stationarity : A multi scale test procedure

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Résumé

The danger of confusing long-range dependence with non-stationarity has been pointed out by many authors. Finding an answer to this difficult question is of importance to model time-series showing trend-like behavior, in particular the river run-off in hydrology, financial asset evolution in financial econometrics or the historical temperature in the study of climates changes.

The main goal of this paper is to develop a test procedure for non-stationarity for possibly long-memory processes. Contrary to most of the proposed methods, the test procedure has the same distribution for short-range and long-range dependence covariance stationary processes, which means that this test is able to detect the presence of non-stationarity for processes showing long-range dependence; in addition, the test procedure is shown to be robust to the presence of slowly varying trends.

The proposed test is formulated in the wavelet domain, where a change in the generalized spectral density results in a change in the covariance structure of the wavelet coefficients across scales. Such tests have been already proposed in
Percival and Whitcher (2002), but these authors do not have taken into account the dependence of the wavelet coefficients within scales and across scales. Therefore, the asymptotic distribution of the test they have proposed was erroneous (and the level of the test under the null hypothesis of stationarity was wrong).

A novel procedure to estimate the covariance of the wavelet coefficients will be presented, with a special emphasis to the estimation of the covariance at coarse scales, based on the asymptotic results obtained in Moulines et al. (2008). Using these estimators of the wavelet covariances, the asymptotic distribution of the test under the null is rigorously justified. The power of the test in the presence of a single jump in the spectral density (and in particular, in the memory coefficient) will also be presented.

This test is applied to river run-off. %and historical temperature data
We will reconsider results obtained in the literature for these time-series, showing that data inhomogeneity is, in these cases, a plausible explanation to the presence of long-range dependence.

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Mots-Clés: change point, wavelet coefficients, spectral domain