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Quasi-Maximum Likelihood Estimation and Bootstrap Inference in Fractional Time Series Models with Heteroskedasticity of Unknown Form

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Abstract

We consider the problem of conducting estimation and inference on the parameters of univariate heteroskedastic fractionally integrated time series models. We first extend existing results in the literature, developed for conditional sum-of-squares estimators in the context of parametric fractional time series models driven by conditionally homoskedastic shocks, to allow for conditional and unconditional heteroskedasticity both of a quite general and unknown form. Global consistency and asymptotic normality are shown to still obtain; however, the covariance matrix of the limiting distribution of the estimator now depends on nuisance parameters derived both from the weak dependence and heteroskedasticity present in the shocks. We then investigate classical methods of inference based on the Wald, likelihood ratio and Lagrange multiplier tests for linear hypotheses on either or both of the long and short memory parameters of the model. The limiting null distributions of these test statistics are shown to be non-pivotal under heteroskedasticity, while that of a robust Wald statistic (based around a sandwich estimator of the variance) is pivotal. We show that wild bootstrap implementations of the tests deliver asymptotically pivotal inference under the null. We demonstrate the consistency and asymptotic normality of the bootstrap estimators, and further establish the global consistency of the asymptotic and bootstrap tests under fixed alternatives. Monte Carlo simulations highlight significant improvements in finite sample behaviour using the bootstrap in both heteroskedastic and homoskedastic environments. Our theoretical developments and Monte Carlo simulations include two bootstrap algorithms which are based on model estimates obtained either under the null hypothesis or unrestrictedly. Our simulation results suggest that the former is preferable to the latter, displaying superior size control yet largely comparable power.

Keywords: conditional/unconditional heteroskedasticity; conditional sum-of-squares; fractional integration; quasi-maximum likelihood estimation; wild bootstrap.

J.E.L. Classifications: C12, C13, C22.

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