

Master-Class on Bootstrap Methods

This master class gives an introduction and overview to bootstrap methods. We will discuss bootstrap schemes for a variety of model and data setups. Further, the focus is on bootstrap tests and bootstrap confidence intervals. We cover both theoretical aspects as well as implementation issues. The class also comprises presentation of simulation results and some illustrative examples.

The main references are given after the outline. The handbook article of Horowitz (2001) provides an excellent introduction to bootstrap. Chapter 11 of Cameron & Trivedi (2005) is a shorter and 'lighter' version of Horowitz (2001). The presentations in Davidson & MacKinnon (2004, 2006) are less technical but contain interesting information on some implementation issues. A few further references are mentioned on the slides that will be provided soon.

Outline

1. Introduction
 - 1.1. General comments
 - 1.2. Introductory Example: iid-bootstrap and bias correction
2. Basic Bootstrap Schemes
 - 2.1. iid, pairs (pairwise), parametric, and semiparametric schemes
3. Bootstrap Tests
 - 3.1. One- and (a)symmetric two-sided tests
 - 3.2. Theoretical Considerations:
 - asymptotic vs. bootstrap approximation to finite sample test setup, consistency of bootstrap, when does the bootstrap not work, asymptotic refinements, behaviour if null hypothesis is false
 - 3.3. Implementation Issues
 - (a) Imposing symmetry or not?
 - Two-sided tests with symmetric or asymmetric bootstrap p-values
 - (b) Imposing H_0 or not?
 - imposing vs. not imposing null hypothesis when estimating parameters and generating bootstrap data, restricted vs. unrestricted residuals, centring of residuals
 - (c) How Many Bootstraps?
 - matching Type-I-error, power of bootstrap, dependence on random numbers
 - 3.4. Bootstrap covariance matrix estimators
 - 3.5. Illustrative Example
 - 3.6. Bootstraps for Time Series Data
 - recursive design bootstraps: initial values, block-bootstrap, sieve-bootstrap, some simulation results and illustrative example
 - 3.7. Bootstraps for Setups with (Conditional) Heteroskedasticity
 - wild bootstrap, pairwise bootstrap, some simulation results
 - 3.8. Bootstraps for panel and clustered data
 - 3.9. Bootstraps for GMM estimation and IV setups

4. Bootstrap Confidence Intervals
 - 4.1. Introduction: Confidence Intervals
 - 4.2. Bootstrap Confidence Intervals: Hall's studentized interval
equal-tailed and symmetric intervals
 - 4.3. Further Bootstrap Confidence Intervals
Efron-interval (standard percentile interval), Hall's percentile interval
 - 4.4. Determination of Bootstrap Quantiles
 - 4.5. Illustrative Example

References:

Cameron, R. & MacKinnon, J. G. (2004). *Microeconometrics: Methods and Applications*, Chapter 11, Cambridge: Cambridge University Press.

Davidson, R. & MacKinnon, J. G. (2004). *Econometric Theory and Methods*, Chapters 4-5, Oxford: Oxford University Press.

Davidson, R. & MacKinnon, J. G. (2006). Bootstrap Methods in Econometrics, in J. Kerry Patterson & Terence C. Mills (eds), *Palgrave Handbook of Econometrics, Vol. 1: Econometric Theory*, Palgrave Macmillan.

Horowitz, J. L. (2001). The Bootstrap, in J. J. Heckmann & E. E. Leamer (eds), *Handbook of Econometrics, Vol. 5*, North-Holland, Amsterdam.

Lütkepohl, H. (2005). *New Introduction to Multiple Time Series Analysis*, Appendix D, Berlin: Springer-Verlag.