# Evaluating econometric inference by Monte Carlo simulation; foundations, pedagogy, methodology, presentation

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Since various decades much of the research in econometric theory is supported or illustrated by Monte Carlo simulation studies. Often the design of such studies follows particular patterns that have become traditional. Performing Monte Carlo studies is usually not taught as such in graduate schools; students are simply encouraged to follow as closely as possible the examples published in the recent relevant literature. Here we try to present the fundamentals of executing such studies, especially regarding their general design, controlling their accuracy, presenting their results in a coherent and palatable way and with respect to the interpretation of their actual findings.

Monte Carlo simulation produces statistical inference on properties of econometric inference techniques. Because here such concepts as sample and sample size, estimators, test statistics and confidence intervals and their asymptotic properties play a role at two different levels (viz. that of the econometric technique under investigation, and of the simulation inference produced) we find it useful to distinguish carefully in our notation between the econometric inference techniques under study and the statistical inference methods employed to interpret the simulation experiments. Thus, we illuminate various aspects that are easily confused or overlooked.

Some basics of Monte Carlo simulation are illustrated in a simple EViews program that examines OLS and TSLS based inference in a simple stylized dynamic model of the macroeconomic consumption function. Such simulation studies seem extremely useful to supplement the teaching of standard but rather abstract econometric theory because it provides a device from which the relevance of asymptotic theory for inference in finite samples can be experienced. Also, it may help students and practitioners to deepen their understanding of concepts such as bias, standard error, test size and power. It is also very useful to experiment with such programs and examine the rejection probability of test statistics when the DGP (data generating process) is in conflict with either or both the null and the alternative hypothesis under test.

The major purpose of most published Monte Carlo studies is to rate and validate the qualities of various alternative competing inference techniques. Here one should aim at both impartiality and efficiency (one can only examine a limited number of techniques over a limited grid of parameterizations by a limited number of simulation replications), which requires a carefully considered Monte Carlo simulation methodology. Illustrated by some practical examples from the context of estimating dynamic panel data models we produce a list of ten commandments on how to design Monte Carlo simulation studies that avoid methodological pitfalls. We also pay attention on how to condense the reporting on simulation findings by employing graphical 2D and 3D methods, which can even be extended to 4D by using animation.

Much of this is based on material from:

Kiviet, J.F., 2007. Judging contending estimators by simulation: tournaments in dynamic panel data models. Chapter 11 (pp. 282-318) in: *The Refinement of Econometric Estimation and Test Procedures* (eds.: G.D.A. Phillips and E. Tzavalis). Cambridge University Press.

Kiviet, J.F., 2007. *Foundations of Monte Carlo simulation*. Lecture note.

Kiviet, J.F., Niemczyk, J., 2007. The asymptotic and finite sample distribution of OLS and simple IV in simultaneous equations. *Journal of Computational Statistics & Data Analysis*, 51, 3296-3318.

Kiviet, J.F., Niemczyk, J., 2007. On the limiting and empirical distribution of IV estimators when some of the instruments are invalid. UvA-Econometrics Discussion Paper 2006/02.