The deterministic simulation bias in the Klein-Goldberger model

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THE DETERMINISTIC SIMULATION BIAS
IN THE KLEIN-GOLDBERGER MODEL

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When dealing with a nonlinear econometric model, it is well known that deterministically "simulated values can be expected to diverge systematically from the corresponding historical values" (Howrey and Kelejian [1971,p.305]).

In a recent paper by Bianchi and Calzolari [1979], it was shown that the difference between the deterministic simulation value (assuming an exact knowledge of the structural coefficients) and the corresponding historical value can be regarded as one component of the ex-post forecast error for each endogenous variable; since this difference is expected to have a nonzero mean (deterministic simulation bias), a stochastic simulation experiment was undertaken to try to estimate such a mean for the endogenous variables of the Klein-Goldberger model in the one-step simulation at 1965.

Despite the extremely large number of replications (200 000), a clear nonzero mean, or bias, was checked only for four variables, among the 16 endogenous which should be influenced by the nonlinearities of the model.

Purpose of this paper is to measure with accuracy the deterministic simulation bias for all the endogenous variables of the Klein-Goldberger model (the version of the model is the same used in Bianchi and Calzolari [1979]); since the simple random sampling previously used was proved to be computationally inefficient for this purpose, resort has been here done to a variance reduction technique based on antithetic-variate sampling which also allows a substantial saving of computation time (for a description of the method see, for example, Moy [1971]).

For the one-step simulation at 1965 the experiment has been performed in the following way (symbols and algorithms adopted are the same as in Bianchi and Calzolari [1979]).

1) The model has been solved deterministically at time h=1965.

2) A vector of additive pseudo-random structural disturbances $\tilde{U}_h$ has been inserted and the model solved.

3) The same vector, with the opposite sign $(-\tilde{U}_h)$, has been inserted, the model again solved and the computed values of the endogenous variables have been averaged with those obtained at step 2.

4) The so obtained means of the endogenous variables, subtracted from the deterministic simulation values, supply an estimate of the bias with a variance which is, in this case, much smaller than in the case of a couple of replications with simple random sampling (for example, the variance is exactly zero for all the nonsimultaneous variables of the model and it would be zero for all the variables of a linear model).

The process from step 2 to 4 has been replicated several times, thus further reducing the variance and allowing, at the same time, to compute the sample standard deviation of the mean.

8000 replications (more exactly 8000 couples of replications, requiring 3 minutes of CPU time on a computer IBM/370 model 168) have been quite sufficient in this case; for each of the 16 simultaneous endogenous variables, the sample standard deviation is from 6 to 70 times smaller than the estimated bias (in absolute value), thus ensuring a quite good computational accuracy.

The results are displayed in the table below (the values of the estimated biases and of the corresponding standard errors are multiplied by a scaling factor 10^5).(2)

It is clearly confirmed the conclusion in Bianchi and Calzolari [1979] concerning the small practical usefulness of these results in the case of the Klein-Goldberger model. The problem of the deterministic simulation bias, however, is rather interesting from a theoretical point of view. Therefore this paper, on one side, has shown how to deal with the problem in a computationally efficient way and, on the other side, has supplied an accurate measurement of the phenomenon on a model, like the Klein-Goldberger, frequently used in the literature as a nonlinear-test-model.

(2) Results for other years of the sample period, as well as results in case of multiperiod dynamic simulations, are available, on request, from the author.

Klein-Goldberger revised model

One-period simulation at 1965

	Deterministic Simulation Value	Estimated Bias × 10^5	Standard Deviation of Estimated Bias × 10^5
C_d	55.3	-521.	18.
C_n	303.4	-564.	20.
R	22.4	-105.	3.7
H	7.55	-14.4	0.53
I_m	30.4	-118.	12.
X	530.1	-1218.	44.
h	101.6	-279.	10.
W	310.8	-604.	22.
w	5.518	-6.39	0.23
r	4.89	0.	0.
I	46.7	0.	0.
D	59.1	0.	0.
r_s	4.63	0.	0.
P_c	42.0	14423.	197.
N_w	67.9	-293.	10.
Y	369.9	-2255.	80.
p	1.225	-4.67	0.76
S_c	1.9	15304.	205.
π	86.2	11516.	166.
π_r	33.8	-2743.	38.

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