Advanced Econometrics II
GMM Assignment

Deadline: 2012-02-23 23:59

You are to hand in your report via email to ta@zamojski.net by 23:59 on Thursday Feb, 23. Your answers are to be TeXed in full, and include full code in the body of the report.

You can work in groups of two.

The quality of your coding will be judged (commenting, efficiency, etc.). Your code should be easy to read. Things that make it easier: lots of comments (e.g. explaining what loops are meant to do), camel case variable names (e.g. mErrorsUniformlyDistributed), consistency. You are to include your code in the body of the report, e.g. if you are TeXing your answers then with the listings package. You can use Ox, Python, C++, or Matlab. If I am not able to run your code after extracting your answers (assuming they are zipped) to a separate folder you will lose points.

In this assignment you will be asked to construct Newey-West HAC (nwHAC henceforth) estimates of covariance matrices and to apply the feasible GMM procedure to several cases. Please have this in mind while writing your code. You will also be asked to check if there were any structural breaks, given the model you will be estimating.

Problem 1 Structural break test and its adequacy

One of the simplest (to implement) methods to investigate the existence of an unknown number of breaks at unknown dates is the sequential method proposed by Bai (1997) for which you can also use tests described in Bai and Perron (1998), BP henceforth. Although they establish the asymptotic results (equivalence of this method with other methods), they have considered only the OLS estimation. It is possible to extend this to GIV estimation, see Hall, Han, Boldea (2008). However, the issue of multiple break points, esp. at unknown dates, has not been widely investigated in the context of GMM estimators, thus it is unknown if this sequential procedure will work equally well in the more general GMM framework. One of the tasks in this assignment is to empirically check if the procedure works.

Note that this problem is computationally intensive, so much so that you may now **skip repartition if you want**. Although many tests can be used to implement the procedure, you will probably want to look at Bai and Perron (1998) equation 12. Given assumptions that are relevant for Problem 2 (and thus you may assume them also in Problem 1), Bai and Perron (2003) explain this further:

> In the case of a pure structural change model, we consider more possible specifications on how to estimate the relevant asymptotic covariance matrix. They are the following: [...] Serial correlation in the errors, different distributions for the data and the errors across segments. Here, we make use of the fact that the errors in different segments are asymptotically independent. Hence, the limiting variance is given by $V\left(\hat{\delta}_i\right) \equiv \text{diag}\left(V\left(\hat{\delta}_1\right), ..., V\left(\hat{\delta}_{m+1}\right)\right)$ [..]. This can be consistently estimated, segment by segment, with a HAC estimator of $V\left(\hat{\delta}_i\right)$ using only data from segment i.

In this test, under the null there are $m = 0$ breaks. The alternative states there are $m = k$ breaks. Thus, in the case of sequential method, this test (statistic) simplifies a lot.

I would encourage you to beta test your code with a considerably smaller series. For instance:

t	β_{0t}	β_{1t}	β_{2t}	π_{0t}	σ^2_{ut}	σ^2_{vt}	ρ_t
0-199	1	0	0.5	1	1	1	0.5
200-399	1	0	-0.5	1	1	1	0.5
400-599	1	2	0	1	1	1	0.5

Consider the following DGP:

$$y_t = \beta_{0t} + \beta_{1t}x_t + \beta_{2t}y_{t-1} + u_t \tag{1}$$

$$x_t = \pi_{0t}w_t + v_t \tag{2}$$

Where $u_t \sim \mathrm{N}\left(0, \sigma^2_{ut}\right)$, $v_t \sim \mathrm{N}\left(0, \sigma^2_{vt}\right)$ are contemporaneously correlated with the correlation coefficient being ρ_t; $w_t \sim \mathrm{N}\left(0, 1\right)$; $y_0 = 0$.

In your simulations use, at least (meaning you can extend the procedure if you want to check more cases), the specification for the values of parameters presented in Table 1.

t	β_{0t}	β_{1t}	β_{2t}	π_{0t}	σ^2_{ut}	σ^2_{vt}	ρ_t
0-199	0	0	0.5	1	1	1	0
200-399	0	0	0.5	1	1	1	0.5
400-599	0	0.5	0.5	1	1	1	0.5
600-799	0	0.5	0.5	1	2	1	0.5
800-999	1	0.5	0.5	1	1	1	0.5
1000-1199	1	-0.5	0.5	1	1	1	0.5
1200-1399	1	0	0.5	1	1	1	0.5
1400-1599	1	0	-0.5	1	1	1	0.5

Table 1: Parameters to be used in the simulations.

a) Implement the BP procedure with feasible GMM, using w_t as instrument for x_t, and nwHAC (truncation parameter $p = 6$). You may use GIV regression as a starting point.

b) Propose and implement a bootstrap procedure. Note that a bootstrap does not necessarily mean *residual* bootstrap. Compare your results with asymptotics.

c) Produce a graphic similar to Figure 1 in Bai (1997) for both asymptotic and bootstrap version of the test. Use an adequate number of Monte Carlo replications and boostraps. Comment on your results, in particular what is the usefulness of the procedure with respect to particular changes in parameters.

d) Can you think of a way this procedure can be improved upon in the maximum likelihood framework?

Problem 2 GMM

You will be using the data for consumption (C_t) and disposable income (Y_t) contained in consumption.data dataset accompanying the book. The sample period you are interested in is 1948+X:1-1996-Y:4 where X and Y are integers $\in [1, 9]$ derived by recursively summing digits in your dates of birth. The model you will be investigating is:

$$\Delta c_t = \beta_0 + \beta_1 \Delta y_t + \beta_2 \Delta y_{t-1} + u_t \tag{3}$$

a) Construct the necessary variables such that

$$a_t = \log A_t \tag{4}$$

$$\Delta a_t = a_t - a_{t-1} \tag{5}$$

Report the first and the last 10 rows of your regressands and regressors.

b) Provide summary statistics and give intuition behind the transformations in a).

c) Estimate the model with OLS.

Assume there is evidence for both heteroskedasticity and serial correlation.

d) Calculate four sets of HAC estimates of the standard errors of the OLS parameter estimates, using nwHAC estimator with the lag truncation parameter set to the values $p = \{2, 4, 6, 8\}$.

Using the squares of Δy_t, Δy_{t-1}, and Δc_{t-1} as additional instruments:

e) Obtain feasible efficient GMM estimates of the parameters in the model by minimizing the criterion function (9.42), with $\hat{\Sigma}$ given by the HAC estimators computed as earlier (remember you need to start from a consistent estimator).

For $p = 6$:

f) Report the GMM weighting matrix (as discussed in Homework 3) and and argue if it is worth restricting in any form.

g) Obtain iterated feasible efficient GMM estimates. Justify the stopping rule for iteration. Warning: It may be necessary to rescale the instruments so as to avoid numerical problems.

h) Comment on the impact of truncation and iteration on results.

i) Perform the BP test for structural breaks.

References

J. Bai. Estimating multiple breaks one at a time. *Econometric Theory*, 13(03):315–352, June 1997.

J. Bai and P. Perron. Estimating and testing linear models with multiple structural changes. *Econometrica*, 66(1): 47–78, January 1998.

J. Bai and P. Perron. Computation and analysis of multiple structural change models. *Journal of Applied Econometrics*, 18(1):1–22, 2003. URL `http://ideas.repec.org/a/jae/japmet/v18y2003i1p1-22.html`.

R. Davidson and J. G. MacKinnon. *Econometric Theory and Methods*. Oxford University Press, 2004.