Carnegie Mellon University
Tepper School of Business

47-902 Advanced Economic Analysis II Spring 2009
(6 units)

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Class Meetings: Monday & Wednesday
3:30 – 5:00 rm 147 Posner Hall

OVERVIEW

The past 10 years has seen a number of advances beyond traditional two-step GMM estimation. These advances have focused on providing moment-based estimators and hypothesis tests with more accurate approximation to the sampling distributions. Examples include: continuous updated GMM (Hansen, Heaton and Yaron 1996, JBES), the empirical likelihood estimator (Imbens et al., 1998, Econometrica) and the exponential tilting estimator of (Kitamura and Stutzer 1997, Econometrica), GEL estimators (Newey and Smith 2004, Econometrica), Bootstrap GMM (Hall and Horowitz 1996, Econometrica), GMM with Weak Instruments (Stock and Wright 2000, Econometrica), Kleibergen's $k-$statistic (Kleibergen 2005, Econometrica), GMM with the Empirical Saddlepoint (Sowell, 2008). For empirical work these estimators are preferred over the traditional two-step GMM estimator.

This course will present (i) the motivation for these advances, (ii) a summary of published results and (iii) current research.

GRADING

Your course grade will be determined by the average of your problem set scores.

The problem sets will be a combination of derivations and MATLAB programming exercises.

SEQUENCE OF TOPICS IN THE LECTURES

1. Traditional two-stage GMM. Introduce notation. Refresh the basic consistency and asymptotic normality arguments (first order asymptotics). Introduce the identifying subspace and overidentifying subspace. Hansen's test for overidentifying restrictions and its asymptotic distribution.

   Note the basic structure of GMM estimation and inference is concerned with three terms

   $$M(\theta)'W_N(\theta)G_N(\theta).$$

   Note that the small sample distribution are often not well approximated by the first order asymptotic results.

   Think of applied work as obtaining estimates for θ, $M(\theta)$ and $W_N(\theta)$ to be plugged into the formulas for the asymptotic distribution.

2. A simple MATLAB program to perform two-step GMM.

3. Introduction to one-step GMM estimators. Think of these as providing alternative estimates for θ, $M(\theta)$ and $W_N(\theta)$ to be plugged into the formulas for the asymptotic distribution. Three different ways to test the validity of the overidentifying restrictions.

4. A simple MATLAB program for a one-step estimator.

5. The Asymptotic distribution for one-step GMM estimators using the general $h(\bullet)$ function.

6. The calculation of the higher order bias for one-step GMM estimators. This then gives the bias corrected estimators.

7. The calculation of the higher order MSE for one-step GMM estimators. This gives a way to rank estimator with the same higher order bias.

8. Edgeworth expansions as a higher order generalization of the first order expansion that gives the Central Limit Theorem. Cumulant Generating Function. The Moment Generating Function.

9. Problems with Edgeworth expansions. The Bootstrap. How the Edgeworth expansion shows the bootstrap's faster order of convergence.

10. The S-sets for GMM with weak instruments.

11. Improving the S-set confidence intervals with Kleibergen's $k-$statistic.

12. Introduction to the saddlepoint approximation. The application of an Edgeworth expansion for every point in the extended parameter space. The higher rate of convergence for the saddlepoint approximation. The importance of normalization to (possibly) increase the rate of convergence.

13. MATLAB program to perform a saddlepoint approximation for the sample mean of a known distribution.

14. The saddlepoint approximation for parameter estimates determined by estimation equations with a known distribution.

15. The empirical saddlepoint approximation. The saddlepoint approximation for parameter estimates determined by estimation equations with an unknown distribution.

16. MATLAB program to perform the empirical saddlepoint approximation.

SOME BASIC REFERENCES

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2. Back, Kerry and David P. Brown (1993) "Implied Probabilities in GMM Estimators" *Econometrica* Vol. 61, No. 4, pp. 971-975.

3. Bao, Yong and Aman Ullah (2003) "The Second-Order Bias and Mean Squared Error of Estimators in Time Series Models" working paper Department of Economics, University of California, Riverside.

4. Brown, Bryan W and Newey, Whitney K, (2002) "Generalized Method of Moments, Efficient Bootstrapping, and Improved Inference," *Journal of Business and Economic Statistics*, vol. 20(4), pages 507-17.

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18. Rilstone, Paul, V. K. Srivastava and Aman Ullah, "The Second-Order Bias and Mean Squared Error of Nonlinear Estimators" *Journal of Econometrics*, Vol 75, pp. 369-395.

19. Schennach, Susanne M. (2003) "Exponentially Tilted Empirical Likelihood" working paper Department of Economics, University of Chicago.

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22. Stock, James H and Wright, Jonathan H and Yogo, Motohiro (2002) "A Survey of Weak Instruments and Weak Identification in Generalized Method of Moments," Journal of Business and Economic Statistics, vol. 20(4), pages 518-29.

As we go over different topics during the mini, there is always the possibility that you get lost in the details and miss the main themes. To prevent this, stay focused on the following question during this mini:

How are the following ideas related?

1. Hansen's J statistic. This tests the validity of the overidentifying restrictions.
2. The terms M and Σ_g where $M = E\left[\frac{\partial g(x_i,\theta_0)}{\partial \theta'}\right]$ and $\sqrt{N}G_N(\theta_0) = \frac{1}{\sqrt{N}}\sum_{i=1}^{N} g(x_i,\theta_0) \sim N(0,\Sigma_g)$.
3. The $m \times 1$ Lagrange Multiplier γ in the one-step GMM estimators.
4. The $m \times 1$ parameter λ in the GEL estimators.
5. The $k-$statistic in Kleibergen's confidence intervals when the model has weak instruments.
6. The $k \times 1$ parameter λ in the extended GMM objective function in Sowell (2008). This is the parameterization used in the empirical saddlepoint approximation.