ECON 7331 — ECONOMETRICS I

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Hours: You can usually drop by anytime, sometimes I am out Thursday-Friday and sometimes I work at home in the morning, so email for an appointment if you want to be sure (emailing about appointments is the best way, because I use my inbox to keep track of appointments).

Learning Outcomes:

- Students will learn, through lectures, homeworks, and TA-sessions, to master econometric tools at a level that, in conjunction with other core-classes, enables the students to perform statistical analysis of economic models.
- Students will develop their technical skills as a background for doing empirical work to the level expected in graduate economics programs. For this purpose, student will learn to use the econometric software to estimate models on actual economic data.
- Students will learn the basic ideas of advanced econometrics with a focus on empirically relevant issues.

Course Description

I list at the bottom of this file what I taught in the Spring of 2016. Last year I took over the class at short notice, so I hope to get a little further, but in particular I plan to add programs in the matrix computer languages Gauss and Matlab. I am very experienced with Gauss but the TA master's Matlab and in any event matrix languages are quite similar. We will also use the Stata econometrics package, which is ubiquitous in applied microeconomics. Programming of econometric estimators (or rather adapting programs that I post) is an essential part of the class. The exams will include computer code (maybe with a line missing that you have to add [maybe in words]) so if you don't understand the code, you will be lost.

The topics you should know for the exam is what is taught in class. It is usually not helpful to read further material at this stage, but it is often very helpful to read an alternative presentation of the same material. Even undergraduate texts, which do not use matrix algebra, may be helpful in getting a better feeling for various tools.

Readings:

Textbooks:

I plan to use Davidson and MacKinnon: "Econometric Theory and Methods" Oxford University Press 2004 and Econometric Analysis, William H. Greene, 7th Edition, Prentice Hall, 2012 (this

book is among the 100 all-time most cited books in the world according to Prof. Greene's web-site). I may also post some supplementary papers or links and some notes of my own but, again, you are supposed to know all that has been taught in class and nothing more. I find Davidson and MacKinnon more to the point, but if you prefer many examples, there are more in Greene (but I think often that makes it easier to get lost, but we are all different). Personally, I also like Goldberger: A course in Econometrics, which is really to the point, but it is a bit old now. I will assume you have access to Davidson-MacKinnon and Green and will often post homeworks from these books.
Notes Notes, homeworks, information, etc. will be posted on the class web-page. The class web-page will be accessible from my home page.
Material covered last year (this is all standard stuff and this will be covered again—I hope to get a bit further, but the exact topics will depend on time and my feeling for students' understanding:

1. Theoretical derivation of the regression coefficient (vector) and its variance.

2. Working with numerical examples—the linear model with 2 regressors will often be used in midterm/exam questions, I may give you some numbers and you should be able to find, say the coefficient and the standard errors.

3. The Frisch-Waugh theorem and applications. I may ask you to prove the FW theorem, so make sure you are comfortable working with the projection matrix $P_X = X\,(X'X)^{-1}X'$ and the residual maker $M_X = I - P_X = I - X\,(X'X)^{-1}X'$

4. R^2, adjusted R^2, and partial R^2

5. the t- and F-test and the Chow-test (and similar simple applications of the F-test that I may think of). Confidence intervals.

6. Functional Form (as I covered it in class: dummy variables, interactions, elasticities, semi-log, etc.)

7. Data Problems (as I covered it in class: omitted variable bias, classical measurement error, multi-collinearity, Winsorizing, truncating (also called trimming) data)

8. Asymptotics. You will need to use the Law of Large Numbers (LLN) and the Central Limit Theorem (CLT), but I did not mention the explicit version of the LLN or the CLT, so you can talk about "the" LLN, and "the" CLT.

9. Consistency of OLS (assumptions needed on $X'X$ and explaining that $X'\epsilon$ is a sum of independent variables so that a LNN holds).

10. Convergence of the t-test to a standard normal. Convergence of the F-test to Chi-square test for $N \to \infty$.

11. GLS. Understand that if Ω is the variance matrix, one can choose a Cholesky factorization so that $\Omega^{-1/2}$ is lower triangular and multiplying the $n'th$ row with the true error vector corresponds to calculating $x_n - E(x_n|x_{n-1}, ...x_1)$ (and scaling with the standard error). Therefore the elements of $\Omega^{-1/2}e$ are i.i.d., which is equivalent to $var(\Omega^{-1/2}\, e) = \Omega^{-1/2}\, var(e)\, \Omega^{-1/2'} = \Omega^{-1/2}\, \Omega\, \Omega^{-1/2'} = I$. This got a little detailed, but you can take that as a reminder that formulas for the variance of matrix times a stochastic vector are essential for OLS/GLS theory.

12. Feasible GLS. Main examples: 1) autocorrelation in residuals 2) heteroskedasticity

13. White robust variance estimator. Explain why it works (under suitable assumptions).

14. Maximum Likelihood. Be able to show that $\hat{\beta}_{OLS} = \hat{\beta}_{ML}$ under the standard assumptions plus normality and explain the relation between are standard OLS estimate of the error variance and the ML estimate of the error variance. Also, be able to derive the ML estimator in the case of heteroskedasticity. (I won't ask for the case of autocorrelated residuals.)

15. The IV estimator when there are more instruments than regressors and the special case when the number of instruments is equal to the number of regressors.

16. Explain why the IV-estimator is consistent (and list the assumptions) but not unbiased. (Note: there isn't so much to remember about the assumptions, we basically assume "what we need" in order to get consistency.)