SYLLABUS FOR AAEC5126 "EMPIRICAL ECONOMICS", SPRING 2020

INSTRUCTOR: KLAUS MOELTNER

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Course Information:

location:	ROBESON 103
time:	TR 9:30am - 10:45am
office hours:	TR, 1-2pm or by appointment

1. Course Description and Objectives

This course constitutes the second module of the first-year PhD sequence in Economics or Agricultural and Applied Economics, following ECON/AAEC 5125. The 5125 module provided the statistical and probability-theoretic foundation for engaging in econometric research. Importantly, you learned about the interplay between *economic theory*, *actual data*, and *statistical processes*. You also learned to think carefully about your modeling assumptions, and to question and examine them as rigorously as possible.

Building on this foundation, the emphasis of this course lies primarily on the *mathematical description* and the *computational implementation* of econometric models.

The former requires proficiency in matrix algebra, an important objective of this course. The latter will introduce you to computational programming. You will build all of your models "from scratch", and thus maintain full control over their components.

As for programming software, I decided to use `R`. It is not only free, but also well supported by a worldwide community of experts and users. From attending numerous meetings and conferences in econometrics and statistics in recent years I can personally attest to its widespread adoption by the stats community, and its rapidly growing popularity amongst empirical economists.

Another aim of this course is to get you started on *technical writing*, of the kind you would use to produce a professional journal paper with mathematical and statistical content. You will be using `LaTeX`, via `TeXnicCenter`, another free and widely supported package. In essence, `LaTeX` is a programming approach to typesetting. If you're already "TeXting", great. If not, you have likely

experienced at least some frustration with Word's equation editor or Mathtype, and you will find the `LaTeX` technology an attractive alternative to these "canned" packages. I recently made the switch, and would never go back to conventional word processors for my technical writing.

Using `LaTeX` also promotes another advantage of `R`: Via `R`'s sub-module `Sweave` you will learn to create unified documents that include all of your (i) statistical programming code, (ii) mathematical equations, (iii) comments and discussion, and (iv) results in a single file.

To lower your startup costs getting a handle on these software packages, you will find detailed installation and configuration instructions on our course web site, given in the header above. Throughout the semester, I will post numerous examples of `R, LaTeX`, and `Sweave` files on the course web site to facilitate your use of these packages.

In terms of econometric topics, we revisit some of the estimation methods you encountered in ECON/AAEC 5125, such as least-squares (LS) and maximum likelihood (ML), this time focusing on mathematical structure and computational implementation. In addition, we will cover extensions of the basic ("ordinary") LS framework to incorporate more flexible model structures. Most notably these extensions include instrumental variable (IV) approaches and generalized least squares (GLS).

We will also spend some time on perhaps the most popular analytical framework in applied micro-economics these days: the estimation of causal treatment effects. This topic builds naturally on Least Squares and MLE techniques, but introduces some new perspectives on causality and its "enemy" - endogeneity.

Last but not least, I would like to provide you with some exposure to Bayesian modeling, for the following reasons: (i) It provides several advantages over "classical" (or "frequentist") methods in many situations, (ii) With the advent of enhanced computing power, it has enjoyed a strong resurgence amongst econometricians in recent years, (iii) It is not covered - at least not in any technical detail - in any other mandatory ECON or AAEC course, and (selfishly) (iv) It's the approach I prefer for my own research.

This selection of what I consider essential topics at your stage of studies comes at the price of leaving other important areas of applied econometrics untreated, most notably panel data and time series methods. For the former, I refer you to AAEC 6564 ("Panel Data Econometrics"), and for the latter to AAEC 5984 ("Applied Economic Forecasting"), as well as STAT 5414 ("Time Series Analysis 1") and STAT 5664 ("Applied Statistical Time Series Analysis for Research Scientists").

2. Textbooks

I will be primarily using my own lecture notes (posted on the web as we move along), but I recommend the following textbooks as useful reference and background sources:

2.1. **General references.** Greene (2012): Covers a broad array of econometric topics and includes numerous empirical examples. Not always the most accessible treatment, but very comprehensive. A good companion for your graduate years and beyond. If you have an older or the latest (8^{th} edition), that's fine as well. The chapter numbers in my notes and in the overview attached to

this syllabus refer to the 2012 (7^{th}) edition, but the chapter headings in Greene have remained the same. This should make it easy for you to find the corresponding chapter in the other versions.

Kennedy (2003): A not-too-technical digest of common econometric models and techniques. Fills the "cryptic gaps" in (Greene, 2008). Another "keeper" beyond this course.

Wooldridge (2010): A comprehensive technical, graduate-level text like Greene, but with more details on derivations and more practical examples for some of the topics we'll cover.

2.2. **Specific topics.** Angrist and Pischke (2009): Very applied and accessible paperback with focus on today's micro-econometric "hot topics", such as Instrumental Variable methods, regression discontinuity, quantile regression, and other identification strategies to measure treatment effects. Useful beyond this course, especially if you take AAEC 5946 ("Microeconometrics") down the line.

Koop et al. (2007): An applied Bayesian text that is light on theory and heavy on intuition, examples, and practice. Useful beyond this course if you take my Bayesian course down the line (to be offered in fall 2011).

2.3. **Mathematical background.** Simon and Blume (1994): A comprehensive, accessible treatment of mathematical background material used in economic analysis. For this course, chapters 8 - 11, and 27 are most relevant. Highly recommended for those of you who want to brush up on Euclidean spaces, vector operations, and matrix algebra.

2.4. **Software-related.** Kleiber and Zeileis (2008): User-friendly paperback that describes fundamental functions in `R`, and illustrates how `R`can be used for a variety of common econometric applications. Only caveat: Does not build models from scratch using matrix programming, but rather builds on the "canned" packages available in `R`. Worth getting if you continue to work with `R`beyond this course (I hope you will).

You might also want to explore the many other volumes in the recently established "Use R!" series.

3. Grading and Other Administrative Issues

3.1. **Grading.** You can collect up to 180 points in this course as follows:

- Problem Sets (20 points each): There are five problem sets. Generally, you will have 10-14 days to complete them. Group work is encouraged for these exercises!
- Midterm Exam (30 points): In class exam. March 19, 2019 (regular class time and location)
- Final Exam (50 points): In class exam. May 12 (Tue), 2019, 10:05 am - 12:05 pm (regular class location unless announced otherwise)

If you anticipate handing in a problem set late or missing one of the exams, please let me know *beforehand*, if possible. I will give you an extension for completing the problem set or a make-up exam if your absence is due to a *convincing* reason.

3.2. **Student conduct.** The Virginia Tech honor system applies to all graded work in this course. For more information, visit `http://www.honorsystem.vt.edu`

3.3. **Students with disabilities.** Please let me know if you have a documented disability, so we can provide any accommodations you may need.

References

Angrist, J. D. and Pischke, J. (2009). *Mosty Harmless Econometrics*, Princeton University Press, Cheltenham, U.K.
Greene, W. (2008). *Econometric Analysis*, 6th edition edn, Pearson / Prentice Hall.
Greene, W. (2012). *Econometric Analysis*, 7th edition edn, Pearson / Prentice Hall.
Kennedy, P. (2003). *A Guide to Econometrics*, 5th edition edn, MIT Press.
Kleiber, C. and Zeileis, A. (2008). *Applied Econometrics with R*, Springer.
Koop, G., Poirier, D. and Tobias, J. (2007). *Bayesian Econometric Methods*, Cambridge University Press.
Simon, C. and Blume, L. (1994). *Mathematics for Economists*, W.W. Norton & Company.
Wooldridge, J. (2010). *Econometric Analysis of Cross-Section and Panel Data*, 2nd edition edn, MIT Press.

Semester Schedule for AAEC5126, Spring 2020
(subject to adjustments)

Week	Dates	Topic	References*	PS's / Exams
Module 1: Classical Linear Regression and Least Squares				
1	Jan. 23**	Overview of estimation frameworks / causality and conditional expectation	G12; K1; W1,2	
2	Jan. 28, 30	Classical linear regression model (CLRM); Least Squares	G2,3; K3; W4	
3	Feb. 4, 6	Finite sample properties of estimators	G4, K2	PS1 due Feb. 6
Module 2: Maximum Likelihood Estimation				
4	Feb. 11**	CLRM using Maximum Likelihood (ML) Estimation	G14; W13	
5	Feb. 18, 20	ML: Optimization, computation	GAppE	
Module 3: Asymptotics, Inference, Hypothesis Testing				
6	Feb. 25, 27	Asymptotic theory	G4,AppD; KAppC; W3	PS2 due Feb. 27
7	Mar. 3, 5	Asymptotic properties of LS and ML estimators	G4	
8	Mar. 17, 19	Inference, hypothesis testing, model selection in LS and ML	G5,14; K4	Mar. 19: midterm exam
Module 4: Instrumental Variables, Generalized Linear Regression				
9	Mar. 24, 26	Instrumental variables, Two-stage least squares	G8; K9; W4	PS3 due Mar.26
10	Mar. 31, Apr. 2	Generalized linear regression; Heteroskedasticity, Serial correlation	G9; K8	
Module 5: Estimating causal treatment effects				
11	Apr. 7, 9	Theoretical foundation; regression approach	AP2,3; W21	PS4 due Apr. 9
12	Apr. 14, 16	Matching methods	AP3; W21	
Module 6: An Introduction to Bayesian Econometrics				
13	Apr. 21, 23	Introduction to Bayesian Inference; CLRM via Gibbs Sampling	KPT1,2,11	PS5 due Apr. 23
14	Apr. 28, 30	Predicition, Model fit	KPT7	
15	May 5, 7	Model Comparison	KPT5,13	
16	May 12	Final exam		10:05am - 12:05 pm

*G=Greene, K=Kennedy, KPT=Koop, Poirier,Tobias, AP=Angrist & Pischke, W=Wooldridge
**Instructor out of town on Jan. 21 and Feb. 13