BOSTON COLLEGE
Department of Economics

Econometrics Field Comprehensive Exam

May 27, 2016

ALL MUST COMPLETE PART A OF THIS EXAM

Part A – ECON7771 – Econometric Methods – Prof. Lewbel

THEN CHOOSE AND COMPLETE TWO PARTS BELOW:

Part B – ECON8821 – Time Series – Prof. Xiao

Part C – ECON8822 – Cross Section & Panel Econometrics – Profs. Hoderlein

Part D – ECON8823 -- Applied Econometrics – Prof. Baum

Please use a separate bluebook for each part.

Please write your alias, part and question number(s) on each bluebook.

Please read the entire exam before writing anything.

Field Examination in Econometrics
May 2016 PART A

1. Suppose I have a system of two linear regression equations.

a. Explain when I might use each of the following estimators: i) Seemingly unrelated regressions, ii) Two stage least squares, iii) Three stage least squares.

b. What are the relative advantages and disadvantages of each of these three estimators?

2. Suppose we observe n iid observations of a random variable Y_i. let F denote the distribution function of Y, and let $E(Y_i) = \mu$ where μ is finite, but the variance of Y_i is infinite. Let $\overline{Y} = \sum_{i=1}^n Y_i/n$ and let $\widehat{F}(y) = \sum_{i=1}^n I(Y_i \le y)/n$.

Tell if each of the following statements is definitely true, possibly true, or definitely false, and explain why (stating the relevant theorem or theorems is sufficient for explaining why).

a. $n^{1/2}\left(\overline{Y} - \mu\right)$ converges in distribution to a normal.

b. $\overline{Y}$ converges in mean square to μ.

c. $\overline{Y}$ converges in probability to μ.

d. $\widehat{F}(y)$ is an unbiased estimator of $F(y)$ for any finite y.

e. $\widehat{F}(y)$ is a consistent estimator of $F(y)$ for any finite y.

3. Let $Y_i^* = X_i b - e_i$ for some unknown constant b. We do not observe Y_i^*. But we do observe n iid observations of the vector (Y_i, X_i), where $Y_i = \max(0, X_i b - e_i)$, or equivalently, $Y_i = I(X_i b - e_i > 0)(X_i b - e_i)$. Let $F_{y^*|x}(Y_i^* \mid X_i)$ denote the conditional probability distribution function of Y_i^* given X_i, and let $f_{y^*|x}(Y_i^* \mid X_i)$ denote the conditional probability density function of Y_i^* given X_i. Assume e_i is independent of X_i and e_i and has a standard normal distribution. let $\Phi(.)$ be the cumulative standard normal distribution function and let $\phi(.)$ be the standard normal probability density function.

a. Explain why the log likelihood function for estimating b equals this expression:

$$LnL = \sum_{i=1}^{n} I(Y_i^* \le 0) \ln\left[Prob\left(Y_i^* \le 0 \mid X_i\right)\right] + I(Y_i^* > 0) \ln f_{y^*|x}(Y_i^* \mid X_i)$$

b. We cannot maximize this likelihood function as written, because it is expressed in terms of Y_i^* which we don't observe, and in terms of $f_{y^*|x}$ which we don't know. Rewrite this likelihood function just in terms of observable variables and known functions.

c. Does this likelihood function satisfy the assumptions needed to have the resulting ML estimator $\widehat{b}$ be asymptotically efficient?

PART B

Time Series Econometrics, May, 2016

Question 1. Given an ARMA process $X_t + 0.6X_{t-2} = \varepsilon_t + 1.2\varepsilon_{t-1}$, determine whether it is causal and invertible.

Question 2. Derive the autocovariance and autocorrelation functions of an AR(1) process:

$$X_t = \alpha X_{t-1} + \varepsilon_t, |\alpha| < 1,$$

where ε_t are iid $(0, \sigma^2)$.

Question 3. Consider OLS estimation of the following regression

$$y_t = \beta' x_t + u_t,$$

where $\{u_t\}$ is stationary ergodic with spectral density $f_{uu}(\cdot)$, $\{x_t\}$ is stationary ergodic with $\mathrm{E}(x_t x_t') = M$,

$$\widehat{\beta} = \left(\sum x_t^2\right)^{-1} \sum x_t y_t$$

(1) what's the limiting distribution of $\widehat{\beta}$? (2) How to construct an estimator of the variance of $\widehat{\beta}$? (3) How to construct the t-ratio statistic of $\widehat{\beta}$?

Question 4. Consider the following process

$$y_t = \alpha y_{t-1} + u_t,\ \alpha = 1$$

where u_t are iid $(0, \sigma^2)$, and consider the OLS estimation of the AR coefficient

$$\widehat{\alpha} = \frac{\sum y_{t-1} y_t}{\sum y_{t-1}^2}$$

(1) what's the limiting distribution of $\widehat{\alpha}$? (2) Construct the t-statistic for $\widehat{\alpha}$ and derive the limiting distribution of $\widehat{\alpha}$

EC 8822

Part C - Cross Section and Panel Data Econometrics
Stefan Hoderlein and Martin Spindler

May, 27 2016

Instructions: this part is an one hour, closed book exam. Attempt to answer formally and avoid lengthy verbal parts. There are 40 credits in total, and the individual credits for the questions are displayed as guidance. All questions may be answered, but the best grade is usually awarded with less than full credit. Please use two separate books for questions 1-8 and 9-10.

1. Consider the mean regression of a dependent variable Y on a K-dim random vector X. Why is this an interesting object from an economic perspective? Give two examples of economic appliactions (4 credits).

2. Let $f_X(x)$ denote the density of the vector X at a point x. Define the (product) kernel based estimator for $f_X(x)$, and explain its building principle. In particular, define a kernel formally and explain its' functioning (4 credits).

3. Let $\hat{f}_X(x)$ denote this estimator. Sketch its bias formally in the case of $K = 1$, and f_X being three times continuously differentiable. Emphasize: formally (4 credits).

4. How would the variance of the estimator change in the general case with $K > 1$. Explain the so-called curse of dimensionality (3 credits).

5. How would your bias result change in the case where f is differentiable of higher order, and you were given means to make use of it (3 credits)?

6. Consider the semiparametric binary choice model, where

$$Y = 1\{X'\beta - U > 0\},$$

where X is a K-vector of observable random variables, β is a fixed K vector of coefficients, and U is a scalar unobservable. Assume that U is fully independent of X. Derive a way to identify β up to scale (i.e., give a formal sketch of your argument, 4 credits).

7. Why is nonparametrics useful in the binary choice model? Specifically, what disadvantage of maximum likelihood does it allow to avoid, and how? (2 credits).

8. The local average treatment effect (LATE): what are the main differences in the setup between "selection on observables" and an approach that leads to LATE as the identified parameter? (4 credits)

9. Define the Lasso estimator and state the optimization problem on which Lasso is based (4 credits)

10. Describe four variants of the Lasso estimator formally and describe in detail how they differ from standard Lasso. What are their advantages and disadvantages? (8 credits)

PART D

ECON8823: Applied Econometrics Comprehensive, Spring 2016

Answer all questions. They are equally weighted.

1. Write an essay discussing the Vector Error Correction Model (VECM), explaining the tests you would use to justify its use, and the interpretation of the results of estimation.

2. Write an essay discussing the use of propensity score matching as a method of computing treatment effects from observational data.

3. Write an essay discussing the 'fractional logit' model of Papke and Wooldridge, explaining the context where you would employ this technque and its advantages in that empirical context.