AFRICAN ECONOMIC RESEARCH CONSORTIUM (AERC)

Collaborative PhD Programme in Economics for Sub-Saharan Africa

COMPREHENSIVE EXAMINATIONS IN CORE AND ELECTIVE FIELDS

FEBRUARY – MARCH 2013

ECONOMETRICS

Time: 08:00 – 11:00 GMT **Date: Tuesday, February 19, 2013**

INSTRUCTIONS:

Answer a total of **FOUR** questions: **ONE** question from Section A; **ONE** question from Section B.
In Section C, you **MUST** answer **ONE** question from **Questions (5) and (6)**; and **ONE** question from **Questions (7) and (8)**. Statistical tables are provided.

Section A: 15 Marks [27 minutes]

Answer only ONE Question from this Section

Question 1

In a study of the impact of foreign aid on domestic tax revenue in a certain Sub-Saharan African country, an econometrician specified the following model:

$TAXGDP_t = \beta_0 + \beta_1 GDPPC_t + \beta_2 TRADEOP_t + \beta_3 AIDGDP_t + \beta_4 LIBERAL_t + u_t$; t=1,2,…,74

where *TAXGDP* is the total tax revenue as a percentage of GDP **(%);** *GDPPC* is the GDP per capita (millions of shillings); *TRADEOP***(**percent of GDP**)** is a variable defining the degree of openness of the country's economy to international trade (i.e., $TRADEOP = \left(\frac{EXPORTS + IMPORTS}{GDP} \right) x100$); LIBERAL is a dummy variable that seeks to capture the impact of trade liberalization in the country on tax revenue (LIBERAL=0 before liberalization, LIBERAL=1 after liberalization).

The above model is estimated using quarterly time series data. Use the regression results reported below to answer the questions that follow:

Dependent variable: **TAXGDP**

Independent Variable	Coefficient	Standard Error	T-ratio	p-value
CONSTANT	15.2841	1.1030	13.86	1.29e-021
GDPPC	6.8289e-07	6.3788e-07	1.071	0.2881
TRADEOP	-0.0473	0.0280	-1.686	0.0963
AIDGDP	-0.2549	0.0532	-4.795	9.04e-06
LIBERAL	-0.4253	0.2290	-1.857	0.0675

Mean of dependent variable=11.77465; Standard deviation of dependent variable=0.944508

Sum of squared residuals=30.59363; Standard error of the regression=0.665872

R-squared=0.530218; Adjusted R-squared=0.502984

Durbin Watson statistic=0.251553; rho=0.849204

Jarque-Bera statistic=3.641 (p-value=0.16196); F-ratio = 19.4692 (p-value = 9.24e-011)

Correlation matrix of variables

	TRADEOP	AIDGDP	TAXGDP	GDPPC	LIBERAL
TRADEOP	1.0000	-0.8853	0.5531	0.8958	-0.6979
AIDGDP		1.0000	-0.6979	0.8775	-0.6106
TAXGDP			1.0000	0.5845	0.3050
GDPPC				1.0000	0.7247
LIBERAL					1.0000

(a) Interpret the estimated slope coefficient for *AIDGDP* (i.e., $\hat{\beta}_3 = -0.2549$) in the above model. **(2 marks)**

(b) Construct a 95 percent confidence interval for β_3, the coefficient of AIDGDP, and use it to test the hypothesis that AIDGDP is a significant determinant of TAXGDP in this country. **(3 marks)**

(c) Test for significance of the overall regression in the above model. Use 5% level of significance. What is the meaning of testing for significance of the overall regression? **(4 marks)**

(d) Is multicollinearity a concern in this model? **(2 marks)**

(e) Test for first order autocorrelation in the above model. Use 5% level of significance. **(4 marks)**

Question 2

(a) Consider a simple linear regression model

(i) Write down the model and explain the components of the model **(2 marks)**

(ii) List the standard assumptions regarding the error term of the model **(2 marks)**

(b) Quarterly data on gasoline consumption and price are given. A simple linear regression of the logarithm of gasoline consumption on the logarithm of price gives the following results:

Dependent variable: logarithm of gasoline consumption

Variable	Coefficient	T statistic	P-value
Constant	2.12	3.87	0.00
Log of Price	-2.15	-18.16	0.00
R^2	0.86		
R^2(adj)	0.85		
S.E regression	0.05		
SS residual	0.16		
Durbin Watson	0.29		
F-Statistic	329.75		
Prob(F statistic)	0.00		

(i) Give the economic interpretation of the regression results. **(3 marks)**

(ii) If you were a seller of gasoline, would you contemplate raising the price of the product? Explain. **(3 marks)**

(iii) Comment on the goodness of fit of the estimated model. **(3 marks)**

(iv) Explain the statistical significance of the model. **(2 marks)**

Section B: 25 Marks [45 minutes]

Answer only ONE Question from this Section

Question 3

The link between deficits and interest rates is an issue of interest to academics and policy makers in Africa and other countries. One commonly tested hypothesis is the crowding-out hypothesis, which suggests that higher deficits should lead to higher interest rates. To test this hypothesis, it is commonplace for econometricians to examine the direction of Granger causality between deficits and interest rates. Evidence of Granger causality from deficits to interest rates is deemed to be in favor of the crowding-out hypothesis. Suppose that you are hired as a consultant to test the empirical validity of the crowding-out hypothesis, and you decide to estimate a bivariate VAR(1) model to investigate the relationship between deficits (denoted by d_t) and interest rates (denoted by r_t), where both variables are measured in levels. To this end, you estimate the model by ordinary least squares using 30 annual observations and obtain the following results:

Independent variable	Dependent variable	
	d_t	r_t
$Constant$	0.25 (1.0)	0.87 (5.0)
d_{t-1}	0.60 (5.3)	0.10 (3.0)
r_{t-1}	0.80 (1.3)	0.40(3.2)
R^2	0.73	0.90

where R^2 is the coefficient of determination and the t statistics are given in brackets besides the parameter estimates.

(a) What would be a plausible economic justification for investigating the crowding-out effect? **(3 marks)**

(b) Explain the justification for estimating the above bivariate VAR (1) model by ordinary least squares. **(3 marks)**

(c) It is often stated that VAR models are linked to the idea of cointegration. Explain the link between VAR models and the idea of cointegration. **(3 marks)**

(d) What is the presumed nature of cointegration between deficits and interest rates from the above bivariate VAR specification, assuming that this specification, in fact, took the cointegration into account? **(3 marks)**

(e) Based on the results reported above, is there any evidence in support of the crowding-out hypothesis? Explain. **(3 marks)**

(f) Suppose that a colleague of yours who is also an econometrician examines your data and recommends that you should re-specify your model as follows:

$$\Delta d_t = \beta_1 + \beta_2 \Delta d_{t-1} + \beta_3 \Delta r_{t-1} + \beta_4 ECT1_t + \varepsilon_t$$
$$\Delta r_t = \delta_1 + \delta_2 \Delta d_{t-1} + \delta_3 \Delta r_{t-1} + \delta_4 ECT2_t + v_t$$

where ECT1 and ECT2 are appropriate Error Correction Terms and Δ is the usual first difference operator. Explain the presumed order of integration of the variables and the presumed cointegration status underlying this specification as well as the role of the error correction terms in this alternative specification. **(4 marks)**

(g) Explain how you would create the error correction term variable (ECT1) in the first equation in the model specification in part (f). **(3 marks)**

(h) What is the difference in the nature of the causality reported in the Table and the causality that is tested in part (f)? **(3 marks)**

Question 4

Consider the following Heckman selection model:

$$w_i^* = x_{1i}'\beta_1 + \varepsilon_{1i} \qquad i = 1, 2, \ldots, N$$
$$h_i^* = x_{2i}'\beta_2 + \varepsilon_{2i}$$
$$w_i = w_i^*, \qquad h_i = 1 \text{ if } h_i^* > 0$$
$$w_i \text{ not observed, } h_i = 0 \text{ if } h_i^* \le 0$$

and
$$\begin{pmatrix} \varepsilon_{1i} \\ \varepsilon_{2i} \end{pmatrix} \sim NID\left[\begin{pmatrix} 0 \\ 0 \end{pmatrix} \begin{pmatrix} \sigma_1^2 & \sigma_{12} \\ \sigma_{12} & 1 \end{pmatrix}\right]$$

where w_i^* denotes person i 's wage and is not observed for people who are not working.

w_i denotes person i 's actual wage

h_i^* indicates net utility

h_i indicates working and not working

(a) Derive the probability that $w_i = 0$, and $E\{w_i \mid h_i = 1\}$. [Hint: $E\{\varepsilon_{1i} \mid h_i = 1\} = \sigma_{12} \dfrac{\phi(x_{2i}'\beta_2)}{\Phi(x_{2i}'\beta_2)}$] **(9 marks)**

(b) If $x_{1i}'\beta = x_{2i}'\beta$ and $\varepsilon_{1i} = \varepsilon_{2i}$, then what type of model is appropriate for estimation? Derive the probability that $w_i = 0$, and $E\{w_i \mid w_i > 0\}$.

[Hint: $E\{\varepsilon_{1i} \mid \varepsilon_{1i} > -x_{1i}'\beta\} = \sigma_1 \frac{\phi(x_{1i}'\beta_1)}{\Phi(x_{1i}'\beta_1)}$] **(9 marks)**

(c) Explain the differences among the censored regression, truncated regression, and the sample selection models. **(7 marks)**

Section C: 60 Marks [108 minutes]

Answer Either Question 5 or Question 6

Question 5

(a) There are many different types of econometric models or time series models with time varying parameters. Briefly describe any two such types. **(4 marks)**

(b) Consider the following AR(2) model of inflation $p_t = \Phi_1 p_{t-1} + \Phi_2 p_{t-2} + \varepsilon_t$

How would you set up the state space representation of this model? Explain the reason for setting up the state space representation of this AR(2) model. **(6 marks)**

(c) Suppose that your objective is to estimate the parameters of the following two-state regime switching AR(1) model of inflation: $p_t = \mu_{st} + \Phi_1 p_{t-1} + \varepsilon_t$, where $st = 1$ if state=1 and st=2 if state=2. Also assume that ε_t is $n.i.d.(0, \sigma_1^2)$ if st=1 and ε_t is $n.i.d.(0, \sigma_2^2)$ if st=2.

(i) Identify all the parameters of this model to be estimated. **(5 points)**

(ii) Rewrite this model in terms of deviations from the means. **(5 points)**

(iii) Now consider a simpler version of this model for which $\Phi_1 = 0$. Explain the context in which this special case is referred to in the Markov regime switching literature as the i.i.d. mixture case. **(5 points)**

(iv) Describe the maximum likelihood estimation of the 2-state i.i.d. mixture case in part (iii). What are the problems one is likely to encounter with maximum likelihood estimation of this i.i.d. mixture case? **(5 points)**

Question 6

Suppose that you are asked by your econometrics lecturer to model exchange rates in your country using a GARCH (1,2) specification. Let the variables representing exchange rates and interest rates be represented by ER and IR, respectively. Now consider the model $ER_t = \beta_1 + \beta_2 IR_t + \varepsilon_t$ where ε_t is $i.i.d.N(0, \sigma^2)$.

(a) Explain why your lecturer might want you to specify a GARCH (1,2) model of exchange rates. Based on your knowledge of the typical behavior of exchange rates, does it seem reasonable to consider constructing a GARCH model of exchange rates? **(4 marks)**

(b) Modify the above model to form a GARCH (1,2) specification. In your modification be sure to indicate the number of lagged conditional variances and the number of lagged disturbances. **(3 marks)**

(c) Derive the unconditional variance of the GARCH (1,2) model you specified in part (b). Is the unconditional variance constant or not constant? **(4 marks)**

(d) What parameter restrictions would you impose in your GARCH (1,2) model? What is the theoretical justification for imposing these parameter restrictions? **(4 marks)**

(e) It is a well-known econometric result that any GARCH model has an equivalent ARMA specification. State the equivalent ARMA specification for the GARCH (1,2) model you specified in part (b). There is no need to derive this result from first principles but you may do so if you wish. **(3 marks)**

(f) Briefly describe how you would test for GARCH (1,2) effect in your model of exchange rates. **(4 marks)**

(g) Suppose that after empirical testing for GARCH (1,2) you opted to specify an ARCH(1) model instead. Modify your specification in part (b) to an ARCH (1) model specification. How would you perform maximum likelihood estimation of the ARCH (1) model? Make sure you include the log-likelihood function for the ARCH (1) specification. **(4 marks)**

(h) Consider the following results of estimating an ARCH (2) model of exchange rates. Comment on the possible presence of ARCH effects. Use 5% level of significance.

(4 points)

Model 2: WLS (ARCH) estimates using the 112 observations 2000:03-2009:06
Dependent variable: Exchange rate
Variable used as weight: 1/sigma

Variable	Coefficient	Standard error	t-ratio	p-value
Constant	0.688815	0.750566	0.9177	0.3608
Inflation Rate	0.00286290	0.000948315	3.019	0.0032***
Discount Rate	0.157767	0.0320601	4.921	3.07e-06***
Alpha(0)	0.3999446	0.251331	1.589	0.1149
Alpha(1)	1.17616	0.0926312	12.70	3.18e-023***
Alpha(2)	-0.267079	0.093434300	-2.859	0.0051***

Statistics based on weighted data:
Sum of squared residuals=100.2912
Standard error of regression=0.959220
R-squared=0.529357
Adjusted R-squared=0.520722
F(2,109)=61.29906; P-value(F)=1.45e-18
Log-likelihood=-152.7375
Akaike criterion=311.4750
Schwarz criterion=319.6305
Hannan-Quinn=314.7840
Rho=0.963974; Durbin-Watson=0.112569

Statistics based on original data:
Mean of dependent variable=6.264189
Standard deviation of dependent variable=2.348855
Sum of squared residuals=486.9793
Standard error of regression=2.113694

Answer Either Question 7 or Question 8

Question 7

Given that

$y = X\beta + \varepsilon$

where y is an $n \times 1$ vector of observations on the dependent variable, X in an $n \times k$ matrix of observations on the independent variables, β is a $k \times 1$ vector of parameters, and ε is an $n \times 1$ vector of errors.

Assume that $E(X'\varepsilon) \neq 0$. Suppose that there is an h-dimensional vector Z of instrumental variables such that $E(Z'\varepsilon) = 0$ and ($h > k$).

(a) Explain why the simple instrumental variable estimator $\hat{\beta} = (Z'X)^{-1}Z'y$ is inappropriate. **(10 marks)**

(b) Derive the appropriate estimator. **(20 marks)**

Question 8

(a) Explain the meaning of a treatment effect and briefly describe how a panel regression with 2 time periods could be used in the analysis of such an effect **(10 marks)**

(b) Suppose we have the following fixed effects model with 2 time periods,

$y_{it} = \beta_1 + \gamma d_{2t} + \beta_2 x_{it} + \alpha_i + u_{it}$

where $d_{2t} = 1$ for time 2, and 0 for time 1; x_{it} is a time-varying explanatory variable and i can be an individual, household, firm or country identifier.

(i) Given two years of data, show how we can estimate the parameters of the model using First difference (FD) estimator **(6 marks)**

(ii) Given two years of data, show how we can estimate the parameters of the model using Pooled OLS **(4 marks)**

(iii) Give an interpretation for α_i and u_{it} **(5 marks)**

(iv) What can be captured by including the time dummy? Give a real world example. **(5 marks)**