MAASAI MARA UNIVERSITY

UNIVERSITY EXAMINATIONS 2022/2023

ECS 4206: APPLIED ECONOMETRICS

DATE: APRIL 2023 **TIME: 2 HOURS**

INSTRUCTIONS: ANSWER QUESTION ONE AND ANY OTHER THREE QUESTIONS.

QUESTION ONE (25 MARKS)

a) Define the following terms as used in time series

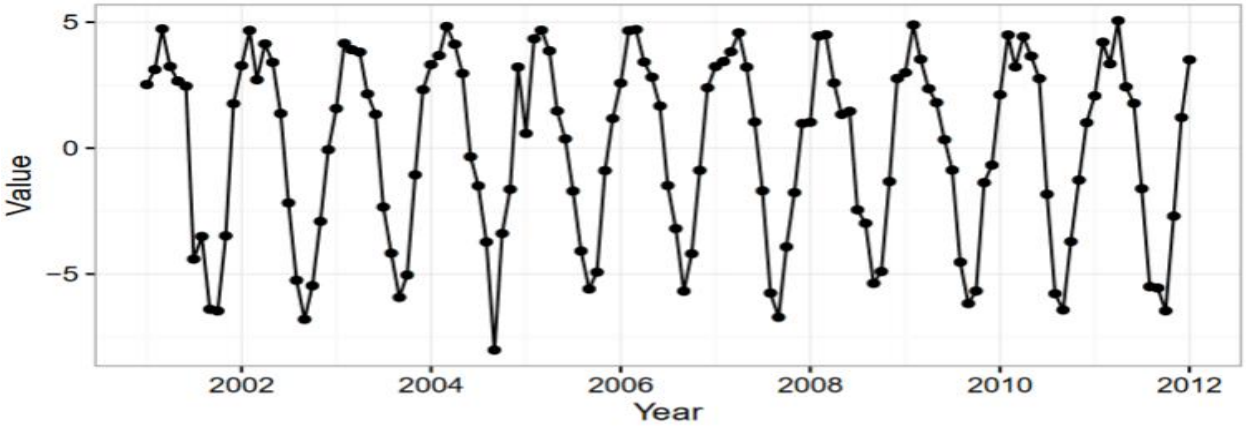
i. Weak stationarity

ii. One simple net return

iii. Asset valuation

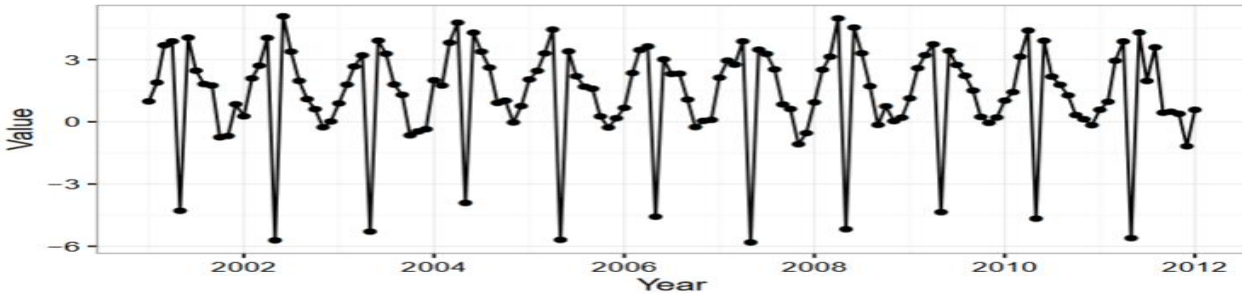
iv. Volatility clustering (4 Marks)

b) Below is a plot of a monthly time series. The investigator who collected it expects there to be an annual seasonal pattern, but she is more interested in the long term trend.



i. Suggest a method she could use to model the seasonality, along with sentence explaining your choice. (2 Marks)

ii. She brings you a second monthly time series shown below. Would you recommend the same method to model the seasonality in this time series? (3 Marks)



c) Below are the ACF and PACF for three time series. For each series, state whether it is autoregressive or moving average and the order (p or q) and explain the reason informing the choice you have made. (6 Marks)

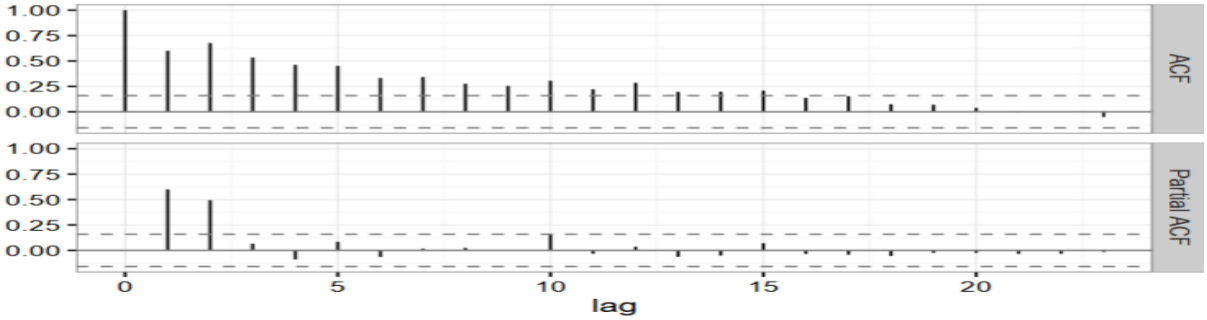


Figure 1

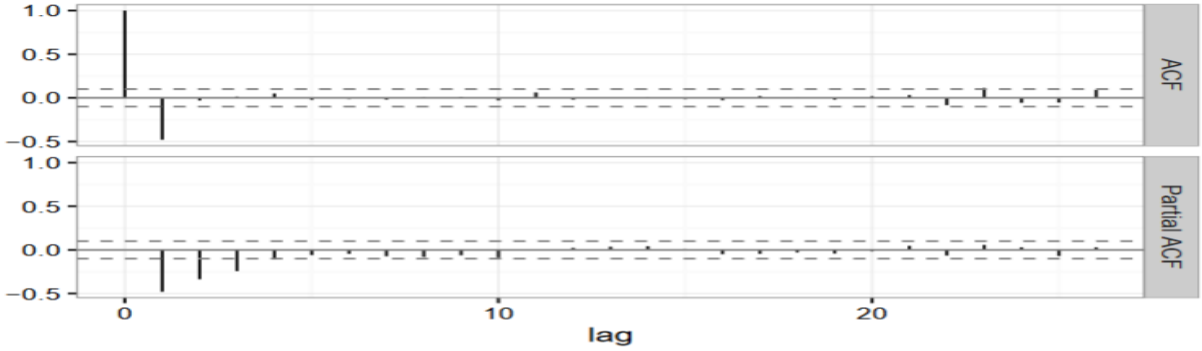


Figure 2

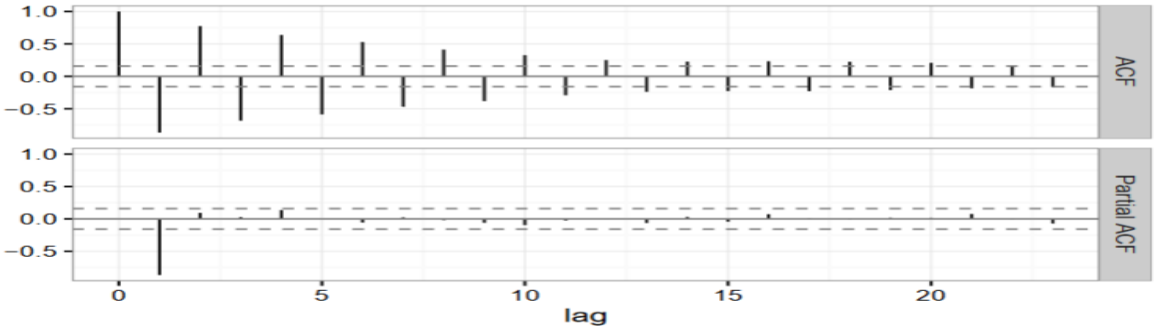


Figure 3

d) Negative log return data from a financial portfolio was analyzed by fitting a model using R statistical software. Part of the outputs are as shown below.

```
> output1=garchFit(formula = ~ garch(1, 2), data = Xt)
> output1
Title:
GARCH Modelling
Call:
garchFit(formula = ~garch(2, 1), data = Xt)
Conditional Distribution:
norm
Coefficient(s):
mu              omega          alpha1         alpha2          beta1
-0.00056548     0.00020670     0.20117133     0.34829608     0.33872893
Std. Errors:
based on Hessian

Error Analysis:
        Estimate      Std. Error    t value       Pr(>|t|)
mu      -5.655e-04    6.600e-04     -0.857        0.392
omega   2.067e-04     3.168e-05     6.524         6.85e-11 ***
alpha1  2.012e-01     3.872e-02     5.195         2.05e-07 ***
alpha2  3.483e-01     6.063e-02     5.745         9.22e-09 ***
beta1   3.387e-01     5.211e-02     6.501         8.00e-11 ***
---
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
Log Likelihood:
3031.464 normalized: 2.020976
```

i) Write down the fitted pure time series model for the series x_t including the residual variance (2 Marks)

ii) Based on the provided model checking statistics, is there any serial correlation in the residuals? Is there any ARCH effect in the residuals? Justify your answer. (2 Marks)

iii) In the Gaussian GARCH(1,1) model is entertained, write the fitted model for the residuals. (2 Marks)

iv) One may combine the time series model with a volatility model to describe the dynamics of US monthly CPI growth rates. Which volatility model is preferred and why? (2 Marks)

v) A GARCH(1,1) model with student-t innovations Is also entertained. Let v be the degrees of freedom, of the student-t innovation. Consider the hypothesis $H_0: V = 5 \ \ versus \ H_a: V \neq 5$. Calculate the test statistic and draw conclusions. (2 Marks)

QUESTION TWO (15 MARKS)

a) The following result are from a perspective study that were considered in building a logis-tic regression model for predicting capsule=1 that included psa, age, and gleason in themodel(model 1). Part of the resulting SAS output follows:

Model Fit Statistics

Criterion	Intercept Only	Intercept and Covariates
AIC	514.289	411.208
SC	518.229	426.969
-2 Log L	512.289	403.208

Analysis of Maximum Likelihood Estimates

Parameter	DF	Estimate	Error	Chi-Square	Pr > ChiSq
Intercept	1	-6.3896	1.4976	18.2045	<.0001
psa	1	0.0266	0.00894	8.8442	0.0029
age	1	-0.0208	0.0188	1.2351	0.2664
gleason	1	1.0790	0.1611	44.8373	<.0001

i. Write the resulting logistic regression equation for model 1 (2 Marks)

ii. What is the predicted probability of having a capsule=1 for a 69-year old man with psa level of 10mg/ml and a gleason score of 5, according to model 1? (2 Marks)

iii. What does the intercept from the model tell you? (2 Marks)

iv. Calculate the odds ratio and 95% confidence interval for psa from the model. Interpret. (3 Marks)

b) Based on a sample of 20 couples,Monica obtained the following regression.

$$\ln\left(\frac{P_i}{1-P_i}\right) = -9.456 + 0.3638 income_i - 1.107 babysitter_i$$

Where P= Probability of restaurant usage

Restaurrant= 1 if went to a to restaurant ;0 elsewhere

Babysitter= 1 if needed a baby sitter: 0 elsewhere

Of the 20 couples,11 regularly went to a restaurant, 6 regularly used a baby sitter and the income ranged from a low of Ksh 17, 000 to a high of Ksh 44, 000.

i. Interpret the preceding logit regression. (2 Marks)

ii. Find out the logit value of a couple with an income of Ksh 44, 000 who needed a babysitter. (2 Marks)

iii. For the same couple, find out the probability of going to a restaurant.

(2 Marks)

SECTION B

QUESTION THREE (15 MARKS)

a)

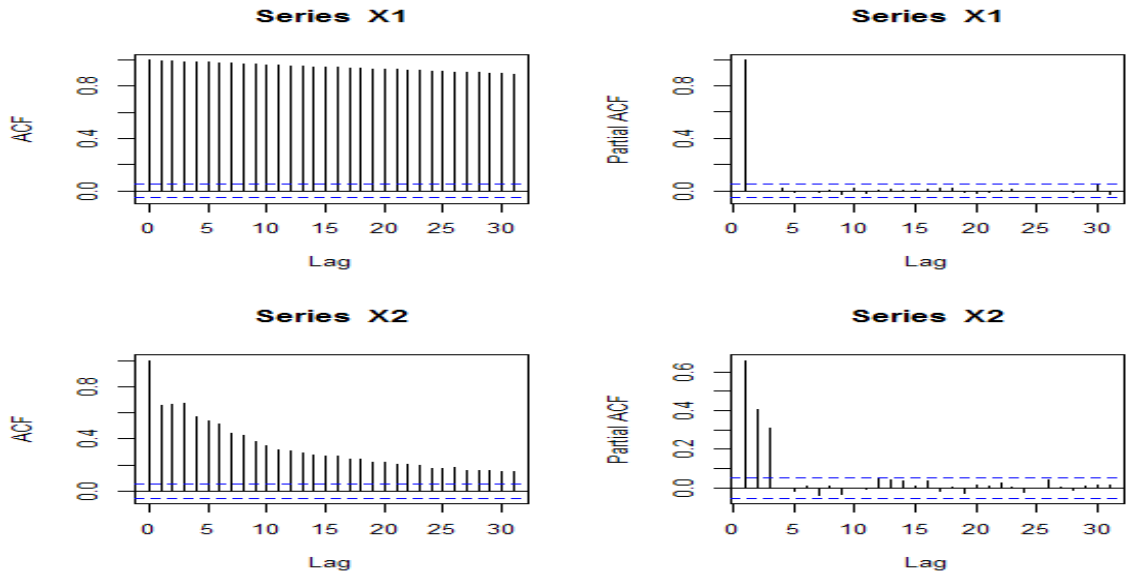
i) Explain the concept of invertibility of the $MA(q)$ process (2 marks)

ii) Determine the autocovariance function of the $MA(q)$ process (3 marks)

b) Determine the stationarity and invertibility of the process

$X_t = \frac{1}{4}X_{t-1} + \frac{3}{64}X_{t-2} + e_t$ (5 marks)

c) Acf and Pacf of two financial time series data were plotted as shown in the figure below. For each plot, state the underlying process and give the respective mathematical expressions. Explain their importance in the real world. (5 marks)



QUESTION FOUR (15 MARKS)

Say you want to assess the importance of increasing the number of police officers on the crime rate. You have access to data at the municipality level and can estimate the equation:

$$Crimeit = \beta 0 + \beta 1\ Policeit + \epsilon i\ .$$

Both measures (number of crimes and number of police officers) are measured per 1000 inhabitants in each municipality.

a) Write down the fixed effects regression model based on the regression model above. Based on this equation, describe what kind of problem you can potentially solve using fixed effects compared to the equation above? What kind of problems can a fixed effects model not solve? (4 marks)

b) What must be true (which assumption needs to hold) in order for us to interpret the coefficient from your panel data regression as a causal relationship? Write down the equation or describe the assumption in words. (3 marks)

c) Using yearly panel data for several time periods, the estimated coefficient on Police is -0.1 in your fixed effects specification. How do you interpret this estimate? Do you believe that this estimate has a causal interpretation? Motivate your answer. (3 marks)

d) Suppose that around half of the municipalities in your data received central government support to increase police density at the same time period and the other half did not. Using this new information, how could you design a study to answer the question above in a causal way? Write down the equation, describe which parameter you are interested in and describe how you would show your readers that it is plausible that the most important assumption for estimating a causal effect holds. (5 marks)

QUESTION FIVE (15 MARKS)

a) Consider the following production function for bus transportation in a particular city;

$$Q = \alpha L^{\beta_1} F^{\beta_2} K^{\beta_3}$$

Where

L=fuel in Fuel input in gallons

K=Capital input in number of busses

L=Labor input in worker hours

Q=Output in millions of bus miles

We estimate the following parameters using historical data

$$\alpha = 0.0012,$$

$$\beta_1 = 0.45$$

$$\beta_2 = 0.20$$

$$\beta_3 = 0.30$$

i) Determine output elasticities for Labor, Fuel, and Capital (3 Marks)

ii) Suppose that Labor hours increase by 100% by what percentage will output increase? (3 Marks)

iii) Suppose that every year, 3% of the buses are taken to service, what effect will this have on output? (2 Marks)

b) Consider the following output table

Labor	**Output**	***Marginal Product***	***Average Product***	***Elasticity of Production***
1	2	*2*	*2*	*1*
2	6	*4*	*3*	*1.3*
3	16	*10*	*5.3*	*1.9*
4	29	*13*	*7.3*	*1.8*
5	43	*14*	*8.6*	*1.7*
6	55	*12*	*9.2*	*1.3*
7	58	*3*	*8.3*	*.36*
8	60	*2*	*7.5*	*.27*
9	59	*-1*	*6.6*	*-.15*
10	56	*-3*	*5.6*	*-.53*

i. Calculate the Marginal product, Average Product, Elasticity of Production (3 Marks)

ii. Within what ranges do we see increasing returns, decreasing returns and negative returns? (2 Marks)