BINDURA UNIVERSITY OF SCIENCE EDUCATION SFM213

HBScSFM

FINANCIAL TIME SERIES ANALYSIS

APR 2025

Time : 3 hours

Candidates may attempt ALL questions in Section A and at most TWO questions in Section B. Each question should start on a fresh page.

SECTION A (40 marks)

Candidates may attempt ALL questions being careful to number them A1 to A4.

A1. Define the terms:

(a) Long memory. [2]

(b) Cointegration. [2]

(c) spurious regression. [2]

A2. (a) What is the significance of the Value at Risk (VaR). [4]

(b) How can ones deal with the problem of non-stationarity in time series? [4]

A3. (a) Distinguish between a causal process and invertible process. [4]

(b) Determine which of the following ARMA processes are causal and which of them are invertible. (In each case $\{Z_t\}$ denotes white noise).

(i) $X_t + 0.2X_{t-1}0.48X_{t-2} = Z_t$. [4]

(ii) $X_t + 1.9X_{t-1} + 0.88Xt - 2 = Z_t + 0.2Z_{t-1} + 0.7Z_{t-2}$. [4]

(iii) $X_t + 0.6X_{t-1} = Z_t + 1.2Z_{t-1}$. [4]

A4. (a) A commonly used model in finance is the random walk. Define the random walk process. [4]

(b) Compute the ACF of the AR(2) process $X_t = 0.8X_{t-2}+Z_t$, $\{Z_t\} \sim WN(0, \sigma^2)$. [6]

SECTION B (60 marks)

Candidates may attempt TWO questions being careful to number them B5 to B7.

B5. (a) Consider the time series model $(1 - 0.7B + 0.8B2)r_t = 0.3 + (1 - 0.5B)a_t$, where $a_t \sim iidN(0; 1)$. Is the model stationary? Why? [3, 2]

(b) Give two situations under which returns of an assert follow an MA(1) model. [2]

(c) Describe two ways by which a GARCH(1,1) model can introduce heavy tails. [3]

(d) Give two reasons by which the return series of an asset tend to contain outliers. [2]

(e) Describe two differences between an AR(1) model and an MA(1) model of a time series. [2]

(f) Give an advantage of Spearman's over the Pearson correlation. [2]

(g) Give a feature that GARCH-M models have, but the GARCH models do not. [1]

(h) Why is the usual R^2 measure not proper in time series analysis? [3]

(i) Give two real applications of seasonal time series models in finance. [2]

(j) Suppose that the daily simple returns of an asset in week 1 were -0.5%, 1.2%, 2.5%, -1.0%, and 0.6%.

(i) What are the corresponding daily log returns? [4]

(ii) What is the weekly simple return of the asset? [4]

B6. (a) Let r_t denote the daily log return of an asset.

(i) Describe a procedure for testing the existence of serial correlations in r_t. What is the reference distribution of the test statistic used? [3]

(ii) Let $\mu_t = E(r_t|F_{t-1})$, where F_{t-1} denotes the information available at time $t-1$. Write the return as $r_t = \mu_t + a_t$. Describe the null hypothesis for testing the ARCH effect of r_t, including definition of the statistics involved in H_0. [4]

(iii) Let $a_t = \sigma_t \epsilon_t$, where $\sigma^2 = E(a_t^2|F_{t-1})$ and ϵ_t are iid random variate with mean zero and variance 1. Describe a statistic discussed in class for testing the null hypothesis that ϵ_t is normally distribution. What is the reference distribution of the test statistic? [3]

(iv) Suppose that σ^2 above satisfies the model $\sigma_t^2 = 0.01 + 0.1a_{t-1}^2 + 0.8\sigma_{t-1}^2$. Compute $E(a_t)$ and $Var(a_t)$. [3, 4]

(b) Provide two reasons that may lead to serial correlations in the observed asset returns even when the underlying true returns are serially uncorrelated. [2]

(c) Provide two methods that can be used to specify the order of an autoregressive time series. [2]

(d) Describe two statistics that can be used to measure dependence between variables. [3]

(e) Provide two volatility models that can be used to model the leverage effect of asset returns. [2]

(f) Describe a nice feature and a drawback of using GARCH models to modeling asset volatility. [2]

(g) Give two potential impacts on the linear regression analysis if the serial dependence in the residuals is overlooked. [2]

B7. (a) Let X and Y be two random variables with $E(Y) = \mu$ and $EY^2 < \infty$.

(i) Show that the constant c that minimizes $E(Y-c)^2$ is $c = \mu$. [6]

(ii) Deduce that the random variable $f(X)$ that minimizes

$$E[(Y - f(X))^2|X]$$

is $f(X) = E[Y|X]$. [4]

(iii) Deduce that the random variable $f(X)$ that minimizes $E(Y - f(X))^2$ is also $f(X) = E[Y|X]$. [3]

(b) Let $\{X_t\}$ be the moving-average process of order 2 given by $X_t = Z_t + \theta Z_{t-2}$, where $\{Z_t\}$ is $WN(0,1)$.

(i) Find the autocovariance and autocorrelation functions for this process when $\theta = 0.8$. [7,5]

(ii) Compute the variance of the sample mean $\dfrac{X_1 + X_2 + X_3 + X_4}{4}$ when $\theta = 0.8$. [5]

END OF QUESTION PAPER