

# 程序代写代做 CS编程辅导

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# University of New South Wales School of Economics

## Financial Econometrics

### Tutorial 6



#### 1. (ARCH model)

Consider the following model,

$$y_t = c + \phi_1 y_{t-1} + \varepsilon_t, \quad |\phi_1| < 1, \quad \varepsilon_t | \Omega_{t-1} \sim N(0, \sigma_t^2),$$

$$\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \alpha_2 \varepsilon_{t-2}^2, \quad \alpha_0 > 0, \quad \alpha_1 \geq 0, \quad \alpha_2 \geq 0, \quad \alpha_1 + \alpha_2 < 1,$$

where  $\Omega_t$  is the information set at the end of period  $t$ .

- Find  $E(\varepsilon_t | \Omega_{t-1})$ ,  $E(y_t | \Omega_{t-1})$  and their unconditional counterparts.
- Find  $\text{Var}(\varepsilon_t | \Omega_{t-1})$ ,  $\text{Var}(y_t | \Omega_{t-1})$  and their unconditional counterparts.
- Is  $\varepsilon_t$  a white noise process? Is it an independent (or iid) WN process? Verify your answer.
- In what fundamental way does the ARCH model differ from the standard (homoscedastic) ARMA models? What is the purpose of the variance equation?
- Ceteris paribus, what is the change in  $\sigma_t^2$  caused by a one-unit change in  $\varepsilon_{t-1}^2$ ?
- Suppose  $\alpha_2 = 0$ ,  $\alpha_1^2 < 1/3$  and  $\varepsilon_t$  is strictly stationary. Find  $E(\varepsilon_t^4)$  and the unconditional kurtosis of  $\varepsilon_t$ . Comment on its implication for the tails of the unconditional distribution of  $\varepsilon_t$ .

[Hint: for a zero-mean normal random variable  $Z \sim N(0, \omega^2)$ ,  $E(Z^4) = 3\omega^4$ .]

#### 2. (GARCH model characteristics)

Consider the following AR(1)-GARCH(1,1) model,

$$y_t = c + \phi_1 y_{t-1} + \varepsilon_t, \quad |\phi_1| < 1, \quad \varepsilon_t | \Omega_{t-1} \sim N(0, \sigma_t^2),$$

$$\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 \sigma_{t-1}^2, \quad \alpha_0 > 0, \quad \alpha_1 \geq 0, \quad \beta_1 \geq 0, \quad \alpha_1 + \beta_1 < 1,$$

where  $\Omega_t$  is the information set at the end of period  $t$ .

- Find  $E(\varepsilon_t | \Omega_{t-1})$ ,  $E(y_t | \Omega_{t-1})$  and their unconditional counterparts.
- Find  $\text{Var}(\varepsilon_t | \Omega_{t-1})$ ,  $\text{Var}(y_t | \Omega_{t-1})$  and their unconditional counterparts.
- Is  $\varepsilon_t$  a white noise process? Is it an independent (or iid) WN process? Verify your answer.
- Ceteris paribus, what is the change in  $\sigma_t^2$  caused by a one-unit change in  $\varepsilon_{t-1}^2$ ?

- (e) Let  $w_t = \varepsilon_t^2 - \sigma_t^2$ . Show (i)  $w_t$  has no autocorrelation; (ii)  $\varepsilon_t^2$  has an ARMA(1,1) representation with  $w_t$  being the shock.
- (f) Some researchers prefer to write  $\alpha_0 = \omega(1 - \alpha_1 - \beta_1)$ , where  $\omega$  is a free parameter (the unconditional variance). Suppose  $\varepsilon_t^2$  is an integrated GARCH(1,1), where  $\alpha_1 + \beta_1 = 1$ , show that the integrated series is in fact an EWMA of  $\varepsilon_t^2$ .



### COMPUTING EXERCISE

#### 3. (Estimation of ARCH)

This question is based on the data contained in the Excel file *SHARE.XLS*. The file contains daily data on the S&P500 from the 2nd of January, 1998 to the 30th of December, 2001 comprising a total of 994 observations. The S&P500 index is designated *PRICE* in the file. Generate the series for the percentage log return as  $R_t = 100 * (\log(PRICE_t) - \log(PRICE_{t-1}))$ .

- (a) Perform the Jarque-Bera test for normality and show the empirical histogram for the returns. Also show the correlogram for the returns and interpret your results.
- (b) Generate the series for the squared return as  $R2_t = R_t^2$  and create time series plot of  $R2$ . Also show the correlogram for squared returns and interpret your results.
- (c) Assume the mean equation for returns is  $R_t = c + \varepsilon_t$ . Perform an LM test for ARCH effects on the residuals from the regression. Interpret the testing results.
- (d) Assume the mean equation for returns is  $R_t = c + \varepsilon_t$ . Estimate an ARCH(5) model given the mean equation specified above. Interpret your results. Are the restrictions for the ARCH parameters satisfied? Extract and plot  $\sigma_t^2$  from the estimated equation. Inspect and comment on the plot. Perform an LM test for ARCH effect on the standardised residual series and comment.
- (e) Compare the histograms of residuals and standardised residuals; and the correlograms of squared residuals and squared standardised-residuals from the model in (d) and comment.
- (f) How would you choose the lags in the variance equation [why ARCH(5)?]? Would a more sophisticated mean equation help? Try some of your suggestions and comment on your results.

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### 4. (Estimation of GARCH)

This question is based on data obtained in the Excel file *SHARE.XLS*. The file contains daily data on the S&P500 index from the 2nd of January, 1998 to the 10th of December, 2001 comprising a total of 2500 observations. The S&P500 index is designated *PRICE* in the file. Generate the series of log returns as:  $R = 100 * (\log(PRICE) - \log(PRICE(-1)))$

- (a) Assume the log returns is

$$R_t = c + \varepsilon_t$$

and that the variance equation for returns is a GARCH(1,1). Estimate the model and interpret your results. Are the sign restrictions for the GARCH specification satisfied?

- (b) Extract and plot  $\sigma_t^2$  from the estimated equation, and make a comparison to the same plot from ARCH(5).
- (c) Perform an LM test on the standardized residuals from this GARCH(1,1) model. Interpret your results.
- (d) Report the Jarque-Bera test for normality on the standardized residuals. Report the correlogram of the squared standardised residuals. Comment on your results.
- (e) Re-estimate the GARCH(1,1) model but do not select heteroscedastic-consistent standard errors. Compare the results with those in (a) and comment.
- (f) Estimate GARCH(2,1), GARCH(1,2) and GARCH(2,2) models. Inspect and comment on the estimation results.