KYIV SCHOOL OF ECONOMICS

Financial Econometrics (2nd part): Introduction to Financial Time Series

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Quiz 2

Please put your name below and answer ANY three out of four questions in 30 minutes:

If you attempt all four questions only **the first three** will be graded!

I. A 2-state Markov Switching Autoregressive model for GNP growth rate in Poltavia is given by

$$g_t = \begin{cases} -0.2 + 0.5g_{t-1} + a_{1t} & \text{if state 1,} \\ 0.3 - 0.5g_{t-1} + a_{2t} & \text{if state 2} \end{cases}$$

where a_{1t} and a_{2t} are independent white noise series.

a. Calculate the mean growth in each state.

Which state corresponds to expansion and which one to contraction?

b. Suppose that $\widetilde{\omega}_1$ is the estimated probability of moving to state 1 in period t conditional on being in state 2 in period $t-1$. In addition, $\widetilde{\omega}_2$ is the estimated probability of moving to state 2 in period t conditional on being in state 1 in period $t-1$. Is $\widetilde{\omega}_1$ likely to be greater or smaller than $\widetilde{\omega}_2$? Explain your argument in 1-2 sentences. *Hint: Recall that economies are typically characterized by quick contraction and slow expansion.*

c. What is expected duration of contraction and expansion in Poltavia?

What is likely to happen to unemployment when this economy is in state 1?

II. Suppose that your assistant has estimated the following AR(2) process for the log returns of the IBM stock:

$$r_t = 0.25 + 0.35r_{t-1} - 0.10r_{t-2} + a_t, \hat{\sigma}_a = 0.09. \tag{1}$$

a. What is the unconditional mean of the log return of the IBM stock?

What can you say about the forecast of the IBM log return after 2 periods? *Hint: You do not have to (but you may) calculate anything here.*

b. Write the corresponding second-order difference equation.

Is the log return of the IBM stock characterized by business cycle behavior?

c. Suppose that your assistant reported the p-value of Q-statistics of squared residuals to be 0.00006. What would you suggest given this results of a nonparametric test for nonlinearity? Explain in 1-2 sentences.

d. Suppose that your prior knowledge of the IBM and other IT stocks tells you that their volatility responds asymmetrically to negative and positive shocks. Which models can you use in this case? Explain in 1-2 sentences.

III. Write TRUE or FALSE and **explain** in 1-2 sentences.

a. One of the assumptions underlying $RiskMetrics^{TM}$ approach to Value at Risk (VaR) calculation is a GARCH(1,1) process without a drift.

b. Calculation of VaR is essentially centered around the estimation of the cumulative distribution function (CDF) and/or its quantiles for the continuously compounded returns.

c. Since log returns are characterized by heavy tails the normality assumption in $RiskMetrics^{TM}$ often leads to overestimation of VaR.

d. VaR for a log return of the IBM stock for a 30-day horizon is simply $\sqrt{30} * VaR_t(1)$, where $VaR_t(1)$ is VaR of the IBM log returns for a 1-day horizon.

e. US civilian unemployment is characterized by countercyclical behavior with a slow rise and quick decay of the unemployment rate.

IV. Suppose you are interested in calculating Value at Risk (VaR) of the continuously compounded log returns of the Intel stock using $RiskMetrics^{TM}$. An investor holds 1,000,000 USD in the long position of the Intel stock.

a. The variance of a continuously compounded daily returns of the Intel stock is 0.25%. Recall that a 5% VaR for a 1-day horizon is given by Amount of the position $* 1.65 * \gamma$, where γ is a measure of volatility. Plug in the numbers (you do not have to calculate!).

What is a 90-day VaR given that $RiskMetrics^{TM}$ is referred to as *squared root of time rule* in VaR calculation?

b. Is this likely to be a lower or an upper bound on the VaR? Explain in 1-2 sentences based on typical characteristics of the log returns.

Suppose that a financial institution cares mostly about profits while a regulatory committee cares mostly about stability of the financial institution even after a catastrophic event. Given these preferences and properties of $RiskMetrics^{TM}$ who would prefer to use $RiskMetrics^{TM}$ - a financial institution or a regulatory committee? Explain in 1-2 sentences.

c. Recall that $RiskMetrics^{TM}$ approach implies that the conditional distribution of the daily log returns $r_t[k]|F_t$ is normal with mean 0 and variance of $k\sigma_{t+1}^2$. What will happen to VaR estimate based on the 5% quantile of the normal distribution with positive mean (compared to $RiskMetrics^{TM}$ estimate)? Explain in 1-2 sentences. *(Hint: It is important to consider the sign of VaR.)*