

# Advanced Risk Management

## Computer Lab 4

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## Question 1

# Data investigation

- Change your working directory
  - ▷ `cd "..."`
- Load the data
  - ▷ `use StockIndex.dta`
    - ★ Variable "newdate" is in a format of business date
- Load business calendar "index", file name "index.stbcal"
  - ▷ `bcal load index`
  - ▷ Business calendar determines which dates should appear in the calendar based on observations containing missing values

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## Question 2

## Bivariate CCC model (1/3)

CCC model stands for **Constant** *Conditional Correlation*:

- Conditional correlation matrix is constant
- Time-variation in the conditional covariance matrix is provided only by dynamic variances

## Bivariate CCC model (2/3)

- Estimate bivariate CCC model
  - ▷ `mgarch ccc (SP500 Dax30), arch(1) garch(1)`
    - ★ `arch(1)`: one ARCH term for each conditional variance process
    - ★ `garch(1)`: one GARCH term for each conditional variance process
- Filter conditional covariance matrix
  - ▷ `predict v_ccc*, variance`
    - ★ This command obtains three variance predictions (SP500/SP500, SP500/Dax30, Dax30/Dax30) with the names starting with `v_ccc`
- Filter conditional correlation matrix
  - ▷ `predict r_ccc*, correlation`
    - ★ This command obtains three correlation predictions (SP500/SP500, SP500/Dax30, Dax30/Dax30) with the names starting with `r_ccc`

## Bivariate CCC model (3/3)

### Questions:

- What is the correlation value SP500/SP500 and Dax30/Dax30?
- What is the correlation value SP500/Dax30? Is it time-varying or constant?
- Can you construct the correlation value SP500/Dax30 using filtered variance estimates? (as a safe check, use the correlation value obtained from the Stata command)

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## Question 3



## Bivariate DCC model

DCC model stands for **Dynamic Conditional Correlation**

- Time-varying correlation matrix
- Use the same commands as above, but change **ccc** into **dcc**
- Pay attention: “Adjustment” ( $\lambda_1$ ,  $\lambda_2$ ) parameters govern the dynamic correlation process
  - ★ “lambda1” corresponds to  $\alpha$
  - ★ “lambda2” corresponds to  $\beta$
- Question: do you find that  $\alpha + \beta < 1$ ?

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## Question 4

## CCC vs DCC

- Construct a plot with the correlation obtained from CCC and DCC models:
  - ▷ What do you expect to see?
  - ▷ Which model produces *constant* correlation? Which model produces *time-varying* correlation?
  - ▷ Do you observe peaks in the correlation around crisis periods?
- Conduct LR test:
  - ▷ Use stored results from both models (we stored estimation results as CCC and DCC)
  - ▷ DCC model is more flexible than CCC; DCC nests CCC (when  $\alpha = \beta = 0$ )
  - ▷ Use command `lrtest`
- Question: do you reject the null from the LR test?

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## Question 5

## Portfolio variance (1/2)

- Use equal portfolio weights for each index:  $w_1 = w_2 = \frac{1}{2}$
- Construct portfolio variance:

$$\begin{aligned}\text{Var}(w_1 R_1 + w_2 R_2) &= w_1^2 \text{Var}(R_1) + w_2^2 \text{Var}(R_2) \\ &\quad + 2w_1 w_2 \text{Cov}(R_1, R_2)\end{aligned}\tag{1}$$

- Using  $w_1 = w_2 = \frac{1}{2}$ , we obtain

$$\begin{aligned}\text{Var}\left(\frac{1}{2}R_1 + \frac{1}{2}R_2\right) &= \frac{1}{4}\text{Var}(R_1) + \frac{1}{4}\text{Var}(R_2) \\ &\quad + \frac{1}{2}\text{Cov}(R_1, R_2)\end{aligned}\tag{2}$$

- $\text{Var}^i(R_1)$ ,  $\text{Var}^i(R_2)$  and  $\text{Cov}^i(R_1, R_2)$  vary for CCC and DCC models,  $i = CCC, DCC$

## Portfolio variance (2/2)

- Obtain portfolio standard deviation:  $\sqrt{\text{Var}\left(\frac{1}{2}R_1 + \frac{1}{2}R_2\right)}$
- Make a graph comparing CCC and DCC portfolio standard deviations
- Questions:
  - ▷ Which pattern do you observe from the implied portfolio standard deviations?
  - ▷ What is the conclusion about the importance of the time-variation in correlation? (Recall: DCC differs from CCC by its time-varying correlation)

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## Question 6

## Multivariate DCC

- Fit DCC model using all four stock indices
- Filter correlation series between SP500 and Dax30
- Compare the results for correlation with the ones obtained from the bivariate DCC model (Question 3)
- Questions:
  - ▷ Which differences do you observe in plotted correlation series?
  - ▷ Can you make a conclusion about how robust/sensitive a DCC model is?



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