# R exercises: week 3

## Financial Econometrics

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# CHAPTER 6: Multivariate GARCH models

1. Run the R file `generate_DVECH.R` to generate from a bivariate DVECH model. Make following changes. Set the sample size of the generated series to $T = 2000$. Try different parameter values and plot the results.
2. Write R code to simulate from a bivariate CCC model. Then do the following:

   - Simulate from the bivariate CCC model a sequence of length $T = 1000$. Use the as parameter values $\rho_{12,t} = \rho_{12} = 0.5$
   - Plot the simulated conditional variances, covariance and correlation. Comment on the results.

# CHAPTER 7: Estimation of multivariate GARCH models

1. Inspect carefully the R file `estimation_sDVECH.R` for the estimation of a bivariate DVECH(1,1) model by maximum likelihood. Do the following

   - Use as dataset the bivariate time series of weekly log-returns of Microsoft (MSFT) and Intel (INTC) from beginning of 2005 to the end of 2016. Estimate a bivariate scalar DVECH(1,1) model and report the parameter estimates.
   - Plot the estimated conditional variances $\sigma^2_{1,t}$ and $\sigma^2_{2,t}$ for Microsoft and Intel respectively. Plot the estimated conditional covariance $\sigma_{12,t}$ as well as the estimated conditional correlation $\rho_{12,t}$, namely $\rho_{12,t} = \sigma_{12,t}/\sqrt{\sigma^2_{1,t}\sigma^2_{2,t}}$. Comment on the results. Is the conditional covariance positive in all time periods?
   - Obtain the 1-step ahead forecast for the conditional covariance matrix of $(y_{1,T+1}, y_{2,T+1})$, i.e. $\Sigma_{T+1}$, where 1 denotes Microsoft and 2 denotes Intel.

2. Inspect carefully the R file `CT_estimation_sDVECH.R` for the estimation of a bivariate sDVECH(1,1) model by covariance targeting. Do the following

   - Use as dataset the bivariate time series of weekly log-returns of Microsoft (MSFT) and Intel (INTC) from beginning of 2005 to the end of 2016. Estimate a bivariate sDVECH(1,1) model and report the parameter estimates.
   - Plot the estimated conditional variances $\sigma^2_{1,t}$ and $\sigma^2_{2,t}$ for Microsoft and Intel respectively. Plot the estimated conditional covariance $\sigma_{12,t}$ as well as the estimated conditional correlation $\rho_{12,t}$. Comment on the results.
   - Obtain the 1-step ahead forecast for the conditional covariance matrix of $(y_{1,T+1}, y_{2,T+1})$, i.e. $\Sigma_{T+1}$, where 1 denotes Microsoft and 2 denotes Intel.

3. Inspect carefully the R file `estimation_CCC.R` for the estimation of a bivariate CCC model. Do the following

   - Use as dataset the bivariate time series of weekly log-returns of Microsoft (MSFT) and Intel (INTC) from beginning of 2005 to the end of 2016. Estimate a bivariate CCC model and report the parameter estimates.
   - Plot the estimated conditional variances $\sigma^2_{1,t}$ and $\sigma^2_{2,t}$ for Microsoft and Intel respectively. Plot the estimated conditional covariance $\sigma_{12,t}$ as well as the estimated conditional correlation $\rho_{12,t}$. Comment on the results.
   - Obtain the 1-step ahead forecast for the conditional covariance matrix of $(y_{1,T+1}, y_{2,T+1})$, i.e. $\Sigma_{T+1}$, where 1 denotes Microsoft and 2 denotes Intel.

# CHAPTER 8: Econometric analysis with multivariate GARCH

1. Inspect carefully the R file `portfolio_CCC.R` to obtain optimal portfolio weights using a bivariate CCC model. Then do the following

   - Use as dataset the bivariate time series of monthly log-returns of Apple (AAPL) and Intel (INTC) from beginning of 2006 to the end of 2016. Obtain and plot the optimal portfolio weights $k_{1,t}$ and $k_{2,t}$, where 1 denotes Apple and 2 denote Intel, that maximize the Sharpe Ratio. Comment on the results.
   - Obtain the optimal portfolio weights for next month, namely $k_{1,T+1}$ and $k_{2,T+1}$.
   - Obtain and plot the log-returns of the optimal portfolio, i.e. $\{y_{p,t}\}_{t=1}^{T}$ where $y_{p,t} = k_{1,t}y_{1,t} + k_{2,t}y_{2,t}$.
   - Obtain and plot the conditional variance $\sigma_{p,t}^2$ and the conditional mean $\mu_{p,t} = \mu_p$ of the optimal portfolio.

2. Repeat the previous exercise using the bivariate sDVECH(1,1) model instead of the CCC model. Use covariance targeting to estimate the model. Compare the optimal weights with those obtained with the CCC model. Comment on the results.