TIØ4317
Empirical and Quantitative Methods in Finance
Exercise 6

Instructions

Solutions to the problems will be posted on BlackBoard after the deadline. You can use either Excel or a high-level programming language, e.g., R or Python, to solve the programming exercises. Write your solutions using MS Word or LaTeX and deliver it in a single PDF.

Deadline: Monday 10.03.2025, 23:59. **Grading:** Passed/Failed.

Task 1: MGARCH

The following two models have been estimated to forecast volatilities and correlations of a portfolio of energy futures. The estimation was conducted using the ARCH Maximum Likelihood method, incorporating different covariance specifications. Below are the results.

1. Write down the equation for each model and explain their meaning.
2. Explain the challenges of multivariate volatility forecasting and discuss how the two models above are addressing those challenges.
3. Comment on the significance of correlations in both models. Do you think that the models are flexible enough to adequately forecast the correlations between energy future returns?

Task 2: VAR

1. Define the Vector Autoregressive (VAR) model and write its general equation.
2. What are the advantages and limitations of using a VAR model in time series forecasting?
3. How do you determine the optimal lag length in a VAR model?
4. Explain the concept of Granger causality in the context of VAR models.
5. How can impulse response functions (IRFs) be used to interpret VAR model results?

System: UNTITLED
Estimation Method: ARCH Maximum Likelihood (BFGS / Marquardt steps)

Sample: 1/05/2000 8/28/2017
Included observations: 4507
Total system (balanced) observations 9014
Presample covariance: backcast (parameter =0.7)
Convergence achieved after 78 iterations
Coefficient covariance computed using outer product of gradients

	Coefficient	Std. Error	z-Statistic	Prob.
C(1)	0.000555	0.000279	1.992415	0.0463
C(2)	0.000612	0.000324	1.889101	0.0589
	Variance Equation Coefficients			
C(3)	9.09E-06	9.21E-07	9.872943	0.0000
C(4)	1.28E-05	1.23E-06	10.40005	0.0000
C(5)	2.48E-05	2.43E-06	10.22410	0.0000
C(6)	0.282993	0.005797	48.81496	0.0000
C(7)	0.333943	0.006479	51.54028	0.0000
C(8)	0.081249	0.025633	3.169643	0.0015
C(9)	-0.039982	0.032657	-1.224290	0.2208
C(10)	0.950920	0.002006	474.1009	0.0000
C(11)	0.927887	0.003074	301.8817	0.0000

Log likelihood	22658.89	Schwarz criterion	-10.03444
Avg. log likelihood	2.513744	Hannan-Quinn criter.	-10.04458
Akaike info criterion	-10.05010		

Equation: HOILRET = C(1)

R-squared	-0.000210	Mean dependent var	0.000179
Adjusted R-squared	-0.000210	S.D. dependent var	0.025955
S.E. of regression	0.025958	Sum squared resid	3.036276
Durbin-Watson stat	2.055004		

Equation: GASOLINERET = C(2)

R-squared	-0.000206	Mean dependent var	0.000217
Adjusted R-squared	-0.000206	S.D. dependent var	0.027477
S.E. of regression	0.027479	Sum squared resid	3.402578
Durbin-Watson stat	1.994247		

Covariance specification: Diagonal BEKK
GARCH = M + A1*RESID(-1)*RESID(-1)'*A1 + D1*(RESID(-1)*(RESID(-1)<0))*(RESID(-1)*(RESID(-1)<0))'*D1 + B1*GARCH(-1)*B1
M is an indefinite matrix
A1 is a diagonal matrix
D1 is a diagonal matrix
B1 is a diagonal matrix

Transformed Variance Coefficients

	Coefficient	Std. Error	z-Statistic	Prob.
M(1,1)	9.09E-06	9.21E-07	9.872943	0.0000
M(1,2)	1.28E-05	1.23E-06	10.40005	0.0000
M(2,2)	2.48E-05	2.43E-06	10.22410	0.0000
A1(1,1)	0.282993	0.005797	48.81496	0.0000
A1(2,2)	0.333943	0.006479	51.54028	0.0000
D1(1,1)	0.081249	0.025633	3.169643	0.0015
D1(2,2)	-0.039982	0.032657	-1.224290	0.2208
B1(1,1)	0.950920	0.002006	474.1009	0.0000
B1(2,2)	0.927887	0.003074	301.8817	0.0000

System: UNTITLED
Estimation Method: ARCH Maximum Likelihood (BFGS / Marquardt steps)
Covariance specification:
Date: 06/19/21 Time: 14:53
Sample: 1/05/2000 8/28/2017
Included observations: 4507
Total system (balanced) observations 9014
Presample covariance: backcast (parameter =0.7)
Convergence achieved after 32 iterations
Coefficient covariance computed using outer product of gradients

	Coefficient	Std. Error	z-Statistic	Prob.
C(1)	0.000524	0.000249	2.106330	0.0352
C(2)	0.000580	0.000302	1.918179	0.0551

Variance Equation Coefficients

C(3)	8.20E-06	8.14E-07	10.07828	0.0000
C(4)	0.091374	0.004116	22.20140	0.0000
C(5)	0.896730	0.004199	213.5726	0.0000
C(6)	1.81E-05	1.94E-06	9.338277	0.0000
C(7)	0.109451	0.004900	22.33644	0.0000
C(8)	0.870748	0.005809	149.8839	0.0000
C(9)	0.681547	0.006542	104.1821	0.0000

Log likelihood	22501.88	Schwarz criterion	-9.968502
Avg. log likelihood	2.496326	Hannan-Quinn criter.	-9.976797
Akaike info criterion	-9.981309		

Equation: HOILRET = C(1)

R-squared	-0.000177	Mean dependent var	0.000179
Adjusted R-squared	-0.000177	S.D. dependent var	0.025955
S.E. of regression	0.025958	Sum squared resid	3.036174
Durbin-Watson stat	2.055073		

Equation: GASOLINERET = C(2)

R-squared	-0.000174	Mean dependent var	0.000217
Adjusted R-squared	-0.000174	S.D. dependent var	0.027477
S.E. of regression	0.027479	Sum squared resid	3.402469
Durbin-Watson stat	1.994311		

Covariance specification: Constant Conditional Correlation
GARCH(i) = M(i) + A1(i)*RESID(i)(-1)^2 + B1(i)*GARCH(i)(-1)
COV(i,j) = R(i,j)*@SQRT(GARCH(i)*GARCH(j))

Transformed Variance Coefficients

	Coefficient	Std. Error	z-Statistic	Prob.
M(1)	8.20E-06	8.14E-07	10.07828	0.0000
A1(1)	0.091374	0.004116	22.20140	0.0000
B1(1)	0.896730	0.004199	213.5726	0.0000
M(2)	1.81E-05	1.94E-06	9.338277	0.0000
A1(2)	0.109451	0.004900	22.33644	0.0000
B1(2)	0.870748	0.005809	149.8839	0.0000
R(1,2)	0.681547	0.006542	104.1821	0.0000