

Practical 3

Notes for Eviews9

Nur Dhani Hendranastiti

Financial Modelling and Business Forecasting

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ARCH

- The model:

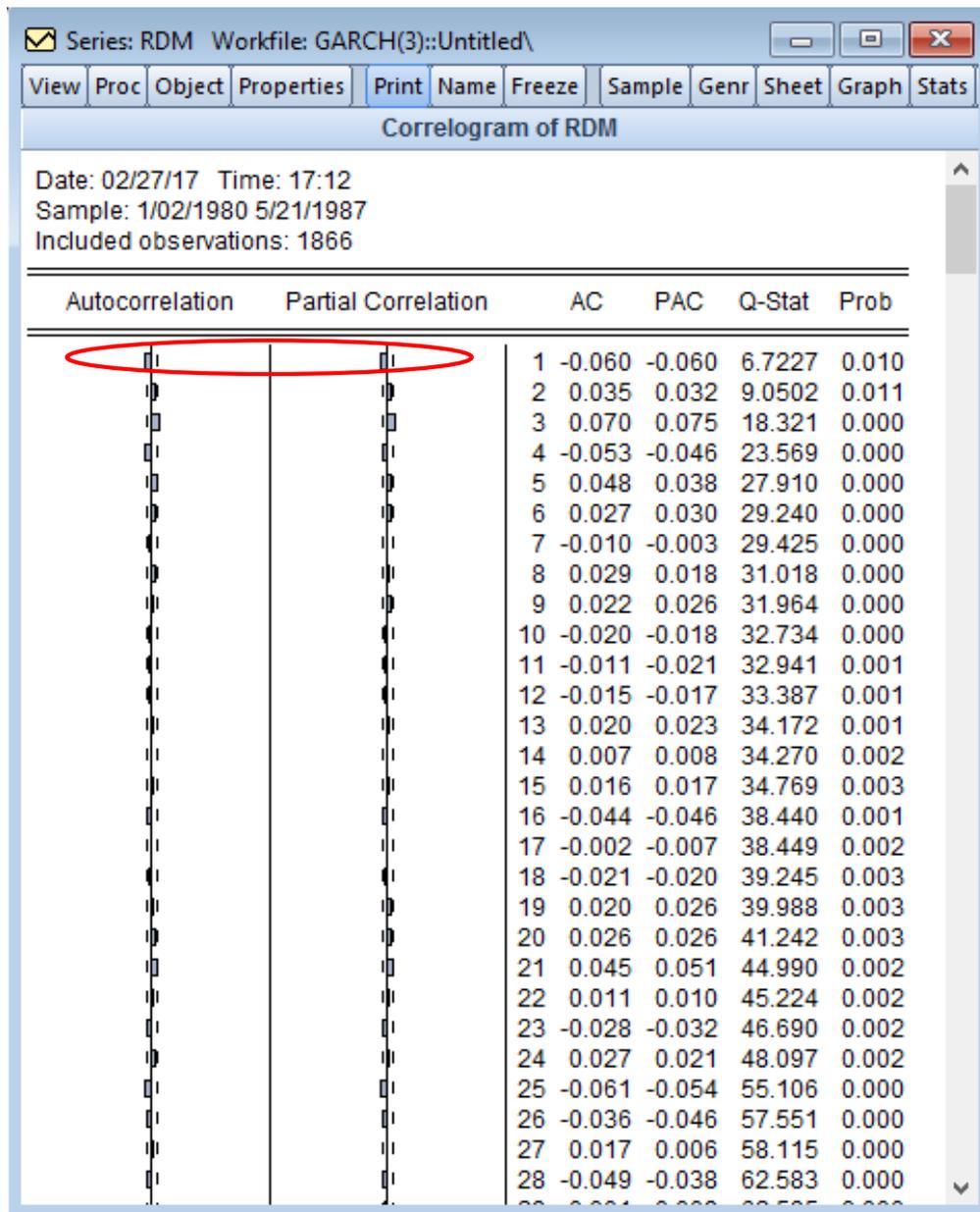
$$\hat{u}_t^2 = \gamma_0 + \gamma_1 \hat{u}_{t-1}^2 + \gamma_2 \hat{u}_{t-2}^2 + \dots + \gamma_q \hat{u}_{t-q}^2 + v_t$$

- Testing for “ARCH effects”

$H_0 : \gamma_1 = 0$ and $\gamma_2 = 0$ and $\gamma_3 = 0$ and ... and $\gamma_q = 0$

$H_1 : \gamma_1 \neq 0$ or $\gamma_2 \neq 0$ or $\gamma_3 \neq 0$ or ... or $\gamma_q \neq 0$.

If the value of the test statistic is greater than the critical value from the χ^2 distribution, then reject the null hypothesis.



Identification of ARMA Model

ARMA Estimation

Equation Estimation

Specification Options

Equation specification

Dependent variable followed by list of regressors including ARMA and PDL terms, OR an explicit equation like $Y=c(1)+c(2)^*X$.

rdm c ar(1)

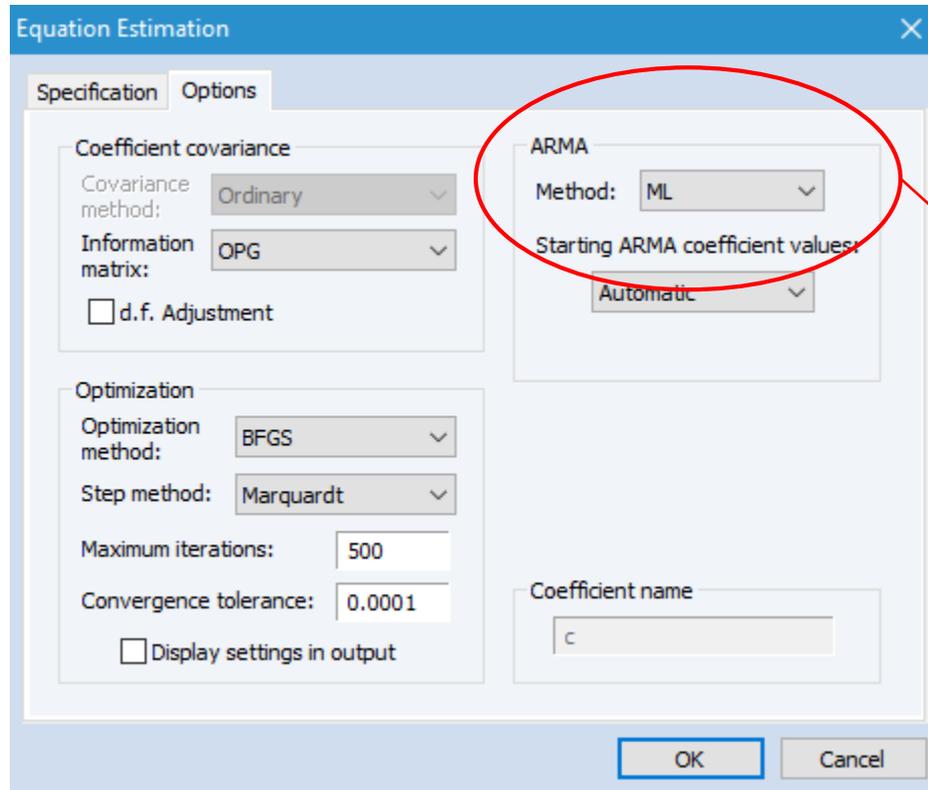
Estimation settings

Method: LS - Least Squares (NLS and ARMA)

Sample: 1/02/1980 5/21/1986

OK Cancel

ARMA Estimation



The screenshot shows the 'Equation Estimation' dialog box with two tabs: 'Specification' and 'Options'. The 'Options' tab is active. Under the 'Coefficient covariance' section, 'Covariance method' is set to 'Ordinary' and 'Information matrix' is set to 'OPG'. There is a checkbox for 'd.f. Adjustment' which is unchecked. Under the 'Optimization' section, 'Optimization method' is 'BFGS', 'Step method' is 'Marquardt', 'Maximum iterations' is 500, and 'Convergence tolerance' is 0.0001. There is a checkbox for 'Display settings in output' which is unchecked. The 'ARMA' section is circled in red and contains 'Method: ML' and 'Starting ARMA coefficient values: Automatic'. At the bottom, there is a 'Coefficient name' field with the value 'c'. 'OK' and 'Cancel' buttons are at the bottom right.

The default for ARMA method in Eviews9 is Maximum Likelihood (ML), but we need to use Least Square

ARMA Estimation

Equation Estimation

Specification Options

Coefficient covariance

Covariance method: Ordinary

Information matrix: OPG

d.f. Adjustment

Optimization

Optimization method: BFGS

Step method: Marquardt

Maximum iterations: 500

Convergence tolerance: 0.0001

Display settings in output

ARMA

Method: CLS

Starting AR: ML

Starting AR: GLS

Starting AR: CLS

Starting AR: OLS/TSLS

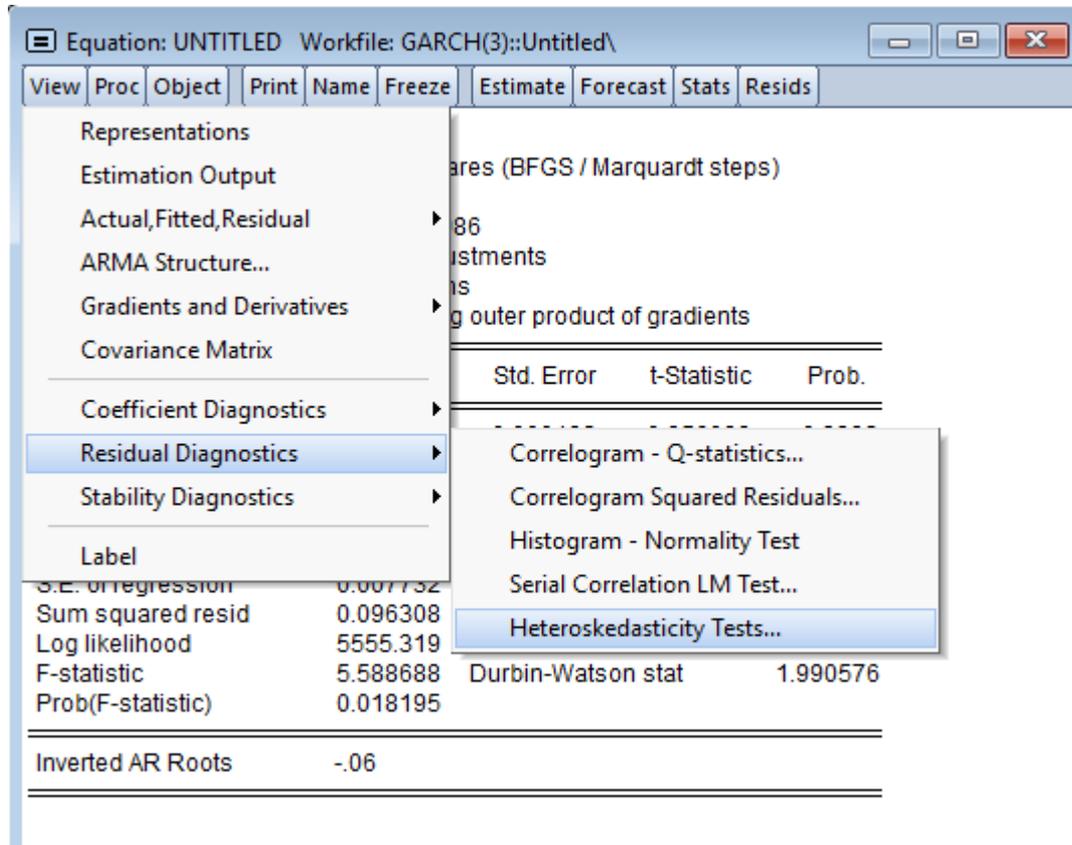
Coefficient name

c

OK Cancel

Choose the CLS
(Conditional
Least Square) for
the ARMA
method

Checking Heteroskedasticity



The screenshot shows the EViews software interface. The title bar reads "Equation: UNTITLED Workfile: GARCH(3)::Untitled\". The menu bar includes "View", "Proc", "Object", "Print", "Name", "Freeze", "Estimate", "Forecast", "Stats", and "Resids". The "View" menu is open, showing options like "Representations", "Estimation Output", "Actual,Fitted,Residual", "ARMA Structure...", "Gradients and Derivatives", "Covariance Matrix", "Coefficient Diagnostics", "Residual Diagnostics", "Stability Diagnostics", and "Label". The "Residual Diagnostics" option is selected, opening a sub-menu with "Correlogram - Q-statistics...", "Correlogram Squared Residuals...", "Histogram - Normality Test", "Serial Correlation LM Test...", and "Heteroskedasticity Tests...". The "Heteroskedasticity Tests..." option is highlighted. Below the menu, a table of regression statistics is visible.

	Std. Error	t-Statistic	Prob.
S.E. of regression	0.007732		
Sum squared resid	0.096308		
Log likelihood	5555.319		
F-statistic	5.588688		
Prob(F-statistic)	0.018195		
Durbin-Watson stat		1.990576	
Inverted AR Roots			-.06

Estimating ARCH

Equation Estimation

Specification Options

Mean equation

Dependent followed by regressors & ARMA terms OR explicit equation:

`dm c ar(1)` ARCH-M: None

Variance and distribution specification

Model: GARCH/TARCH

Variance regressors:

Order:

ARCH: 6 Threshold order: 0

GARCH: 0

Restrictions: None

Error distribution: Normal (Gaussian)

Estimation settings

Method: ARCH - Autoregressive Conditional Heteroskedasticity

Sample: 1/02/1980 5/21/1987

OK Cancel

Estimating ARCH

Equation Estimation

Specification Options

Estimation Options

Optimization method: BFGS

Step method: Marquardt

Max Iterations: 500

Convergence: 0.0001

Display iteration settings

Starting values

Starting coefficient values: EViews supplied

Presample variance: Backcast with parameter = 0.7

Backcast presample MA terms

Coefficient name: c

Coefficient covariance

Covariance method: Ordinary

Information matrix: OPG

Derivatives

Use numeric only

OK Cancel

The default in Eviews9 for the Optimization method is BFGS. Please change it into Eviews Legacy

Estimating ARCH

Equation Estimation

Specification Options

Estimation Options

Optimization method: EViews legacy

Legacy method: Marquardt

Max Iterations: 500

Convergence: 0.0001

Display iteration settings

Starting values

Starting coefficient values: EViews supplied

Presample variance: Backcast with parameter = 0.7

Backcast presample MA terms

Coefficient name: c

Coefficient covariance

Covariance method: Ordinary

Derivatives

Select method to favor:

Accuracy Speed

Use numeric only

OK Cancel

GARCH

- The model:

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^q \alpha_i u_{t-i}^2 + \sum_{j=1}^p \beta_j \sigma_{t-j}^2$$

- We model the conditional variance

Extension of GARCH

- GARCH assumes that positive and negative shock has same magnitude of effect on volatility (variance of error)
- It might not be the case, the effect might have different magnitude called as **Leverage Effect**
- Types:
 - GJR-GARCH
 - EGARCH

GJR - GARCH

- The model:

$$\sigma_t^2 = \alpha_0 + \alpha_1 u_{t-1}^2 + \beta \sigma_{t-1}^2 + \gamma u_{t-1}^2 I_{t-1}$$

where $I_{t-1} = 1$ if $u_{t-1} < 0$
= 0 otherwise

If there is leverage effect, $\gamma > 0$

Negative shock is expressed by $u_{t-1} < 0$, resulting $I_{t-1} = 1$

- We require $\alpha_1 + \gamma \geq 0$ and $\alpha_1 \geq 0$ for non-negativity.

Leverage effects: *volatility rises more following a price fall than following a price rise of the same magnitude.*

GJR - GARCH

Equation: UNTITLED Workfile: GARCH(3)::Untitled\

View Proc Object Print Name Freeze Estimate Forecast Stats Resids

Dependent Variable: RDM
 Method: ML ARCH - Normal distribution (Marquardt / EViews legacy)
 Date: 02/22/18 Time: 19:47
 Sample (adjusted): 1/04/1980 5/21/1987
 Included observations: 1865 after adjustments
 Convergence achieved after 10 iterations
 Presample variance: backcast (parameter = 0.7)
 GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*RESID(-1)^2*(RESID(-1)<0) + C(6)*GARCH(-1)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-0.000290	0.000148	-1.963970	0.0495
AR(1)	-0.078218	0.024887	-3.142882	0.0017
Variance Equation				
C	1.05E-06	3.12E-07	3.371450	0.0007
RESID(-1)^2	0.078403	0.011342	6.912471	0.0000
RESID(-1)^2*(RESID(-1)<0)	0.034773	0.014465	2.404015	0.0162
GARCH(-1)	0.892826	0.012568	71.03789	0.0000
R-squared	0.001854	Mean dependent var	-1.96E-05	
Adjusted R-squared	0.001318	S.D. dependent var	0.007770	
S.E. of regression	0.007765	Akaike info criterion	-6.999506	
Sum squared resid	0.112332	Schwarz criterion	-6.981712	
Log likelihood	6533.039	Hannan-Quinn criter.	-6.992949	
Durbin-Watson stat	1.955766			
Inverted AR Roots	-08			

$$\sigma_t^2 = \alpha_0 + \alpha_1 u_{t-1}^2 + \beta \sigma_{t-1}^2 + \gamma u_{t-1}^2 I_{t-1}$$

EGARCH

- The model:

$$\log(\sigma_t^2) = \omega + \beta \log(\sigma_{t-1}^2) + \gamma \frac{u_{t-1}}{\sqrt{\sigma_{t-1}^2}} + \alpha \left[\frac{|u_{t-1}|}{\sqrt{\sigma_{t-1}^2}} - \sqrt{\frac{2}{\pi}} \right]$$

The relationship
between volatility and
returns is negative →
 γ is negative →
leverage effect

EGARCH

Equation: UNTITLED Workfile: GARCH(3)::Untitled\

View Proc Object Print Name Freeze Estimate Forecast Stats Resids

Dependent Variable: RDM
 Method: ML ARCH - Normal distribution (Marquardt / EViews legacy)
 Date: 02/22/18 Time: 19:52
 Sample (adjusted): 1/04/1980 5/21/1987
 Included observations: 1865 after adjustments
 Convergence achieved after 11 iterations
 Presample variance: backcast (parameter = 0.7)
 LOG(GARCH) = C(3) + C(4)*ABS(RESID(-1))@SQRT(GARCH(-1)) + C(5)*RESID(-1)@SQRT(GARCH(-1)) + C(6)*LOG(GARCH(-1))

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-0.000314	0.000145	-2.169099	0.0301
AR(1)	-0.082236	0.024145	-3.405867	0.0007
Variance Equation				
C(3)	-0.418916	0.075316	-5.562085	0.0000
C(4)	0.196645	0.019921	9.871341	0.0000
C(5)	-0.019000	0.009381	-2.025374	0.0428
C(6)	0.972646	0.006865	141.6762	0.0000
R-squared	0.001425	Mean dependent var	-1.96E-05	
Adjusted R-squared	0.000889	S.D. dependent var	0.007770	
S.E. of regression	0.007767	Akaike info criterion	-7.002333	
Sum squared resid	0.112381	Schwarz criterion	-6.984539	
Log likelihood	6535.676	Hannan-Quinn criter.	-6.995776	
Durbin-Watson stat	1.946998			
Inverted AR Roots	-.08			

$$\log(\sigma_t^2) = \omega + \beta \log(\sigma_{t-1}^2) + \gamma \frac{u_{t-1}}{\sqrt{\sigma_{t-1}^2}} + \alpha \left[\frac{|u_{t-1}|}{\sqrt{\sigma_{t-1}^2}} - \sqrt{\frac{2}{\pi}} \right]$$

GARCH-in Mean

- The model:

$$y_t = \mu + \delta \sigma_{t-1} + u_t, \quad u_t \sim N(0, \sigma_t^2)$$

$$\sigma_t^2 = \alpha_0 + \alpha_1 u_{t-1}^2 + \beta \sigma_{t-1}^2$$

Sort of risk premium;
It is expected that risk is compensated by higher return;
Can be done by including the risk into mean process;
If the coefficient is positive & significant, there is positive correlation between risk and return

GARCH-in Mean – Std.Dev

Equation Estimation

Specification Options

Mean equation
Dependent followed by regressors & ARMA terms OR explicit equation:
rdm c ar(1)

Variance and distribution specification

Model: GARCH/TARCH

Order:
ARCH: 1 Threshold order: 0
GARCH: 1

Restrictions: None

Variance regressors:

ARCH-M:
Std. Dev.
None
Std. Dev.
Variance
Log(Var)

Error distribution:
Normal (Gaussian)

Estimation settings

Method: ARCH - Autoregressive Conditional Heteroskedasticity

Sample: 1/02/1980 5/21/1987

OK Cancel

GARCH-in Mean – Std.Dev

Equation: UNTITLED Workfile: GARCH(3)::Untitled\

View Proc Object Print Name Freeze Estimate Forecast Stats Resids

Dependent Variable: RDM
Method: ML ARCH - Normal distribution (Marquardt / EViews legacy)
Date: 02/22/18 Time: 20:03
Sample (adjusted): 1/04/1980 5/21/1987
Included observations: 1865 after adjustments
Convergence achieved after 12 iterations
Presample variance: backcast (parameter = 0.7)
GARCH = C(4) + C(5)*RESID(-1)^2 + C(6)*GARCH(-1)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
@SQRT(GARCH)	0.244695	0.087546	2.795034	0.0052
C	-0.001847	0.000595	-3.101392	0.0019
AR(1)	-0.085665	0.025174	-3.402917	0.0007

Variance Equation

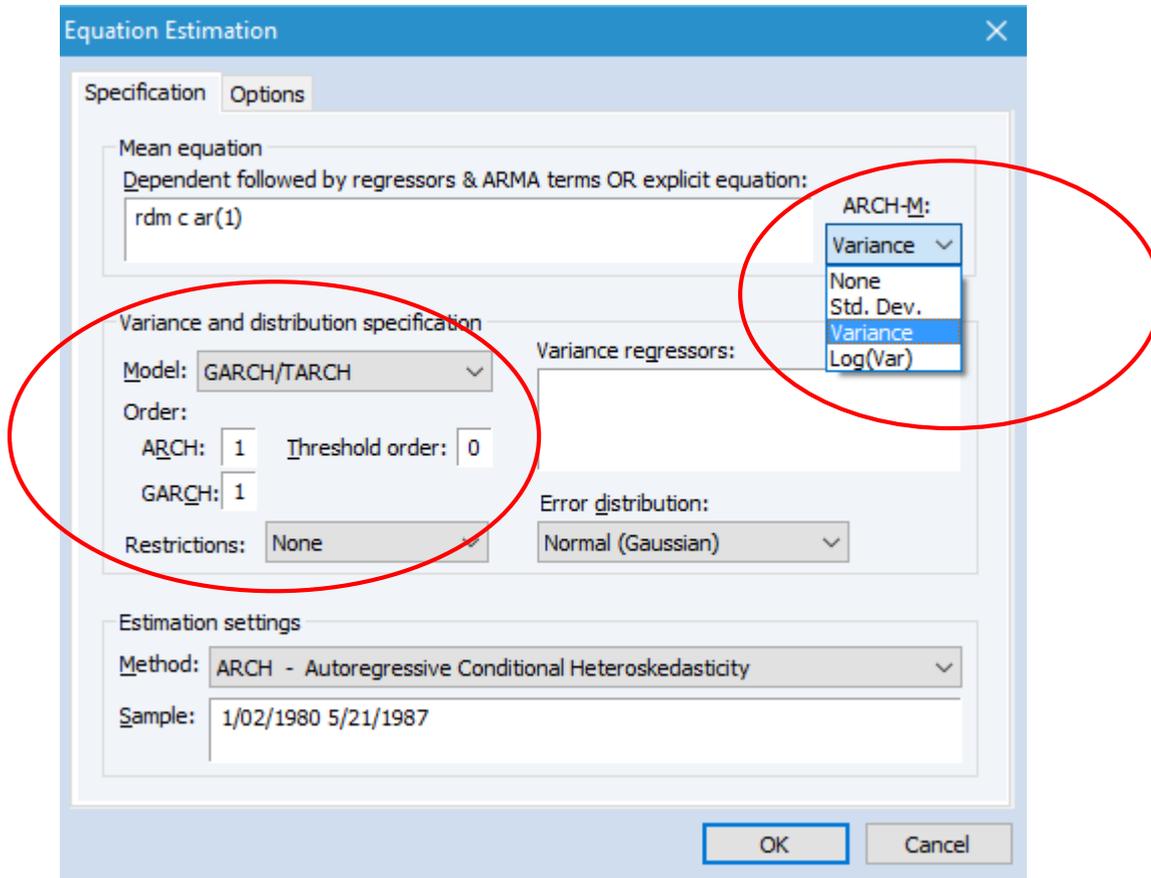
C	1.23E-06	3.19E-07	3.865632	0.0001
RESID(-1)^2	0.098935	0.010504	9.418936	0.0000
GARCH(-1)	0.885149	0.012378	71.50927	0.0000

R-squared 0.008327 Mean dependent var -1.96E-05
Adjusted R-squared 0.007262 S.D. dependent var 0.007770
S.E. of regression 0.007742 Akaike info criterion -7.002372
Sum squared resid 0.111604 Schwarz criterion -6.984578
Log likelihood 6535.712 Hannan-Quinn criter. -6.995816
Durbin-Watson stat 1.958257

Inverted AR Roots -.09

$$y_t = \mu + \delta \sigma_{t-1} + u_t, \quad u_t \sim N(0, \sigma_t^2)$$

GARCH-in Mean – Variance



GARCH-in Mean – Variance

Equation: UNTITLED Workfile: GARCH(3)::Untitled\

View Proc Object Print Name Freeze Estimate Forecast Stats Resids

Dependent Variable: RDM
Method: ML ARCH - Normal distribution (Marquardt / EViews legacy)
Date: 02/22/18 Time: 20:06
Sample (adjusted): 1/04/1980 5/21/1987
Included observations: 1865 after adjustments
Convergence achieved after 13 iterations
Presample variance: backcast (parameter = 0.7)
GARCH = C(4) + C(5)*RESID(-1)^2 + C(6)*GARCH(-1)

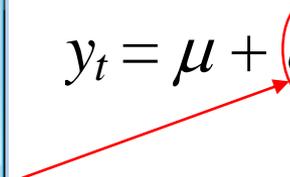
Variable	Coefficient	Std. Error	z-Statistic	Prob.
GARCH	15.71648	5.904249	2.661892	0.0078
C	-0.000969	0.000304	-3.186633	0.0014
AR(1)	-0.086602	0.025170	-3.440729	0.0006

Variance Equation

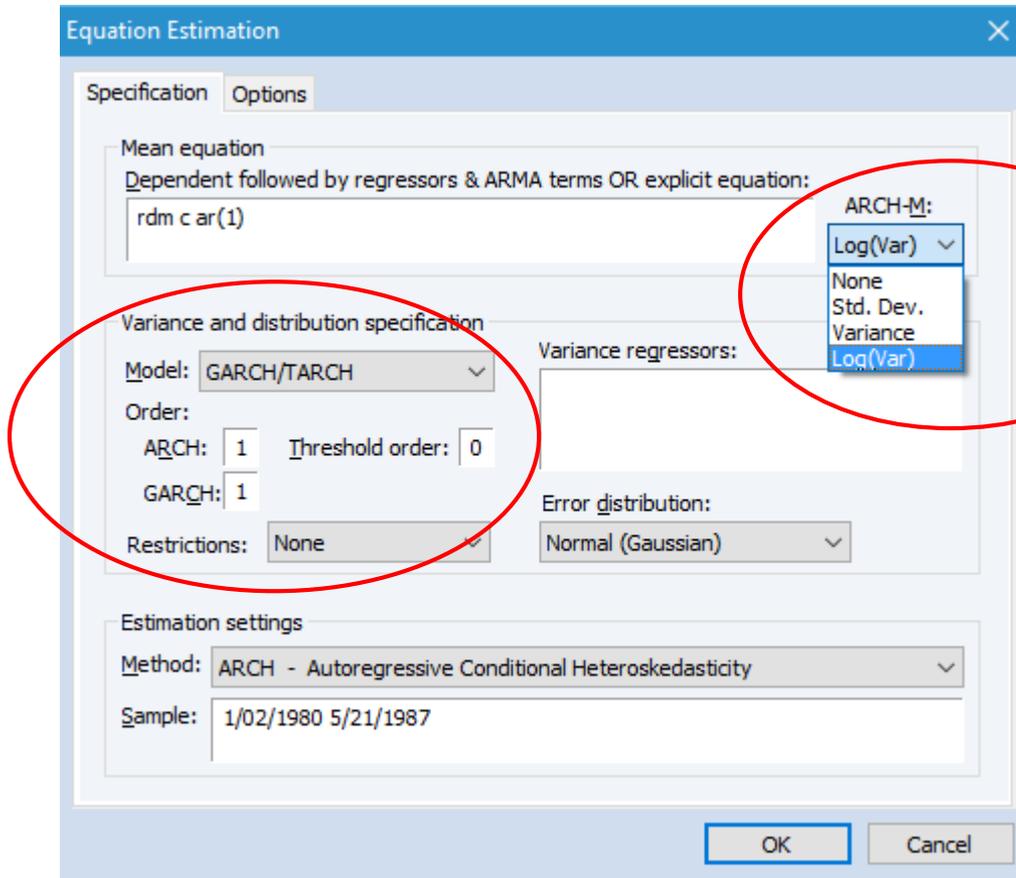
	Coefficient	Std. Error	z-Statistic	Prob.
C	1.24E-06	3.21E-07	3.870716	0.0001
RESID(-1)^2	0.098954	0.010479	9.442854	0.0000
GARCH(-1)	0.884995	0.012385	71.45897	0.0000

R-squared 0.007702 Mean dependent var -1.96E-05
Adjusted R-squared 0.006636 S.D. dependent var 0.007770
S.E. of regression 0.007744 Akaike info criterion -7.002194
Sum squared resid 0.111674 Schwarz criterion -6.984400
Log likelihood 6535.546 Hannan-Quinn criter. -6.995638
Durbin-Watson stat 1.958761

Inverted AR Roots -0.9

$$y_t = \mu + \delta \sigma_{t-1} + u_t, \quad u_t \sim N(0, \sigma_t^2)$$


GARCH-in Mean – Log(Var)



GARCH-in Mean – Log(Var)

Equation: UNTITLED Workfile: GARCH(3)::Untitled\

View Proc Object Print Name Freeze Estimate Forecast Stats Resids

Dependent Variable: RDM
Method: ML ARCH - Normal distribution (Marquardt / EViews legacy)
Date: 02/22/18 Time: 20:07
Sample (adjusted): 1/04/1980 5/21/1987
Included observations: 1865 after adjustments
Convergence achieved after 10 iterations
Presample variance: backcast (parameter = 0.7)
GARCH = C(4) + C(5)*RESID(-1)^2 + C(6)*GARCH(-1)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
LOG(GARCH)	0.000821	0.000299	2.744274	0.0061
C	0.008070	0.003019	2.673102	0.0075
AR(1)	-0.085285	0.025114	-3.395921	0.0007

Variance Equation

	Coefficient	Std. Error	z-Statistic	Prob.
C	1.24E-06	3.21E-07	3.870447	0.0001
RESID(-1)^2	0.098684	0.010520	9.380760	0.0000
GARCH(-1)	0.885182	0.012436	71.17952	0.0000

R-squared 0.008179 Mean dependent var -1.96E-05
Adjusted R-squared 0.007114 S.D. dependent var 0.007770
S.E. of regression 0.007743 Akaike info criterion -7.002208
Sum squared resid 0.111620 Schwarz criterion -6.984414
Log likelihood 6535.559 Hannan-Quinn criter. -6.995652
Durbin-Watson stat 1.956490

Inverted AR Roots -0.9

$$y_t = \mu + \delta \sigma_{t-1} + u_t, \quad u_t \sim N(0, \sigma_t^2)$$

Forecasting

The screenshot displays the EViews software interface. At the top, the menu bar includes 'View', 'Proc', 'Object', 'Print', 'Name', 'Freeze', 'Estimate', 'Forecast', 'Stats', and 'Resids'. The 'Forecast' menu item is circled in red. Below the menu bar, the main window shows the results of a GARCH(3) model estimation for the dependent variable 'RDM'. The model is specified as $GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*GARCH(-1)$. A table of coefficients is shown below the model equation, with a red arrow pointing from the 'Forecast' menu to the 'AR(1)' coefficient. The table is as follows:

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-0.000360	0.000144	-2.509008	0.0121
AR(1)	-0.078862	0.028002	-2.816279	0.0049

Below the coefficient table is the 'Variance Equation' table:

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	1.09E-06	3.05E-07	3.579756	0.0003
RESID(-1)^2	0.098988	0.011005	8.994833	0.0000
GARCH(-1)				

Overlaid on the bottom of the main window is the 'Forecast' dialog box. The 'Forecast of' section shows 'Equation: UNTITLED' and 'Series: RDM'. The 'Series names' section has 'Forecast name: dmf'. The 'Method' section has 'Dynamic forecast' selected with a radio button, which is circled in red. Other options include 'Static forecast', 'Structural (ignore ARMA)', and 'Coef uncertainty in S.E. calc' (checked). The 'Forecast sample' is set to '1/02/1980 5/21/1987'. The 'Output' section has 'Forecast graph' and 'Forecast evaluation' checked. At the bottom, there are 'OK' and 'Cancel' buttons.

Dynamic, multi-step forecasts starting from the 1st period in the forecast sample; takes the previously forecasted values of the lagged dependent variables

Static, a sequence of one-step ahead forecast using the actual values (if available).

References

- Brooks (2014), Chapter 9 “Modeling Volatility and Correlation”, 3rd Edition Cambridge
- Eviews9 help and user guide

http://www.eviews.com/help/helpintro.html#page/content%2FForecast-Forecasting_from_Equations_in_EViews.html%23