

Practical 3

Notes for Eviews9

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Financial Modelling and Business Forecasting

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ARCH

- The model:

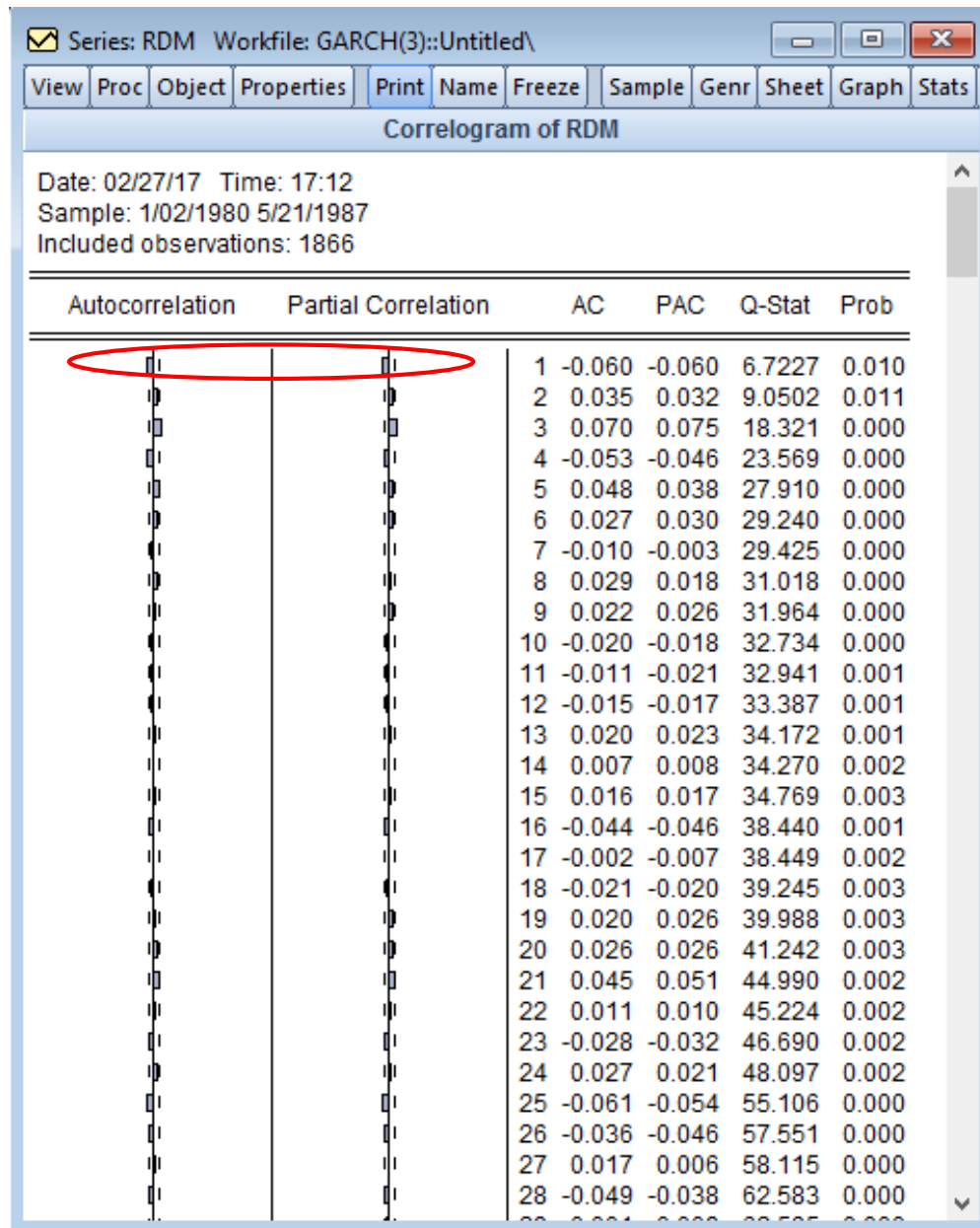
$$\hat{u}_t^2 = \gamma_0 + \gamma_1 \hat{u}_{t-1}^2 + \gamma_2 \hat{u}_{t-2}^2 + \dots + \gamma_q \hat{u}_{t-q}^2 + v_t$$

- Testing for “ARCH effects”

$H_0 : \gamma_1 = 0 \text{ and } \gamma_2 = 0 \text{ and } \gamma_3 = 0 \text{ and } \dots \text{ and } \gamma_q = 0$

$H_1 : \gamma_1 \neq 0 \text{ or } \gamma_2 \neq 0 \text{ or } \gamma_3 \neq 0 \text{ or } \dots \text{ or } \gamma_q \neq 0.$

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)

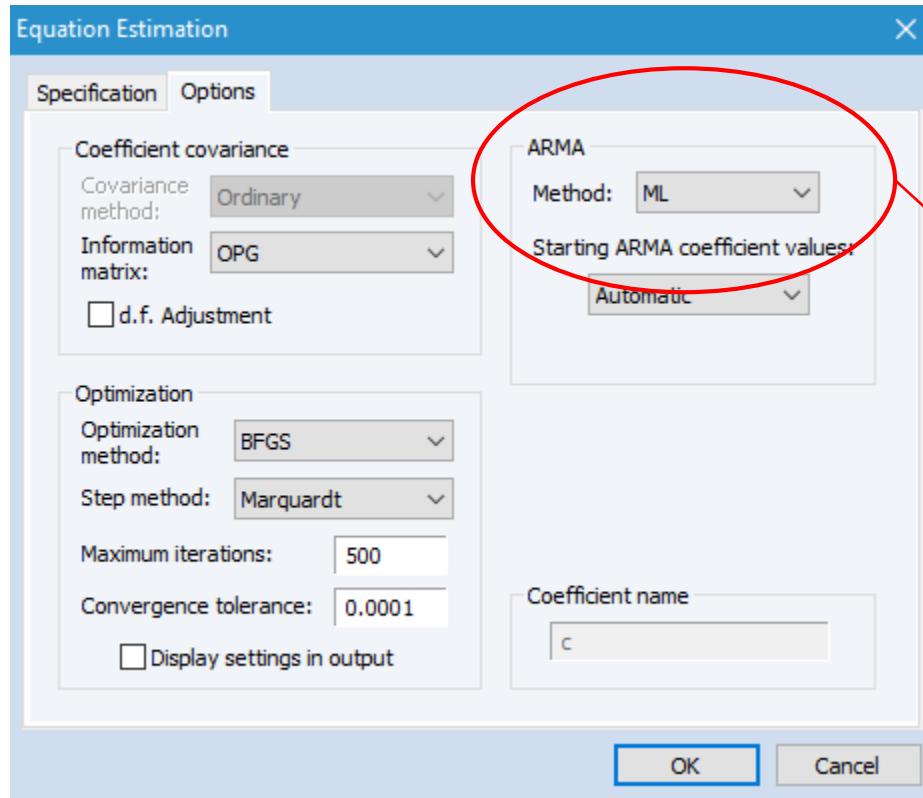
Estimation settings

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 the 'Specification' tab selected. The 'ARMA' section is circled in red. The 'Coefficient covariance' section shows 'Covariance method' set to 'Ordinary' and 'Information matrix' set to 'OPG'. The 'Optimization' section shows 'Optimization method' set to 'BFGS' and 'Step method' set to 'Marquardt'. The 'Maximum iterations' is set to 500 and 'Convergence tolerance' is set to 0.0001. The 'Starting ARMA coefficient values' are set to 'Automatic'. The 'Coefficient name' is set to 'c'. The 'OK' button is highlighted with a blue border.

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: ML

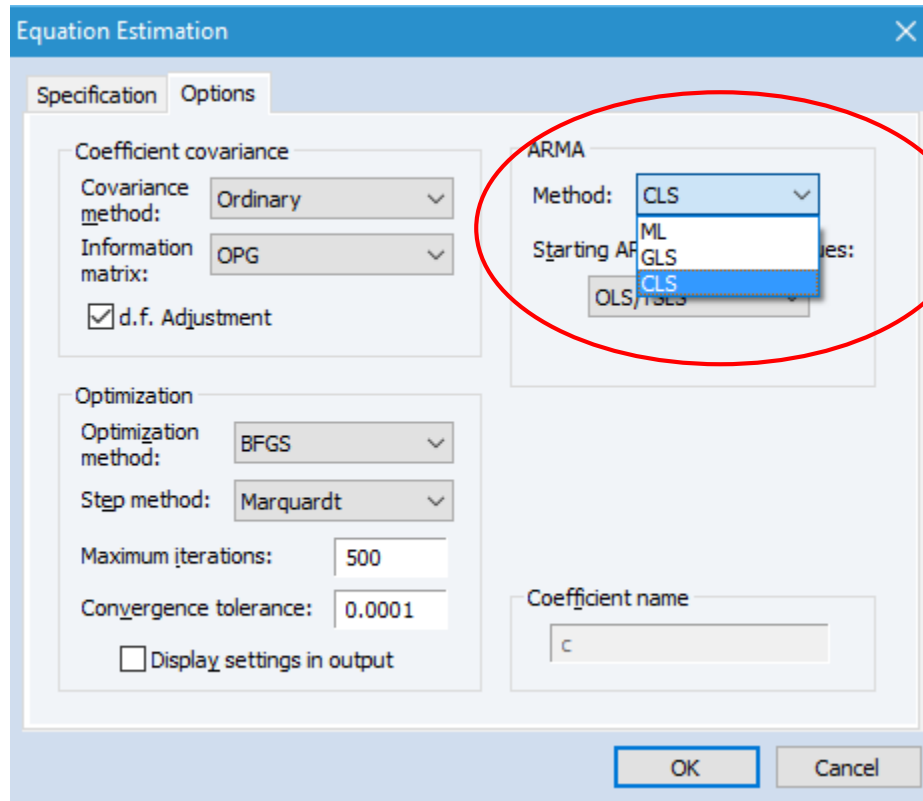
Starting ARMA coefficient values: Automatic

Coefficient name: c

OK Cancel

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

ARMA Estimation



The screenshot shows the 'Equation Estimation' dialog box with the 'Specification' tab selected. The 'ARMA' section has a 'Method' dropdown menu open, showing options: CLS, ML, GLS, and OLS/TSLS. The 'CLS' option is highlighted. Other settings include 'Covariance method: Ordinary', 'Information matrix: OPG', 'd.f. Adjustment' checked, 'Optimization method: BFGS', 'Step method: Marquardt', 'Maximum iterations: 500', 'Convergence tolerance: 0.0001', and 'Coefficient name: c'. The 'OK' button is highlighted.

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: 1

Starting MA: 1

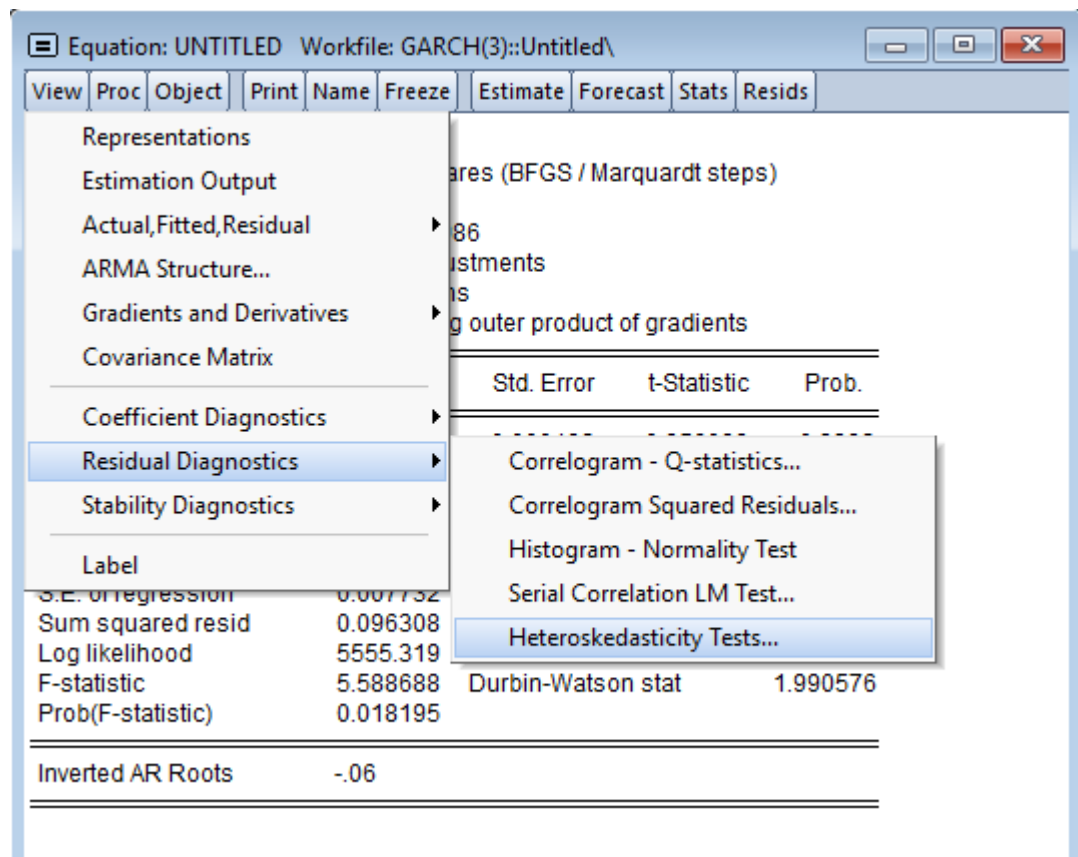
OLS/TSLS

Coefficient name: c

OK Cancel

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

Checking Heteroskedasticity



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

Order:

ARCH: 6 Threshold order: 0

GARCH: 0

Restrictions: None

Variance regressors:

Error distribution: Normal (Gaussian)

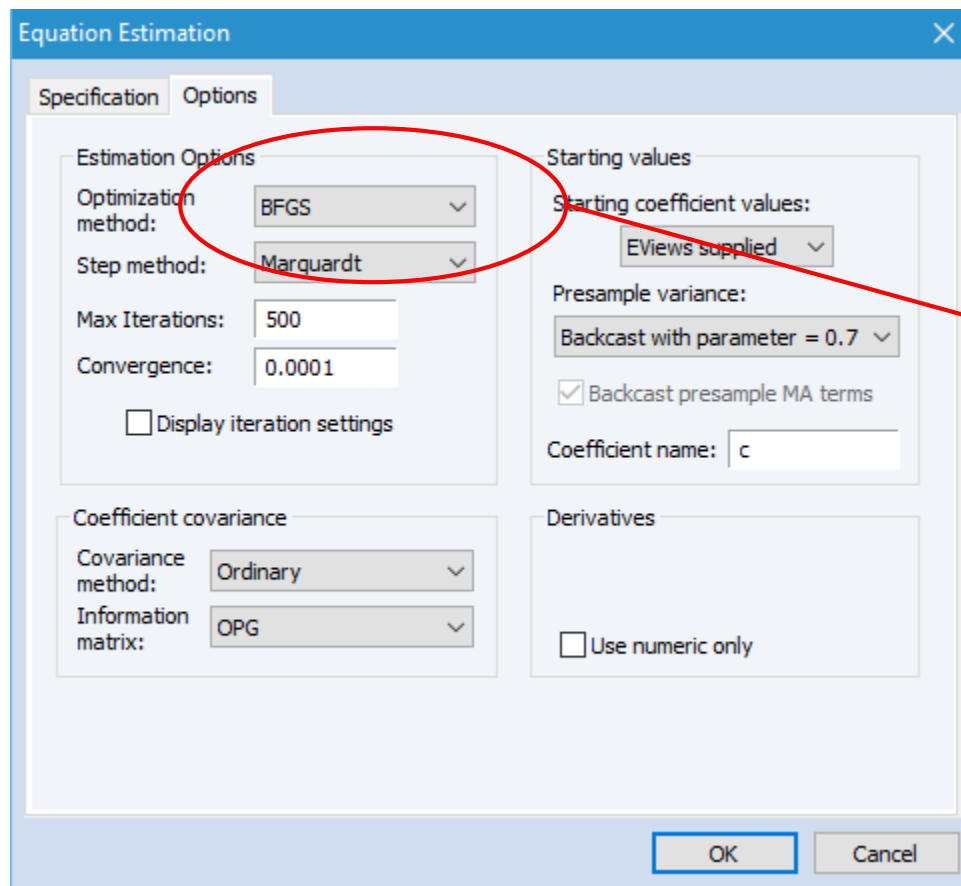
Estimation settings

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

Coefficient covariance

Covariance method: Ordinary

Information matrix: OPG

Starting values

Starting coefficient values: EViews supplied

Presample variance: Backcast with parameter = 0.7

☒ Backcast presample MA terms

Coefficient name: c

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: EVViews legacy

Legacy method: Marquardt

Max Iterations: 500

Convergence: 0.0001

☐ Display iteration settings

Coefficient covariance

Covariance method: Ordinary

Starting values

Starting coefficient values: EVViews supplied

Presample variance: Backcast with parameter = 0.7

☒ Backcast presample MA terms

Coefficient name: c

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 -0.08

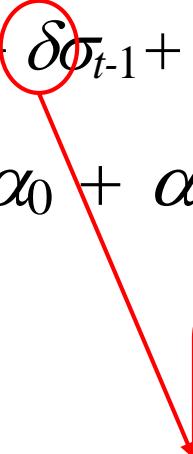
$$\log(\sigma_t^2) = \omega + \beta \log(\sigma_{t-1}^2) + \gamma \frac{u_{t-1}}{\sqrt{\sigma_{t-1}^2}} + \alpha \left[\frac{|u_{t-1}|}{\sqrt{\sigma_{t-1}^2}} - \sqrt{\frac{2}{\pi}} \right]$$

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

The screenshot shows the 'Equation Estimation' dialog box with the 'Specification' tab selected. The 'Mean equation' section contains the text 'Dependent followed by regressors & ARMA terms OR explicit equation:' and the input 'rdm c ar(1)'. The 'Variance and distribution specification' section is highlighted with a red circle. It includes a 'Model:' dropdown set to 'GARCH/TARCH', an 'Order:' section with 'ARCH:' set to 1 and 'Threshold order:' set to 0, and a 'Restrictions:' dropdown set to 'None'. The 'Error distribution:' dropdown is set to 'Normal (Gaussian)'. The 'ARCH-M:' dropdown is also highlighted with a red circle and is open, showing options: 'Std. Dev.', 'None', 'Std. Dev.', 'Variance', and 'Log(Var)'. The 'Estimation settings' section at the bottom shows the 'Method:' dropdown set to 'ARCH - Autoregressive Conditional Heteroskedasticity' and the 'Sample:' range set to '1/02/1980 5/21/1987'. The 'OK' and 'Cancel' buttons are at the bottom right.

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:

Error distribution:
Normal (Gaussian)

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

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

GARCH-in Mean – Variance

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

GARCH-in Mean – Log(Var)

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:
Log(Var)
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 – 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

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	-.09
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$$y_t = \mu + \delta \sigma_{t-1} + u_t, \quad u_t \sim N(0, \sigma_t^2)$$

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: 02/23/17 Time: 20:56
Sample (adjusted): 1/04/1980 5/21/1986
Included observations: 1613 after adjustments
Convergence achieved after 10 iterations
Presample variance: backcast (parameter = 0.7)
GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*GARCH(-1)

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

Variance Equation

C	1.09E-06	3.05E-07	3.579756	0.0003
RESID(-1)^2	0.098988	0.011005	8.994833	0.0000
GARCH(-1)				

R-squared
Adjusted R-squared
S.E. of regression
Sum squared residuals
Log likelihood
Durbin-Watson
Inverted AR Root

Forecast

Forecast of
Equation: UNTITLED Series: RDM

Series names
Forecast name:
S.E. (optional):
GARCH(optional):

Method
☒ Dynamic forecast
☐ Static forecast
☐ Structural (ignore ARMA)
☒ Coef uncertainty in S.E. calc

Forecast sample

Output
☒ Forecast graph
☒ Forecast evaluation

☒ Insert actuals for out-of-sample observations

OK Cancel

Forecasting

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