Practical 3
Notes for Eviews9

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Financial Modelling and Business Forecasting

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ARCH

- The model:

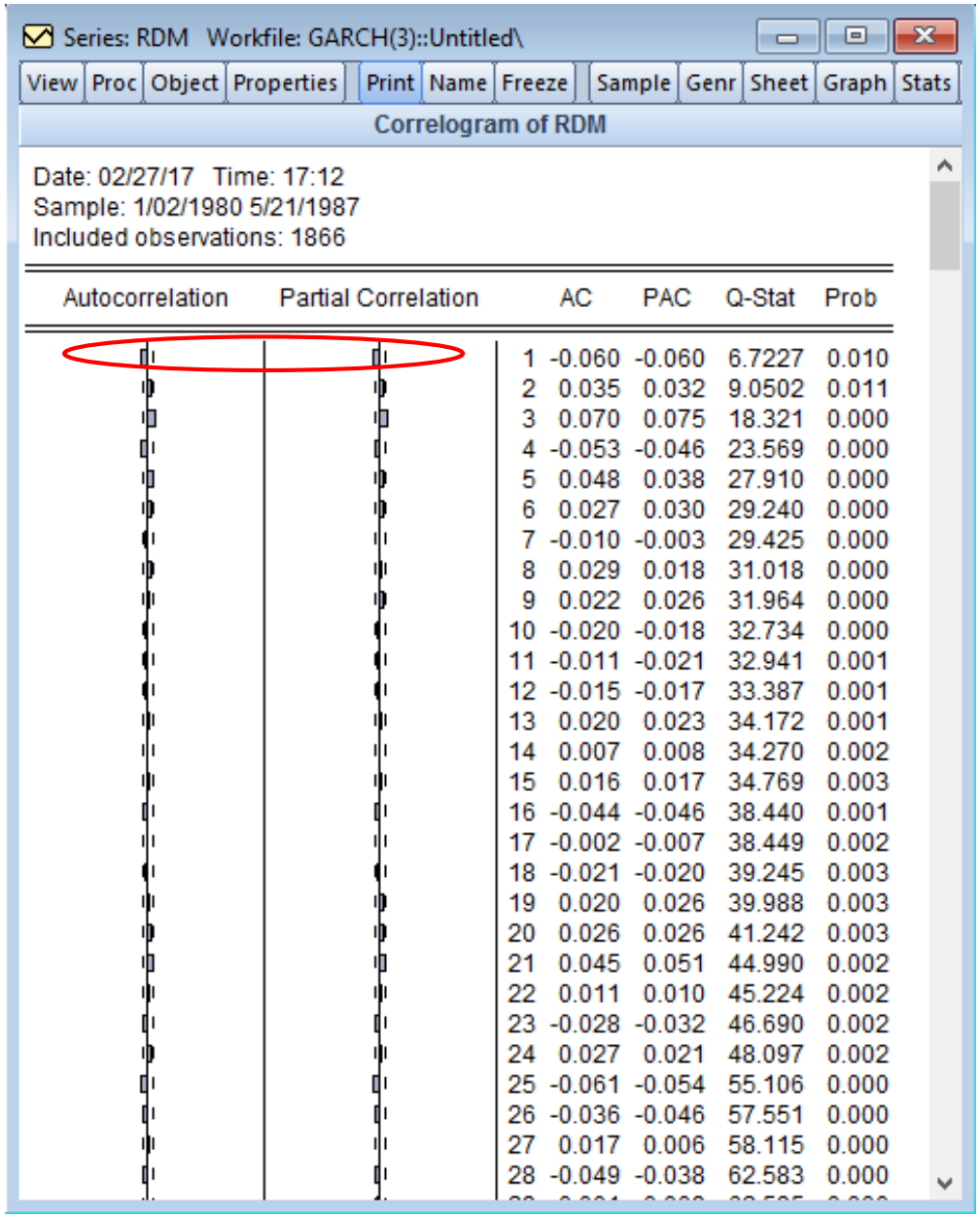
$$\hat{u}_t^2 = \gamma_0 + \gamma_1 \hat{u}_{t-1}^2 + \gamma_2 \hat{u}_{t-2}^2 + \ldots + \gamma_q \hat{u}_{t-q}^2 + v_t$$

- Testing for "ARCH effects"

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

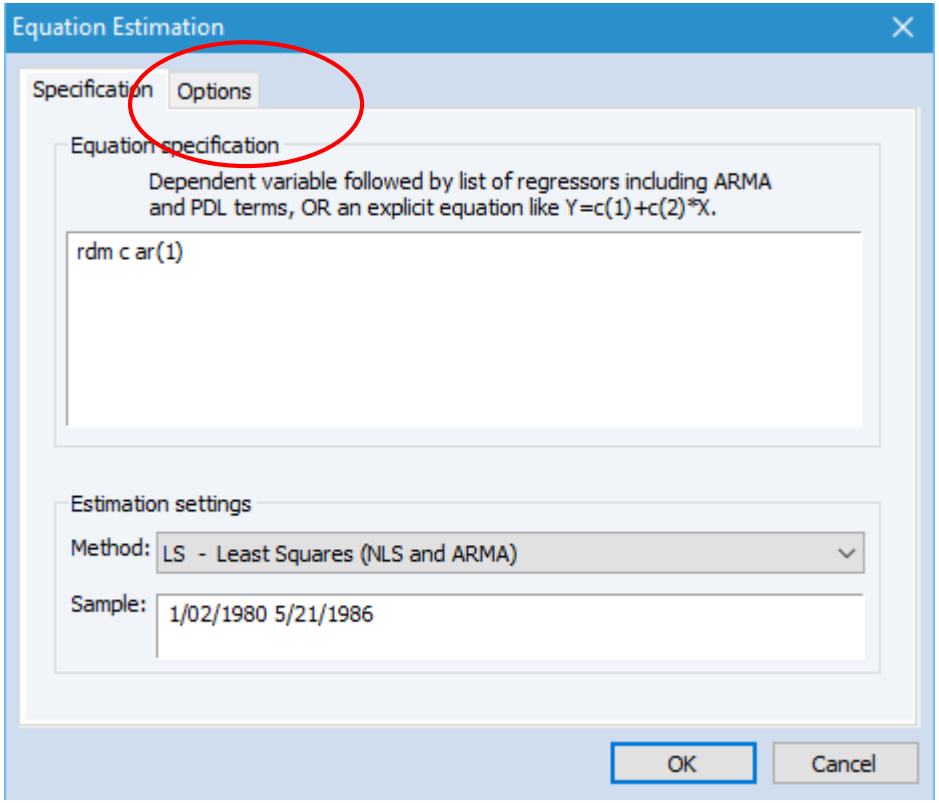
  $H_1 : \gamma_1 \neq 0$ or $\gamma_2 \neq 0$ or $\gamma_3 \neq 0$ or ... or $\gamma_q \neq 0$.

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

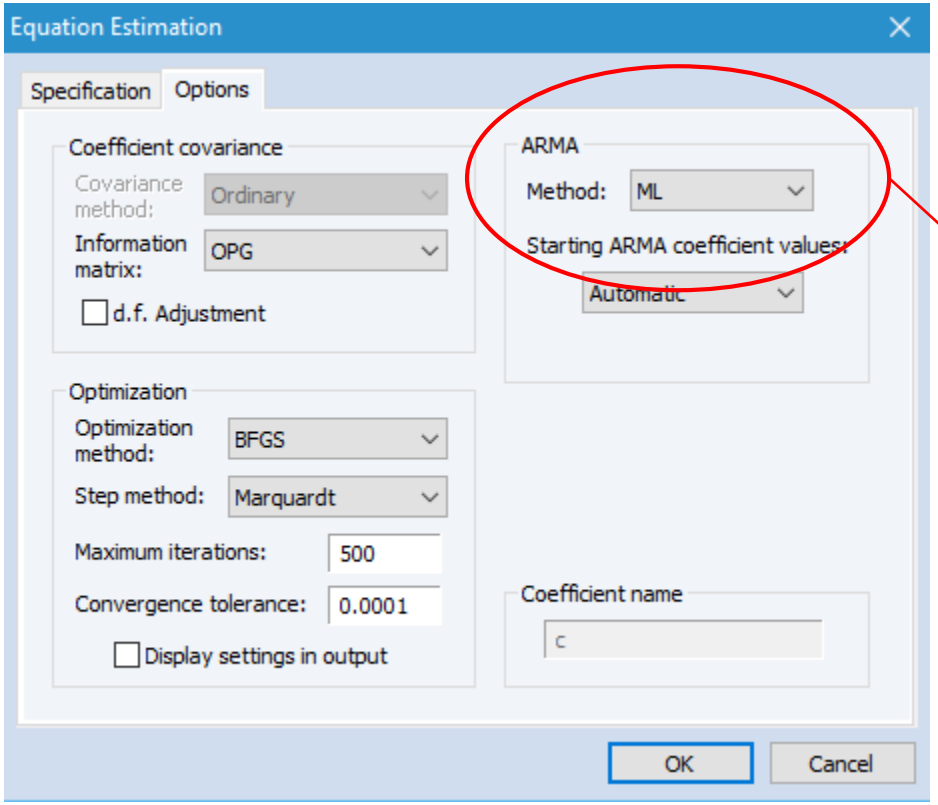


Identification of ARMA Model

ARMA Estimation

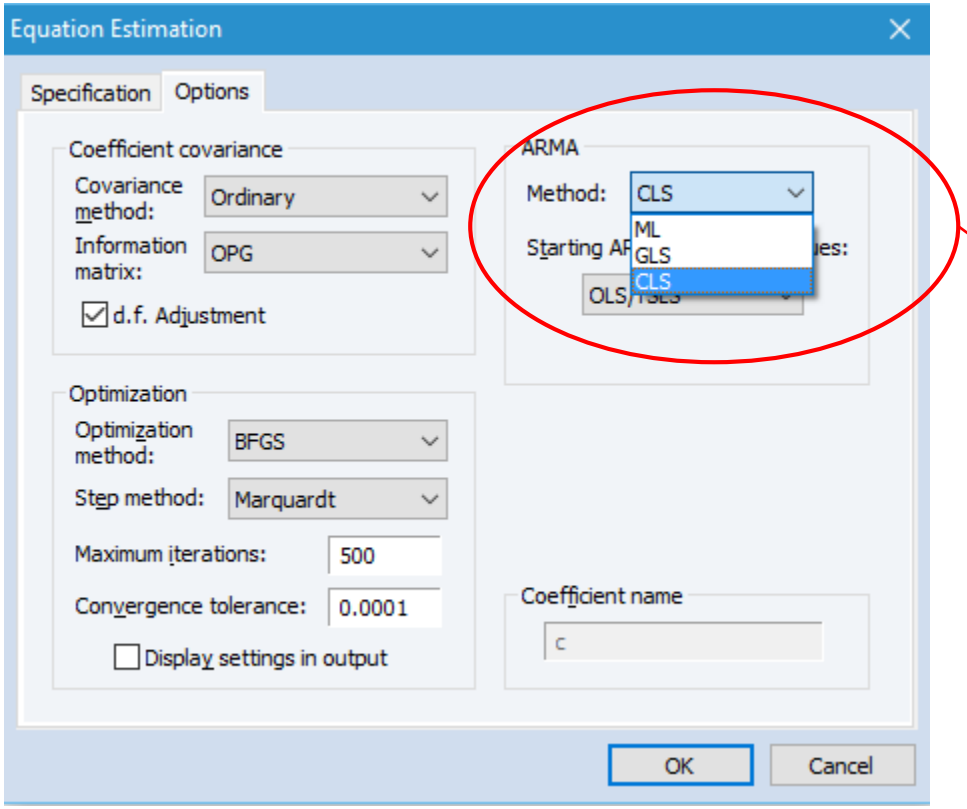


ARMA Estimation



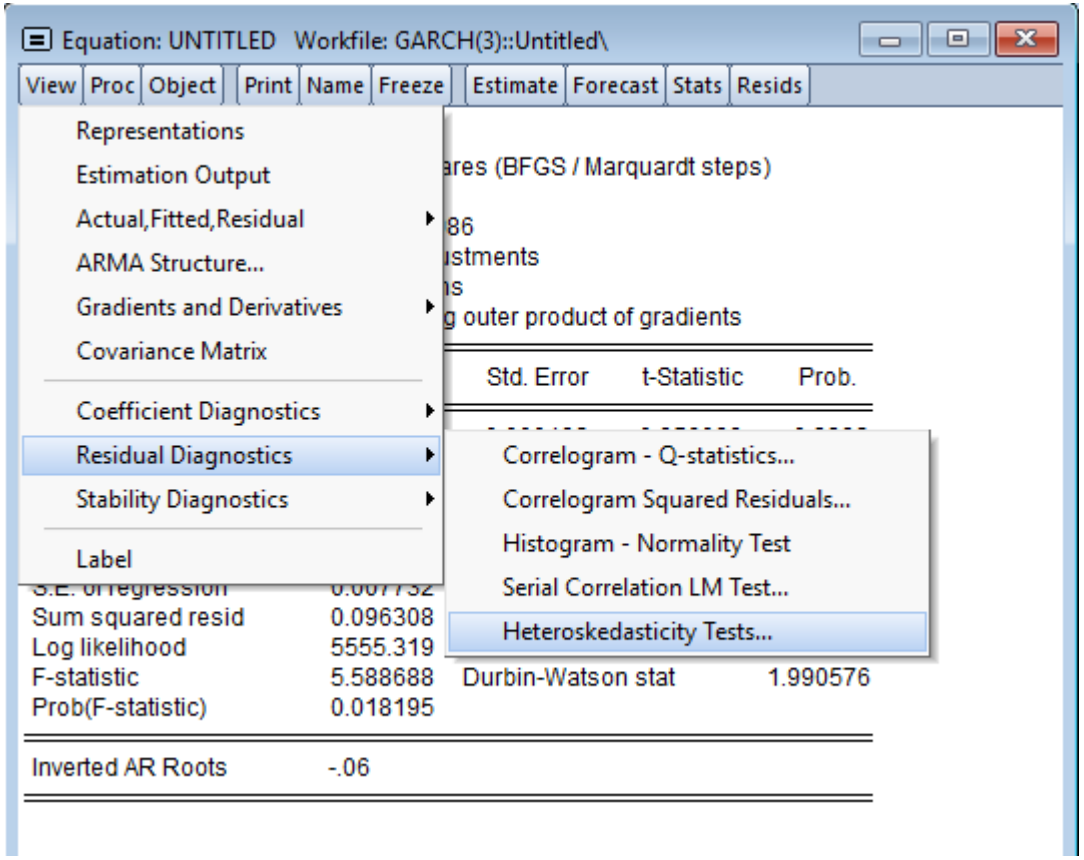
The default for ARMA method in Eviews9 is Maximum Likelihood (ML), but we need to use Least Square

ARMA Estimation

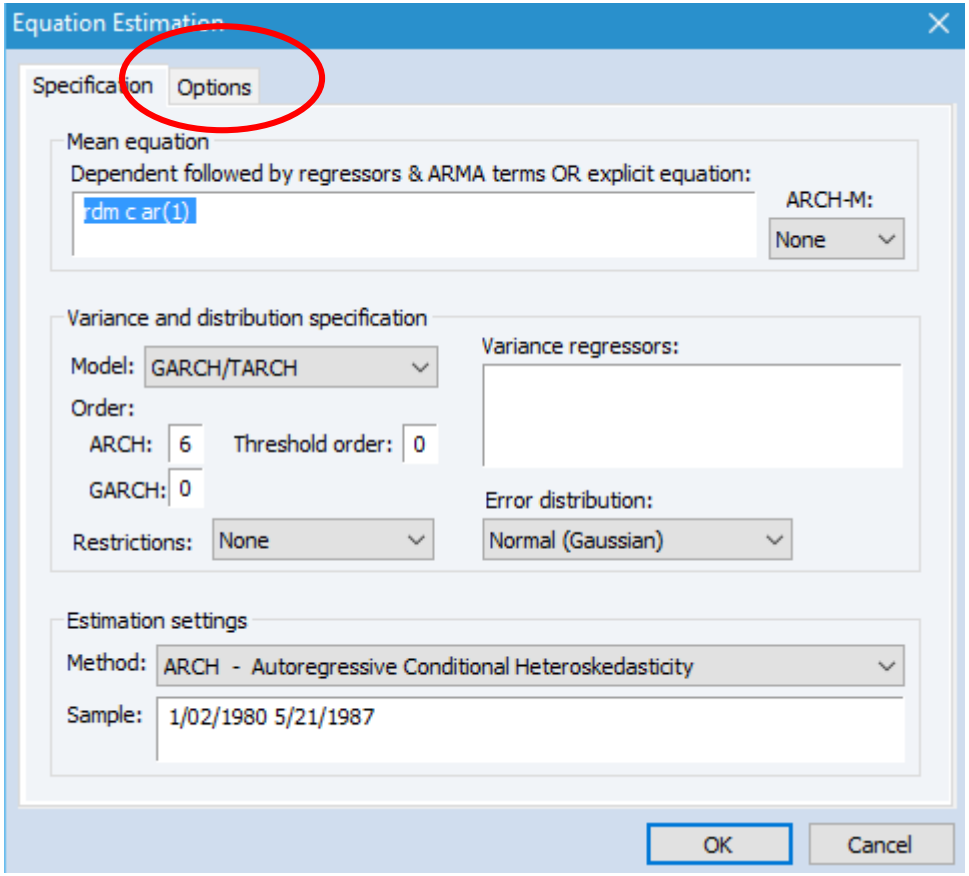


Choose the CLS (Conditional Least Square) for the ARMA method

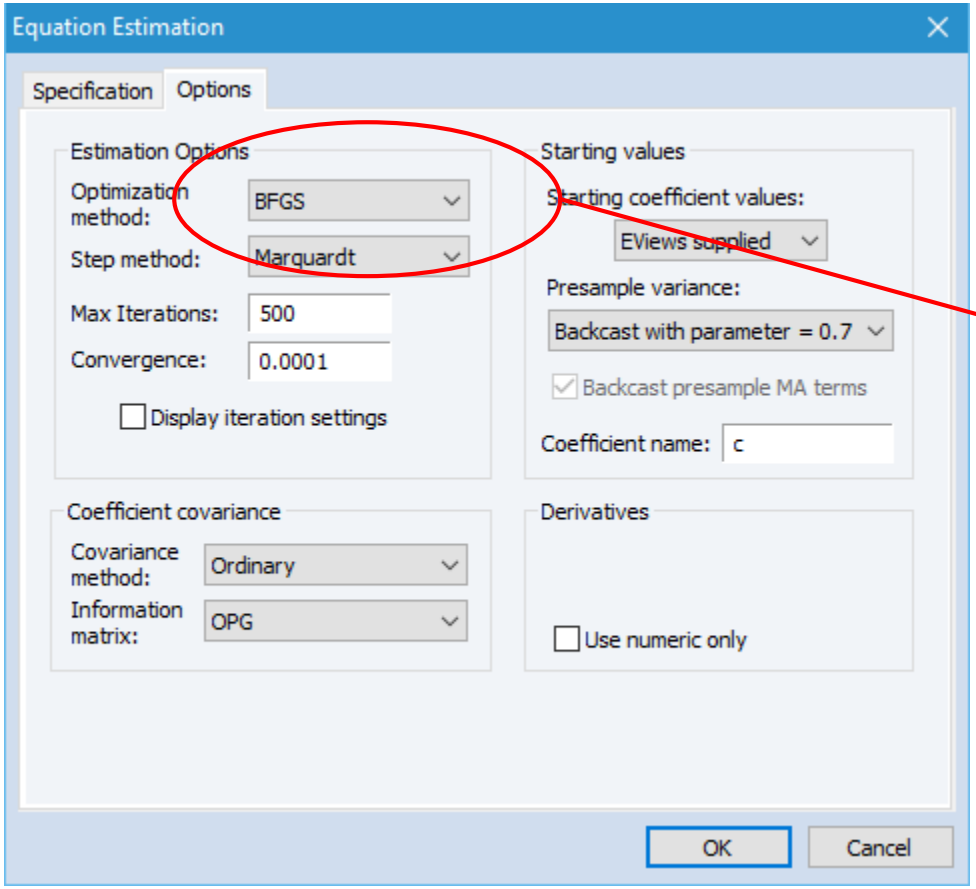
Checking Heteroskedasticity



Estimating ARCH

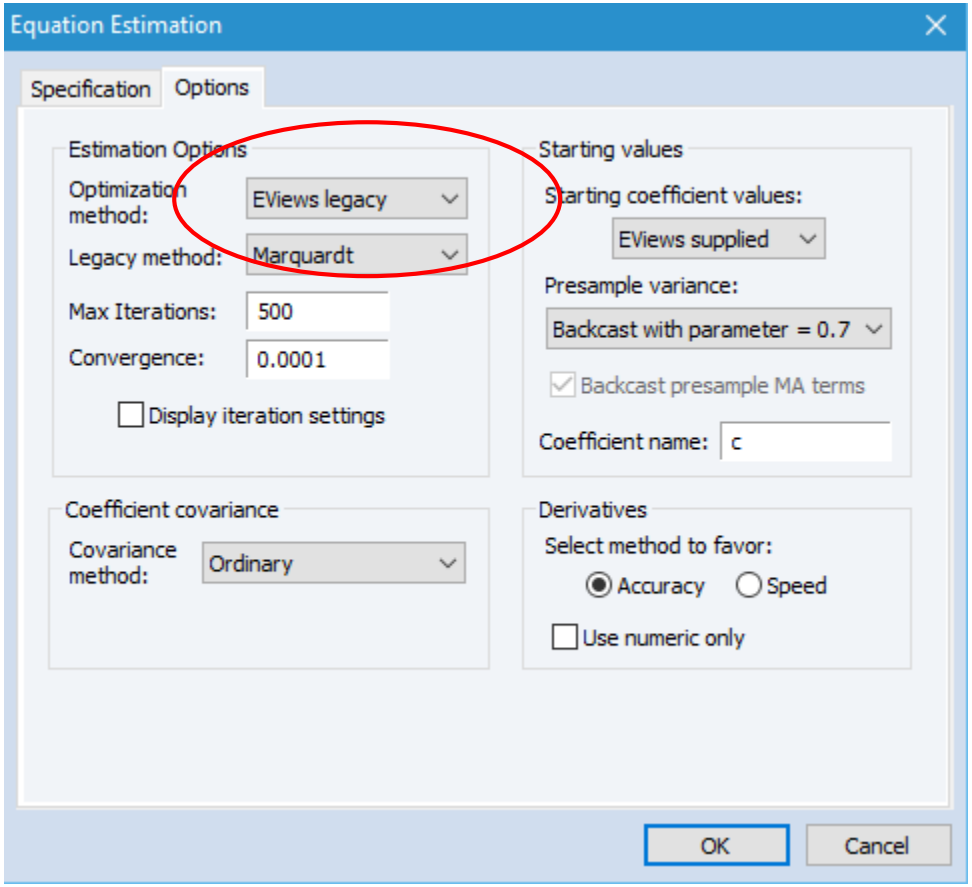


Estimating ARCH



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

Estimating ARCH



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

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

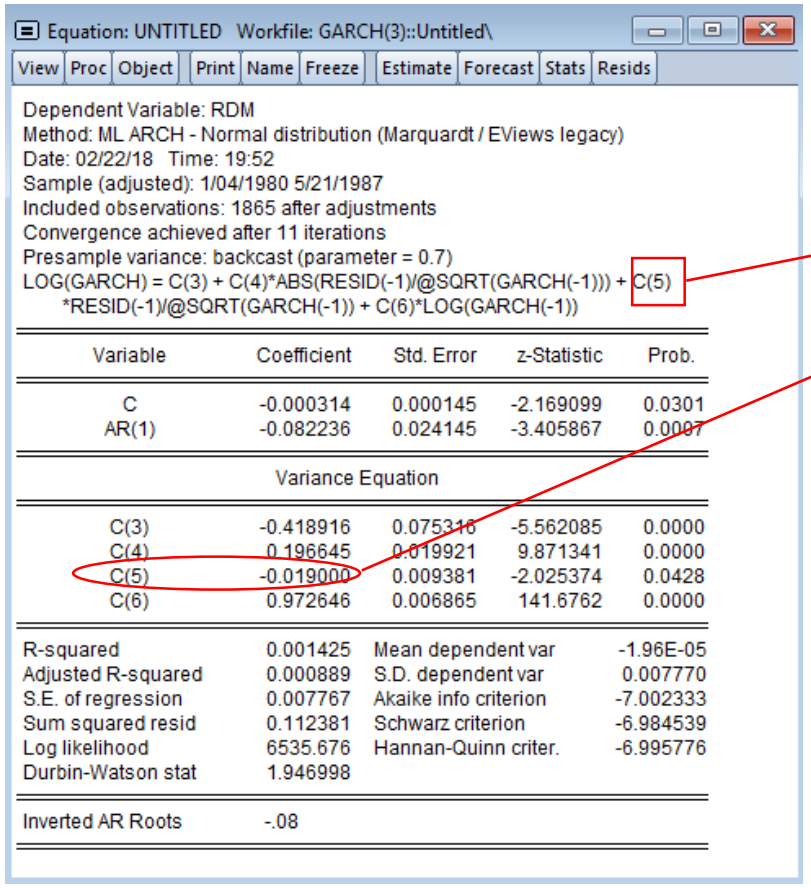
EGARCH

- 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

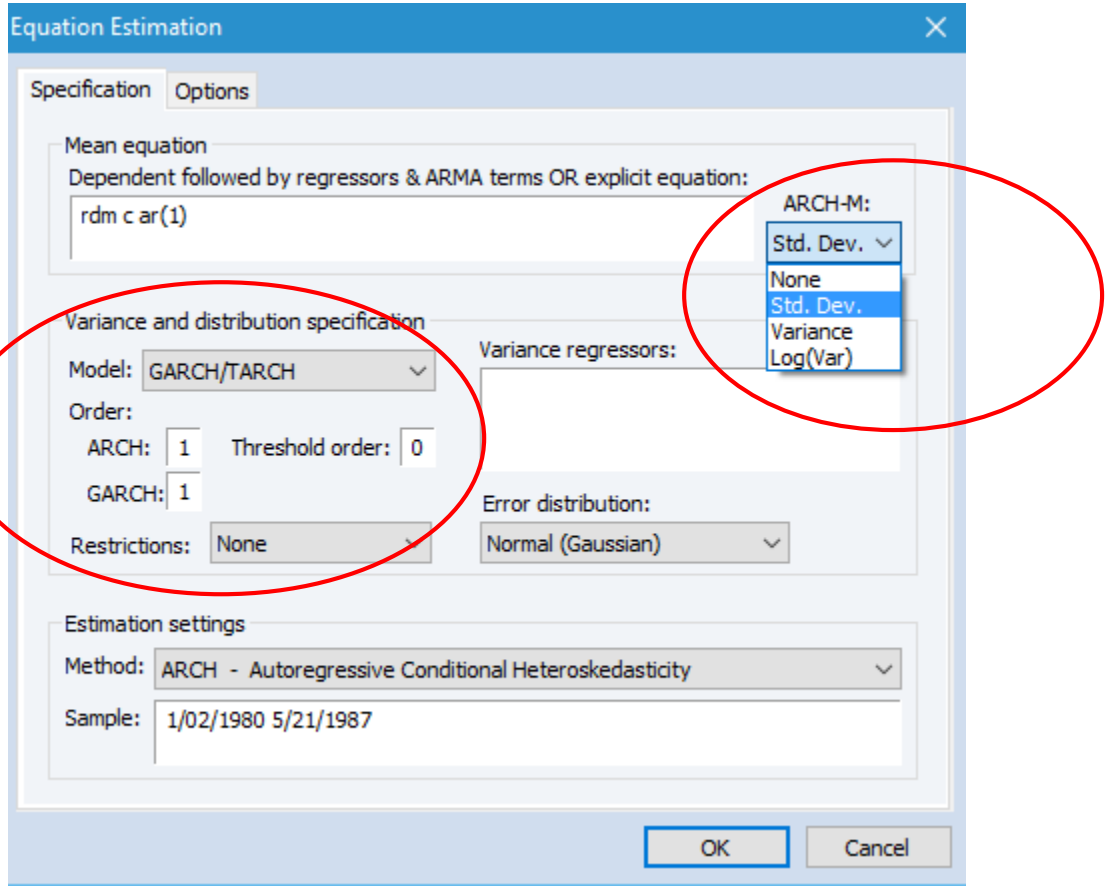
- The model:

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

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

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



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)

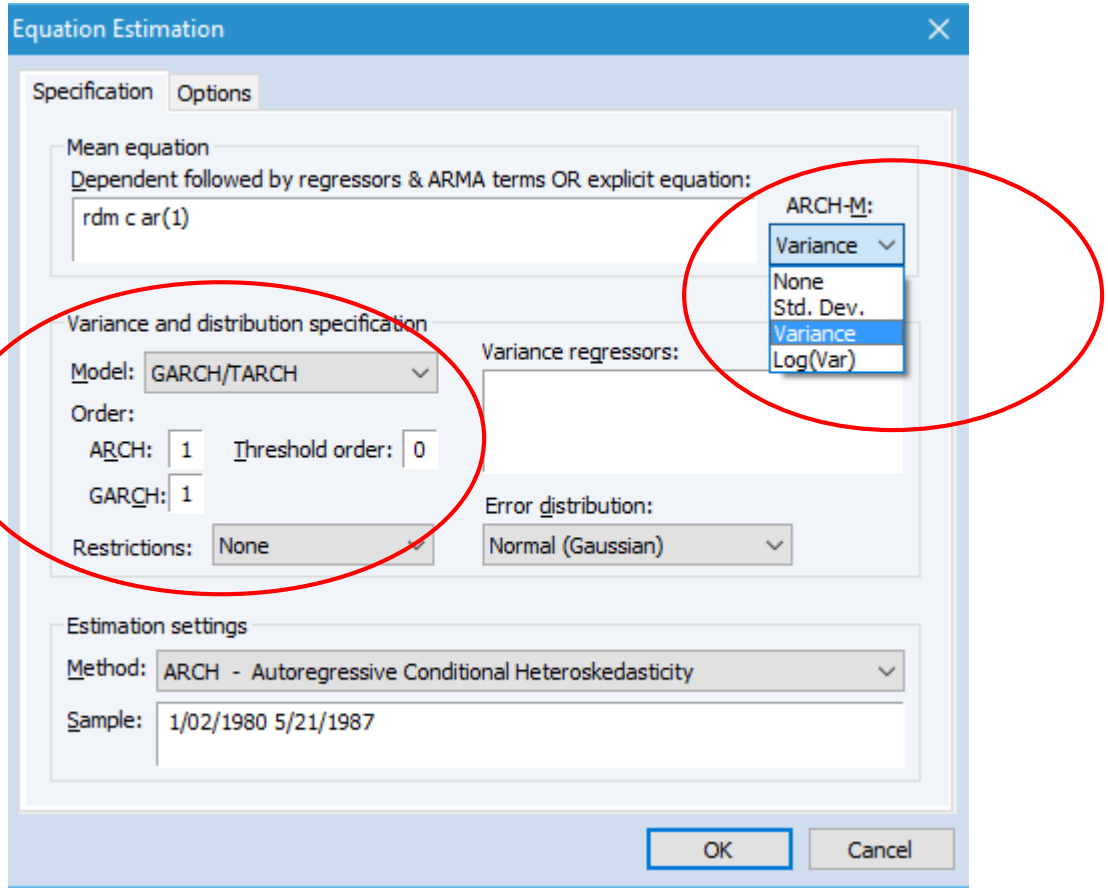
Variable	Coefficient	Std. Error	z-Statistic	Prob.
@SQRT(GARCH)	0.244695	0.087546	2.795034	0.0052
C	-0.001847	0.000595	-3.101392	0.0019
AR(1)	-0.085665	0.025174	-3.402917	0.0007
Variance Equation				
C	1.23E-06	3.19E-07	3.865632	0.0001
RESID(-1)^2	0.098935	0.010504	9.418936	0.0000
GARCH(-1)	0.885149	0.012378	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		

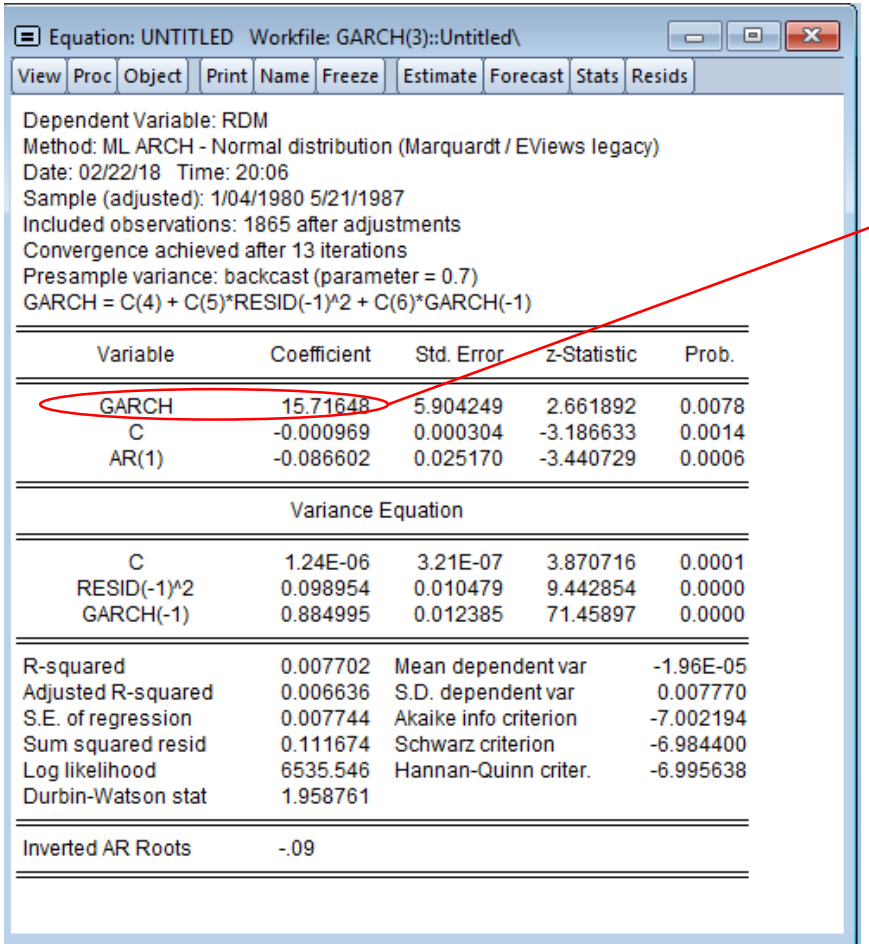
Inverted AR Roots	-.09

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

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

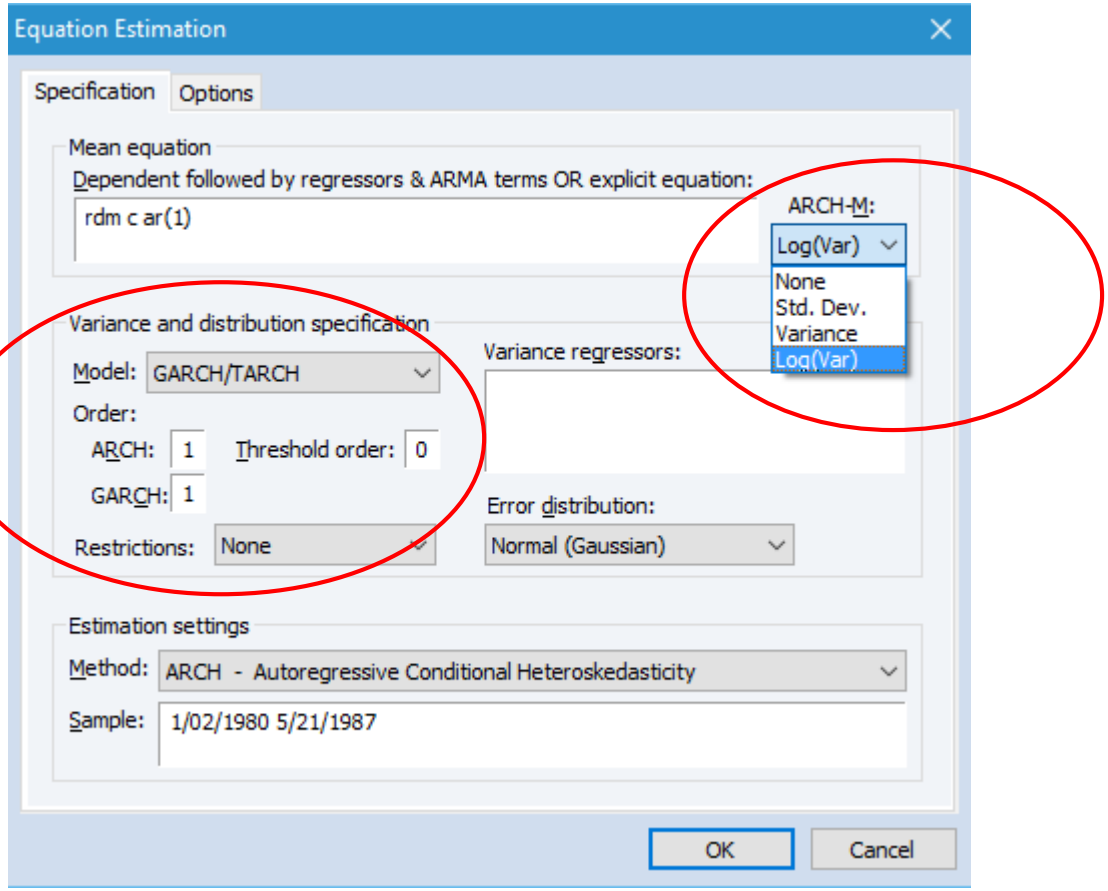
C	1.24E-06	3.21E-07	3.870716	0.0001
RESID(-1)^2	0.098954	0.010479	9.442854	0.0000
GARCH(-1)	0.884995	0.012385	71.45897	0.0000

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		

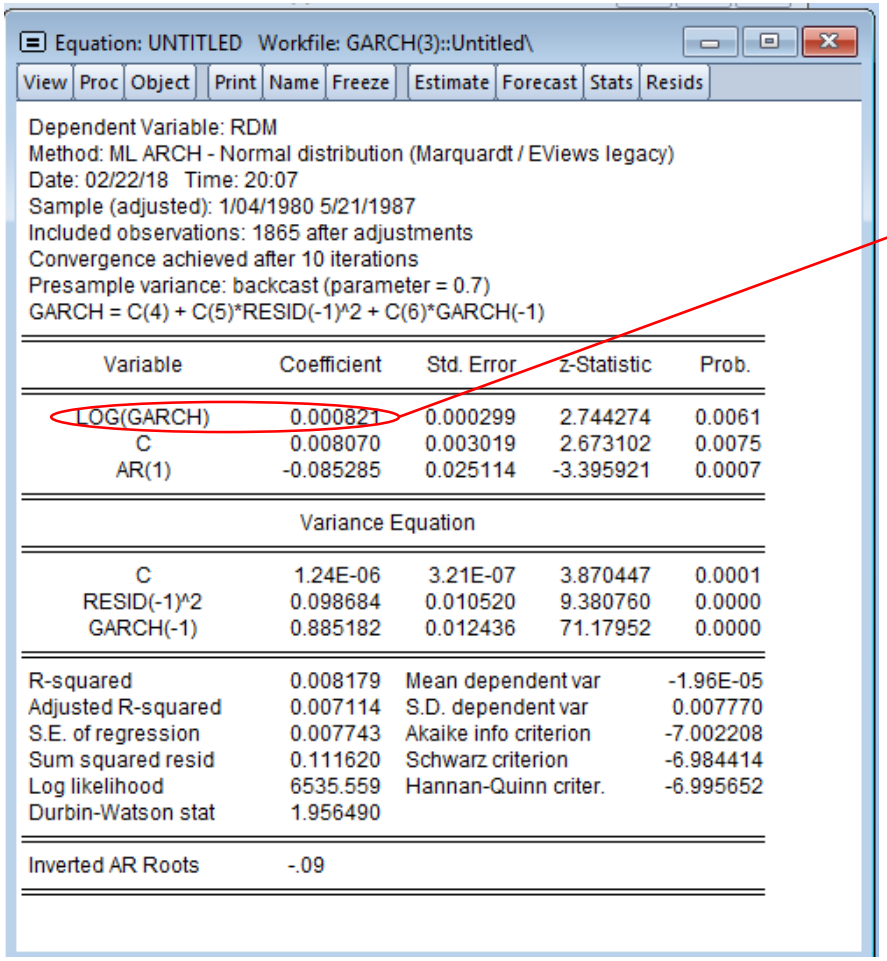
Inverted AR Roots	-.09

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

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

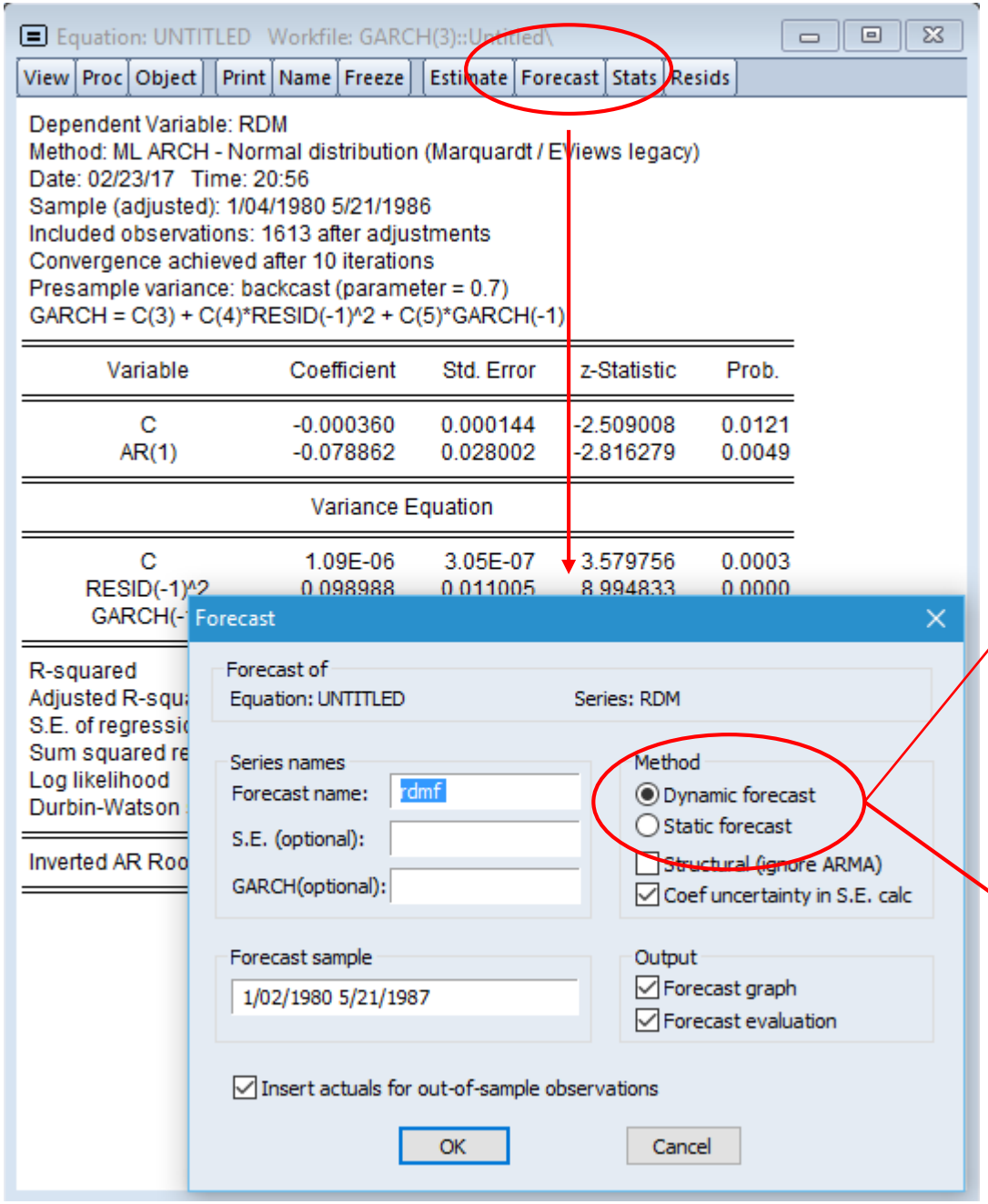
C	1.24E-06	3.21E-07	3.870447	0.0001
RESID(-1)^2	0.098684	0.010520	9.380760	0.0000
GARCH(-1)	0.885182	0.012436	71.17952	0.0000

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

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

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