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Financial Econometrics
ECON3206/5206
Tutorial 8

Sample Answers/Hints to Tutorial 11

1. (Miscellaneous questions)

(a) The conditional variance matrix of a vector of returns is useful for designing "mean-variance efficient" portfolios. A mean-variance efficient portfolio on a given set of assets is one that has the minimum variance for a desired mean return. Consider one-day ahead problem with n assets. Let $r = [r_1, \ldots, r_n]'$ be the vector of the 1-day returns for the assets. The mean of r, $\mu = E(r) = [\mu_1, \ldots, \mu_n]'$, is also an n dimensional vector. The variance of r,

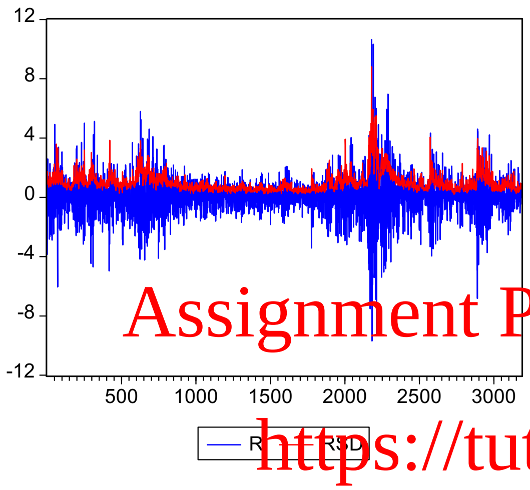
$$V = \mathrm{Var}(r) = \begin{bmatrix} V_{11} & \cdots & V_{1n} \\ \vdots & \ddots & \vdots \\ V_{n1} & \cdots & V_{nn} \end{bmatrix} = \begin{bmatrix} \mathrm{Var}(r_1) & \cdots & \mathrm{Cov}(r_1, r_n) \\ \vdots & \ddots & \vdots \\ \mathrm{Cov}(r_n, r_1) & \cdots & \mathrm{Var}(r_n) \end{bmatrix},$$

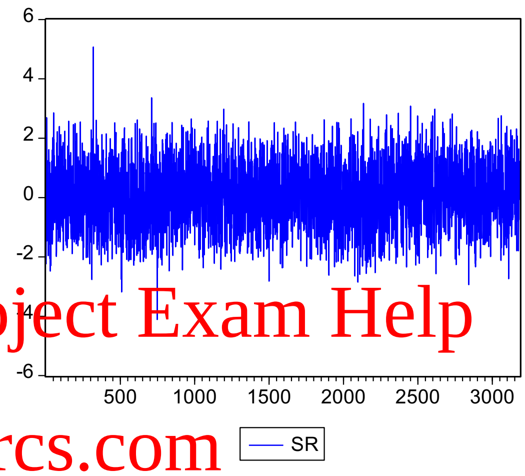
is an $n \times n$ dimensional matrix. Because the covariances are symmetric $\mathrm{Cov}(r_i, r_j) = \mathrm{Cov}(r_j, r_i)$, the matrix V is symmetric with $V_{ij} = V_{ji}$ for all i and j. Suppose that you invest a portion of you wealth, w_i, in asset i, for $i = 1, \ldots, n$, where $\sum_{i=1}^{n} w_i = 1$. Then your portfolio is determined by the weight vector $w = [w_1, \ldots, w_n]'$ and your portfolio return is given by $r_p = \sum_{i=1}^{n} w_i r_i = w'r$ with the mean $\mu_p = E(r_p) = \sum_{i=1}^{n} w_i \mu_i = w'\mu$ and variance $\sigma_p^2 = Var(r_p) = w'Vw$. To obtain the mean-variance efficient portfolio, you choose w to minimise the variance $w'Vw$ for a given mean return μ_p. Because the weights in w can be any set of numbers with $\sum_{i=1}^{n} w_i = 1$ and the portfolio return variance σ_p^2 must be non-negative, a variance matrix V must be such that $w'Vw \geq 0$ for any w with $\sum_{i=1}^{n} w_i = 1$ (ie, V must be semi-positive definite). Hence a variance matrix V is required to be symmetric and semi-positive definite.

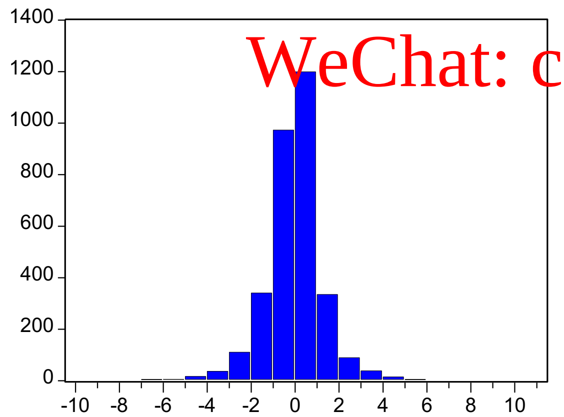
(b) The daily realised variance (RV) of an asset return is constructed from the intraday returns, eg, intraday 5-minute returns. Originally, the RV is computed as the sum of the squared intraday returns. However, there are alternative (and better) ways to compute the RV. The daily RV is an estimate of the integrated variance, which can be regarded as the spot or instantaneous variance of the return.

2. (Realised volatility, data source: http://realized.oxford-man.ox.ac.uk/data)

(a) The time series plots show that the variations in R are accurately mirrored in the levels of RSD. The difference between the plots of R and SR provides a sharp contrast: the clustering in R is mostly attributable to RSD. The histogram and descriptive statistics of R show the usual return characteristics: close-to-zero mean, large standard deviation, negative skewness, large kurtosis, and decisively non-normal. However, the histogram and descriptive statistics of SR are much close to those of a standard normal random variable, although the null hypothesis of normality is still rejected at the 5% level (p-value 0.033). Notice that SR is standardised by using the spot or instantaneous realised variance, which is NOT the conditional variance. The histogram of LRV indicates that it is positively skewed with a kurtosis greater than 3, roughly bell-shaped but non-normal.

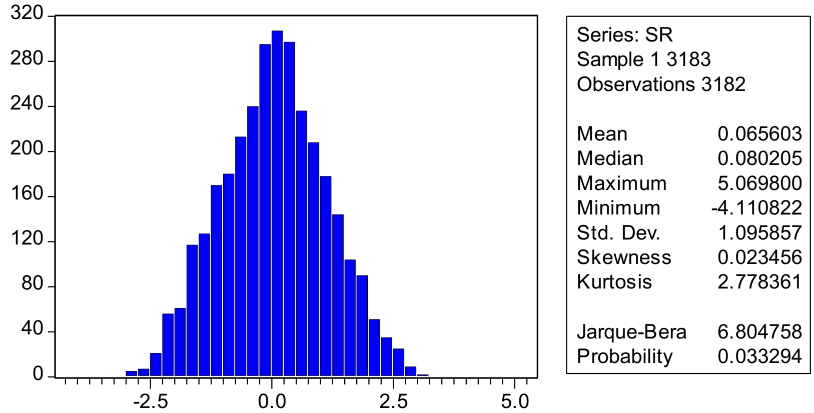


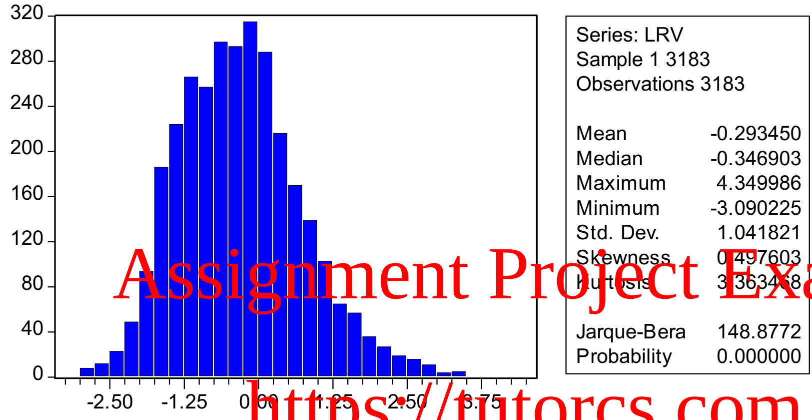




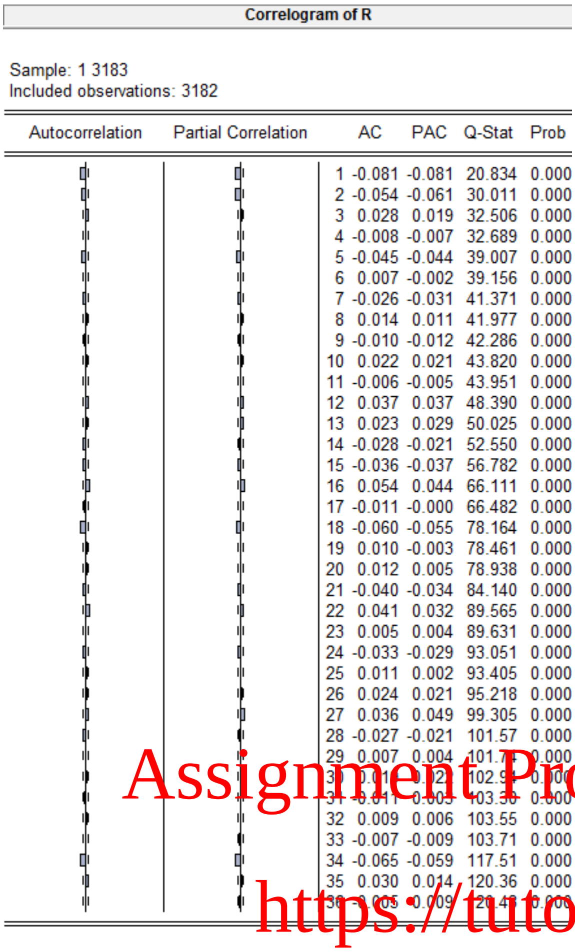
Series: R
Sample 1 3183
Observations 3182

Mean	0.000137
Median	0.054678
Maximum	10.64203
Minimum	-9.688362
Std. Dev.	1.351514
Skewness	-0.128689
Kurtosis	9.940123
Jarque-Bera	6394.700
Probability	0.000000





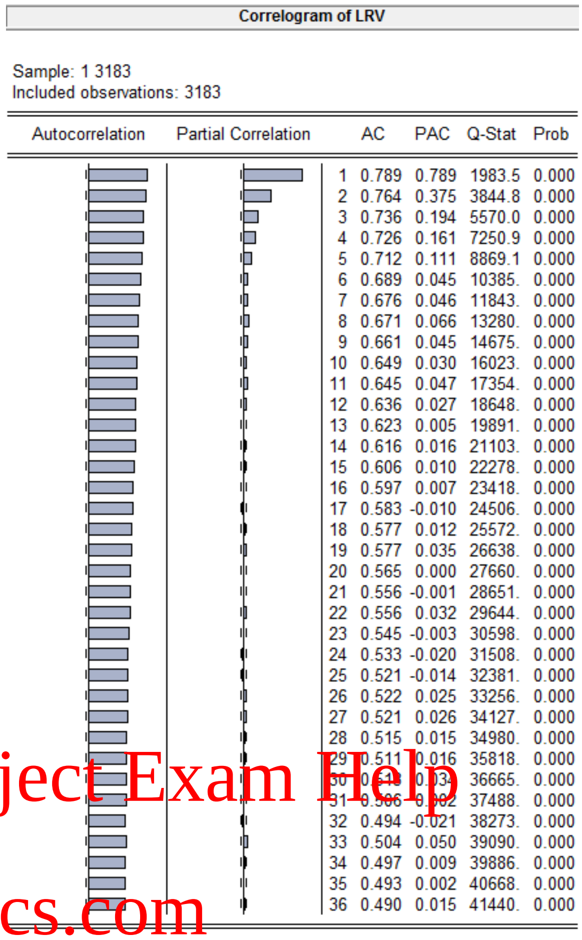
(b) There are statistically significant (with small magnitudes) autocorrelations in R according to correlograms below. The autocorrelations in LRV are large and long-lasting. In particular, the autocorrelations in LRV do not appear to converge to zero quickly as the lag increases. That is, the decay of the autocorrelations does not appear to be exponential.



Correlogram of R

Sample: 1 3183
Included observations: 3182

	AC	PAC	Q-Stat	Prob
1	-0.081	-0.081	20.834	0.000
2	-0.054	-0.061	30.011	0.000
3	0.028	0.019	32.506	0.000
4	-0.008	-0.007	32.689	0.000
5	-0.045	-0.044	39.007	0.000
6	0.007	-0.002	39.156	0.000
7	-0.026	-0.031	41.371	0.000
8	0.014	0.011	41.977	0.000
9	-0.010	-0.012	42.286	0.000
10	0.022	0.021	43.820	0.000
11	-0.006	-0.005	43.951	0.000
12	0.037	0.037	48.390	0.000
13	0.023	0.029	50.025	0.000
14	-0.028	-0.021	52.550	0.000
15	-0.036	-0.037	56.782	0.000
16	0.054	0.044	66.111	0.000
17	-0.011	-0.000	66.482	0.000
18	-0.060	-0.055	78.164	0.000
19	0.010	-0.003	78.461	0.000
20	0.012	0.005	78.938	0.000
21	-0.040	-0.034	84.140	0.000
22	0.041	0.032	89.565	0.000
23	0.005	0.004	89.631	0.000
24	-0.033	-0.029	93.051	0.000
25	0.011	0.002	93.405	0.000
26	0.024	0.021	95.218	0.000
27	0.036	0.049	99.305	0.000
28	-0.027	-0.021	101.57	0.000
29	0.007	0.004	101.74	0.000
30	[illegible]	0.022	102.94	0.000
31	-0.011	0.005	103.30	0.000
32	0.009	0.006	103.55	0.000
33	-0.007	-0.009	103.71	0.000
34	-0.065	-0.059	117.51	0.000
35	0.030	0.014	120.36	0.000
36	-0.005	-0.009	120.48	0.000

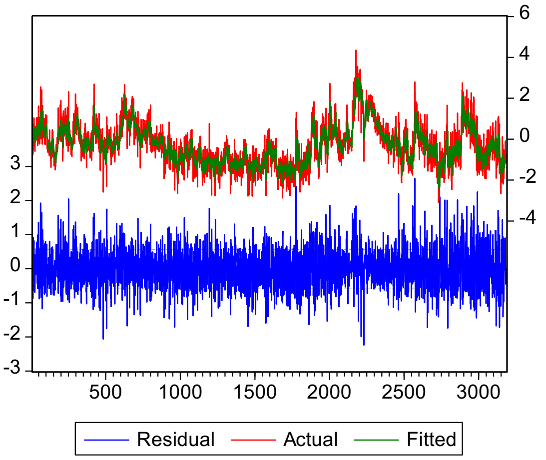


Correlogram of LRV

Sample: 1 3183
Included observations: 3183

	AC	PAC	Q-Stat	Prob
1	0.789	0.789	1983.5	0.000
2	0.764	0.375	3844.8	0.000
3	0.736	0.194	5570.0	0.000
4	0.726	0.161	7250.9	0.000
5	0.712	0.111	8869.1	0.000
6	0.689	0.045	10385.	0.000
7	0.676	0.046	11843.	0.000
8	0.671	0.066	13280.	0.000
9	0.661	0.045	14675.	0.000
10	0.649	0.030	16023.	0.000
11	0.645	0.047	17354.	0.000
12	0.636	0.027	18648.	0.000
13	0.623	0.005	19891.	0.000
14	0.616	0.016	21103.	0.000
15	0.606	0.010	22278.	0.000
16	0.597	0.007	23418.	0.000
17	0.583	-0.010	24506.	0.000
18	0.577	0.012	25572.	0.000
19	0.577	0.035	26638.	0.000
20	0.565	0.000	27660.	0.000
21	0.556	-0.001	28651.	0.000
22	0.556	0.032	29644.	0.000
23	0.545	-0.003	30598.	0.000
24	0.533	-0.020	31508.	0.000
25	0.521	-0.014	32381.	0.000
26	0.522	0.025	33256.	0.000
27	0.521	0.026	34127.	0.000
28	0.515	0.015	34980.	0.000
29	0.511	0.016	35818.	0.000
30	0.518	0.034	36665.	0.000
31	0.506	0.002	37488.	0.000
32	0.494	-0.021	38273.	0.000
33	0.504	0.050	39090.	0.000
34	0.497	0.009	39886.	0.000
35	0.493	0.002	40668.	0.000
36	0.490	0.015	41440.	0.000

(c) The augmented Dickey-Fuller test on LRV rejects the null hypothesis of a unit-root. Hence, the evidence suggests that LRV is still stationary despite its large and long-lasting autocorrelations. To fit an ARMA model to LRV, the partial autocorrelations suggest that an AR(11) would be a candidate (2 standard error band $2/\sqrt{T} \approx 0.035$, any AC or PAC within the bands are statistically zero). Here, maybe incorrectly, we assume the autocorrelations exponentially decay to zero. The estimation results show that most of the AR coefficients are statistically significant (except lags 6,7,9 and 10). More than 70% of the variations in LRV are explained by the AR(11) model. The actual-fitted-residual plot demonstrates that the model fits the data well. The correlogram of the residuals shows little autocorrelation. Hence the AR(11) model has done a good job in capturing the autocorrelations in LRV, although the true data-generating-process could be a long-memory ARFIMA model. From the residual histogram below, the residual distribution is not normal with positive skewness and heavy tails, although it is roughly bell-shaped. The main point of this part is that the long-lasting autocorrelations of LRV can be approximately captured by an AR(p) with a moderately large p (here we have $p = 11$).



Augmented Dickey-Fuller Unit Root Test on LRV

Null Hypothesis: LRV has a unit root
Exogenous: Constant
Lag Length: 7 (Automatic based on SIC, MAXLAG=28)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.074429	0.0000
Test critical values:	1% level	-3.432221	
	5% level	-2.862252	
	10% level	-2.567193	

*MacKinnon (1996) one-sided p-values.

Correlogram of Residuals

Sample: 12 3183
Included observations: 3172
Q-statistic probabilities adjusted for 11 ARMA term(s)

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.002	-0.002	0.0083	
		2	-0.001	-0.001	0.0108	
		3	-0.002	-0.002	0.0284	
		4	-0.003	-0.003	0.0521	
		5	-0.004	-0.004	0.1025	
		6	-0.003	-0.003	0.1271	
		7	-0.007	-0.007	0.2665	
		8	-0.008	-0.008	0.4907	
		9	-0.008	-0.008	0.7091	
		10	-0.015	-0.015	1.4392	
		11	-0.026	-0.026	3.6017	
		12	0.007	0.006	3.7442	0.053
		13	-0.012	-0.012	4.1815	0.124
		14	0.002	0.001	4.1898	0.242
		15	0.002	0.001	4.1998	0.380
		16	0.002	0.001	4.2101	0.520
		17	-0.028	-0.028	6.6871	0.351
		18	-0.015	-0.016	7.3904	0.389
		19	0.022	0.021	8.9368	0.348
		20	-0.001	-0.002	8.9405	0.443
		21	-0.009	-0.010	9.2105	0.512
		22	0.028	0.028	11.804	0.379
		23	0.007	0.007	11.977	0.448
		24	-0.017	-0.018	12.906	0.455
		25	-0.041	-0.041	18.199	0.198
		26	-0.011	-0.012	18.603	0.232
		27	0.002	0.001	18.614	0.289
		28	-0.006	-0.008	18.741	0.344
		29	-0.009	-0.009	19.011	0.391
		30	0.027	0.028	21.314	0.320
		31	0.005	0.004	21.384	0.375
		32	-0.037	-0.038	25.886	0.211
		33	0.031	0.031	28.908	0.147
		34	0.014	0.012	29.566	0.162
		35	0.003	0.000	29.603	0.198
		36	0.015	0.014	30.335	0.212

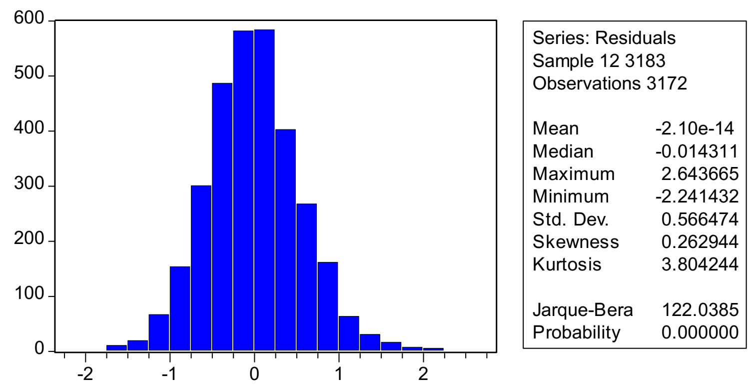
Dependent Variable: LRV
Method: Least Squares

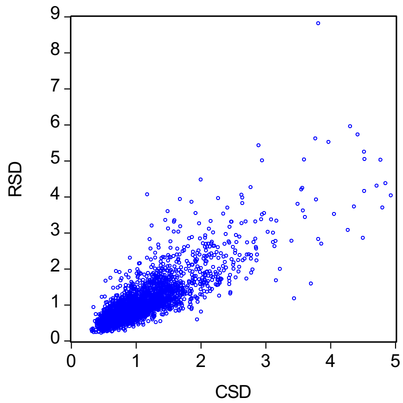
Sample (adjusted): 12 3183
Included observations: 3172 after adjustments
Convergence achieved after 3 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.312751	0.171904	-1.819333	0.0690
AR(1)	0.352555	0.017767	19.84350	0.0000
AR(2)	0.20517[illegible]	0.018839	10.89072	0.0000
AR(3)	0.082500	0.019186	4.300025	0.0000
AR(4)	0.092932	0.019229	4.833018	0.0000
AR(5)	0.071244	0.019304	3.690581	0.0002
AR(6)	0.003165	0.019346	0.163608	0.8700
AR(7)	0.005566	0.019303	0.288337	0.7731
AR(8)	0.040333	0.019233	2.097080	0.0361
AR(9)	0.024005	0.019185	1.251233	0.2109
AR(10)	0.014099	0.018835	0.748551	0.4542
AR(11)	0.049803	0.017761	2.804105	0.0051

R-squared	0.704864	Mean dependent var	-0.295525
Adjusted R-squared	0.703837	S.D. dependent var	1.042723
S.E. of regression	0.567459	Akaike info criterion	1.708479
Sum squared resid	1017.551	Schwarz criterion	1.731413
Log likelihood	-2697.648	F-statistic	686.0859
Durbin-Watson stat	2.002453	Prob(F-statistic)	0.000000

Inverted AR Roots	.98	.66-.39i	.66+.39i	.29+.67i
	.29-.67i	-.06+.73i	-.06-.73i	-.50+.56i
	-.50-.56i	-.71+.20i	-.71-.20i	





(d) The scatter plot above shows the connection and difference between the conditional volatility estimates (CSD) and the spot or instantaneous volatility estimates (RSD). The CSD can be regarded as a point forecast of RSD.

(e) The estimation results of EGARCH(2,1) below shows that the model has adequately represented the clustering in the return R, as the ARCH test does not reject the null hypothesis of no ARCH effect in the standardised residuals. The time series and scatter plots show the similarities and differences between the conditional standard deviation from EGARCH and the conditional standard deviation based on LRV. While EGSD and CSD differ markedly, they have extremely strong cross-correlations (see the cross-correlogram below). For example, the static correlation is almost perfect (0.9285).

Dependent Variable: R
Method: ML - ARCH (Marquardt) - Normal distribution

Sample (adjusted): 3 3183
Included observations: 3181 after adjustments
Convergence achieved after 16 iterations
Bollerslev-Wooldrige robust standard errors & covariance
Variance backcast: ON
LOG(GARCH) = C(3) + C(4)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(5)*ABS(RESID(-2)/@SQRT(GARCH(-2))) + C(6)*RESID(-1) /@SQRT(GARCH(-1)) + C(7)*LOG(GARCH(-1))

	Coefficient	Std. Error	z-Statistic	Prob.
C	-0.000747	0.015103	-0.049470	0.9605
AR(1)	-0.051799	0.016694	-3.102858	0.0019
Variance Equation				
C(3)	-0.100653	0.014989	-6.715242	0.0000
C(4)	-0.106205	0.070985	-1.496157	0.1346
C(5)	0.239996	0.067293	3.566442	0.0004
C(6)	-0.136642	0.013501	-10.12120	0.0000
C(7)	0.976230	0.004232	230.7022	0.0000

R-squared	0.005709	Mean dependent var	0.001357
Adjusted R-squared	0.003829	S.D. dependent var	1.349975
S.E. of regression	1.347388	Akaike info criterion	2.923228
Sum squared resid	5762.255	Schwarz criterion	2.936574
Log likelihood	-4642.394	F-statistic	3.037228
Durbin-Watson stat	2.064707	Prob(F-statistic)	0.005791

Inverted AR Roots	-.05

ARCH Test:

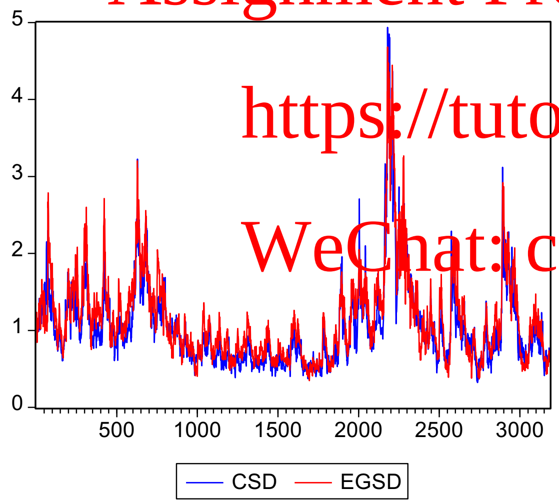
F-statistic	0.571744	Probability	0.853196
Obs*R-squared	6.300539	Probability	0.852578

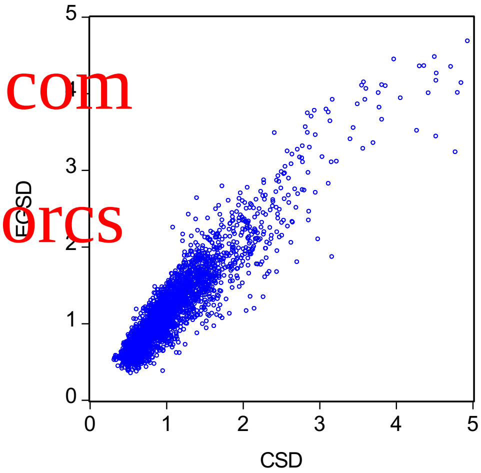
Test Equation:
Dependent Variable: STD_RESID^2
Method: Least Squares

Sample (adjusted): 14 3183
Included observations: 3170 after adjustments
White Heteroskedasticity-Consistent Standard Errors & Covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.943109	0.064534	14.61414	0.0000
STD_RESID^2(-1)	0.005062	0.035266	0.143540	0.8859
STD_RESID^2(-2)	0.008608	0.017323	0.496885	0.6193
STD_RESID^2(-3)	-0.023500	0.013776	-1.705877	0.0881
STD_RESID^2(-4)	-0.003841	0.014189	-0.270678	0.7867
STD_RESID^2(-5)	0.012061	0.015728	0.766866	0.4432
STD_RESID^2(-6)	-0.006952	0.013672	-0.508474	0.6112
STD_RESID^2(-7)	0.023840	0.022081	1.079664	0.2804
STD_RESID^2(-8)	0.002116	0.014556	0.145408	0.8844
STD_RESID^2(-9)	0.009801	0.017094	0.573384	0.5664
STD_RESID^2(-10)	0.018366	0.017243	1.065147	0.2869
STD_RESID^2(-11)	0.012033	0.014944	0.805208	0.4208

R-squared	0.001988	Mean dependent var	1.000805
Adjusted R-squared	-0.001489	S.D. dependent var	1.794991
S.E. of regression	1.796327	Akaike info criterion	4.013143
Sum squared resid	10190.20	Schwarz criterion	4.036089
Log likelihood	-6348.832	F-statistic	0.571744
Durbin-Watson stat	2.000136	Prob(F-statistic)	0.853196

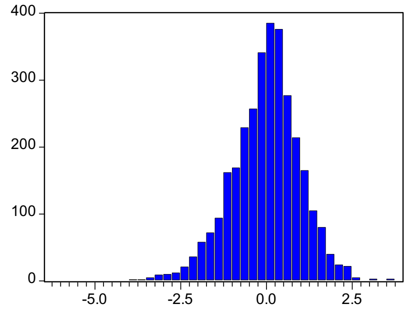




Cross Correlogram of CSD and EGSD

Sample: 1 3183
Included observations: 3172
Correlations are asymptotically consistent approximations

CSD,EGSD(-i)	CSD,EGSD(+i)	i	lag	lead
		0	0.9285	0.9285
		1	0.9256	0.9265
		2	0.9141	0.9139
		3	0.8996	0.9033
		4	0.8846	0.8915
		5	0.8683	0.8783
		6	0.8526	0.8665
		7	0.8385	0.8556
		8	0.8250	0.8442
		9	0.8118	0.8326
		10	0.7985	0.8208
		11	0.7846	0.8086
		12	0.7702	0.7940
		13	0.7566	0.7806
		14	0.7428	0.7661
		15	0.7302	0.7538
		16	0.7180	0.7415



Series: Standardized Residuals
Sample 3 3183
Observations 3181

Mean	0.003251
Median	0.076611
Maximum	3.629484
Minimum	-6.069213
Std. Dev.	1.000745
Skewness	-0.408280
Kurtosis	4.214804
Jarque-Bera	283.9731
Probability	0.000000

(f) The estimation results below confirms that the dependence structure of R is well captured by the extended AR(1)-EGARCH(2,1). No statistically-significant autocorrelations are observed in either the standardised residuals or their squares (see ARCH test as well as correlograms below). The coefficient on LRV(-1) is large and statistically significant, implying that LRV_{t-1} carries useful volatility information that is not available in either v_{t-1}, v_{t-2} or $\ln(\sigma_{t-1}^2)$. The in-sample fit is materially improved with the likelihood ratio being LR = 2[(-4548.36) – (-4642.39)] = 188.06 (compared against $\chi^2_{(1)}$ 5% critical value 3.84). The AIC and SIC criteria also favour the inclusion of LRV(-1) in the variance equation. The point estimate of β_1 is 0.7719, much smaller than the estimate 0.9762 in part (e). However, the persistence in the conditional variance of EGARCH that includes LRV(-1) should be measured differently. It should depend on both β_1 and the coefficient on LRV(-1), ψ, probably in a complicated way.

Dependent Variable: R
Method: ML - ARCH (Marquardt) - Normal distribution

Sample (adjusted): 3 3183
Included observations: 3181 after adjustments
Convergence achieved after 16 iterations
Bollerslev-Wooldrige robust standard errors & covariance
Variance backcast: ON
LOG(GARCH) = C(3) + C(4)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(5)*ABS(RESID(-2)/@SQRT(GARCH(-2))) + C(6)*RESID(-1) /@SQRT(GARCH(-1)) + C(7)*LOG(GARCH(-1)) + C(8)*LRV(-1)

	Coefficient	Std. Error	z-Statistic	Prob.
C	0.006952	0.014012	0.496143	0.6198
AR(1)	-0.046619	0.015392	-3.028768	0.0025
Variance Equation				
C(3)	0.169376	0.041642	4.067440	0.0000
C(4)	-0.317796	0.055023	-5.775660	0.0000
C(5)	0.188086	0.046006	4.088320	0.0000
C(6)	-0.177266	0.018350	-9.660251	0.0000
C(7)	0.771866	0.031834	24.24693	0.0000
C(8)	0.221003	0.031880	6.932430	0.0000

R-squared	0.005363	Mean dependent var	0.001357
Adjusted R-squared	0.003169	S.D. dependent var	1.349975
S.E. of regression	1.347835	Akaike info criterion	2.864734
Sum squared resid	5764.258	Schwarz criterion	2.879987
Log likelihood	-4548.360	F-statistic	2.444080
Durbin-Watson stat	2.074423	Prob(F-statistic)	0.016912
Inverted AR Roots	-.05		

ARCH Test:

F-statistic	0.418546	Probability	0.948689
Obs*R-squared	4.614767	Probability	0.948380

Test Equation:
Dependent Variable: STD_RESID^2
Method: Least Squares

Sample (adjusted): 14 3183
Included observations: 3170 after adjustments
White Heteroskedasticity-Consistent Standard Errors & Covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.999512	0.069689	14.34255	0.0000
STD_RESID^2(-1)	-0.008288	0.020747	-0.399457	0.6896
STD_RESID^2(-2)	0.018144	0.018819	0.964146	0.3350
STD_RESID^2(-3)	-0.006367	0.020036	-0.317795	0.7507
STD_RESID^2(-4)	-0.008246	0.014231	-0.579442	0.5623
STD_RESID^2(-5)	0.001070	0.017501	0.061135	0.9513
STD_RESID^2(-6)	-0.017404	0.014033	-1.240273	0.2150
STD_RESID^2(-7)	0.004411	0.017841	0.247217	0.8048
STD_RESID^2(-8)	-0.011805	0.013867	-0.851298	0.3947
STD_RESID^2(-9)	-0.001033	0.016356	-0.063170	0.9496
STD_RESID^2(-10)	0.015271	0.020076	0.760638	0.4469
STD_RESID^2(-11)	0.015435	0.016396	0.941373	0.3466

R-squared	0.001456	Mean dependent var	1.000700
Adjusted R-squared	-0.002022	S.D. dependent var	1.655155
S.E. of regression	1.656828	Akaike info criterion	3.851465
Sum squared resid	8668.960	Schwarz criterion	3.874411
Log likelihood	-6092.572	F-statistic	0.418546
Durbin-Watson stat	2.000321	Prob(F-statistic)	0.948689

Correlogram of Standardized Residuals

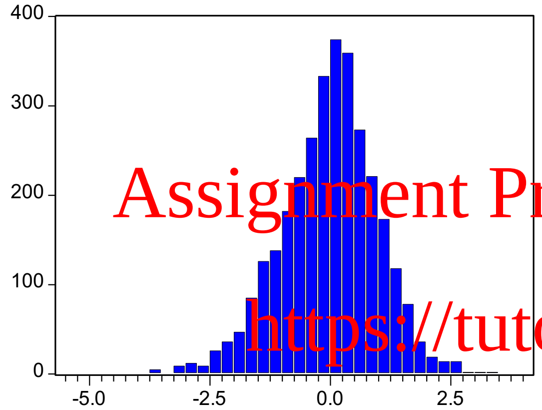
Sample: 3 3183
Included observations: 3181
Q-statistic probabilities adjusted for 1 ARMA term(s)

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.001	-0.001	0.0050	
		2	-0.030	-0.030	2.8065	0.094
		3	0.010	0.010	3.1159	0.211
		4	0.006	0.005	3.2383	0.356
		5	-0.023	-0.023	4.9848	0.289
		6	-0.014	-0.014	5.6503	0.342
		7	-0.006	-0.008	5.7685	0.450
		8	-0.017	-0.018	6.6961	0.461
		9	-0.007	-0.007	6.8599	0.552
		10	0.019	0.018	8.0284	0.531
		11	0.015	0.015	8.7620	0.555
		12	0.038	0.039	13.442	0.265
		13	0.026	0.026	15.546	0.213
		14	-0.017	-0.016	16.488	0.224
		15	-0.015	-0.014	17.206	0.245
		16	0.018	0.017	18.231	0.251

Correlogram of Standardized Residuals Squared

Sample: 3 3183
Included observations: 3181
Q-statistic probabilities adjusted for 1 ARMA term(s)

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.008	-0.008	0.2175	
		2	0.018	0.018	1.2584	0.262
		3	-0.007	-0.007	1.4114	0.494
		4	-0.008	-0.009	1.6299	0.653
		5	0.001	0.001	1.6335	0.803
		6	-0.018	-0.018	2.6985	0.746
		7	0.004	0.004	2.7575	0.839
		8	-0.012	-0.012	3.2457	0.861
		9	-0.000	-0.001	3.2462	0.918
		10	0.014	0.015	3.9169	0.917
		11	0.016	0.016	4.7643	0.906
		12	0.015	0.014	5.4752	0.906
		13	-0.007	-0.007	5.6275	0.934
		14	0.012	0.012	6.1028	0.942
		15	-0.055	-0.054	15.793	0.326
		16	0.010	0.009	16.128	0.374



Series: Standardized Residuals
Sample 3 3183
Observations 3181

Mean	-0.004635
Median	0.071906
Maximum	3.779356
Minimum	-5.438914
Std. Dev.	0.999997
Skewness	-0.327574
Kurtosis	3.727077
Jarque-Bera	126.9562
Probability	0.000000