1. Test whether there exists significant ARCH effects.

```
. g rspot=(spot/l.spot)-1
(1 missing value generated)

. g rfuture=(future/l.future)-1
(1 missing value generated)

. reg rfuture rspot if t>1
```

Source	SS	df	MS			
				Number of obs	=	7,683
				F(1, 7681)	=	6787.70
Model	.01531231	1	.01531231	Prob > F	=	0.0000
Residual	.017327485	7,681	2.2559e-06	R-squared	=	0.4691
				Adj R-squared	=	0.4691
Total	.032639795	7,682	4.2489e-06	Root MSE	=	.0015

rfuture	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
rspot	.7889924	.0095766	82.39	0.000	.7702196	.8077651
_cons	7.58e-06	.0000171	0.44	0.658	-.000026	.0000412

```
. estat archlm
LM test for autoregressive conditional heteroskedasticity (ARCH)
```

lags(*p*)	chi2	df	Prob > chi2
1	6.951	1	0.0084

H0: no ARCH effects *vs.* H1: ARCH(*p*) disturbance

Since Prob>Chi^2 is 0.0084 which is less than 0.05 significant level, we reject H_0: no ARCH effects. Therefore, there exist ARCH.

2. Estimate GARCH(p,q) for spot return (rspot) using future return (rfuture) as explanatory variable for mean equation – determine the most appropriated order p and q for variance equation using SBIC given the maximum lag equals to 2.

```
. reg rspot rfuture if t>1
```

Source	SS	df	MS			
				Number of obs	=	7,683
				F(1, 7681)	=	6787.70
Model	.011539538	1	.011539538	Prob > F	=	0.0000
Residual	.013058198	7,681	1.7001e-06	R-squared	=	0.4691
				Adj R-squared	=	0.4691
Total	.024597736	7,682	3.2020e-06	Root MSE	=	.0013

rspot	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
rfuture	.594594	.007217	82.39	0.000	.5804466	.6087413
_cons	8.01e-06	.0000149	0.54	0.590	-.0000212	.0000372

```
. estat archlm
LM test for autoregressive conditional heteroskedasticity (ARCH)
```

lags(*p*)	chi2	df	Prob > chi2
1	4.919	1	0.0266

H0: no ARCH effects *vs.* H1: ARCH(*p*) disturbance

```
. est store ols

. est table ols arch*, star(0.1 0.05 0.01) stat(N rss LL F chi2 aic bic)
```

Variable	ols	arch1	arch2
_			
rfuture	.59459397***		
_cons	8.007e-06		
rfuture			
rspot		.81227376***	.8356596***
_cons		-1.779e-06	-.00001466
ARCH			
arch			
L1.		.23368728***	.24679928***
L2.			.1915003***
_cons		1.839e-06***	1.497e-06***
Statistics			
N	7683	7683	7683
rss	.0130582		
LL			
F	6787.7049		
chi2		110866.6	108336.82
aic	-80262.049	-78428.289	-78693.691
bic	-80248.155	-78400.502	-78658.957

legend: * p<.1; ** p<.05; *** p<.01

```
.
. qui arch rfuture rspot, arch(1) nolog

. est store arch1

. qui arch rfuture rspot, arch(1/2) nolog

. est store arch2
```

```
. qui arch rspot rfuture, arch(1) garch(1) nolog

. est store garch11

. qui arch rspot rfuture, arch(1) garch(1/2) nolog

. est store garch21

. qui arch rspot rfuture, arch(1/2) garch(1) nolog

. est store garch12

. qui arch rspot rfuture, arch(1/2) garch(1/2) nolog

. est store garch22

. est table garch*, star(0.1 0.05 0.01) stat(N rss LL F chi2 aic bic)
```

Variable	garch11	garch21	garch12	garch22
rspot				
rfuture	.6471721***	.64002158***	.62591033***	.62371239***
_cons	6.393e-07	-2.531e-06	-8.749e-06	-.00001062
ARCH				
arch				
L1.	.18339896***	.17044859***	.10390561***	.10141341***
L2.			.23783648***	.29886482***
garch				
L1.	.60659693***	.84898803***	.34036791***	.07659235***
L2.		-.20697058***		.17715583***
_cons	3.858e-07***	3.503e-07***	6.225e-07***	6.862e-07***
Statistics				
N	7683	7683	7683	7683
rss				
LL				
F				
chi2	126856.95	131273.3	127295.78	120955.81
aic	-81027.53	-81061.507	-81150.803	-81192.527
bic	-80992.796	-81019.826	-81109.122	-81143.899

legend: * p<.1; ** p<.05; *** p<.01

From the table, the model with the lowest BIC (-81143.899) is GARCH (2,2). Hence, the most appropriated order of p, and q is 2 and 2, respectively.

3. From (2), predict the variance of future return (rfuture).

Chitphatsorn Sitthisomprasong 6104641011

```
. arch rspot rfuture, arch(1/2) garch(1/2) nolog

ARCH family regression

Sample: 2 - 7684                                Number of obs     =      7,683
Distribution: Gaussian                          Wald chi2(1)      =  120955.81
Log likelihood =  40603.26                      Prob > chi2       =     0.0000
```

rspot	Coef.	OPG Std. Err.	z	P>|z|	[95% Conf.	Interval]
rspot						
rfuture	.6237124	.0017934	347.79	0.000	.6201974	.6272273
_cons	-.0000106	9.47e-06	-1.12	0.262	-.0000292	7.94e-06
ARCH						
arch						
L1.	.1014134	.008253	12.29	0.000	.0852379	.1175889
L2.	.2988648	.0063883	46.78	0.000	.286344	.3113857
garch						
L1.	.0765924	.0154154	4.97	0.000	.0463787	.106806
L2.	.1771558	.0174298	10.16	0.000	.1429941	.2113176
_cons	6.86e-07	1.36e-08	50.58	0.000	6.60e-07	7.13e-07

```
. predict sigma2, variance

. line sigma2 t
```