Assignment 6

1. Estimate Autoregressive Integrated Moving Average (ARIMA(p,d,q)) model for spot return (*rspot*) and future return (*rfuture*) – determine the most appropriated order for p, d, and q using SBIC given the maximum lag equals 5.

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

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

. dfuller rspot, trend lags(1) regress

Augmented Dickey-Fuller test for unit root         Number of obs   =      7681

                                 ---------- Interpolated Dickey-Fuller ----------
                 Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)           -63.787            -3.960            -3.410            -3.120
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0000

------------------------------------------------------------------------------
D.rspot          |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-----------------+------------------------------------------------------------
       rspot     |
         L1.     |  -1.005168   .0157581   -63.79   0.000    -1.036058   -.9742776
         LD.     |   .0517018   .0113974     4.54   0.000     .0293598    .0740439
      _trend     |   9.56e-10   9.19e-09     0.10   0.917    -1.71e-08    1.90e-08
       _cons     |   .0000199   .0000408     0.49   0.626      -.00006    .0000998
------------------------------------------------------------------------------

. dfuller rfuture, trend lags(1) regress

Augmented Dickey-Fuller test for unit root         Number of obs   =      7681

                                 ---------- Interpolated Dickey-Fuller ----------
                 Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)           -65.070            -3.960            -3.410            -3.120
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0000

------------------------------------------------------------------------------
D.rfuture        |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-----------------+------------------------------------------------------------
     rfuture     |
         L1.     |  -1.063572   .0163449   -65.07   0.000    -1.095612   -1.031531
         LD.     |     .03575   .0114053     3.13   0.002     .0133924    .0581076
      _trend     |   1.17e-09   1.06e-08     0.11   0.912    -1.96e-08    2.19e-08
       _cons     |   .0000231    .000047     0.49   0.624    -.0000691    .0001152
------------------------------------------------------------------------------
```

```
. qui arima rspot, arima(1,0,1) nolog

. est store arima101

. qui arima rspot, arima(1,0,2) nolog

. est store arima102

. qui arima rspot, arima(1,0,3) nolog

. est store arima103

. qui arima rspot, arima(1,0,4) nolog

. est store arima104

. qui arima rspot, arima(1,0,5) nolog

. est store arima105

. qui arima rspot, arima(2,0,1) nolog

. est store arima201

. qui arima rspot, arima(2,0,2) nolog

. est store arima202

. qui arima rspot, arima(2,0,3) nolog

. est store arima203

. qui arima rspot, arima(2,0,4) nolog

. est store arima204

. qui arima rspot, arima(2,0,5) nolog

. est store arima205
```

```
. qui arima rspot, arima(3,0,1) nolog

. est store arima301

. qui arima rspot, arima(3,0,2) nolog

. est store arima302

. qui arima rspot, arima(3,0,3) nolog

. est store arima303

. qui arima rspot, arima(3,0,4) nolog

. est store arima304

. qui arima rspot, arima(3,0,5) nolog

. est store arima305

. qui arima rspot, arima(4,0,1) nolog

. est store arima401

. qui arima rspot, arima(4,0,2) nolog

. est store arima402

. qui arima rspot, arima(4,0,3) nolog

. est store arima403

. qui arima rspot, arima(4,0,4) nolog

. est store arima404

. qui arima rspot, arima(4,0,5) nolog

. est store arima405

. qui arima rspot, arima(5,0,1) nolog

. est store arima501

. qui arima rspot, arima(5,0,2) nolog

. est store arima502

. qui arima rspot, arima(5,0,3) nolog

. est store arima503
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. qui arima rspot, arima(5,0,4) nologlog

. est store arima504

. qui arima rspot, arima(5,0,5) nologlog

. est store arima505
```

```
. est table arima10*,star(0.1 0.5 0.01) stat(N ll chi2 aic bic)
```

Variable	arima101	arima102	arima103	arima104	arima105
rspot					
_cons	.00002358*	.00002358*	.00002358*	.00002357*	.0000236*
ARMA					
ar					
L1.	-.39222121***	.42866768***	.65121793**	-.44187083	.19422255
ma					
L1.	.44515732***	-.38284317***	-.60570251**	.48778128	-.14853288
L2.		-.06805288***	-.0785457***	-.02952615	-.0578027**
L3.			.01541405*	-.04117544	-.00879285
L4.				-.00216734	.00427518
L5.					-.02212732**
sigma					
_cons	.00178634***	.00178491***	.00178487***	.00178491***	.00178452***
Statistics					
N	7683	7683	7683	7683	7683
ll	37713.142	37719.292	37719.478	37719.305	37720.958
chi2	119.51861	100.14226	108.29283	133.21806	101.26927
aic	-75418.284	-75428.583	-75426.956	-75424.609	-75425.916
bic	-75390.497	-75393.85	-75385.276	-75375.982	-75370.342

legend: * p<.5; ** p<.1; *** p<.01

```
. . est table arima20*,star(0.1 0.5 0.01) stat(N ll chi2 aic bic)
```

Variable	arima201	arima202	arima203	arima204	arima205
rspot					
_cons	.00002357*	.00002358*	.00002357*	.00002358*	.00002356*
ARMA					
ar					
L1.	.38018903***	.4428634***	-.29668626	.20849639	.63271495***
L2.	-.06525664***	.06485063	.18525538	.3777193*	-.9174531***
ma					
L1.	-.33467542**	-.39715673***	.3426502	-.16259964	-.58719207***
L2.		-.13338401*	-.22062902	-.4368354*	.83979784***
L3.			-.0455461	-.02891993	.05477838***
L4.				.02145033*	-.0341015***
L5.					-.03010547***
sigma					
_cons	.00178498***	.00178489***	.00178489***	.00178475***	.00178388***
Statistics					
N	7683	7683	7683	7683	7683
ll	37719.008	37719.388	37719.394	37719.987	37723.723
chi2	97.508642	100.31373	120.1281	104.88266	710.97147
aic	-75428.017	-75426.777	-75424.788	-75423.974	-75429.446
bic	-75393.283	-75385.096	-75376.161	-75368.4	-75366.925

legend: * p<.5; ** p<.1; *** p<.01

```
. est table arima30*,star(0.1 0.5 0.01) stat(N ll chi2 aic bic)
```

Variable	arima301	arima302	arima303	arima304	arima305
rspot					
_cons	.00002358*	.00002358*	.00002358*	.00002358*	.00002358*
ARMA					
ar					
L1.	.77437319***	.75391093*	-.00931271	.11658227*	.1701239
L2.	-.08500113***	-.07142142	.14076076	-.77533773***	-.75368747***
L3.	.02486609*	.02349348	.27348399**	.50689845***	.56032548**
ma					
L1.	-.72875825***	-.70829213*	.05444554	-.07070647	-.12433777
L2.		-.0126675	-.19087608*	.72188531***	.69756857***
L3.			-.29968133**	-.48362803***	-.53417632**
L4.				-.06737448***	-.06847815***
L5.					.00392646
sigma					
_cons	.00178484***	.00178484***	.00178455***	.00178409***	.00178409***
Statistics					
N	7683	7683	7683	7683	7683
ll	37719.588	37719.589	37720.837	37722.792	37722.804
chi2	116.99403	115.5826	113.25114	10208.991	9995.0318
aic	-75427.175	-75425.178	-75425.675	-75427.585	-75425.609
bic	-75385.495	-75376.55	-75370.101	-75365.064	-75356.141

legend: * p<.5; ** p<.1; *** p<.01

```
. est table arima40*,star(0.1 0.5 0.01) stat(N ll chi2 aic bic)
```

Variable	arima401	arima402	arima403	arima404	arima405
rspot					
_cons	.00002358*	.00002358*	.00002358*	.00002358*	.00002358*
ARMA					
ar					
L1.	.7666053**	.19158964	.11455665*	.11554831*	-.54927322
L2.	-.0847024***	.40155116	-.84432053***	-.7579017***	-.78567965***
L3.	.02504525*	-.03039789	.4764288***	.51349215***	-.04793383
L4.	-.00097078	.02217215*	-.06669135***	.01738201	.25111025
ma					
L1.	-.72097599**	-.14607877	-.0688967	-.0697206	.59533818
L2.		-.45952184	.79187066***	.70442344***	.76310459***
L3.			-.45274427***	-.49036213***	.03649951
L4.				-.08464192	-.30317115
L5.					-.04483284
sigma					
_cons	.00178484***	.0017848***	.00178412***	.00178409***	.00178407***
Statistics					
N	7683	7683	7683	7683	7683
ll	37719.59	37719.787	37722.647	37722.799	37722.91
chi2	116.13751	103.18568	9970.8895	10384.247	10621.886
aic	-75425.181	-75423.574	-75427.294	-75425.598	-75423.821
bic	-75376.553	-75368	-75364.773	-75356.131	-75347.407

legend: * p<.5; ** p<.1; *** p<.01

```
. est table arima50*,star(0.1 0.5 0.01) stat(N ll chi2 aic bic)
```

Variable	arima501	arima502	arima503	arima504	arima505
rspot					
_cons	.00002358*	.00002357*	.00002356*	.00002358*	.00002357*
ARMA					
ar					
L1.	.16545423	.27864545	.40295474*	.45006125	.64948609*
L2.	-.05696613**	-.38380205*	-.81262761**	-.79649687***	-.844491*
L3.	-.00729372	.0132755	-.23254742	.79695972	.13043438
L4.	.00131372	-.01409715	-.01690687	-.14085523	-.03624586
L5.	-.02387488**	-.027723**	-.03802772*	.02389748	.21166048*
ma					
L1.	-.11967988	-.23291976	-.35731992*	-.40421962	-.60425085*
L2.		.32183899	.7460888**	.72684872***	.76637039*
L3.			.27286254	-.75498242	-.07798537
L4.				.06527172	.00341651
L5.					-.24345546*
sigma					
_cons	.0017845***	.00178443***	.00178393***	.00178407***	.00178371***
Statistics					
N	7683	7683	7683	7683	7683
ll	37721.078	37721.395	37723.49	37722.895	37724.453
chi2	102.58864	114.46132	754.18517	7125.4394	2753.0424
aic	-75426.156	-75424.789	-75426.981	-75423.79	-75424.907
bic	-75370.582	-75362.269	-75357.513	-75347.376	-75341.546

legend: * p<.5; ** p<.1; *** p<.01

From all above, we firstly started with “Unit Root Test”. Based from first 2 table, McKinnon p-value is 0 which was less than 0.05. Then, Ho is rejected, beta is not equal to 1. Therefore, there is no Unit Root Problem or Stationary d(0).

Next, we have to fine the appropriate degree of P and Q. First, we have to set the maximum lag (maximum lag in this case is 5). Then, we have to run 25 combination as followed:
(1,0,1) (1,0,2) (1,0,3) (1,0,4) (1,0,5)
(2,0,1) (2,0,2) (2,0,3) (2,0,4) (2,0,5)
(3,0,1) (3,0,2) (3,0,3) (3,0,4) (3,0,5)
(4,0,1) (4,0,2) (4,0,3) (4,0,4) (4,0,5)
(5,0,1) (5,0,2) (5,0,3) (5,0,4) (5,0,5)

Lastly, find the lowest value in BIC. In this case, **ARIMA (1,0,2) is the most appropriate order for rspot** since it has the lowest value.

For rfuture case, repeat the step of rspot to find the appropriated order.