Assignment 8

1. Estimate VARs models using spot return (rspot) and future return (rfuture) as endogenous variables and determine the most appropriated lags models using SBIC.

To estimate the VARs model, we need to perform unit root test in order to ensure that all variables are stationary. However, this test already performed in the past assignment and it shows that all variables are stationary. Then, we determine the optimal lag by using SBIC as a criteria. We find out that the model with 6 lags is the most appropriated model since it has the lowest SBIC value which is -20.053.

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

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

. varsoc rspot rfuture, maxlag(10)

   Selection-order criteria
   Sample:  12 - 7684                        Number of obs      =      7673
```

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	76671.7				7.2e-12	-19.9843	-19.9837	-19.9825
1	76840.9	338.5	4	0.000	6.9e-12	-20.0274	-20.0255	-20.0219
2	76931.4	180.85	4	0.000	6.7e-12	-20.0499	-20.0468	-20.0408
3	76963.2	63.709	4	0.000	6.7e-12	-20.0571	-20.0528	-20.0445
4	76979.4	32.291	4	0.000	6.7e-12	-20.0603	-20.0547	-20.044
5	77017.6	76.544	4	0.000	6.6e-12	-20.0692	-20.0624	-20.0493
6	77049.6	63.872	4	0.000	6.5e-12	-20.0765	-20.0684	-20.053*
7	77059.6	20.054	4	0.000	6.5e-12	-20.0781	-20.0688	-20.0509
8	77070.3	21.332	4	0.000	6.5e-12	-20.0798	-20.0693*	-20.0491
9	77076.4	12.37*	4	0.015	6.5e-12*	-20.0804*	-20.0686	-20.046
10	77080.2	7.4487	4	0.114	6.5e-12	-20.0803	-20.0673	-20.0423

```
   Endogenous:  rspot rfuture
    Exogenous:  _cons
```

```
. var rspot rfuture, lag(1/6)

Vector autoregression

Sample:  8 - 7684                               Number of obs     =      7,677
Log likelihood =    77062.5                     AIC               =  -20.06943
FPE            =   6.59e-12                     HQIC              =  -20.06136
Det(Sigma_ml)  =   6.55e-12                     SBIC              =   -20.0459

Equation           Parms      RMSE     R-sq      chi2     P>chi2
------------------------------------------------------------------
rspot                 13     .001777   0.0159   124.0308   0.0000
rfuture               13     .002042   0.0211   165.0864   0.0000
------------------------------------------------------------------
```

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
rspot						
rspot						
L1.	-.0429887	.0160995	-2.67	0.008	-.0745432	-.0114342
L2.	-.1255145	.0163803	-7.66	0.000	-.1576194	-.0934097
L3.	-.0654555	.0165559	-3.95	0.000	-.0979044	-.0330066
L4.	-.0555308	.0165648	-3.35	0.001	-.0879973	-.0230644
L5.	-.0646528	.0163598	-3.95	0.000	-.0967173	-.0325882
L6.	-.0420281	.0160563	-2.62	0.009	-.0734979	-.0105584
rfuture						
L1.	.1025108	.0140081	7.32	0.000	.0750554	.1299661
L2.	.0827253	.0143869	5.75	0.000	.0545274	.1109231
L3.	.0530446	.0145602	3.64	0.000	.0245072	.081582
L4.	.057478	.0145501	3.95	0.000	.0289603	.0859958
L5.	.0435619	.0143967	3.03	0.002	.0153449	.0717788
L6.	.0372007	.0140183	2.65	0.008	.0097254	.064676
_cons	.0000232	.0000203	1.14	0.252	-.0000165	.0000629
rfuture						
rspot						
L1.	.2117743	.0185008	11.45	0.000	.1755133	.2480352
L2.	.0743206	.0188235	3.95	0.000	.0374272	.1112139
L3.	.0828566	.0190252	4.36	0.000	.0455679	.1201454
L4.	.0448446	.0190355	2.36	0.018	.0075357	.0821535
L5.	.0674903	.0187999	3.59	0.000	.0306433	.1043374
L6.	.0590473	.0184511	3.20	0.001	.0228838	.0952109
rfuture						
L1.	-.1623592	.0160974	-10.09	0.000	-.1939096	-.1308088
L2.	-.1054217	.0165328	-6.38	0.000	-.1378253	-.073018
L3.	-.0724314	.0167319	-4.33	0.000	-.1052253	-.0396376
L4.	-.042915	.0167203	-2.57	0.010	-.0756863	-.0101437
L5.	-.0604119	.016544	-3.65	0.000	-.0928375	-.0279863
L6.	-.0392965	.0161092	-2.44	0.015	-.0708699	-.0077232
_cons	.0000259	.0000233	1.11	0.266	-.0000198	.0000715

2. Perform stability test and Granger exogeneity test.

To evaluate the model, we need to test for stability and exogeneity. For the stability tes, the result shows that all the eigen values lie inside the unit circle and VAR satisfies stability condition, meaning that the model has stability property. For the Granger exogeneity test, the purpose is to prove for independency. The prob > Chi2 for all variables is 0.00 (<0.05), implying that we can reject the null hypothesis that the variables are exogeneity at 95% confidence level. Therefore, both variables are endogeneity or interdependent relation.

```
. varstable, graph
```

Eigenvalue stability condition

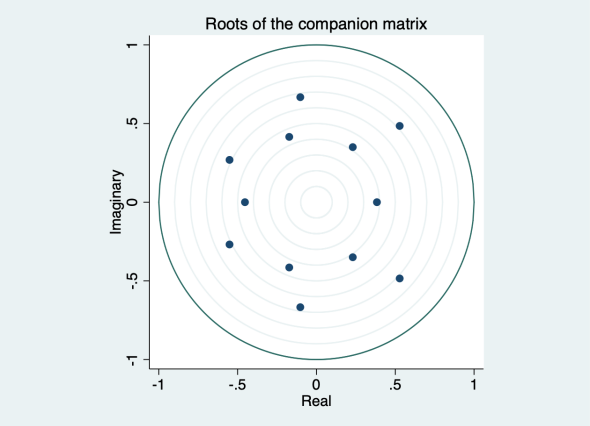
Eigenvalue	Modulus
.5279554 + .4847924*i*	.716771
.5279554 - .4847924*i*	.716771
-.1022778 + .6675194*i*	.67531
-.1022778 - .6675194*i*	.67531
-.5513603 + .2689237*i*	.613448
-.5513603 - .2689237*i*	.613448
-.4536067	.453607
-.1726167 + .4151256*i*	.449584
-.1726167 - .4151256*i*	.449584
.2305361 + .3500458*i*	.419141
.2305361 - .3500458*i*	.419141
.3837855	.383786

All the eigenvalues lie inside the unit circle.
VAR satisfies stability condition.

```
. vargranger
```

Granger causality Wald tests

Equation	Excluded	chi2	df	Prob > chi2
rspot	rfuture	82.299	6	0.000
rspot	ALL	82.299	6	0.000
rfuture	rspot	148.42	6	0.000
rfuture	ALL	148.42	6	0.000



3. Perform Impulse response analysis and determine which variable has more impact.

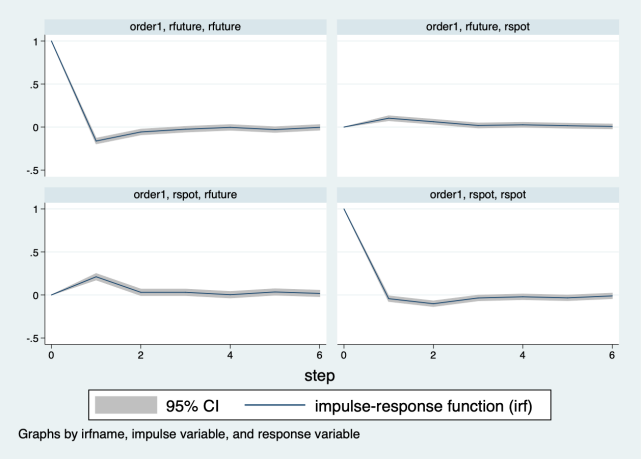
To interpret the estimated results, we need to derive the impact to be Impulse response function (IRF). However, in reality, the innovations or error term in VAR are not contemporaneously independent of once another. Then, it would be better to look at Cumulative orthogonal impulse response function (COIRF). The result shows that all values are significant since the lower and upper do not cover 0. The impulse response of rspot has a slightly higher imapct on rspot. While the impulse response of rfuture has a higher impact on rfuture.

```
. irf create order1, order(rspot rfuture) step(6) set(irf01)
(file irf01.irf created)
(file irf01.irf now active)
(file irf01.irf updated)

. irf table irf, impulse(rspot rfuture) response(rspot rfuture)
```

Results from order1

step	(1) irf	(1) Lower	(1) Upper	(2) irf	(2) Lower	(2) Upper	(3) irf	(3) Lower	(3) Upper	(4) irf	(4) Lower	(4) Upper
0	1	1	1	0	0	0	0	0	0	1	1	1
1	-.042989	-.074543	-.011434	.211774	.175513	.248035	.102511	.075055	.129966	-.162359	-.19391	-.130809
2	-.101957	-.133505	-.070409	.030833	-.00561	.067276	.061675	.034224	.089126	-.057352	-.089063	-.025641
3	-.034997	-.066566	-.003428	.030738	-.005677	.067153	.018216	-.009265	.045697	-.025324	-.057023	.006376
4	-.02148	-.052956	.009995	.002714	-.033596	.039023	.026291	-.001106	.053688	-.004062	-.035665	.027541
5	-.033647	-.06485	-.002443	.034962	-.001046	.070971	.01553	-.011653	.042713	-.029332	-.060699	.002035
6	-.010717	-.041519	.020085	.017646	-.017933	.053226	.006933	-.01982	.033686	-.003566	-.034475	.027344

```
95% lower and upper bounds reported
(1) irfname = order1, impulse = rspot, and response = rspot
(2) irfname = order1, impulse = rspot, and response = rfuture
(3) irfname = order1, impulse = rfuture, and response = rspot
(4) irfname = order1, impulse = rfuture, and response = rfuture

. irf graph irf, impulse(rspot rfuture) response(rspot rfuture)
```



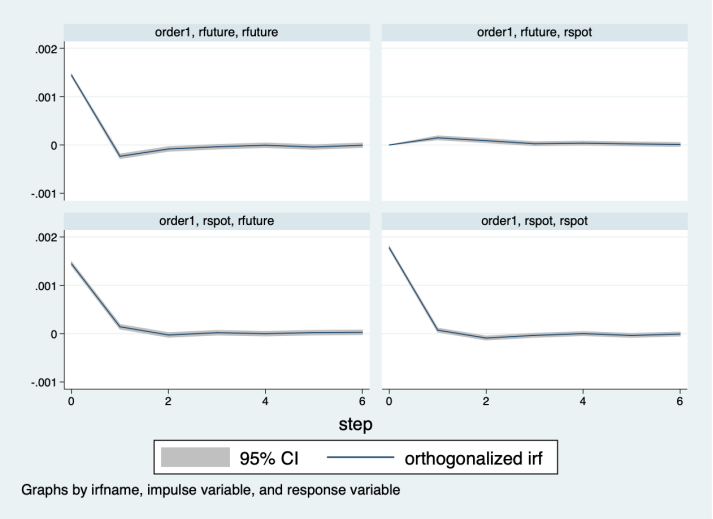
```
. irf table oirf, impulse(rspot rfuture) response(rspot rfuture)
```

Results from order1

step	(1) oirf	(1) Lower	(1) Upper	(2) oirf	(2) Lower	(2) Upper	(3) oirf	(3) Lower	(3) Upper	(4) oirf	(4) Lower	(4) Upper
0	.001775	.001747	.001803	.001444	.001404	.001483	0	0	0	.001441	.001419	.001464
1	.000072	.000032	.000112	.000142	.000096	.000188	.000148	.000108	.000187	-.000234	-.00028	-.000188
2	-.000092	-.000132	-.000052	-.000028	-.000074	.000018	.000089	.000049	.000128	-.000083	-.000128	-.000037
3	-.000036	-.000076	4.1e-06	.000018	-.000028	.000064	.000026	-.000013	.000066	-.000037	-.000082	9.2e-06
4	-1.8e-07	-.00004	.00004	-1.0e-06	-.000047	.000045	.000038	-1.6e-06	.000077	-5.9e-06	-.000051	.00004
5	-.000037	-.000077	2.5e-06	.00002	-.000026	.000066	.000022	-.000017	.000062	-.000042	-.000087	2.9e-06
6	-9.0e-06	-.000049	.000031	.000026	-.00002	.000072	1.0e-05	-.000029	.000049	-5.1e-06	-.00005	.000039

95% lower and upper bounds reported
(1) irfname = order1, impulse = rspot, and response = rspot
(2) irfname = order1, impulse = rspot, and response = rfuture
(3) irfname = order1, impulse = rfuture, and response = rspot
(4) irfname = order1, impulse = rfuture, and response = rfuture

```
. irf graph oirf, impulse(rspot rfuture) response(rspot rfuture)
```



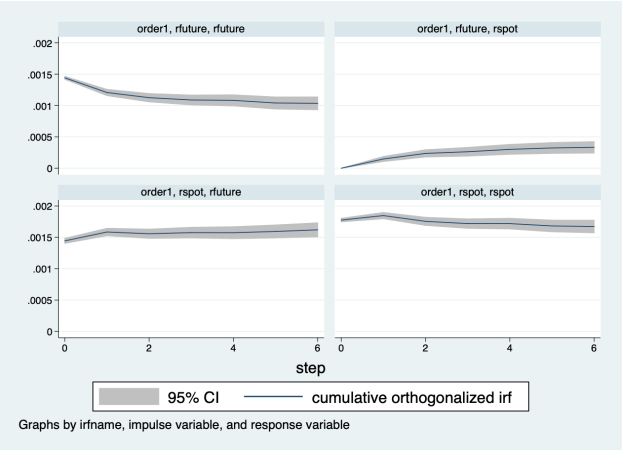

```
. irf table coirf, impulse(rspot rfuture) response(rspot rfuture)
```

Results from order1

step	(1) coirf	(1) Lower	(1) Upper	(2) coirf	(2) Lower	(2) Upper	(3) coirf	(3) Lower	(3) Upper	(4) coirf	(4) Lower	(4) Upper
0	.001775	.001747	.001803	.001444	.001404	.001483	0	0	0	.001441	.001419	.001464
1	.001847	.001798	.001896	.001585	.001527	.001644	.000148	.000108	.000187	.001207	.001158	.001257
2	.001755	.001691	.001819	.001557	.001484	.00163	.000237	.00018	.000294	.001125	.001059	.00119
3	.001719	.001644	.001794	.001575	.001491	.001659	.000263	.000194	.000332	.001088	.00101	.001166
4	.001719	.001635	.001803	.001574	.00148	.001668	.000301	.000223	.000379	.001082	.000995	.00117
5	.001682	.001589	.001774	.001594	.001491	.001697	.000323	.000238	.000409	.00104	.000945	.001136
6	.001673	.001573	.001772	.00162	.001509	.001731	.000333	.000242	.000424	.001035	.000934	.001136

95% lower and upper bounds reported
(1) irfname = order1, impulse = rspot, and response = rspot
(2) irfname = order1, impulse = rspot, and response = rfuture
(3) irfname = order1, impulse = rfuture, and response = rspot
(4) irfname = order1, impulse = rfuture, and response = rfuture

```
. irf graph coirf, impulse(rspot rfuture) response(rspot rfuture)
```



4. Perform forecast error variance decomposition and determine variable that has more impact on each endogenous variable.

From the results, we can see that the lower and upper do not cover 0, meaning that the test is significant. In addition, when looking at fevd, we can see the percentage of the variance of predicted Y caused by orthogonal innovation from each variable. So, impulse response of rspot has more impact on rspot since the percentage of decomposition is higher compared with rfuture (99% > 1%). While impulse response of rfuture has almost the same impact on rspot and rfuture (50%).

```
. irf table fevd, impulse(rspot rfuture) response(rspot)

                              Results from order1
```

step	(1) fevd	(1) Lower	(1) Upper	(2) fevd	(2) Lower	(2) Upper
0	0	0	0	0	0	0
1	1	1	1	0	0	0
2	.993131	.989465	.996798	.006869	.003202	.010535
3	.990693	.98638	.995006	.009307	.004994	.01362
4	.990483	.986145	.994821	.009517	.005179	.013855
5	.990038	.98565	.994426	.009962	.005574	.01435
6	.989888	.985487	.994289	.010112	.005711	.014513

```
95% lower and upper bounds reported
(1) irfname = order1, impulse = rspot, and response = rspot
(2) irfname = order1, impulse = rfuture, and response = rspot

. irf table fevd, impulse(rspot rfuture) response(rfuture)

                              Results from order1
```

step	(1) fevd	(1) Lower	(1) Upper	(2) fevd	(2) Lower	(2) Upper
0	0	0	0	0	0	0
1	.500791	.484986	.516596	.499209	.483404	.515014
2	.496679	.480799	.512558	.503321	.487442	.519201
3	.495972	.480066	.511879	.504028	.488121	.519934
4	.495855	.479951	.51176	.504145	.48824	.520049
5	.495851	.479947	.511756	.504149	.488244	.520053
6	.495689	.479783	.511594	.504311	.488406	.520217

```
95% lower and upper bounds reported
(1) irfname = order1, impulse = rspot, and response = rfuture
(2) irfname = order1, impulse = rfuture, and response = rfuture
```