1.

```
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

If we use information criteria to identify the lag order of VAR that best fit the data. The lowest value of SBIC is -20.0882 at the 4th lag order. Thus it is the most appropriate.

```
. 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.

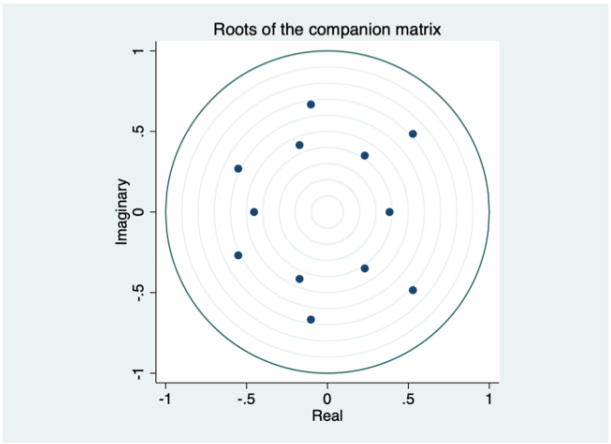
```
. varstable, graph
```

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.

The stability test, All item in eigenvalues must be lower than 1 or lie in the unit circle. Thus VARs satisfies stability condition. This means the model has stability property and shock will be converge to 0.




```
. 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

Granger test is performed to create independence. The null hypothesis $H_0: \Delta_{21}(L) = 0$ and $\Delta_{12}(L) = 0$. The result show that for all variables Prob > Chi2 is lower than 0.05, H_0 is rejected, therefore rspot and rfuture are endogenity variables.

3.

```
. irf create order1, order( rspot rfuture ) step(10) set(irf01)
(file irf01.irf created)
(file irf01.irf now active)
(file irf01.irf updated)
```

1. Direction: All variables have positive response each other
2. Magnitude: rspot on rfuture has more impact than rfuture since the gap shock response of rspot on rfuture is greater than r future on rspot.

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

Results from order1

step	(1) irf	(1) Lower	(1) Upper
0	1	1	1
1	-.042989	-.074543	-.011434
2	-.101957	-.133505	-.070409
3	-.034997	-.066566	-.003428
4	-.02148	-.052956	.009995
5	-.033647	-.06485	-.002443
6	-.010717	-.041519	.020085

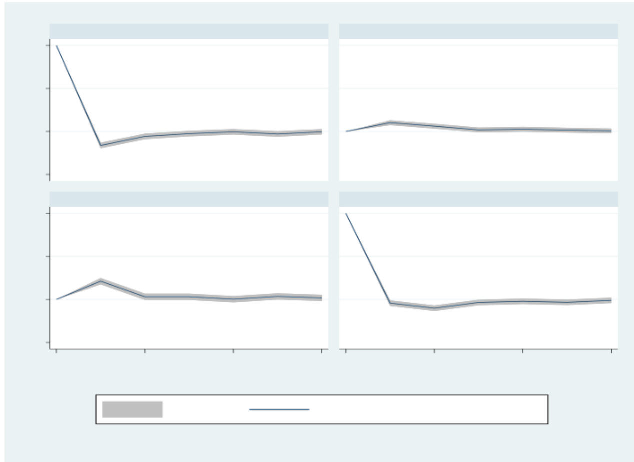
step	(2) irf	(2) Lower	(2) Upper
0	0	0	0
1	.211774	.175513	.248035
2	.030833	-.00561	.067276
3	.030738	-.005677	.067153
4	.002714	-.033596	.039023
5	.034962	-.001046	.070971
6	.017646	-.017933	.053226

step	(3) irf	(3) Lower	(3) Upper
0	0	0	0
1	.102511	.075055	.129966
2	.061675	.034224	.089126
3	.018216	-.009265	.045697
4	.026291	-.001106	.053688
5	.01553	-.011653	.042713
6	.006933	-.01982	.033686

step	(4) irf	(4) Lower	(4) Upper
0	1	1	1
1	-.162359	-.19391	-.130809
2	-.057352	-.089063	-.025641
3	-.025324	-.057023	.006376
4	-.004062	-.035665	.027541
5	-.029332	-.060699	.002035
6	-.003566	-.034475	.027344

3. Derivation: It takes 6 period to goes to 0.

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 table oirf, impulse(rspot rfuture) response(rspot rfuture)

Results from order1

step	(1) oirf	(1) Lower	(1) Upper
0	.001775	.001747	.001803
1	.000072	.000032	.000112
2	-.000092	-.000132	-.000052
3	-.000036	-.000076	4.1e-06
4	-1.8e-07	-.00004	.00004
5	-.000037	-.000077	2.5e-06
6	-9.0e-06	-.000049	.000031

step	(2) oirf	(2) Lower	(2) Upper
0	.001444	.001404	.001483
1	.000142	.000096	.000188
2	-.000028	-.000074	.000018
3	.000018	-.000028	.000064
4	-1.0e-06	-.000047	.000045
5	.00002	-.000026	.000066
6	.000026	-.00002	.000072

step	(3) oirf	(3) Lower	(3) Upper
0	0	0	0
1	.000148	.000108	.000187
2	.000089	.000049	.000128
3	.000026	-.000013	.000066
4	.000038	-1.6e-06	.000077
5	.000022	-.000017	.000062
6	1.0e-05	-.000029	.000049

step	(4) oirf	(4) Lower	(4) Upper
0	.001441	.001419	.001464
1	-.000234	-.00028	-.000188
2	-.000083	-.000128	-.000037
3	-.000037	-.000082	9.2e-06
4	-5.9e-06	-.000051	.00004
5	-.000042	-.000087	2.9e-06
6	-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 table coirf, impulse(rspot rfuture) response(rspot rfuture)

                    Results from order1
```

step	(1) coirf	(1) Lower	(1) Upper
0	.001775	.001747	.001803
1	.001847	.001798	.001896
2	.001755	.001691	.001819
3	.001719	.001644	.001794
4	.001719	.001635	.001803
5	.001682	.001589	.001774
6	.001673	.001573	.001772

step	(2) coirf	(2) Lower	(2) Upper
0	.001444	.001404	.001483
1	.001585	.001527	.001644
2	.001557	.001484	.00163
3	.001575	.001491	.001659
4	.001574	.00148	.001668
5	.001594	.001491	.001697
6	.00162	.001509	.001731

0	0	0	0
1	.000148	.000108	.000187
2	.000237	.00018	.000294
3	.000263	.000194	.000332
4	.000301	.000223	.000379
5	.000323	.000238	.000409
6	.000333	.000242	.000424

step	(4) coirf	(4) Lower	(4) Upper
0	.001441	.001419	.001464
1	.001207	.001158	.001257
2	.001125	.001059	.00119
3	.001088	.00101	.001166
4	.001082	.000995	.00117
5	.00104	.000945	.001136
6	.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
```

→ We use COIRF to look at the significant of the impulse response. The result shows that all values have lower bound more than 0. Thus the lower and upper bound don't cover 0, All values are significant

4.

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

Results from order1

step	(1) fevd	(1) Lower	(1) Upper
0	0	0	0
1	1	1	1
2	.993131	.989465	.996798
3	.990693	.98638	.995006
4	.990483	.986145	.994821
5	.990038	.98565	.994426
6	.989888	.985487	.994289

step	(2) fevd	(2) Lower	(2) Upper
0	0	0	0
1	0	0	0
2	.006869	.003202	.010535
3	.009307	.004994	.01362
4	.009517	.005179	.013855
5	.009962	.005574	.01435
6	.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
0	0	0	0
1	.500791	.484986	.516596
2	.496679	.480799	.512558
3	.495972	.480066	.511879
4	.495855	.479951	.51176
5	.495851	.479947	.511756
6	.495689	.479783	.511594

step	(2) fevd	(2) Lower	(2) Upper
0	0	0	0
1	.499209	.483404	.515014
2	.503321	.487442	.519201
3	.504028	.488121	.519934
4	.504145	.48824	.520049
5	.504149	.488244	.520053
6	.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

From the table all the values are significant since the lower bound and upper bound don't cover 0.

From Variation in rspot For 10 period about 99% of variation in rspot caused by rspot itself and less than 1% cause by rfuture
From Variation in rfuture. For 10 period about half of variation in rfuture cause by itself and half cause by rspot
Thus rspot has greater impact to rfuture than rfuture have impact on rspot.

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