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

```
. tsset time
        time variable:  time, 1 to 795
                delta:  1 unit

. g spot2 = spot-l.spot
(1 missing value generated)

. gen future2 = future-l.future
(1 missing value generated)

. gen rspot= spot2/l.spot
(1 missing value generated)

. gen rfuture = future2/l.future
(1 missing value generated)

. varsoc rspot rfuture, maxlag(5)

   Selection-order criteria
   Sample:  7 - 795                              Number of obs      =       789
```

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	4774.48				1.9e-08	-12.0975	-12.093	-12.0857
1	4837.65	126.33	4	0.000	1.6e-08	-12.2475	-12.2339	-12.212
2	4857.92	40.555	4	0.000	1.6e-08	-12.2888	-12.266	-12.2296
3	4882.17	48.486*	4	0.000	1.5e-08*	-12.3401*	-12.3082*	-12.2572*
4	4884.45	4.5566	4	0.336	1.5e-08	-12.3357	-12.2948	-12.2292
5	4886.05	3.2155	4	0.522	1.5e-08	-12.3297	-12.2796	-12.1994

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

-lag 3 is the most appropriated since it has the lowest SBIC.

```
. var rspot rfuture, lag(1/3)

Vector autoregression

Sample:  5 - 795                              Number of obs      =       791
Log likelihood =    4893.31                   AIC                =  -12.33707
FPE            =   1.50e-08                   HQIC               =  -12.30527
Det(Sigma_ml)  =   1.45e-08                   SBIC               =  -12.25435
```

Equation	Parms	RMSE	R-sq	chi2	P>chi2
rspot	7	.018581	0.0169	13.624	0.0341
rfuture	7	.0217	0.0338	27.62952	0.0001

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
rspot						
rspot						
L1.	.1282088	.1145511	1.12	0.263	-.0963071	.3527248
L2.	.2334538	.118681	1.97	0.049	.0008434	.4660643
L3.	-.1169759	.1100791	-1.06	0.288	-.332727	.0987753

rfuture						
L1.	-.0590319	.0980706	-0.60	0.547	-.2512466	.1331829
L2.	-.1415632	.1041653	-1.36	0.174	-.3457234	.062597
L3.	.1057702	.096238	1.10	0.272	-.0828529	.2943933
_cons	-.000025	.0006579	-0.04	0.970	-.0013144	.0012644
rfuture						
rspot						
L1.	.5741704	.1337768	4.29	0.000	.3119727	.8363682
L2.	.5086657	.1385999	3.67	0.000	.237015	.7803165
L3.	.0617779	.1285544	0.48	0.631	-.190184	.3137398
rfuture						
L1.	-.520118	.1145303	-4.54	0.000	-.7445933	-.2956428
L2.	-.4253538	.1216479	-3.50	0.000	-.6637794	-.1869283
L3.	-.0947954	.1123902	-0.84	0.399	-.3150762	.1254854
_cons	.0000732	.0007683	0.10	0.924	-.0014326	.001579

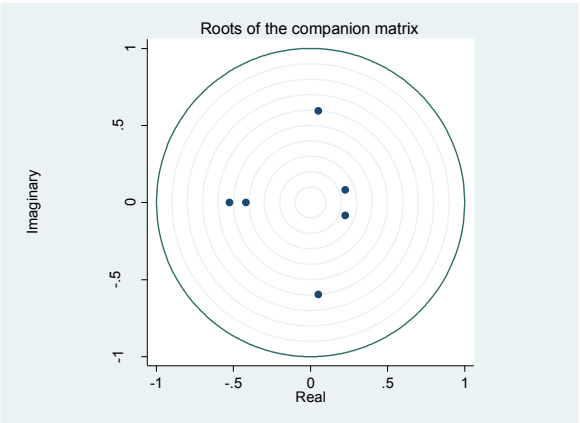
2. Perform stability test and Granger exogeneity test.

```
. varstable, graph
```

Eigenvalue stability condition

Eigenvalue	Modulus
.05126276 + .5960908*i*	.598291
.05126276 - .5960908*i*	.598291
-.5255917	.525592
-.4199276	.419928
.2255423 + .0823411*i*	.240103
.2255423 - .0823411*i*	.240103

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	4.8624	3	0.182
rspot	ALL	4.8624	3	0.182
rfuture	rspot	25.19	3	0.000
rfuture	ALL	25.19	3	0.000

-rfuture does not cause rspot, since p-value of Wald test is more than 0.05.

-rspot causes rfuture, since p-value of Wald test is less than 0.05.

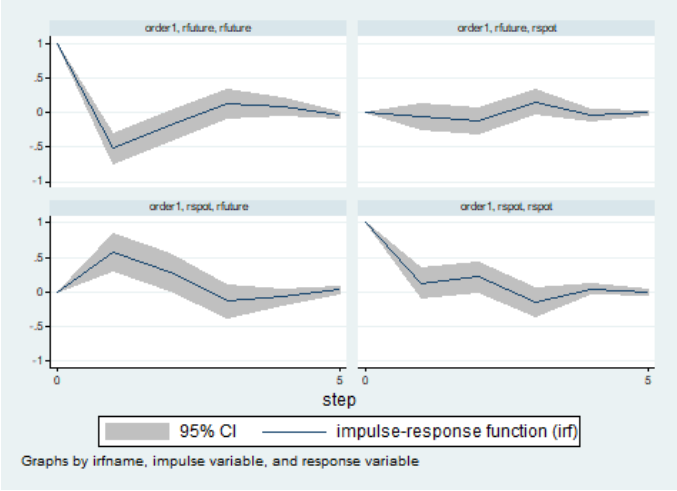
3. Perform Impulse response function analysis (irf), Orthogonal impulse response function analysis (oirf), Cumulative impulse response function analysis (coirf), make interpretation of the analysis, and determine which variable has more impact (using Cholesky order – rspot rfuture).

```
. irf create order1, order(rspot rfuture) step(5) 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	.128209	-.096307	.352725	.57417	.311973	.836368	-.059032	-.251247	.133183	-.520118	-.744593	-.295643
2	.215997	-.004582	.436576	.283643	.022104	.545182	-.118428	-.30696	.070103	-.188725	-.412415	.034964
3	-.157378	-.363594	.048839	-.140741	-.388189	.106707	.161576	-.013545	.336696	.126573	-.084013	.337158
4	.044136	-.033389	.12166	-.074446	-.192648	.043755	-.035795	-.116425	.044835	.092632	-.027457	.212721
5	-.002029	-.037484	.033426	.03033	-.017472	.078132	.003637	-.027138	.034412	-.029808	-.073835	.014219

insignificant

```
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

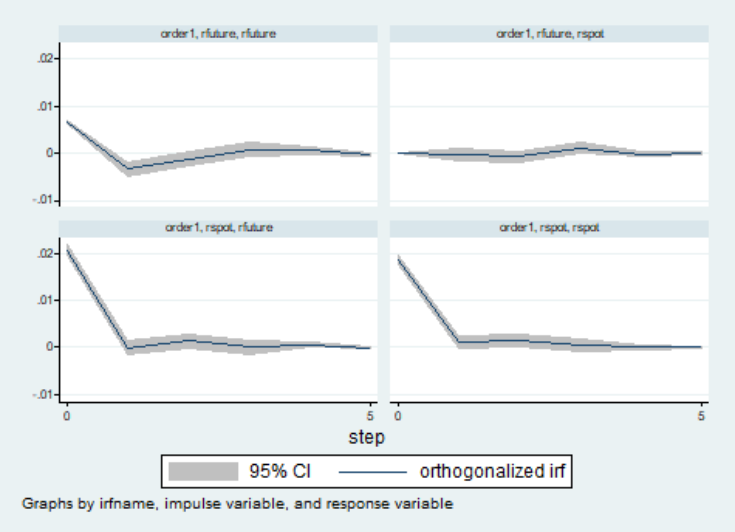
step	(1) oirf	(1) Lower	(1) Upper	(2) oirf	(2) Lower	(2) Upper	(3) oirf	(3) Lower	(3) Upper	(4) oirf	(4) Lower	(4) Upper
0	.018499	.017587	.019411	.020599	.019487	.021711	0	0	0	.006512	.006191	.006833
1	.001156	-.000134	.002445	-.000092	-.001615	.00143	-.000384	-.001636	.000867	-.003387	-.004858	-.001916
2	.001556	.000268	.002844	.00136	-.000159	.002878	-.000771	-.002	.000457	-.001229	-.002687	.000229
3	.000417	-.000872	.001706	3.7e-06	-.001515	.001522	.001052	-.000089	.002194	.000824	-.000548	.002196
4	.000079	-.000334	.000492	.000531	.000055	.001007	-.000233	-.000758	.000292	.000603	-.000179	.001386
5	.000037	-.000242	.000317	-.000053	-.000327	.000222	.000024	-.000177	.000224	-.000194	-.000481	.000093

insignificant.

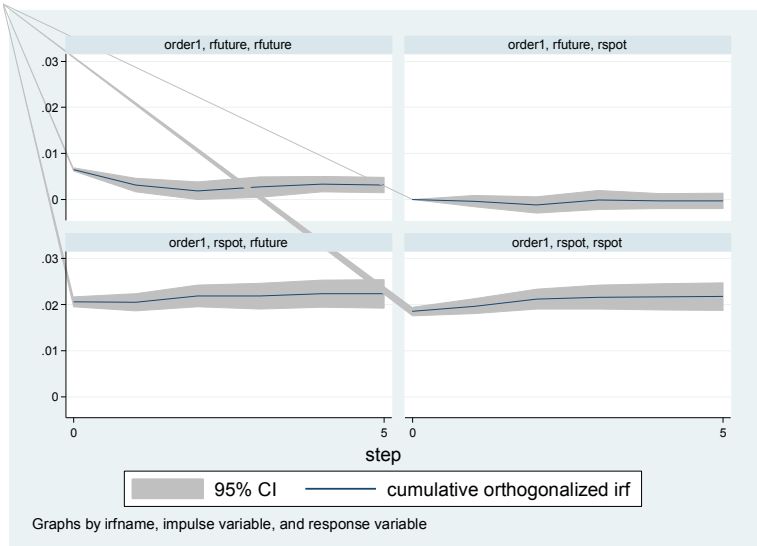
insignificant

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



4. Perform Forecast error variance decomposition (fevd) and determine variable that has more impact on each endogenous variable.

```
. 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	.99957	.99677	1.00237	.00043	-.00237	.00323
3	.997858	.991698	1.00402	.002142	-.004018	.008302
4	.994684	.985216	1.00415	.005316	-.004153	.014784
5	.994529	.984823	1.00424	.005471	-.004235	.015177

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

-rspot has more impact on rspot than rfuture, and rfuture is insignificant.

```
. 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	.909133	.897058	.921209	.090867	.078791	.102942
2	.887324	.863844	.910804	.112676	.089196	.136156
3	.884973	.861047	.908899	.115027	.091101	.138953
4	.883726	.859086	.908366	.116274	.091634	.140914
5	.883128	.858185	.908071	.116872	.091929	.141815

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

-rspot has more impact on rfuture than rfuture. Both are significant.

5. Determine whether changing Cholesky order from – “rspot rfuture” to “rfuture rspot” will change the results of irf, oirf, coirf, and fevd. Why? or why not?

-Yes, the changing in Cholesky order will changes the results of oirf, coirf, and fevd, but not changes the result of irf, because changing the order will also change the Choloeski factorization, which will affect oirf, coirf and fevd.