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Assignment 6

Due: 27/10/2020

From the data set `Assignment 5-8.dta`:

Requirements:

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.
2. Perform in-sample (both static and dynamic) forecast of the two series (sport return (*rspot*) and future return (*rfuture*), then, compute RMSE of each forecast.
3. Perform out-sample three-period ahead (dynamic) forecast of the two series (sport return (*rspot*) and future return (*rfuture*).

1.

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

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

Step1 : Perform unit root test to find integrated order of rfuture and rspot

```
. dfuller rspot, trend lags(1) regress

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

	Test Statistic	Interpolated Dickey-Fuller: 1% Critical Value	5% Critical Value	10% Critical 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

Since p-value = 0.0000 < 0.05, the null hypothesis of unit root is rejected which means return on spot is stationary. ⇒ rspot ~ I(0)

```
. dfuller rfuture, trend lags(1) regress

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

	Test Statistic	Interpolated Dickey-Fuller: 1% Critical Value	5% Critical Value	10% Critical 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

Since p-value = 0.0000 < 0.05, the null hypothesis of unit root is rejected which means return on future is stationary. ⇒ rfuture ~ I(0)

Step2 : With maximum lag of 5,

run ARIMA (1,0,1) (2,0,1) (3,0,1) (4,0,1) (5,0,1)
(1,0,2) (2,0,2) (3,0,2) (4,0,2) (5,0,2)
(1,0,3) (2,0,3) (3,0,3) (4,0,3) (5,0,3)
(1,0,4) (2,0,4) (3,0,4) (4,0,4) (5,0,4)
(1,0,5) (2,0,5) (3,0,5) (4,0,5) (5,0,5)

For rspot,

```
. 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
. qui arima rspot, arima(5,0,4) nolog
. est store arima504
. qui arima rspot, arima(5,0,5) nolog
. 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**	-.4418708	.19422255
ma					
L1.	.44515732***	-.38284317***	-.60570251**	.48778125	-.14853288
L2.		-.06805288***	-.0785457***	-.02952616	-.0578027**
L3.			.01541405*	-.04117543	-.00879285
L4.				-.00216733	.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	133.21805	101.26927
aic	-75418.284	-75428.583	-75426.956	-75424.609	-75425.916
bic	-75390.497	-75393.85	-75385.276	-75375.982	-75370.342

↳ Lowest

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*	.00002357*
ARMA					
ar					
L1.	.38018903***	.4428634***	-.29668626	.20849565	.63263472***
L2.	-.06525664***	.06485063	.18525538	.37776554*	-.91731069***
ma					
L1.	-.33467542**	-.39715673***	.3426502	-.16260084	-.58710754***
L2.		-.13338401*	-.22062902	-.43688009*	.83965418***
L3.			-.0455461	-.02892354	.05476885***
L4.				.02145155*	-.03409321***
L5.					-.03012065***
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	104.88451	708.52048
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	.11659349*	.17008802
L2.	-.08500113***	-.07142142	.14076076	-.77533292***	-.75369599***
L3.	.02486609*	.02349348	.27348399**	.50690923***	.56028712**
ma					
L1.	-.72875825***	-.70829213*	.05444554	-.07071828	-.12430409
L2.		-.0126675	-.19087608*	.72187978***	.69757843***
L3.			-.29968133**	-.48363964***	-.53414149**
L4.				-.06737484***	-.06847599***
L5.					.00392386
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	10208.316	9990.7007
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	.11479526*	.11582617*	-.55025558
L2.	-.0847024***	.40155116	-.84422456***	-.75582354***	-.78564519***
L3.	.02504525*	-.03039789	.47666348***	.51458285***	-.04871012
L4.	-.00097078	.02217215*	-.06669164***	.01927272	.25153939
ma					
L1.	-.72097599**	-.14607877	-.06913672	-.07000046	.59631735
L2.		-.45952184	.79177357***	.70233001***	.76311658***
L3.			-.45297968***	-.49146562***	.03723265
L4.				-.08652975	-.30357175
L5.					-.04488519
sigma					
_cons	.00178484***	.0017848***	.00178412***	.00178409***	.00178406***
Statistics					
N	7683	7683	7683	7683	7683
ll	37719.59	37719.787	37722.647	37722.799	37722.91
chi2	116.13751	103.18568	9967.2195	10380.653	10631.708
aic	-75425.181	-75423.574	-75427.294	-75425.598	-75423.821
bic	-75376.553	-75368	-75364.773	-75356.13	-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*	.00002357*	.00002358*	.00002357*
ARMA					
ar					
L1.	.16545423	.27864543	.40337768*	.45212007	.65262081*
L2.	-.05696613**	-.38380203*	-.81291959**	-.79726544***	-.84750045*
L3.	-.00729372	.0132755	-.23210031	.79847234	.13436587
L4.	.00131373	-.01409715	-.01694377	-.14234401	-.03733553
L5.	-.02387488**	-.027723**	-.03800524*	.02403092	.21196901*
ma					
L1.	-.11967988	-.23291974	-.35773961*	-.40627736	-.6073824*
L2.		.32183897	.74635725**	.72752725***	.76923758*
L3.			.27245433	-.75638633	-.08161162
L4.				.06670883	.00421319
L5.					-.24353795*
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	754.25914	7103.9873	2765.8623
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

According to SIC, ARIMA(1,0,2) is the most appriated.

For rfuture,

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

. est store arima101

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

. est store arima102

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

. est store arima103

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

. est store arima104

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

. est store arima105
```

```
. qui arima rfuture, arima(2,0,1) nolog

. est store arima201

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

. est store arima202

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

. est store arima203

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

. est store arima204

. qui arima rfuture, arima(2,0,5) nolog
flat log likelihood encountered, cannot find uphill direction
r(430);

. est store arima205

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

. est store arima301

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

. est store arima302

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

. est store arima303

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

. est store arima304

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

. est store arima305

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

. eat store arima401
command eat is unrecognized
r(199);

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

. est store arima402

. qui arima rfuture, arima(4,0,3) nolog
flat log likelihood encountered, cannot find uphill direction
r(430);

. est store arima403

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

. est store arima404

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

. est store arima405
```

```
. qui arima rfuture, arima(5,0,1) nolog

. est store arima501

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

. est store arima502

. qui arima rfuture, arima(5,0,3) nolog
flat log likelihood encountered, cannot find uphill direction
r(430);

. est store arima503

. qui arima rfuture, arima(5,0,4) nolog
flat log likelihood encountered, cannot find uphill direction
r(430);

. est store arima504

. qui arima rfuture, arima(5,0,5) nolog

. 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
rfuture					
_cons	.00002616*	.00002615*	.00002616*	.00002616*	.00002616*
ARMA					
ar					
L1.	.57862596***	.1646139*	-.99197304***	.79694551	-.18361821
ma					
L1.	-.61250239***	-.19269514*	.96410702***	-.82502776	.15556594
L2.		-.03060977**	-.06339899***	-.01284196	-.04031228*
L3.			-.03780979***	.02240568	-.01199443
L4.				.00289807	-.00091534
L5.					-.00688194
sigma					
_cons	.00205937***	.00205903***	.00205869***	.00205901***	.00205897***
Statistics					
N	7683	7683	7683	7683	7683
ll	36620.387	36621.683	36622.888	36621.711	36621.87
chi2	81.753207	31.061825	22842.295	196.91844	20.219307
aic	-73232.774	-73233.366	-73233.777	-73229.421	-73227.74
bic	-73204.987	-73198.632	-73192.096	-73180.794	-73172.166

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
rfuture					
_cons	.00002615*	.00002616*	.00002616*	.00002616*	
ARMA					
ar					
L1.	.1969293*	.15226369	-.89430512***	-.21232298	
L2.	-.02961053**	.01296948	.09704817	.77352156*	
ma					
L1.	-.22502128*	-.18034762	.8665611***	.18454868	
L2.		-.0439096	-.15750986*	-.81501263*	
L3.			-.03516485***	.00871318	
L4.				.02643959*	
sigma					
_cons	.00205903***	.00205902***	.00205869***	.00205868***	
_					
__000001					
L1.					-.20330359*
L2.					-.26517311*
__000002					
L1.					.1763371*
L2.					.22465735*
L3.					-.01997915*
L4.					-.01071388*
L5.					-.00857039*
Statistics					
N	7683	7683	7683	7683	7647
ll	36621.673	36621.684	36622.933	36622.979	36449.918
chi2	31.861358	30.82904	19137.176	7239.8844	
aic	-73233.346	-73231.368	-73231.866	-73229.957	-72885.836
bic	-73198.612	-73189.687	-73183.239	-73174.383	-72837.241

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
rfuture					
_cons	.00002616*	.00002616*	.00002618*	.00002616*	.00002623*
ARMA					
ar					
L1.	.43745093	-.8588441***	-.52730643***	-.83394427***	.11450194
L2.	-.02300296*	.09802834	-.40394239**	-.75287048***	-.78193681**
L3.	.00950901	-.03401356**	.5172721***	.22994552*	.52764551
ma					
L1.	-.46553637	.83106571***	.49689489***	.80688492***	-.14225297
L2.		-.15724365*	.3607837**	.69579157***	.75064017*
L3.			-.55348204***	-.28633741*	-.55031249
L4.				-.02531876**	-.01478091
L5.					.01311722
sigma					
_cons	.00205902***	.00205869***	.0020583***	.00205707***	.00205765**
Statistics					
N	7683	7683	7683	7683	7683
ll	36621.693	36622.898	36624.395	36628.568	36624.99
chi2	52.880576	16996.577	3952.7293	1327885.2	3.643e+08
aic	-73231.387	-73231.797	-73232.791	-73239.135	-73229.98
bic	-73189.706	-73183.17	-73177.217	-73176.615	-73160.512

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*				
ARMA					
ar					
L1.	.7666053**	-.27076585		-1.0427955*	-1.8659442***
L2.	-.0847024***	.69595584*		-.79913042**	-1.662099***
L3.	.02504525*	.00458302		.17871583	-.59873507*
L4.	-.00097078	.02386132*		.13904422	.18881867*
ma					
L1.	-.72097599**	.24300559		1.0151444*	1.8391885***
L2.		-.7390312*		.73527284**	1.5774407***
L3.				-.24364538*	.48084118*
L4.				-.16675929	-.27555808*
L5.					-.02918537**
sigma					
_cons	.00178484***	.00205868***		.00205818***	.00205674***
rfuture					
_cons		.00002616*		.00002616*	.00002616*
_					
__000001					
L1.			-.18517822*		
L2.			-.23095887*		
L3.			.15772674*		
L4.			-.00484301		
__000002					
L1.			.15784926		
L2.			.19096724*		
L3.			-.17612485*		
Statistics					
N	7683	7683	7649	7683	7683
ll	37719.59	36622.973	36459.436	36624.797	36629.764
chi2	116.13751	7371.4012		6823.8852	1535282.3
aic	-75425.181	-73229.946	-72904.872	-73229.594	-73237.529
bic	-75376.553	-73174.371	-72856.276	-73160.126	-73161.115

↳ Lowest

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
rfuture					
_cons	.00002616*	.00002615*			.00002616*
ARMA					
ar					
L1.	-.17881777	-.36005042***			-1.1264127***
L2.	-.04028792*	-.93315791***			-1.0832***
L3.	-.01301738	-.04434096***			-.79433959***
L4.	-.00282876	-.03507235***			.14986178
L5.	-.00826276*	-.01257805*			.00289008
ma					
L1.	.15074717	.33201757**			1.0987435***
L2.		.88799104***			1.0170981***
L3.					.71923226***
L4.					-.21672849*
L5.					-.0374674
sigma					
_cons	.00205896***	.00205884***			.002058***
_					
__000001					
L1.			-.19167923*	-.19682708*	
L2.			-.24450765*	-.24287984*	
L3.			.11301221	.11685688	
L4.			-.00665161	.04279334	
L5.			-.00441732	-.0029626	
__000002					
L1.			.16433907*	.16987653*	
L2.			.20433355*	.2025795*	
L3.			-.13201063	-.13599487	
L4.				-.04948282	
Statistics					
N	7683	7683	7649	7648	7683
ll	36621.909	36622.334	36459.482	36455.307	36625.427
chi2	20.150745	185.32903			77058.181
aic	-73227.818	-73226.669	-72902.965	-72892.613	-73226.855
bic	-73172.244	-73164.148	-72847.426	-72830.134	-73143.494

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

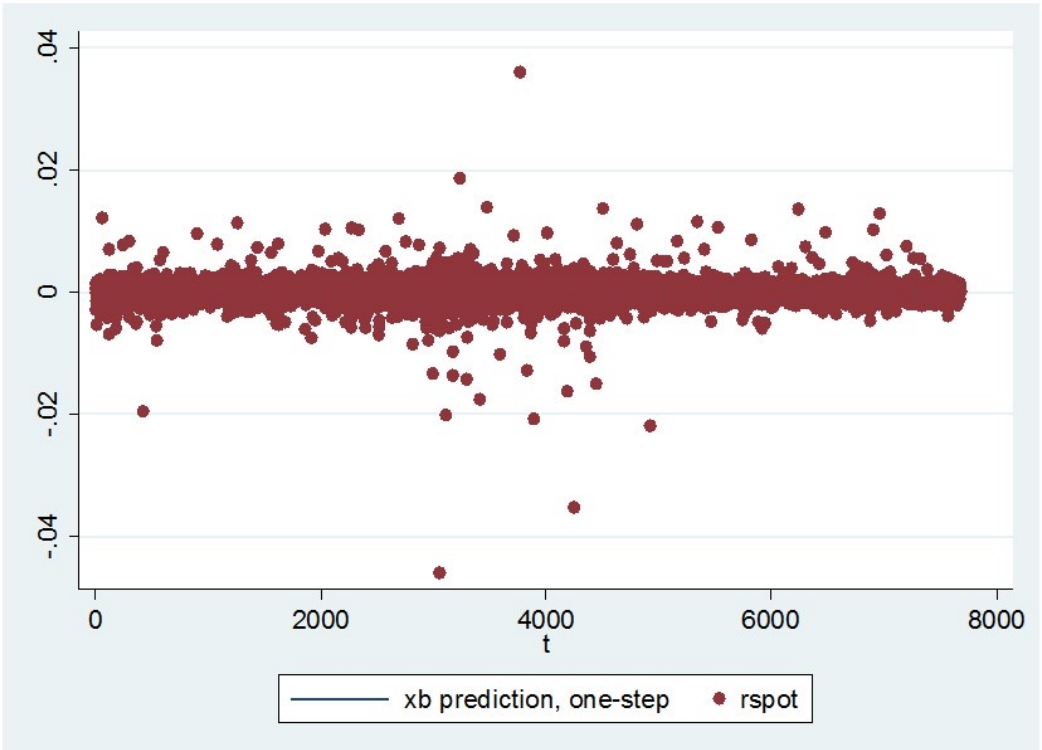
According to SIC, ARIMA(4,0,1) is the most appriated.

2. For rspot,

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

ARIMA regression

Sample:  2 - 7684                               Number of obs     =       7683
                                                Wald chi2(3)      =     100.14
Log likelihood =  37719.29                      Prob > chi2       =     0.0000
```

rspot	Coef.	OPG Std. Err.	z	P>|z|	[95% Conf.	Interval]
rspot						
_cons	.0000236	.0000205	1.15	0.251	-.0000167	.0000639
ARMA						
ar						
L1.	.4286677	.14387	2.98	0.003	.1466877	.7106476
ma						
L1.	-.3828432	.1441239	-2.66	0.008	-.6653209	-.1003655
L2.	-.0680529	.0088279	-7.71	0.000	-.0853552	-.0507505
/sigma	.0017849	2.07e-06	861.95	0.000	.0017809	.001789

```
Note: The test of the variance against zero is one sided, and the two-sided
      confidence interval is truncated at zero.

. predict rspothat_s, xb

. twoway (line rspothat_s t, sort) (scatter rspot t, sort)
```



```
. gen fe=rspot-rspothat_s
(1 missing value generated)

. gen sfe=fe^2
(1 missing value generated)

. sum sfe if t>=2
```

Variable	Obs	Mean	Std. Dev.	Min	Max
sfe	7,683	3.19e-06	.0000348	1.61e-15	.0020963

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

↳ RMSE for static forecast

```
ARIMA regression

Sample:  2 - 7684                               Number of obs     =       7683
                                                Wald chi2(3)      =     100.14
Log likelihood =  37719.29                      Prob > chi2       =     0.0000
```

rspot	Coef.	OPG Std. Err.	z	P>|z|	[95% Conf.	Interval]
rspot						
_cons	.0000236	.0000205	1.15	0.251	-.0000167	.0000639
ARMA						
ar						
L1.	.4286677	.14387	2.98	0.003	.1466877	.7106476
ma						
L1.	-.3828432	.1441239	-2.66	0.008	-.6653209	-.1003655
L2.	-.0680529	.0088279	-7.71	0.000	-.0853552	-.0507505
/sigma	.0017849	2.07e-06	861.95	0.000	.0017809	.001789

```
Note: The test of the variance against zero is one sided, and the two-sided
      confidence interval is truncated at zero.

. predict rspothat_d, y dynamic(.)
Note: beginning dynamic predictions in period       5.

. gen dfe=rspot-rspothat_d if t<7685
(1 missing value generated)

. gen sdfe=dfe^2
(1 missing value generated)

. sum sdfe
```

Variable	Obs	Mean	Std. Dev.	Min	Max
sdfe	7,683	3.20e-06	.000035	8.09e-12	.0021155

↳ RMSE for dynamic forecast

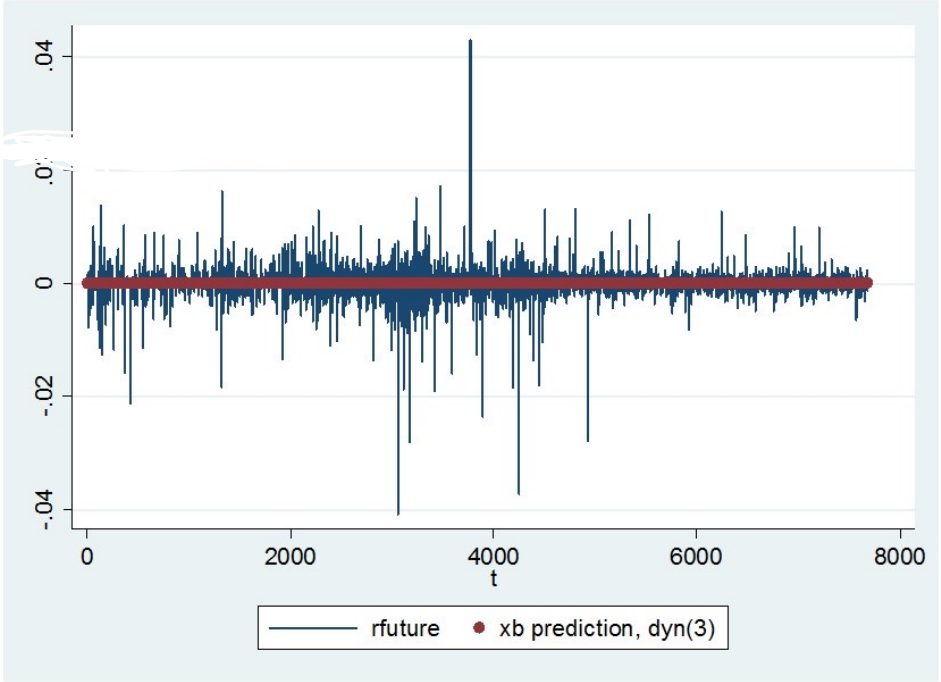
For rfuture

```
. arima rfuture, arima(4,0,1) nolog

ARIMA regression

Sample:  2 - 7684                               Number of obs     =       7683
                                                Wald chi2(5)      =     166.88
Log likelihood =  36621.71                      Prob > chi2       =     0.0000
```

rfuture	Coef.	OPG Std. Err.	z	P>|z|	[95% Conf.	Interval]
rfuture						
_cons	.0000262	.0000224	1.17	0.243	-.0000178	.0000701
ARMA						
ar						
L1.	.7606505	.9615855	0.79	0.429	-1.124023	2.645324
L2.	-.0139064	.0297025	-0.47	0.640	-.0721222	.0443094
L3.	.0210186	.0363835	0.58	0.563	-.0502917	.0923289
L4.	.0031587	.0151091	0.21	0.834	-.0264546	.032772
ma						
L1.	-.7887411	.960966	-0.82	0.412	-2.6722	1.094718
/sigma	.002059	2.68e-06	768.30	0.000	.0020538	.0020643

Note: The test of the variance against zero is one sided, and the two-sided confidence interval is truncated at zero.

```
. predict rfuturehat_s, xb

. twoway (line rfuturehat_s t, sort) (scatter rfuture t, sort)
```



```
. gen fe_future=rfuture-rfuturehat_s
(1 missing value generated)

. gen sfe_future=fe_future^2
(1 missing value generated)

. sum sfe_future if t>=2
```

Variable	Obs	Mean	Std. Dev.	Min	Max
sfe_future	7,683	4.24e-06	.0000388	1.92e-15	.0018415

RMSE for static forecast

```
. arima rfuture, arima(4,0,1) nolog

ARIMA regression

Sample:  2 - 7684                               Number of obs     =       7683
                                                Wald chi2(5)      =     166.88
Log likelihood =  36621.71                      Prob > chi2       =     0.0000
```

rfuture	Coef.	OPG Std. Err.	z	P>|z|	[95% Conf.	Interval]
rfuture						
_cons	.0000262	.0000224	1.17	0.243	-.0000178	.0000701
ARMA						
ar						
L1.	.7606505	.9615855	0.79	0.429	-1.124023	2.645324
L2.	-.0139064	.0297025	-0.47	0.640	-.0721222	.0443094
L3.	.0210186	.0363835	0.58	0.563	-.0502917	.0923289
L4.	.0031587	.0151091	0.21	0.834	-.0264546	.032772
ma						
L1.	-.7887411	.960966	-0.82	0.412	-2.6722	1.094718
/sigma	.002059	2.68e-06	768.30	0.000	.0020538	.0020643

```
Note: The test of the variance against zero is one sided, and the two-sided
      confidence interval is truncated at zero.

. predict rfuturehat_d, y dynamic(.)
Note: beginning dynamic predictions in period       7.

. gen dfe_future=rfuture-rfuturehat_d
(1 missing value generated)

. gen sdfe_future=dfe_future^2
(1 missing value generated)

. sum sdfe_future if t<7685
```

RMSE for dynamic forecast

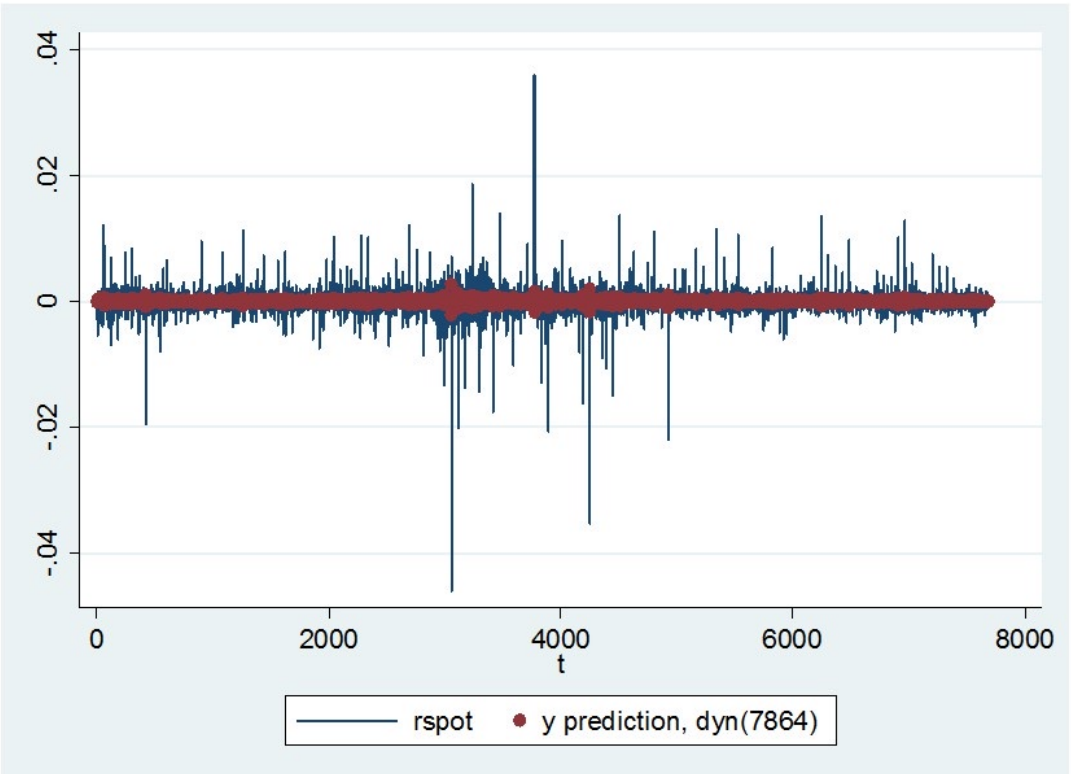
Variable	Obs	Mean	Std. Dev.	Min	Max
sdfe_future	7,683	4.25e-06	.0000388	6.47e-10	.0018373

3.

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

ARIMA regression

Sample:  2 - 7684                               Number of obs     =       7683
                                                Wald chi2(3)      =     100.14
Log likelihood =  37719.29                      Prob > chi2       =     0.0000
```

rspot	Coef.	OPG Std. Err.	z	P>|z|	[95% Conf.	Interval]
rspot						
_cons	.0000236	.0000205	1.15	0.251	-.0000167	.0000639
ARMA						
ar						
L1.	.4286677	.14387	2.98	0.003	.1466877	.7106476
ma						
L1.	-.3828432	.1441239	-2.66	0.008	-.6653209	-.1003655
L2.	-.0680529	.0088279	-7.71	0.000	-.0853552	-.0507505
/sigma	.0017849	2.07e-06	861.95	0.000	.0017809	.001789

```
Note: The test of the variance against zero is one sided, and the two-sided
      confidence interval is truncated at zero.

. predict rspothat, y dynamic(7864)

. twoway (line rspot t, sort) (scatter rspothat t,sort)
```



```
. arima rfuture, arima(4,0,1) nolog

ARIMA regression

Sample:  2 - 7684                               Number of obs     =       7683
                                                Wald chi2(5)      =     166.88
Log likelihood =  36621.71                      Prob > chi2       =     0.0000
```

rfuture	Coef.	OPG Std. Err.	z	P>|z|	[95% Conf.	Interval]
rfuture						
_cons	.0000262	.0000224	1.17	0.243	-.0000178	.0000701
ARMA						
ar						
L1.	.7606505	.9615855	0.79	0.429	-1.124023	2.645324
L2.	-.0139064	.0297025	-0.47	0.640	-.0721222	.0443094
L3.	.0210186	.0363835	0.58	0.563	-.0502917	.0923289
L4.	.0031587	.0151091	0.21	0.834	-.0264546	.032772
ma						
L1.	-.7887411	.960966	-0.82	0.412	-2.6722	1.094718
/sigma	.002059	2.68e-06	768.30	0.000	.0020538	.0020643

```
Note: The test of the variance against zero is one sided, and the two-sided
      confidence interval is truncated at zero.

. predict rfuturehat, y dynamic(7864)

. twoway (line rfuture t, sort) (scatter rfuturehat t,sort)
```