

Assignment 4 Guideline Solution

From the data set assign04.dta:

Requirements:

1. Test whether the series spot and future are stationary series.

```
. tsset t
      time variable: t, 1 to 7684
              delta: 1 unit
```

```
. dfuller spot, trend lag(1) regress
```

Augmented Dickey-Fuller test for unit root Number of obs = 7682

	Test Statistic	----- 1% Critical Value	Interpolated Dickey-Fuller 5% Critical Value	----- 10% Critical Value
Z(t)	-2.438	-3.960	-3.410	-3.120

Mackinnon approximate p-value for Z(t) = 0.3597

D.spot	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]
spot					
L1.	-.001489	.0006108	-2.44	0.015	-.0026862 -.0002917
LD.	.0440347	.0114011	3.86	0.000	.0216855 .0663839
_trend	.0000171	8.32e-06	2.05	0.040	7.62e-07 .0000334
_cons	.7447753	.302873	2.46	0.014	.1510615 1.338489

```
. dfuller future, trend lag(1) regress
```

Augmented Dickey-Fuller test for unit root Number of obs = 7682

	Test Statistic	----- 1% Critical Value	Interpolated Dickey-Fuller 5% Critical Value	----- 10% Critical Value
Z(t)	-2.563	-3.960	-3.410	-3.120

Mackinnon approximate p-value for Z(t) = 0.2971

D.future	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]
future					
L1.	-.001768	.0006898	-2.56	0.010	-.0031202 -.0004159
LD.	-.0275938	.0114077	-2.42	0.016	-.0499561 -.0052315
_trend	.0000222	.00001	2.22	0.026	2.62e-06 .0000418
_cons	.86276	.3338726	2.58	0.010	.2082785 1.517241

- *spot and future are nonstationary.*

2. Determine order of integration of the series spot and future.

```
. dfuller d.spot, trend lag(1) regress
```

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

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

```
-----
Z(t)          -63.765          -3.960          -3.410          -3.120
-----
```

Mackinnon approximate p-value for Z(t) = 0.0000

```
-----
D2.spot      |      Coef.  Std. Err.    t    P>|t|    [95% Conf. Interval]
-----+-----
   D.spot
   L1.      | -1.005364   .0157667   -63.77  0.000   -1.036271   -.974457
   LD.      |  .0508571   .011398    4.46   0.000    .0285139   .0732003
  _trend    |  7.82e-07   4.94e-06   0.16   0.874   -8.90e-06   .0000105
  _cons     |  .0088178   .0219189   0.40   0.687   -.0341492   .0517848
-----
```

```
. dfuller d.future , trend lag(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)          -65.269          -3.960          -3.410          -3.120
-----
```

Mackinnon approximate p-value for Z(t) = 0.0000

```
-----
D2.future    |      Coef.  Std. Err.    t    P>|t|    [95% Conf. Interval]
-----+-----
   D.future
   L1.      | -1.067592   .0163567   -65.27  0.000   -1.099655   -1.035528
   LD.      |  .038008    .0114045   3.33   0.001    .0156522   .0603639
  _trend    |  1.01e-06   5.59e-06   0.18   0.856   -9.94e-06   .000012
  _cons     |  .0096235   .0247823   0.39   0.698   -.0389566   .0582036
-----
```

- *spot and future are Integrated series of order 1 or I(1).*

3. Generate series of the return of spot (*rspot*) and return of future (*rfuture*) and test whether they are stationary.

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

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

```
. dfuller rspot, trend lag(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
-----
```

```
. dfuller rspot, lag(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)	-63.791	-3.430	-2.860	-2.570

Mackinnon approximate p-value for Z(t) = 0.0000

D.rspot	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]	
rspot						
L1.	-1.005165	.0157571	-63.79	0.000	-1.036053	-.9742771
LD.	.0517007	.0113967	4.54	0.000	.0293601	.0740413
_cons	.0000235	.0000204	1.15	0.248	-.0000164	.0000635

. dfuller rfuture, trend lag(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

. dfuller rfuture, lag(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)	-65.074	-3.430	-2.860	-2.570

Mackinnon approximate p-value for Z(t) = 0.0000

D.rfuture	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]	
rfuture						
L1.	-1.063569	.0163439	-65.07	0.000	-1.095608	-1.031531
LD.	.0357488	.0114046	3.13	0.002	.0133927	.0581049
_cons	.0000276	.0000235	1.17	0.241	-.0000185	.0000736

- *rspot and rfuture are stationary.*

- 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.

```
. *Define Variable y
.   g y = rspot
(1 missing value generated)

. *Specify order p d q
. forvalue d = 0(1)0 {
```

```

2. forvalue p = 1(1)5 {
3. forvalue q = 1(1)5 {
4.     display "estimate arima`p``d``q'"
5.     capture: quietly arima y, arima(`p',`d',`q') nolog
6.     if _rc~=0 {
7.         display "flatlog when pdq =" `p``d``q'
8.         continue
9.     }
10.    estimates store arima`p``d``q'
11.    display "arima`p``d``q' already estimated"
12. }
13. }
14. estimates table arima1`d'1 arima1`d'2 arima1`d'3 arima1`d'4 arima1`d'5, star(0.1 0.05
0.01) stat(aic bic ll)
15. estimates table arima2`d'1 arima2`d'2 arima2`d'3 arima2`d'4 arima2`d'5, star(0.1 0.05
0.01) stat(aic bic ll)
16. estimates table arima3`d'1 arima3`d'2 arima3`d'3 arima3`d'4 arima3`d'5, star(0.1 0.05
0.01) stat(aic bic ll)
17. estimates table arima4`d'1 arima4`d'2 arima4`d'3 arima4`d'4 arima4`d'5, star(0.1 0.05
0.01) stat(aic bic ll)
18. estimates table arima5`d'1 arima5`d'2 arima5`d'3 arima5`d'4 arima5`d'5, star(0.1 0.05
0.01) stat(aic bic ll)
19. }
estimate arima101
arima101 already estimated
estimate arima102
arima102 already estimated
estimate arima103
arima103 already estimated
estimate arima104
arima104 already estimated
estimate arima105
arima105 already estimated
estimate arima201
arima201 already estimated
estimate arima202
arima202 already estimated
estimate arima203
arima203 already estimated
estimate arima204
arima204 already estimated
estimate arima205
arima205 already estimated
estimate arima301
arima301 already estimated
estimate arima302
arima302 already estimated
estimate arima303
arima303 already estimated
estimate arima304
arima304 already estimated
estimate arima305
arima305 already estimated
estimate arima401
arima401 already estimated
estimate arima402
arima402 already estimated
estimate arima403
arima403 already estimated
estimate arima404
arima404 already estimated
estimate arima405
arima405 already estimated
estimate arima501
arima501 already estimated
estimate arima502
arima502 already estimated
estimate arima503
arima503 already estimated
estimate arima504
arima504 already estimated
estimate arima505
arima505 already estimated

```

Variable	arima101	arima102	arima103	arima104	arima105

y		.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						
aic		-75418.284	-75428.583	-75426.956	-75424.609	-75425.916
bic		-75390.497	-75393.85	-75385.276	-75375.982	-75370.342
ll		37713.142	37719.292	37719.478	37719.305	37720.958

Legend: * p<.1; ** p<.05; *** p<.01						

Variable		arima201	arima202	arima203	arima204	arima205

y						
_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						
aic		-75428.017	-75426.777	-75424.788	-75423.974	-75429.446
bic		-75393.283	-75385.096	-75376.161	-75368.4	-75366.925
ll		37719.008	37719.388	37719.394	37719.987	37723.723

Legend: * p<.1; ** p<.05; *** p<.01						

Variable		arima301	arima302	arima303	arima304	arima305

y						
_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						
aic		-75427.175	-75425.178	-75425.675	-75427.585	-75425.609
bic		-75385.495	-75376.55	-75370.101	-75365.064	-75356.141

Variable	arima401	arima402	arima403	arima404	arima405
11	37719.588	37719.589	37720.837	37722.792	37722.804
Legend: * p<.1; ** p<.05; *** p<.01					
y					
_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					
aic	-75425.181	-75423.574	-75427.294	-75425.598	-75423.821
bic	-75376.553	-75368	-75364.773	-75356.13	-75347.407
ll	37719.59	37719.787	37722.647	37722.799	37722.91

Legend: * p<.1; ** p<.05; *** p<.01

Variable	arima501	arima502	arima503	arima504	arima505
y					
_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					
aic	-75426.156	-75424.789	-75426.981	-75423.79	-75424.907
bic	-75370.582	-75362.269	-75357.513	-75347.376	-75341.546
ll	37721.078	37721.395	37723.49	37722.895	37724.453

Legend: * p<.1; ** p<.05; *** p<.01

```
. drop y
. *Define Variable y
.   g y = rfuture
(1 missing value generated)

. *Specify order p d q
. forvalue d = 0(1)0 {
2.   forvalue p = 1(1)3 {
3.     forvalue q = 1(1)3 {
4.       display "estimate arima`p`d`q`"
5.       capture: quietly arima y, arima(`p`,`d`,`q`) nolog
```

```

6.         if _rc~=0 {
7.         display "flatlog when pdq =" `p`d`q'
8.         continue
9.         }
10.        estimates store arima`p`d`q'
11.        display "arima`p`d`q' already estimated"
12.    }
13. }
14. estimates table arima1`d`1 arima1`d`2 arima1`d`3 arima1`d`4 arima1`d`5, star(0.1 0.05
0.01) stat(aic bic ll)
15. estimates table arima2`d`1 arima2`d`2 arima2`d`3 arima2`d`4 arima2`d`5, star(0.1 0.05
0.01) stat(aic bic ll)
16. estimates table arima3`d`1 arima3`d`2 arima3`d`3 arima3`d`4 arima3`d`5, star(0.1 0.05
0.01) stat(aic bic ll)
17. estimates table arima4`d`1 arima4`d`2 arima4`d`3 arima4`d`4 arima4`d`5, star(0.1 0.05
0.01) stat(aic bic ll)
18. estimates table arima5`d`1 arima5`d`2 arima5`d`3 arima5`d`4 arima5`d`5, star(0.1 0.05
0.01) stat(aic bic ll)
19. }
estimate arima101
arima101 already estimated
estimate arima102
arima102 already estimated
estimate arima103
arima103 already estimated
estimate arima201
arima201 already estimated
estimate arima202
arima202 already estimated
estimate arima203
arima203 already estimated
estimate arima301
arima301 already estimated
estimate arima302
arima302 already estimated
estimate arima303
arima303 already estimated

```

Variable	arima101	arima102	arima103	arima104	arima105
y					
_cons	.00002616	.00002615	.00002616	.00002357	.0000236
ARMA					
ar					
L1.	.57862596***	.1646139	-.99197304***	-.4418708	.19422255
ma					
L1.	-.61250239***	-.19269514	.96410702***	.48778125	-.14853288
L2.		-.03060977**	-.06339899***	-.02952616	-.0578027**
L3.			-.03780979***	-.04117543	-.00879285
L4.				-.00216733	.00427518
L5.					-.02212732*
sigma					
_cons	.00205937***	.00205903***	.00205869***	.00178491***	.00178452***
Statistics					
aic	-73232.774	-73233.366	-73233.777	-75424.609	-75425.916
bic	-73204.987	-73198.632	-73192.096	-75375.982	-75370.342
ll	36620.387	36621.683	36622.888	37719.305	37720.958

Legend: * p<.1; ** p<.05; *** p<.01

Variable	arima201	arima202	arima203	arima204	arima205
y					
_cons	.00002615	.00002616	.00002616	.00002358	.00002357
ARMA					
ar					
L1.	.1969293	.15226369	-.89430512***	.20849565	.63263472***
L2.	-.02961053**	.01296948	.09704817	.37776554	-.91731069***
ma					

L1.	-.22502128	-.18034762	.8665611***	-.16260084	-.58710754***
L2.		-.0439096	-.15750986	-.43688009	.83965418***
L3.			-.03516485***	-.02892354	.05476885***
L4.				.02145155	-.03409321***
L5.					-.03012065***
sigma					
_cons	.00205903***	.00205902***	.00205869***	.00178475***	.00178388***
Statistics					
aic	-73233.346	-73231.368	-73231.866	-75423.974	-75429.446
bic	-73198.612	-73189.687	-73183.239	-75368.4	-75366.925
ll	36621.673	36621.684	36622.933	37719.987	37723.723
Legend: * p<.1; ** p<.05; *** p<.01					
Variable	arima301	arima302	arima303	arima304	arima305
y					
_cons	.00002616	.00002616	.00002618	.00002358	.00002358
ARMA					
ar					
L1.	.43745093	-.8588441***	-.52730643***	.11659349	.17008802
L2.	-.02300296	.09802834	-.40394239**	-.77533292***	-.75369599***
L3.	.00950901	-.03401356**	.5172721***	.50690923***	.56028712*
ma					
L1.	-.46553637	.83106571***	.49689489***	-.07071828	-.12430409
L2.		-.15724365	.3607837**	.72187978***	.69757843***
L3.			-.55348204***	-.48363964***	-.53414149*
L4.				-.06737484***	-.06847599***
L5.					.00392386
sigma					
_cons	.00205902***	.00205869***	.0020583***	.00178409***	.00178409***
Statistics					
aic	-73231.387	-73231.797	-73232.791	-75427.585	-75425.609
bic	-73189.706	-73183.17	-73177.217	-75365.064	-75356.141
ll	36621.693	36622.898	36624.395	37722.792	37722.804
Legend: * p<.1; ** p<.05; *** p<.01					
Variable	arima401	arima402	arima403	arima404	arima405
y					
_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					
aic	-75425.181	-75423.574	-75427.294	-75425.598	-75423.821
bic	-75376.553	-75368	-75364.773	-75356.13	-75347.407
ll	37719.59	37719.787	37722.647	37722.799	37722.91
Legend: * p<.1; ** p<.05; *** p<.01					
Variable	arima501	arima502	arima503	arima504	arima505

y	_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	aic	-75426.156	-75424.789	-75426.981	-75423.79	-75424.907
	bic	-75370.582	-75362.269	-75357.513	-75347.376	-75341.546
	ll	37721.078	37721.395	37723.49	37722.895	37724.453

Legend: * p<.1; ** p<.05; *** p<.01

end of do-file

- *The most appropriated order for rspot is ARIMA(1,0,2).*
- *The most appropriated order for rfuture is ARIMA(1,0,1).*