Modeling

September 28, 2020

[1]:
```python
import pandas as pd
import numpy as np
%matplotlib notebook
import matplotlib.pyplot as plt
from datetime import datetime
import statsmodels.api as sm
from statsmodels.tsa.arima_model import ARIMA
```

[3]:
```python
# HIT (BA)
hit_HT = pd.read_csv('./hit/hit_HT.csv')
hit_HH = pd.read_csv('./hit/hit_HH.csv')
hit_KT = pd.read_csv('./hit/hit_KT.csv')
hit_LG = pd.read_csv('./hit/hit_LG.csv')
hit_LT = pd.read_csv('./hit/hit_LT.csv')
hit_NC = pd.read_csv('./hit/hit_NC.csv')
hit_OB = pd.read_csv('./hit/hit_OB.csv')
hit_SK = pd.read_csv('./hit/hit_SK.csv')
hit_SS = pd.read_csv('./hit/hit_SS.csv')
hit_WO = pd.read_csv('./hit/hit_WO.csv')

ba_HT = hit_HT.iloc[:,[1,2]]
ba_HH = hit_HH.iloc[:,[1,2]]
ba_KT = hit_KT.iloc[:,[1,2]]
ba_LG = hit_LG.iloc[:,[1,2]]
ba_LT = hit_LT.iloc[:,[1,2]]
ba_NC = hit_NC.iloc[:,[1,2]]
ba_OB = hit_OB.iloc[:,[1,2]]
ba_SK = hit_SK.iloc[:,[1,2]]
ba_SS = hit_SS.iloc[:,[1,2]]
ba_WO = hit_WO.iloc[:,[1,2]]
```

[4]:
```python
# PIT (ER)
pit_HT = pd.read_csv('./pit/pit_HT.csv')
pit_HH = pd.read_csv('./pit/pit_HH.csv')
pit_KT = pd.read_csv('./pit/pit_KT.csv')
pit_LG = pd.read_csv('./pit/pit_LG.csv')
pit_LT = pd.read_csv('./pit/pit_LT.csv')
```

```
pit_NC = pd.read_csv('./pit/pit_NC.csv')
pit_OB = pd.read_csv('./pit/pit_OB.csv')
pit_SK = pd.read_csv('./pit/pit_SK.csv')
pit_SS = pd.read_csv('./pit/pit_SS.csv')
pit_WO = pd.read_csv('./pit/pit_WO.csv')
er_HT = pit_HT.iloc[:,[1,2]]
er_HH = pit_HH.iloc[:,[1,2]]
er_KT = pit_KT.iloc[:,[1,2]]
er_LG = pit_LG.iloc[:,[1,2]]
er_LT = pit_LT.iloc[:,[1,2]]
er_NC = pit_NC.iloc[:,[1,2]]
er_OB = pit_OB.iloc[:,[1,2]]
er_SK = pit_SK.iloc[:,[1,2]]
er_SS = pit_SS.iloc[:,[1,2]]
er_WO = pit_WO.iloc[:,[1,2]]
```

[5]:
```
# PIT (WLS)
wls_HT = pit_HT.iloc[:,[1,3]]
wls_HH = pit_HH.iloc[:,[1,3]]
wls_KT = pit_KT.iloc[:,[1,3]]
wls_LG = pit_LG.iloc[:,[1,3]]
wls_LT = pit_LT.iloc[:,[1,3]]
wls_NC = pit_NC.iloc[:,[1,3]]
wls_OB = pit_OB.iloc[:,[1,3]]
wls_SK = pit_SK.iloc[:,[1,3]]
wls_SS = pit_SS.iloc[:,[1,3]]
wls_WO = pit_WO.iloc[:,[1,3]]
```

[6]:
```
#
def modeling(data,order,steps,trend='c'): #   , arima  ,   ,
    data = data.iloc[:,1]  #
    model = ARIMA(data,order=order)
    model_fit = model.fit(trend=trend,full_output=True,disp=True)
    print("{}\n".format(model_fit.summary()))
    fore = model_fit.forecast(steps=steps)
    f = pd.DataFrame(fore[0])
    f.index = pd.RangeIndex(start=len(data),stop=len(data)+steps,step=1)
    model_fit.plot_predict()
    plt.plot(f)
    print("  ",f)
```

1

HH 10 HT 12 KT 9 LG 7 LT 9 NC 7 OB 12 SK 9 SS 11 WO 9

2 BA(hit)

HH 2,0,2 HT 1,0,2 KT 2,1,0 LG 2,0,0 LT 2,0,4 NC 1,0,0 OB 1,0,4 SK 2,1,0 SS 0,2,1 WO 4,0,3

[7]:
```
#  BA
modeling(ba_HH,(2,0,2),10)
```

```
                              ARMA Model Results
==============================================================================
Dep. Variable:                     BA   No. Observations:                  112
Model:                     ARMA(2, 2)   Log Likelihood                 384.622
Method:                       css-mle   S.D. of innovations              0.008
Date:                Sun, 27 Sep 2020   AIC                           -757.245
Time:                        00:52:20   BIC                           -740.934
Sample:                             0   HQIC                          -750.627

==============================================================================
                 coef    std err          z      P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
const          0.2348      0.008     30.579      0.000       0.220       0.250
ar.L1.BA       0.3913      0.240      1.631      0.103      -0.079       0.862
ar.L2.BA       0.4922      0.229      2.147      0.032       0.043       0.942
ma.L1.BA       0.0673      0.234      0.288      0.774      -0.391       0.526
ma.L2.BA       0.2853      0.117      2.447      0.014       0.057       0.514
                                    Roots
=============================================================================
                  Real          Imaginary           Modulus         Frequency
-----------------------------------------------------------------------------
AR.1            1.0823           +0.0000j            1.0823            0.0000
AR.2           -1.8773           +0.0000j            1.8773            0.5000
MA.1           -0.1179           -1.8686j            1.8723           -0.2600
MA.2           -0.1179           +1.8686j            1.8723            0.2600
-----------------------------------------------------------------------------
```

<IPython.core.display.Javascript object>

<IPython.core.display.HTML object>

	0
112	0.230051
113	0.237423
114	0.233488
115	0.235576
116	0.234457
117	0.235047
118	0.234727
119	0.234892

```
120   0.234799
121   0.234843
```

[26]:
```
#  BA
modeling(ba_HT,(1,0,2),12,'c')
```

```
                              ARMA Model Results
==============================================================================
Dep. Variable:                     BA   No. Observations:                  109
Model:                     ARMA(1, 2)   Log Likelihood                 347.943
Method:                       css-mle   S.D. of innovations              0.010
Date:                Sat, 26 Sep 2020   AIC                           -685.887
Time:                        01:02:26   BIC                           -672.430
Sample:                             0   HQIC                          -680.430

==============================================================================
                 coef    std err          z      P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
const          0.2620      0.009     29.878      0.000       0.245       0.279
ar.L1.BA       0.9280      0.056     16.543      0.000       0.818       1.038
ma.L1.BA       0.1414      0.112      1.265      0.206      -0.078       0.361
ma.L2.BA      -0.4062      0.117     -3.467      0.001      -0.636      -0.177
                                    Roots
=============================================================================
                  Real          Imaginary           Modulus         Frequency
-----------------------------------------------------------------------------
AR.1            1.0776           +0.0000j            1.0776            0.0000
MA.1           -1.4045           +0.0000j            1.4045            0.5000
MA.2            1.7527           +0.0000j            1.7527            0.0000
-----------------------------------------------------------------------------
```

```
<IPython.core.display.Javascript object>
```

```
<IPython.core.display.HTML object>
```

```
              0
109   0.286989
110   0.285649
111   0.283947
112   0.282368
113   0.280903
114   0.279544
115   0.278282
116   0.277111
117   0.276025
118   0.275017
```

```
119   0.274081
120   0.273213
```

[27]:
```python
#KT BA
modeling(ba_KT,(2,1,0),9,'nc')
```

```
                             ARIMA Model Results
==============================================================================
Dep. Variable:                   D.BA   No. Observations:                  110
Model:                 ARIMA(2, 1, 0)   Log Likelihood                 355.761
Method:                       css-mle   S.D. of innovations              0.010
Date:                Sat, 26 Sep 2020   AIC                           -705.523
Time:                        01:02:32   BIC                           -697.421
Sample:                             1   HQIC                          -702.237

==============================================================================
                 coef    std err          z      P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
ar.L1.D.BA     0.2161      0.098      2.216      0.027       0.025       0.407
ar.L2.D.BA     0.1811      0.097      1.861      0.063      -0.010       0.372
                                    Roots
=============================================================================
                  Real          Imaginary           Modulus         Frequency
-----------------------------------------------------------------------------
AR.1            1.8279           +0.0000j            1.8279            0.0000
AR.2           -3.0212           +0.0000j            3.0212            0.5000
-----------------------------------------------------------------------------
```

```
<IPython.core.display.Javascript object>
```

```
<IPython.core.display.HTML object>
```

```
              0
111   0.287613
112   0.288108
113   0.288326
114   0.288463
115   0.288532
116   0.288571
117   0.288592
118   0.288604
119   0.288610
```

[28]:
```python
#LG BA
modeling(ba_LG,(2,0,0),7)
```

```
                            ARMA Model Results
==============================================================================
Dep. Variable:                     BA   No. Observations:                  113
Model:                     ARMA(2, 0)   Log Likelihood                 367.203
Method:                       css-mle   S.D. of innovations              0.009
Date:                Sat, 26 Sep 2020   AIC                           -726.407
Time:                        01:02:41   BIC                           -715.497
Sample:                             0   HQIC                          -721.980

==============================================================================
                 coef    std err          z      P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
const          0.2787      0.005     61.489      0.000       0.270       0.288
ar.L1.BA       1.1319      0.128      8.839      0.000       0.881       1.383
ar.L2.BA      -0.3237      0.128     -2.521      0.012      -0.575      -0.072
                                    Roots
=============================================================================
                  Real          Imaginary           Modulus         Frequency
-----------------------------------------------------------------------------
AR.1            1.7484           -0.1799j            1.7576           -0.0163
AR.2            1.7484           +0.1799j            1.7576            0.0163
-----------------------------------------------------------------------------
```

```
<IPython.core.display.Javascript object>
```

```
<IPython.core.display.HTML object>
```

```
            0
113  0.272637
114  0.274004
115  0.275347
116  0.276423
117  0.277207
118  0.277746
119  0.278103
```

[42]:

```
#  BA
modeling(ba_LT,(2,0,4),9)
```

```
                            ARMA Model Results
==============================================================================
Dep. Variable:                     BA   No. Observations:                  110
Model:                     ARMA(2, 4)   Log Likelihood                 377.968
Method:                       css-mle   S.D. of innovations              0.008
Date:                Sat, 26 Sep 2020   AIC                           -739.936
Time:                        01:06:10   BIC                           -718.333
```

```
Sample:                             0   HQIC                          -731.174

==============================================================================
                 coef    std err          z      P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
const          0.2668      0.006     45.199      0.000       0.255       0.278
ar.L1.BA       1.7050      0.139     12.262      0.000       1.433       1.978
ar.L2.BA      -0.8043      0.138     -5.815      0.000      -1.075      -0.533
ma.L1.BA      -0.5370      0.147     -3.647      0.000      -0.826      -0.248
ma.L2.BA      -0.1005      0.116     -0.866      0.387      -0.328       0.127
ma.L3.BA      -0.0451      0.102     -0.443      0.658      -0.245       0.154
ma.L4.BA       0.4827      0.091      5.301      0.000       0.304       0.661
                                    Roots
=============================================================================
                  Real          Imaginary           Modulus         Frequency
-----------------------------------------------------------------------------
AR.1            1.0600           -0.3461j            1.1151           -0.0502
AR.2            1.0600           +0.3461j            1.1151            0.0502
MA.1            0.9096           -0.6024j            1.0910           -0.0931
MA.2            0.9096           +0.6024j            1.0910            0.0931
MA.3           -0.8628           -0.9981j            1.3193           -0.3634
MA.4           -0.8628           +0.9981j            1.3193            0.3634
-----------------------------------------------------------------------------
```

```
<IPython.core.display.Javascript object>
```

```
<IPython.core.display.HTML object>
```

```
              0
110  0.264672
111  0.263119
112  0.260621
113  0.263019
114  0.265325
115  0.267327
116  0.268886
117  0.269935
118  0.270468
```

[57]:
```
#NC BA
modeling(ba_NC,(1,0,0),7)
```

```
                              ARMA Model Results
==============================================================================
Dep. Variable:                     BA   No. Observations:                  110
Model:                     ARMA(1, 0)   Log Likelihood                 387.947
```

```
Method:                       css-mle   S.D. of innovations              0.007
Date:                Sat, 26 Sep 2020   AIC                           -769.895
Time:                        01:23:43   BIC                           -761.793
Sample:                             0   HQIC                          -766.609

==============================================================================
                 coef    std err          z      P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
const          0.2722      0.018     15.150      0.000       0.237       0.307
ar.L1.BA       0.9666      0.030     32.672      0.000       0.909       1.025
                                    Roots
=============================================================================
                  Real          Imaginary           Modulus         Frequency
-----------------------------------------------------------------------------
AR.1            1.0345           +0.0000j            1.0345            0.0000
-----------------------------------------------------------------------------
```

```
<IPython.core.display.Javascript object>
```

```
<IPython.core.display.HTML object>
```

```
            0
110  0.283605
111  0.283224
112  0.282855
113  0.282498
114  0.282154
115  0.281821
116  0.281499
```

[56]:

```
#OB BA
modeling(ba_OB,(1,0,4),12)
```

```
                              ARMA Model Results
==============================================================================
Dep. Variable:                     BA   No. Observations:                  112
Model:                     ARMA(1, 4)   Log Likelihood                 360.897
Method:                       css-mle   S.D. of innovations              0.010
Date:                Sat, 26 Sep 2020   AIC                           -707.794
Time:                        01:23:34   BIC                           -688.764
Sample:                             0   HQIC                          -700.073

==============================================================================
                 coef    std err          z      P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
const          0.2846      0.007     42.242      0.000       0.271       0.298
```

```
ar.L1.BA       0.6462      0.134      4.827      0.000      0.384      0.909
ma.L1.BA       0.4539      0.123      3.687      0.000      0.213      0.695
ma.L2.BA       0.2091      0.104      2.008      0.045      0.005      0.413
ma.L3.BA       0.5663      0.105      5.418      0.000      0.361      0.771
ma.L4.BA       0.4175      0.110      3.812      0.000      0.203      0.632
                                    Roots
=============================================================================
                  Real          Imaginary           Modulus         Frequency
-----------------------------------------------------------------------------
AR.1            1.5474           +0.0000j            1.5474            0.0000
MA.1            0.5428           -0.9918j            1.1306           -0.1703
MA.2            0.5428           +0.9918j            1.1306            0.1703
MA.3           -1.2211           -0.6188j            1.3689           -0.4253
MA.4           -1.2211           +0.6188j            1.3689            0.4253
-----------------------------------------------------------------------------
```

```
<IPython.core.display.Javascript object>
```

```
<IPython.core.display.HTML object>
```

```
            0
112  0.259467
113  0.263392
114  0.268439
115  0.273813
116  0.277620
117  0.280081
118  0.281671
119  0.282698
120  0.283362
121  0.283791
122  0.284069
123  0.284248
```

[60]:
```
#SK BA
modeling(ba_SK,(2,1,0),9,'nc')
```

```
                             ARIMA Model Results
==============================================================================
Dep. Variable:                   D.BA   No. Observations:                  113
Model:                 ARIMA(2, 1, 0)   Log Likelihood                 346.393
Method:                       css-mle   S.D. of innovations              0.011
Date:                Sat, 26 Sep 2020   AIC                           -686.786
Time:                        01:39:35   BIC                           -678.604
Sample:                             1   HQIC                          -683.466
```

```
==============================================================================
                 coef    std err          z      P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
ar.L1.D.BA     0.8073      0.107      7.513      0.000       0.597       1.018
ar.L2.D.BA    -0.2627      0.142     -1.850      0.064      -0.541       0.016
                                    Roots
=============================================================================
                  Real          Imaginary           Modulus         Frequency
-----------------------------------------------------------------------------
AR.1            1.5367           -1.2023j            1.9512           -0.1057
AR.2            1.5367           +1.2023j            1.9512            0.1057
-----------------------------------------------------------------------------
```

```
<IPython.core.display.Javascript object>
```

```
<IPython.core.display.HTML object>
```

```
              0
114  0.219258
115  0.218620
116  0.218825
117  0.219158
118  0.219373
119  0.219460
120  0.219473
121  0.219460
122  0.219447
```

[19]:

```python
#SS BA
modeling(ba_SS,(0,2,1),11,'nC')
```

```
                             ARIMA Model Results
==============================================================================
Dep. Variable:                   D.BA   No. Observations:                  111
Model:                 ARIMA(1, 1, 1)   Log Likelihood                 387.744
Method:                       css-mle   S.D. of innovations              0.007
Date:                Sat, 26 Sep 2020   AIC                           -767.487
Time:                        16:44:52   BIC                           -756.649
Sample:                             1   HQIC                          -763.091

==============================================================================
                 coef    std err          z      P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
const          0.0036      0.003      1.125      0.260      -0.003       0.010
ar.L1.D.BA     0.9661      0.040     24.015      0.000       0.887       1.045
ma.L1.D.BA    -0.8399      0.071    -11.882      0.000      -0.978      -0.701
```

```
                                    Roots
=============================================================================
                  Real          Imaginary           Modulus         Frequency
-----------------------------------------------------------------------------
AR.1            1.0350           +0.0000j            1.0350            0.0000
MA.1            1.1906           +0.0000j            1.1906            0.0000
-----------------------------------------------------------------------------
```

```
<IPython.core.display.Javascript object>
```

```
<IPython.core.display.HTML object>
```

```
              0
112  0.292387
113  0.295782
114  0.299184
115  0.302594
116  0.306011
117  0.309434
118  0.312865
119  0.316302
120  0.319745
121  0.323194
122  0.326649
```

[69]:

```
#WO BA
modeling(ba_WO,(4,0,3),9)
```

```
                              ARMA Model Results
==============================================================================
Dep. Variable:                     BA   No. Observations:                  117
Model:                     ARMA(4, 3)   Log Likelihood                 411.833
Method:                       css-mle   S.D. of innovations              0.007
Date:                Sat, 26 Sep 2020   AIC                           -805.667
Time:                        01:43:23   BIC                           -780.807
Sample:                             0   HQIC                          -795.574

==============================================================================
                 coef    std err          z      P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
const          0.2678      0.001    321.423      0.000       0.266       0.269
ar.L1.BA       0.7107      0.073      9.680      0.000       0.567       0.855
ar.L2.BA       0.4449      0.108      4.126      0.000       0.234       0.656
ar.L3.BA       0.6768      0.099      6.833      0.000       0.483       0.871
ar.L4.BA      -0.9008      0.066    -13.661      0.000      -1.030      -0.772
ma.L1.BA       0.2300      0.097      2.374      0.018       0.040       0.420
```

```
ma.L2.BA      -0.4161      0.095     -4.373      0.000      -0.603      -0.230
ma.L3.BA      -0.8139      0.102     -7.958      0.000      -1.014      -0.613
                                    Roots
=============================================================================
                  Real          Imaginary           Modulus         Frequency
-----------------------------------------------------------------------------
AR.1           -0.6402           -0.8019j            1.0261           -0.3572
AR.2           -0.6402           +0.8019j            1.0261            0.3572
AR.3            1.0158           -0.1501j            1.0269           -0.0234
AR.4            1.0158           +0.1501j            1.0269            0.0234
MA.1            1.0000           -0.0000j            1.0000           -0.0000
MA.2           -0.7556           -0.8110j            1.1084           -0.3694
MA.3           -0.7556           +0.8110j            1.1084            0.3694
-----------------------------------------------------------------------------
```

```
<IPython.core.display.Javascript object>
```

```
<IPython.core.display.HTML object>
```

```
              0
117   0.250726
118   0.252510
119   0.254042
120   0.255702
121   0.258116
122   0.260001
123   0.262158
124   0.264667
125   0.266512
```

3 ER(PIT)

HH 201 HT 112 KT 010//414 LG 102 LT 100 NC 210 OB 211 SK 011 SS 010//302 WO 101

[71]:
```
#HH ER
modeling(er_HH,(2,0,1),10)
```

```
                              ARMA Model Results
==============================================================================
Dep. Variable:                     ER   No. Observations:                  110
Model:                     ARMA(2, 1)   Log Likelihood                 -44.164
Method:                       css-mle   S.D. of innovations              0.354
Date:                Sat, 26 Sep 2020   AIC                             98.328
Time:                        01:44:40   BIC                            111.830
Sample:                             0   HQIC                           103.804
```

```
==============================================================================
                 coef    std err          z      P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
const          4.2368      1.270      3.336      0.001       1.748       6.726
ar.L1.ER       1.9676      0.048     40.773      0.000       1.873       2.062
ar.L2.ER      -0.9720      0.048    -20.345      0.000      -1.066      -0.878
ma.L1.ER      -0.9144      0.137     -6.669      0.000      -1.183      -0.646
                                    Roots
=============================================================================
                  Real          Imaginary           Modulus         Frequency
-----------------------------------------------------------------------------
AR.1            1.0122           -0.0658j            1.0143           -0.0103
AR.2            1.0122           +0.0658j            1.0143            0.0103
MA.1            1.0937           +0.0000j            1.0937            0.0000
-----------------------------------------------------------------------------
```

```
<IPython.core.display.Javascript object>
```

```
<IPython.core.display.HTML object>
```

```
              0
110   4.168585
111   4.116964
112   4.067313
113   4.019792
114   3.974548
115   3.931715
116   3.891412
117   3.853743
118   3.818799
119   3.786654
```

[74]:

```
#HT ER
modeling(er_HT,(1,1,2),12,'NC')
```

```
                             ARIMA Model Results
==============================================================================
Dep. Variable:                   D.ER   No. Observations:                  108
Model:                 ARIMA(1, 1, 2)   Log Likelihood                 -74.501
Method:                       css-mle   S.D. of innovations              0.479
Date:                Sat, 26 Sep 2020   AIC                            157.002
Time:                        01:45:08   BIC                            167.731
Sample:                             1   HQIC                           161.352

==============================================================================
                 coef    std err          z      P>|z|      [0.025      0.975]
```

```
------------------------------------------------------------------------------
ar.L1.D.ER    -0.8058      0.169     -4.773      0.000      -1.137      -0.475
ma.L1.D.ER     1.1079      0.128      8.638      0.000       0.857       1.359
ma.L2.D.ER     0.6470      0.076      8.467      0.000       0.497       0.797
                                    Roots
=============================================================================
                  Real          Imaginary           Modulus         Frequency
-----------------------------------------------------------------------------
AR.1           -1.2411           +0.0000j            1.2411            0.5000
MA.1           -0.8562           -0.9014j            1.2432           -0.3709
MA.2           -0.8562           +0.9014j            1.2432            0.3709
-----------------------------------------------------------------------------
```

```
<IPython.core.display.Javascript object>
```

```
<IPython.core.display.HTML object>
```

```
            0
109  4.330714
110  4.674135
111  4.397421
112  4.620385
113  4.440730
114  4.585489
115  4.468848
116  4.562832
117  4.487104
118  4.548123
119  4.498956
120  4.538572
```

[11]:

```
#KT ER
modeling(er_KT,(4,1,4),9,'nc')
```

```
C:\Users\user\Anaconda3\lib\site-packages\statsmodels\base\model.py:548:
HessianInversionWarning: Inverting hessian failed, no bse or cov_params
available
  'available', HessianInversionWarning)
```

```
                             ARIMA Model Results
==============================================================================
Dep. Variable:                   D.ER   No. Observations:                  111
Model:                 ARIMA(4, 1, 4)   Log Likelihood                 -26.198
Method:                       css-mle   S.D. of innovations              0.295
Date:                Sat, 26 Sep 2020   AIC                             70.396
Time:                        16:37:02   BIC                             94.782
Sample:                             1   HQIC                            80.288
```

```
==============================================================================
                 coef    std err          z      P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
ar.L1.D.ER    -0.7634      0.102     -7.502      0.000      -0.963      -0.564
ar.L2.D.ER    -0.5596      0.117     -4.771      0.000      -0.790      -0.330
ar.L3.D.ER    -0.6014      0.127     -4.723      0.000      -0.851      -0.352
ar.L4.D.ER    -0.7099      0.106     -6.712      0.000      -0.917      -0.503
ma.L1.D.ER     0.6127      0.063      9.685      0.000       0.489       0.737
ma.L2.D.ER     0.5129      0.058      8.894      0.000       0.400       0.626
ma.L3.D.ER     0.6127      0.067      9.155      0.000       0.482       0.744
ma.L4.D.ER     1.0000      0.069     14.476      0.000       0.865       1.135
                                    Roots
=============================================================================
                  Real          Imaginary           Modulus         Frequency
-----------------------------------------------------------------------------
AR.1            0.4525           -1.0043j            1.1015           -0.1826
AR.2            0.4525           +1.0043j            1.1015            0.1826
AR.3           -0.8762           -0.6272j            1.0775           -0.4011
AR.4           -0.8762           +0.6272j            1.0775            0.4011
MA.1            0.4755           -0.8797j            1.0000           -0.1711
MA.2            0.4755           +0.8797j            1.0000            0.1711
MA.3           -0.7819           -0.6235j            1.0000           -0.3929
MA.4           -0.7819           +0.6235j            1.0000            0.3929
-----------------------------------------------------------------------------
```

```
<IPython.core.display.Javascript object>
```

```
<IPython.core.display.HTML object>
```

```
             0
112   3.875421
113   3.809631
114   3.766659
115   3.670642
116   3.856234
117   3.840842
118   3.836983
119   3.805084
120   3.709103
```

[12]:
```
#LG ER
modeling(er_LG,(1,0,2),7)
```

```
                              ARMA Model Results
==============================================================================
```

```
Dep. Variable:                     ER   No. Observations:                  113
Model:                     ARMA(1, 2)   Log Likelihood                 -40.403
Method:                       css-mle   S.D. of innovations              0.343
Date:                Sat, 26 Sep 2020   AIC                             90.805
Time:                        11:30:18   BIC                            104.442
Sample:                             0   HQIC                            96.339

==============================================================================
                 coef    std err          z      P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
const          4.3780      0.260     16.836      0.000       3.868       4.888
ar.L1.ER       0.8058      0.076     10.620      0.000       0.657       0.955
ma.L1.ER       0.3068      0.108      2.844      0.004       0.095       0.518
ma.L2.ER       0.3041      0.091      3.337      0.001       0.125       0.483
                                    Roots
=============================================================================
                  Real          Imaginary           Modulus         Frequency
-----------------------------------------------------------------------------
AR.1            1.2410           +0.0000j            1.2410            0.0000
MA.1           -0.5045           -1.7418j            1.8133           -0.2949
MA.2           -0.5045           +1.7418j            1.8133            0.2949
-----------------------------------------------------------------------------
```

```
<IPython.core.display.Javascript object>
```

```
<IPython.core.display.HTML object>
```

```
            0
113  4.774576
114  4.698293
115  4.636097
116  4.585980
117  4.545595
118  4.513053
119  4.486832
```

[14]:
```
#LT ER
modeling(er_LT,(1,0,0),9)
```

```
                              ARMA Model Results
==============================================================================
Dep. Variable:                     ER   No. Observations:                  110
Model:                     ARMA(1, 0)   Log Likelihood                 -36.496
Method:                       css-mle   S.D. of innovations              0.334
Date:                Sat, 26 Sep 2020   AIC                             78.992
Time:                        11:31:06   BIC                             87.093
```

```
Sample:                             0   HQIC                         82.278

==============================================================================
                 coef    std err          z      P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
const          4.3589      0.382     11.401      0.000       3.610       5.108
ar.L1.ER       0.9216      0.045     20.657      0.000       0.834       1.009
                                    Roots
=============================================================================
                  Real          Imaginary           Modulus         Frequency
-----------------------------------------------------------------------------
AR.1            1.0850           +0.0000j            1.0850            0.0000
-----------------------------------------------------------------------------
```

```
<IPython.core.display.Javascript object>
```

```
<IPython.core.display.HTML object>
```

```
               0
110  4.847453
111  4.809163
112  4.773873
113  4.741349
114  4.711374
115  4.683748
116  4.658287
117  4.634821
118  4.613195
```

[17]:
```python
#NC ER
modeling(er_NC,(2,1,0),7,'nc')
```

```
                             ARIMA Model Results
==============================================================================
Dep. Variable:                   D.ER   No. Observations:                  109
Model:                 ARIMA(2, 1, 0)   Log Likelihood                 -33.920
Method:                       css-mle   S.D. of innovations              0.330
Date:                Sat, 26 Sep 2020   AIC                             73.839
Time:                        11:31:58   BIC                             81.913
Sample:                             1   HQIC                            77.114

==============================================================================
                 coef    std err          z      P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
ar.L1.D.ER     0.1692      0.102      1.653      0.098      -0.031       0.370
ar.L2.D.ER     0.2153      0.102      2.102      0.036       0.015       0.416
```

```
                                    Roots
=============================================================================
                  Real          Imaginary           Modulus         Frequency
-----------------------------------------------------------------------------
AR.1            1.7979           +0.0000j            1.7979            0.0000
AR.2           -2.5840           +0.0000j            2.5840            0.5000
-----------------------------------------------------------------------------
```

```
<IPython.core.display.Javascript object>
```

```
<IPython.core.display.HTML object>
```

```
            0
110  3.933432
111  3.898275
112  3.877997
113  3.866998
114  3.860772
115  3.857351
116  3.855432
```

[20]:

```
#OB ER
modeling(er_OB,(2,1,1),12,'NC')
```

```
                             ARIMA Model Results
==============================================================================
Dep. Variable:                   D.ER   No. Observations:                  111
Model:                 ARIMA(2, 1, 1)   Log Likelihood                 -57.156
Method:                       css-mle   S.D. of innovations              0.402
Date:                Sat, 26 Sep 2020   AIC                            122.312
Time:                        11:32:21   BIC                            133.150
Sample:                             1   HQIC                           126.709

==============================================================================
                 coef    std err          z      P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
ar.L1.D.ER     0.7220      0.153      4.720      0.000       0.422       1.022
ar.L2.D.ER    -0.7015      0.108     -6.519      0.000      -0.912      -0.491
ma.L1.D.ER    -0.5594      0.135     -4.139      0.000      -0.824      -0.295
                                    Roots
=============================================================================
                  Real          Imaginary           Modulus         Frequency
-----------------------------------------------------------------------------
AR.1            0.5146           -1.0774j            1.1940           -0.1791
AR.2            0.5146           +1.0774j            1.1940            0.1791
MA.1            1.7878           +0.0000j            1.7878            0.0000
```

```
-----------------------------------------------------------------------------

<IPython.core.display.Javascript object>

<IPython.core.display.HTML object>

             0
112  4.246179
113  4.185770
114  4.125197
115  4.123841
116  4.165354
117  4.196275
118  4.189478
119  4.162880
120  4.148446
121  4.156683
122  4.172755
123  4.178580
```

[13]:
```
#SK ER
modeling(er_SK,(0,1,1),9,'NC')
```

```
                             ARIMA Model Results
==============================================================================
Dep. Variable:                   D.ER   No. Observations:                  113
Model:                 ARIMA(0, 1, 1)   Log Likelihood                 -39.492
Method:                       css-mle   S.D. of innovations              0.343
Date:                Sat, 26 Sep 2020   AIC                             82.984
Time:                        16:37:48   BIC                             88.439
Sample:                             1   HQIC                            85.198

==============================================================================
                 coef    std err          z      P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
ma.L1.D.ER     0.2533      0.105      2.420      0.016       0.048       0.459
                                    Roots
=============================================================================
                  Real          Imaginary           Modulus         Frequency
-----------------------------------------------------------------------------
MA.1           -3.9473           +0.0000j            3.9473            0.5000
-----------------------------------------------------------------------------

<IPython.core.display.Javascript object>
```

```
<IPython.core.display.HTML object>
```

```
            0
114  5.956982
115  5.956982
116  5.956982
117  5.956982
118  5.956982
119  5.956982
120  5.956982
121  5.956982
122  5.956982
```

[15]:

```
#SS ER
modeling(er_SS,(3,0,2),11,'C')
```

```
                              ARMA Model Results
==============================================================================
Dep. Variable:                     ER   No. Observations:                  111
Model:                     ARMA(3, 2)   Log Likelihood                 -23.193
Method:                       css-mle   S.D. of innovations              0.287
Date:                Sat, 26 Sep 2020   AIC                             60.386
Time:                        16:38:31   BIC                             79.353
Sample:                             0   HQIC                            68.081

==============================================================================
                 coef    std err          z      P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
const          4.7447      0.293     16.181      0.000       4.170       5.319
ar.L1.ER       0.3011      0.056      5.422      0.000       0.192       0.410
ar.L2.ER      -0.4125      0.052     -7.953      0.000      -0.514      -0.311
ar.L3.ER       0.8692      0.056     15.587      0.000       0.760       0.978
ma.L1.ER       0.7992      0.042     19.195      0.000       0.718       0.881
ma.L2.ER       0.9998      0.039     25.313      0.000       0.922       1.077
                                    Roots
=============================================================================
                  Real          Imaginary           Modulus         Frequency
-----------------------------------------------------------------------------
AR.1           -0.3149           -0.9709j            1.0207           -0.2999
AR.2           -0.3149           +0.9709j            1.0207            0.2999
AR.3            1.1043           -0.0000j            1.1043           -0.0000
MA.1           -0.3997           -0.9168j            1.0001           -0.3154
MA.2           -0.3997           +0.9168j            1.0001            0.3154
-----------------------------------------------------------------------------
```

```
<IPython.core.display.Javascript object>
```

<IPython.core.display.HTML object>

```
               0
111  6.036718
112  5.958781
113  5.813561
114  5.688741
115  5.643319
116  5.554905
117  5.438527
118  5.400473
119  5.360173
120  5.262579
121  5.216741
```

[27]:
```
#WO ER
modeling(er_WO,(1,0,1),9)
```

```
                              ARMA Model Results
==============================================================================
Dep. Variable:                     ER   No. Observations:                  117
Model:                     ARMA(1, 1)   Log Likelihood                 -37.002
Method:                       css-mle   S.D. of innovations              0.327
Date:                Sat, 26 Sep 2020   AIC                             82.004
Time:                        11:35:06   BIC                             93.052
Sample:                             0   HQIC                            86.489

==============================================================================
                 coef    std err          z      P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
const          3.7488      0.985      3.805      0.000       1.818       5.680
ar.L1.ER       0.9635      0.033     29.261      0.000       0.899       1.028
ma.L1.ER       0.3425      0.098      3.484      0.000       0.150       0.535
                                    Roots
=============================================================================
                  Real          Imaginary           Modulus         Frequency
-----------------------------------------------------------------------------
AR.1            1.0378           +0.0000j            1.0378            0.0000
MA.1           -2.9196           +0.0000j            2.9196            0.5000
-----------------------------------------------------------------------------
```

<IPython.core.display.Javascript object>

<IPython.core.display.HTML object>

```
               0
```

```
117    5.194384
118    5.141680
119    5.090896
120    5.041965
121    4.994817
122    4.949388
123    4.905616
124    4.863439
125    4.822801
```

4 WLS

HH 302 HT 010//212 KT 010//414 LG 102 LT 103 NC 010/110 OB 411 SK 010/100 SS 010/100 WO 100

[30]:
```
#HH WLS
modeling(wls_HH,(3,0,2),10)
```

```
                              ARMA Model Results
==============================================================================
Dep. Variable:                    WLS   No. Observations:                  110
Model:                     ARMA(3, 2)   Log Likelihood                 156.282
Method:                       css-mle   S.D. of innovations              0.057
Date:                Sat, 26 Sep 2020   AIC                           -298.564
Time:                        11:36:23   BIC                           -279.661
Sample:                             0   HQIC                          -290.897

==============================================================================
                 coef    std err          z      P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
const          0.3988      0.144      2.769      0.006       0.117       0.681
ar.L1.WLS      0.3508      0.110      3.196      0.001       0.136       0.566
ar.L2.WLS     -0.0066      0.146     -0.045      0.964      -0.292       0.279
ar.L3.WLS      0.5745      0.115      4.985      0.000       0.349       0.800
ma.L1.WLS      0.3426      0.032     10.722      0.000       0.280       0.405
ma.L2.WLS      0.9555      0.079     12.038      0.000       0.800       1.111
                                    Roots
=============================================================================
                  Real          Imaginary           Modulus         Frequency
-----------------------------------------------------------------------------
AR.1            1.0382           -0.0000j            1.0382           -0.0000
AR.2           -0.5134           -1.1887j            1.2948           -0.3149
AR.3           -0.5134           +1.1887j            1.2948            0.3149
MA.1           -0.1793           -1.0072j            1.0230           -0.2780
MA.2           -0.1793           +1.0072j            1.0230            0.2780
-----------------------------------------------------------------------------
```

```
<IPython.core.display.Javascript object>
```

```
<IPython.core.display.HTML object>
```

```
            0
110  0.286332
111  0.300901
112  0.304992
113  0.301925
114  0.309193
115  0.314113
116  0.314029
117  0.318142
118  0.322412
119  0.323835
```

[16]:

```
#HT WLS
modeling(wls_HT,(2,1,2),12,'nc')
```

```
                             ARIMA Model Results
==============================================================================
Dep. Variable:                  D.WLS   No. Observations:                  108
Model:                 ARIMA(2, 1, 2)   Log Likelihood                 164.589
Method:                       css-mle   S.D. of innovations              0.053
Date:                Sat, 26 Sep 2020   AIC                           -319.178
Time:                        16:39:00   BIC                           -305.768
Sample:                             1   HQIC                          -313.741

===============================================================================
                  coef    std err          z      P>|z|      [0.025      0.975]
-------------------------------------------------------------------------------
ar.L1.D.WLS     0.1407      0.042      3.329      0.001       0.058       0.224
ar.L2.D.WLS    -0.8400        nan        nan        nan         nan         nan
ma.L1.D.WLS    -0.1790      0.155     -1.152      0.249      -0.483       0.125
ma.L2.D.WLS     0.7419      0.150      4.960      0.000       0.449       1.035
                                    Roots
=============================================================================
                  Real          Imaginary           Modulus         Frequency
-----------------------------------------------------------------------------
AR.1            0.0838           -1.0879j            1.0911           -0.2378
AR.2            0.0838           +1.0879j            1.0911            0.2378
MA.1            0.1206           -1.1547j            1.1610           -0.2334
MA.2            0.1206           +1.1547j            1.1610            0.2334
-----------------------------------------------------------------------------
```

```
C:\Users\user\Anaconda3\lib\site-packages\statsmodels\base\model.py:548:
```

```
HessianInversionWarning: Inverting hessian failed, no bse or cov_params
available
  'available', HessianInversionWarning)
C:\Users\user\Anaconda3\lib\site-packages\statsmodels\tsa\arima_model.py:1490:
RuntimeWarning: invalid value encountered in sqrt
  return np.sqrt(np.diag(-inv(hess)))
C:\Users\user\Anaconda3\lib\site-
packages\scipy\stats\_distn_infrastructure.py:1932: RuntimeWarning: invalid
value encountered in less_equal
  cond2 = cond0 & (x <= _a)
```

```
<IPython.core.display.Javascript object>
```

```
<IPython.core.display.HTML object>
```

```
            0
109  0.669300
110  0.682648
111  0.682595
112  0.671375
113  0.669841
114  0.679050
115  0.681634
116  0.674263
117  0.671055
118  0.676795
119  0.680297
120  0.675969
```

[17]:

```python
#KT WLS
modeling(wls_KT,(4,1,4),9,'nc')
```

```
C:\Users\user\Anaconda3\lib\site-packages\statsmodels\base\model.py:548:
HessianInversionWarning: Inverting hessian failed, no bse or cov_params
available
  'available', HessianInversionWarning)
```

```
                             ARIMA Model Results
==============================================================================
Dep. Variable:                  D.WLS   No. Observations:                  111
Model:                 ARIMA(4, 1, 4)   Log Likelihood                 190.780
Method:                       css-mle   S.D. of innovations              0.042
Date:                Sat, 26 Sep 2020   AIC                           -363.560
Time:                        16:39:32   BIC                           -339.174
Sample:                             1   HQIC                          -353.667

===============================================================================
                  coef    std err          z      P>|z|      [0.025      0.975]
```

```
--------------------------------------------------------------------------------
ar.L1.D.WLS    -0.3149      0.096     -3.277      0.001      -0.503      -0.127
ar.L2.D.WLS    -0.0887      0.097     -0.913      0.361      -0.279       0.102
ar.L3.D.WLS    -0.3893      0.074     -5.292      0.000      -0.533      -0.245
ar.L4.D.WLS    -0.8091      0.087     -9.276      0.000      -0.980      -0.638
ma.L1.D.WLS     0.4172      0.064      6.487      0.000       0.291       0.543
ma.L2.D.WLS     0.2645      0.078      3.377      0.001       0.111       0.418
ma.L3.D.WLS     0.4171      0.065      6.391      0.000       0.289       0.545
ma.L4.D.WLS     0.9999      0.065     15.395      0.000       0.873       1.127
                                    Roots
=============================================================================
                  Real          Imaginary           Modulus         Frequency
-----------------------------------------------------------------------------
AR.1            0.6169          -0.8262j            1.0311           -0.1479
AR.2            0.6169          +0.8262j            1.0311            0.1479
AR.3           -0.8575          -0.6535j            1.0782           -0.3964
AR.4           -0.8575          +0.6535j            1.0782            0.3964
MA.1            0.5626          -0.8268j            1.0001           -0.1549
MA.2            0.5626          +0.8268j            1.0001            0.1549
MA.3           -0.7712          -0.6366j            1.0000           -0.3902
MA.4           -0.7712          +0.6366j            1.0000            0.3902
-----------------------------------------------------------------------------
```

```
<IPython.core.display.Javascript object>
```

```
<IPython.core.display.HTML object>
```

```
             0
112  0.731450
113  0.739907
114  0.719804
115  0.707352
116  0.702117
117  0.705853
118  0.726253
119  0.731611
120  0.730896
```

[35]:
```
#LG WLS
modeling(wls_LG,(1,0,2),7)
```

```
                              ARMA Model Results
==============================================================================
Dep. Variable:                    WLS   No. Observations:                  113
Model:                     ARMA(1, 2)   Log Likelihood                 161.686
Method:                       css-mle   S.D. of innovations              0.057
```

```
Date:                  Sat, 26 Sep 2020   AIC                           -313.373
Time:                          11:40:46   BIC                           -299.736
Sample:                               0   HQIC                          -307.839

==============================================================================
                 coef    std err          z      P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
const          0.6066      0.047     12.980      0.000       0.515       0.698
ar.L1.WLS      0.7576      0.088      8.580      0.000       0.585       0.931
ma.L1.WLS      0.4890      0.081      6.017      0.000       0.330       0.648
ma.L2.WLS      0.6457      0.095      6.782      0.000       0.459       0.832
                                    Roots
=============================================================================
                  Real          Imaginary           Modulus         Frequency
-----------------------------------------------------------------------------
AR.1            1.3199           +0.0000j            1.3199            0.0000
MA.1           -0.3786           -1.1854j            1.2444           -0.2992
MA.2           -0.3786           +1.1854j            1.2444            0.2992
-----------------------------------------------------------------------------
```

```
<IPython.core.display.Javascript object>
```

```
<IPython.core.display.HTML object>
```

```
            0
113  0.596592
114  0.598490
115  0.600457
116  0.601947
117  0.603075
118  0.603931
119  0.604579
```

[37]:
```
#LT WLS
modeling(wls_LT,(1,0,3),9)
```

```
                              ARMA Model Results
==============================================================================
Dep. Variable:                      WLS   No. Observations:                  110
Model:                       ARMA(1, 3)   Log Likelihood                 192.675
Method:                         css-mle   S.D. of innovations              0.041
Date:                  Sat, 26 Sep 2020   AIC                           -373.350
Time:                          11:41:11   BIC                           -357.147
Sample:                               0   HQIC                          -366.778

==============================================================================
```

```
                  coef    std err          z      P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
const           0.5777      0.099      5.835      0.000       0.384       0.772
ar.L1.WLS       0.9494      0.037     25.675      0.000       0.877       1.022
ma.L1.WLS      -0.0277      0.099     -0.280      0.780      -0.221       0.166
ma.L2.WLS       0.1947      0.097      1.999      0.046       0.004       0.386
ma.L3.WLS       0.2718      0.088      3.090      0.002       0.099       0.444
                                    Roots
=============================================================================
                  Real          Imaginary           Modulus         Frequency
-----------------------------------------------------------------------------
AR.1            1.0533           +0.0000j            1.0533            0.0000
MA.1            0.5660           -1.2924j            1.4109           -0.1843
MA.2            0.5660           +1.2924j            1.4109            0.1843
MA.3           -1.8484           -0.0000j            1.8484           -0.5000
-----------------------------------------------------------------------------
```

```
<IPython.core.display.Javascript object>
```

```
<IPython.core.display.HTML object>
```

```
            0
110  0.434011
111  0.417183
112  0.419772
113  0.427759
114  0.435342
115  0.442542
116  0.449377
117  0.455867
118  0.462028
```

[9]:

```
#NC WLS
modeling(wls_NC,(1,1,0),7,'NC')
```

```
                             ARIMA Model Results
==============================================================================
Dep. Variable:                  D.WLS   No. Observations:                  109
Model:                 ARIMA(1, 1, 0)   Log Likelihood                 193.556
Method:                       css-mle   S.D. of innovations              0.041
Date:                Sat, 26 Sep 2020   AIC                           -383.111
Time:                        13:08:09   BIC                           -377.728
Sample:                             1   HQIC                          -380.928

===============================================================================
                  coef    std err          z      P>|z|      [0.025      0.975]
```

```
==============================================================================
ar.L1.D.WLS    -0.1317      0.094     -1.394      0.163      -0.317       0.053
                                    Roots
=============================================================================
                  Real          Imaginary           Modulus         Frequency
-----------------------------------------------------------------------------
AR.1           -7.5924           +0.0000j            7.5924            0.5000
-----------------------------------------------------------------------------
```

```
<IPython.core.display.Javascript object>
```

```
<IPython.core.display.HTML object>
```

```
           0
110  0.562
111  0.562
112  0.562
113  0.562
114  0.562
115  0.562
116  0.562
```

[12]:

```
#OB WLS
modeling(wls_OB,(4,1,1),12,'nc')
```

```
                             ARIMA Model Results
==============================================================================
Dep. Variable:                  D.WLS   No. Observations:                  111
Model:                 ARIMA(4, 1, 1)   Log Likelihood                 160.125
Method:                       css-mle   S.D. of innovations              0.057
Date:                Sat, 26 Sep 2020   AIC                           -308.249
Time:                        13:09:16   BIC                           -291.992
Sample:                             1   HQIC                          -301.654

==============================================================================
                  coef    std err          z      P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
ar.L1.D.WLS     0.7943      0.159      4.981      0.000       0.482       1.107
ar.L2.D.WLS    -0.4144      0.142     -2.913      0.004      -0.693      -0.136
ar.L3.D.WLS     0.7517      0.142      5.279      0.000       0.473       1.031
ar.L4.D.WLS    -0.6329      0.128     -4.947      0.000      -0.884      -0.382
ma.L1.D.WLS    -0.7910      0.150     -5.271      0.000      -1.085      -0.497
                                    Roots
=============================================================================
                  Real          Imaginary           Modulus         Frequency
-----------------------------------------------------------------------------
```

```
AR.1            -0.4476          -0.9891j            1.0857          -0.3176
AR.2            -0.4476          +0.9891j            1.0857           0.3176
AR.3             1.0414          -0.5060j            1.1578          -0.0720
AR.4             1.0414          +0.5060j            1.1578           0.0720
MA.1             1.2643          +0.0000j            1.2643           0.0000
-----------------------------------------------------------------------------
```

```
<IPython.core.display.Javascript object>
```

```
<IPython.core.display.HTML object>
```

```
               0
112  0.469447
113  0.494425
114  0.501232
115  0.519926
116  0.530825
117  0.521045
118  0.518503
119  0.516900
120  0.502430
121  0.495881
122  0.497079
123  0.490883
```

[14]:
```
#SK WLS
modeling(wls_SK,(1,0,0),9)
```

```
                              ARMA Model Results
==============================================================================
Dep. Variable:                    WLS   No. Observations:                  114
Model:                     ARMA(1, 0)   Log Likelihood                 156.880
Method:                       css-mle   S.D. of innovations              0.061
Date:                Sat, 26 Sep 2020   AIC                           -307.759
Time:                        13:12:08   BIC                           -299.551
Sample:                             0   HQIC                          -304.428

==============================================================================
                 coef    std err          z      P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
const          0.3089      0.049      6.346      0.000       0.214       0.404
ar.L1.WLS      0.8891      0.046     19.532      0.000       0.800       0.978
                                    Roots
=============================================================================
                  Real          Imaginary           Modulus         Frequency
-----------------------------------------------------------------------------
```

```
AR.1            1.1247           +0.0000j            1.1247            0.0000
-----------------------------------------------------------------------------
```

<IPython.core.display.Javascript object>

<IPython.core.display.HTML object>

```
            0
114  0.330332
115  0.327959
116  0.325850
117  0.323975
118  0.322307
119  0.320824
120  0.319506
121  0.318334
122  0.317292
```

[18]:
```
#SS WLS
modeling(wls_SS,(1,0,0),11,'NC')
```

```
                              ARMA Model Results
==============================================================================
Dep. Variable:                    WLS   No. Observations:                  111
Model:                     ARMA(1, 0)   Log Likelihood                 175.680
Method:                       css-mle   S.D. of innovations              0.049
Date:                Sat, 26 Sep 2020   AIC                           -347.359
Time:                        13:14:21   BIC                           -341.940
Sample:                             0   HQIC                          -345.161

==============================================================================
                 coef    std err          z      P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
ar.L1.WLS      0.9915      0.008    127.531      0.000       0.976       1.007
                                    Roots
=============================================================================
                  Real          Imaginary           Modulus         Frequency
-----------------------------------------------------------------------------
AR.1            1.0086           +0.0000j            1.0086            0.0000
-----------------------------------------------------------------------------
```

<IPython.core.display.Javascript object>

<IPython.core.display.HTML object>

```
              0
111  0.385696
112  0.382420
113  0.379171
114  0.375950
115  0.372757
116  0.369591
117  0.366451
118  0.363338
119  0.360252
120  0.357192
121  0.354158
```

[19]:
```
#WO WLS
modeling(wls_WO,(1,0,0),9)
```

```
                              ARMA Model Results
==============================================================================
Dep. Variable:                    WLS   No. Observations:                  117
Model:                     ARMA(1, 0)   Log Likelihood                 179.554
Method:                       css-mle   S.D. of innovations              0.052
Date:                Sat, 26 Sep 2020   AIC                           -353.109
Time:                        13:14:38   BIC                           -344.822
Sample:                             0   HQIC                          -349.744

==============================================================================
                 coef    std err          z      P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
const          0.6209      0.071      8.744      0.000       0.482       0.760
ar.L1.WLS      0.9385      0.038     24.473      0.000       0.863       1.014
                                    Roots
=============================================================================
                  Real          Imaginary           Modulus         Frequency
-----------------------------------------------------------------------------
AR.1            1.0655           +0.0000j            1.0655            0.0000
-----------------------------------------------------------------------------
```

```
<IPython.core.display.Javascript object>
```

```
<IPython.core.display.HTML object>
```

```
              0
117  0.480210
118  0.488853
119  0.496965
120  0.504579
```

121	0.511725
122	0.518432
123	0.524726
124	0.530634
125	0.536178