3-白噪声检验

|  |  |  |
| --- | --- | --- |
| Pvalue | lags |  |
| 2.208102 | 1.372875e-01 | 1 |
| 28.999853 | 5.043848e-07 | 2 |
| 31.507975 | 6.644477e-07 | 3 |
| 36.171147 | 2.668336e-07 | 4 |
| 41.507785 | 7.408108e-08 | 5 |
| 45.627973 | 3.510839e-08 | 6 |
| 46.538629 | 6.866438e-08 | 7 |
| 46.550650 | 1.867516e-07 | 8 |
| 46.550650 | 4.758120e-07 | 9 |
| 46.649291 | 1.093558e-06 | 10 |
| 48.594176 | 1.118285e-06 | 11 |
| 50.056040 | 1.365796e-06 | 12 |
| 52.028220 | 1.332727e-06 | 13 |
| 52.432756 | 2.375111e-06 | 14 |
| 53.201109 | 3.570105e-06 | 15 |
| 54.683844 | 4.007421e-06 | 16 |
| 56.011657 | 4.708889e-06 | 17 |
| 56.119584 | 8.533200e-06 | 18 |
| 56.212967 | 1.512752e-05 | 19 |
| 56.230855 | 2.683109e-05 | 20 |
| 56.476099 | 4.294697e-05 | 21 |
| 56.575840 | 7.067493e-05 | 22 |
| 56.844755 | 1.077456e-04 | 23 |
| 56.852952 | 1.752105e-04 | 24 |

4.1-模型定阶

parameters AIC BIC

0 SARIMA(3, 1, 5)x(0, 0, 0, 0) 68.818731 96.717529

1 SARIMA(4, 1, 5)x(0, 0, 0, 0) 70.011834 101.010498

2 SARIMA(2, 1, 3)x(0, 0, 0, 0) 86.547232 105.146430

3 SARIMA(1, 1, 5)x(0, 0, 0, 0) 85.471872 107.170937

4 SARIMA(1, 1, 4)x(0, 0, 0, 0) 90.178415 108.777613

5 SARIMA(1, 1, 3)x(0, 0, 0, 0) 94.106774 109.606106

6 SARIMA(5, 1, 5)x(0, 0, 0, 0) 75.601413 109.699944

7 SARIMA(3, 1, 3)x(0, 0, 0, 0) 88.520900 110.219965

8 SARIMA(2, 1, 4)x(0, 0, 0, 0) 88.537945 110.237010

9 SARIMA(0, 1, 2)x(0, 0, 0, 0) 102.118421 111.418021

10 SARIMA(2, 1, 5)x(0, 0, 0, 0) 86.853152 111.652083

11 SARIMA(4, 1, 3)x(0, 0, 0, 0) 86.932499 111.731431

12 SARIMA(3, 1, 2)x(0, 0, 0, 0) 93.448882 112.048081

13 SARIMA(5, 1, 0)x(0, 0, 0, 0) 95.073181 113.672380

14 SARIMA(0, 1, 5)x(0, 0, 0, 0) 95.751101 114.350299

15 SARIMA(3, 1, 4)x(0, 0, 0, 0) 89.671954 114.470886

16 SARIMA(4, 1, 0)x(0, 0, 0, 0) 99.126801 114.626133

17 SARIMA(0, 1, 3)x(0, 0, 0, 0) 102.742994 115.142459

18 SARIMA(1, 1, 2)x(0, 0, 0, 0) 102.918723 115.318188

19 SARIMA(4, 1, 2)x(0, 0, 0, 0) 93.756418 115.455483

20 SARIMA(4, 1, 1)x(0, 0, 0, 0) 97.133949 115.733148

21 SARIMA(4, 1, 4)x(0, 0, 0, 0) 88.860198 116.758996

22 SARIMA(2, 1, 2)x(0, 0, 0, 0) 102.317885 117.817217

23 SARIMA(5, 1, 1)x(0, 0, 0, 0) 96.500940 118.200005

24 SARIMA(0, 1, 4)x(0, 0, 0, 0) 103.863600 119.362933

25 SARIMA(5, 1, 2)x(0, 0, 0, 0) 95.734609 120.533540

26 SARIMA(5, 1, 4)x(0, 0, 0, 0) 90.555635 121.554299

27 SARIMA(3, 1, 1)x(0, 0, 0, 0) 107.815117 123.314450

28 SARIMA(5, 1, 3)x(0, 0, 0, 0) 97.749060 125.647858

29 SARIMA(2, 1, 0)x(0, 0, 0, 0) 123.706038 133.005637

30 SARIMA(3, 1, 0)x(0, 0, 0, 0) 124.990558 137.390024

31 SARIMA(2, 1, 1)x(0, 0, 0, 0) 125.464340 137.863806

32 SARIMA(1, 1, 1)x(0, 0, 0, 0) 142.572338 151.871937

33 SARIMA(0, 1, 0)x(0, 0, 0, 0) 149.507532 152.607399

34 SARIMA(1, 1, 0)x(0, 0, 0, 0) 149.330406 155.530139

35 SARIMA(0, 1, 1)x(0, 0, 0, 0) 150.284861 156.484594

4.2-使用 𝑆𝐴𝑅𝐼𝑀𝐴(𝑝,𝑑,𝑞)(𝑃,𝐷,𝑄)𝑚 建模

SARIMAX Results

=================================================================

Dep. Variable: y No. Observations: 165

Model: ARIMA(3, 1, 5) Log Likelihood -25.409

Date: Wed, 01 Dec 2021 AIC 68.819

Time: 20:28:03 BIC 96.718

Sample: 0 HQIC 80.145

- 165

Covariance Type: opg

=================================================================

------------------------------------------------------------------------------

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| coef | std | err | z | P>|z| | [0.025 | 0.975] |
| ar.L1 | 0.8024 | 0.072 | 11.129 | 0.000 | 0.661 | 0.944 |
| ar.L2 | -0.9567 | 0.060 | -15.887 | 0.000 | -1.075 | -0.839 |
| ar.L3 | 0.7762 | 0.073 | 10.672 | 0.000 | 0.634 | 0.919 |
| ma.L1 | -1.0211 | 0.587 | -1.741 | 0.082 | -2.171 | 0.129 |
| ma.L2 | 1.8320 | 0.072 | 25.524 | 0.000 | 1.691 | 1.973 |
| ma.L3 | -1.8372 | 1.031 | -1.782 | 0.075 | -3.858 | 0.183 |
| ma.L4 | 0.8997 | 0.072 | 12.546 | 0.000 | 0.759 | 1.040 |
| ma.L5 | -0.8702 | 0.493 | -1.766 | 0.077 | -1.836 | 0.096 |
| sigma2 | 0.0760 | 0.044 | 1.730 | 0.084 | -0.010 | 0.162 |

===================================================================================

Ljung-Box (Q): 16.54 Jarque-Bera (JB): 25229.16

Prob(Q): 1.00 Prob(JB): 0.00

Heteroskedasticity (H): 21.73 Skew: -6.24

Prob(H) (two-sided): 0.00 Kurtosis: 62.47

=================================================================

5-模型显著性检验（残差检验）

|  |  |  |
| --- | --- | --- |
| Pvalue | lags |  |
| 0.000465 | 0.982803 | 1 |
| 0.014395 | 0.992828 | 2 |
| 0.016465 | 0.999441 | 3 |
| 0.024882 | 0.999923 | 4 |
| 0.068117 | 0.999937 | 5 |
| 0.069455 | 0.999993 | 6 |
| 0.069555 | 0.999999 | 7 |
| 0.089212 | 1.000000 | 8 |
| 0.112827 | 1.000000 | 9 |
| 0.116085 | 1.000000 | 10 |
| 0.152512 | 1.000000 | 11 |
| 0.165353 | 1.000000 | 12 |
| 0.179555 | 1.000000 | 13 |
| 0.179565 | 1.000000 | 14 |
| 0.183351 | 1.000000 | 15 |
| 0.183427 | 1.000000 | 16 |
| 0.226541 | 1.000000 | 17 |
| 0.255868 | 1.000000 | 18 |
| 0.296976 | 1.000000 | 19 |
| 0.366957 | 1.000000 | 20 |
| 0.371425 | 1.000000 | 21 |
| 0.371912 | 1.000000 | 22 |
| 0.372876 | 1.000000 | 23 |
| 0.375998 | 1.000000 | 24 |

6-拟合+7-预测

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| y | mean | mean\_se | mean\_ci\_lower | mean\_ci\_upper |
| 0 | 1.091513e+06 | 0.370722 | 1.091512e+06 | 1.091513e+06 |
| 1 | 1.078665e+06 | 0.361605 | 1.078664e+06 | 1.078666e+06 |
| 2 | 1.164171e+06 | 0.333331 | 1.164170e+06 | 1.164171e+06 |
| 3 | 1.131283e+06 | 0.333328 | 1.131282e+06 | 1.131283e+06 |
| 4 | 1.048330e+06 | 0.315712 | 1.048329e+06 | 1.048330e+06 |
| .. | ... | ... | ... | ... |
| 172 | 8.922834e+05 | 0.783497 | 8.922818e+05 | 8.922849e+05 |
| 173 | 1.030516e+06 | 0.791584 | 1.030514e+06 | 1.030517e+06 |
| 174 | 1.118209e+06 | 0.795630 | 1.118207e+06 | 1.118211e+06 |
| 175 | 1.005453e+06 | 0.798342 | 1.005452e+06 | 1.005455e+06 |
| 176 | 9.548642e+05 | 0.801291 | 9.548627e+05 | 9.548658e+05 |