**Miguel Alejandro García Navarro**

**1919323**

**Homework 1**

Inflation is generated and plotted.

Text, letter

Description automatically generated



From the plot one cannot say if it is stationary or not.

Table

Description automatically generated

****Correlogram indicates that there is autocorrelation

From the AC and PAC it seems like it is a stationary process, it slowly goes to zero in the AC, and in the PAC it has one big spike, but 4 in total at the beginning. I propose the next models:

AR(1), AR(2), MA(4), MA(5), MA(6), ARMA(1,1)

**AR(1)**





The residuals of the AR(1) plotted seem to be white-noise, but it can be seen that autocorrelation cannot be said to be zero.

**AR(2)**





The residuals of the AR(2) plotted seem to be white-noise, but it can be seen that autocorrelation cannot be said to be zero.

**MA(4)**





The residuals of the MA(4) plotted seem to be white-noise, but it can be seen that autocorrelation cannot be said to be zero.

**MA(5)**





The residuals of the MA(5) plotted seem to be white-noise, but it can be seen that autocorrelation cannot be said to be zero.

**MA(6)**



The residuals of the MA(6) plotted seem to be white-noise, but it can be seen that autocorrelation cannot be said to be zero.

**ARMA(1,1)**





The residuals of the ARMA(1,1) plotted seem to be white-noise, but it can be seen that autocorrelation cannot be said to be zero.

The next two tables summarize some of the properties of each model tested.

Yellow-shaded are the ones that can be compared. The others are rejected either because of the significancy of their coefficients or because they do not imply stationarity and/or invertibility

|  |  |  |  |
| --- | --- | --- | --- |
|  | **AR(1)** | **AR(2)** | **MA(4)** |
| **Coefficients** | | | |
| Are they all individually significant? (t-test) | Yes | Yes | Yes |
| Are they all jointly significant (F-test or chi-squared test) | Yes | Yes | Yes |
| Do they imply stationarity (AR coefficients) and invertibility (MA coefficients) | Yes | Yes | No |
| **Information criterion** | | | |
| AIC | -1025.94 | -1030.975 | -1026.423 |
| BIC | -1016.57 | -1018.48 | -1007.679 |
| **Diagnostic checks – residuals** | | | |
| Plot the residuals – do they exhibit any remaining pattern? | No | No | Yes |
| ACFs and PACFs of residuals – do they indicate white noise? | No | No | No |
| Ljung-Box Q-Test (p-values in brackets  Q\_lag4  Q\_lag 8  Q\_lag 12 | 12.826 (0.0122)  20.7 (0.0080)  25.53 (0.0125) | 8.221 (0.0838)  14.534 (0.0689)  19.386 (0.0796) | 3.6792 (0.4512)  13.474 (0.0965)  17.173 (0.1432) |

|  |  |  |  |
| --- | --- | --- | --- |
|  | **MA(5)** | **MA(6)** | **ARMA(1,1)** |
| **Coefficients** | | | |
| Are they all individually significant? (t-test) | No | Yes | Yes |
| Are they all jointly significant (F-test or chi-squared test) | Yes | Yes | Yes |
| Do they imply stationarity (AR coefficients) and invertibility (MA coefficients) | No | No | Yes |
| **Information criterion** | | | |
| AIC | -1025.692 | -1034.996 | -1035.257 |
| BIC | -1003.824 | -1010.004 | -1022.761 |
| **Diagnostic checks – residuals** | | | |
| Plot the residuals – do they exhibit any remaining pattern? | No | No | No |
| ACFs and PACFs of residuals – do they indicate white noise? | No | No | No |
| Ljung-Box Q-Test (p-values in brackets  Q\_lag4  Q\_lag 8  Q\_lag 12 | 2.6576 (0.6166)  13.339 (0.1007)  16.063 (0.1884) | 1.9866 (0.7382)  6.6712 (0.5725)  9.5473 (0.6556) | 4.3911 (0.3557)  10.711 (0.2186)  16.416 (0.1729) |

Based on these results, I propose these other models to test:

AR(3), AR(4), MA(3) and ARMA(2,1)

**AR(3)**





The residuals of the AR(3) plotted seem to be white-noise, but it can be seen that autocorrelation cannot be said to be zero.

**AR(4)**



The residuals of the AR(4) plotted seem to be white-noise, but it can be seen that autocorrelation cannot be said to be zero.

**MA(3)**





The residuals of the MA(3) plotted seem to be white-noise, but it can be seen that autocorrelation cannot be said to be zero.

**ARMA(2,1)**



The residuals of the ARMA(2,1) plotted seem to be white-noise, but it can be seen that autocorrelation cannot be said to be zero.

One thing to be noted is that, from all the models tested here, the residuals look almost the same:

The next two tables summarize the properties of each model. Again, the yellow-shaded is the only one that was not rejected based on the significance of its coefficients and on stationarity and invertibility.

|  |  |  |  |
| --- | --- | --- | --- |
|  | **AR(3)** | **AR(4)** | **MA(3)** |
| **Coefficients** | | | |
| Are they all individually significant? (t-test) | Yes | No | No |
| Are they all jointly significant (F-test or chi-squared test) | Yes | Yes | Yes |
| Do they imply stationarity (AR coefficients) and invertibility (MA coefficients) | Yes | Yes | Yes |
| **Information criterion** | | | |
| AIC | -1032.677 | -1034.347 | -1014.393 |
| BIC | -1017.057 | -1015.603 | -998.7736 |
| **Diagnostic checks – residuals** | | | |
| Plot the residuals – do they exhibit any remaining pattern? | No | No | No |
| ACFs and PACFs of residuals – do they indicate white noise? | No | No | No |
| Ljung-Box Q-Test (p-values in brackets  Q\_lag4  Q\_lag 8  Q\_lag 12 | 5.8852 (0.2079)  11.943 (0.1538)  16.947 (0.1516) | 1.4257 (0.8397)  8.2913 (0.4055)  14.55 (0.2670) | 21.769 (0.0002)  29.911 (0.0002)  34.505 (0.0006) |

|  |  |
| --- | --- |
|  | **ARMA(2,1)** |
| **Coefficients** | |
| Are they all individually significant? (t-test) | No |
| Are they all jointly significant (F-test or chi-squared test) | Yes |
| Do they imply stationarity (AR coefficients) and invertibility (MA coefficients) | No |
| **Information criterion** | |
| AIC | -1033.434 |
| BIC | -1017.814 |
| **Diagnostic checks – residuals** | |
| Plot the residuals – do they exhibit any remaining pattern? | No |
| ACFs and PACFs of residuals – do they indicate white noise? | No |
| Ljung-Box Q-Test (p-values in brackets  Q\_lag4  Q\_lag 8  Q\_lag 12 | 4.1339 (0.3882)  10.587 (0.2262)  16.558 (0.1670) |

From the accepted models, we have the next:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Information criterion** | **AR(1)** | **AR(2)** | **ARMA(1,1)** | **AR(3)** |
| **AIC** | -1025.94 | -1030.975 | -1035.257 | -1032.677 |
| **BIC** | -1016.57 | -1018.48 | -1022.761 | -1017.057 |

From these four models, the one with the lowest AIC and BIC is the ARMA(1,1), so this is considered to be the best model.