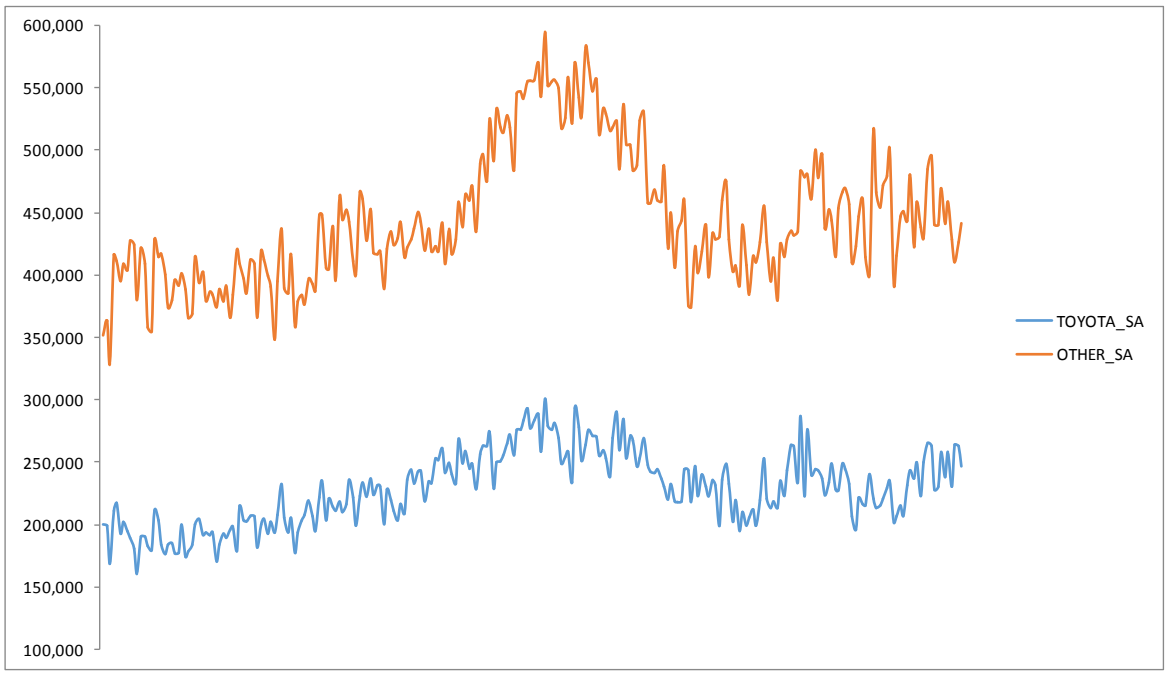
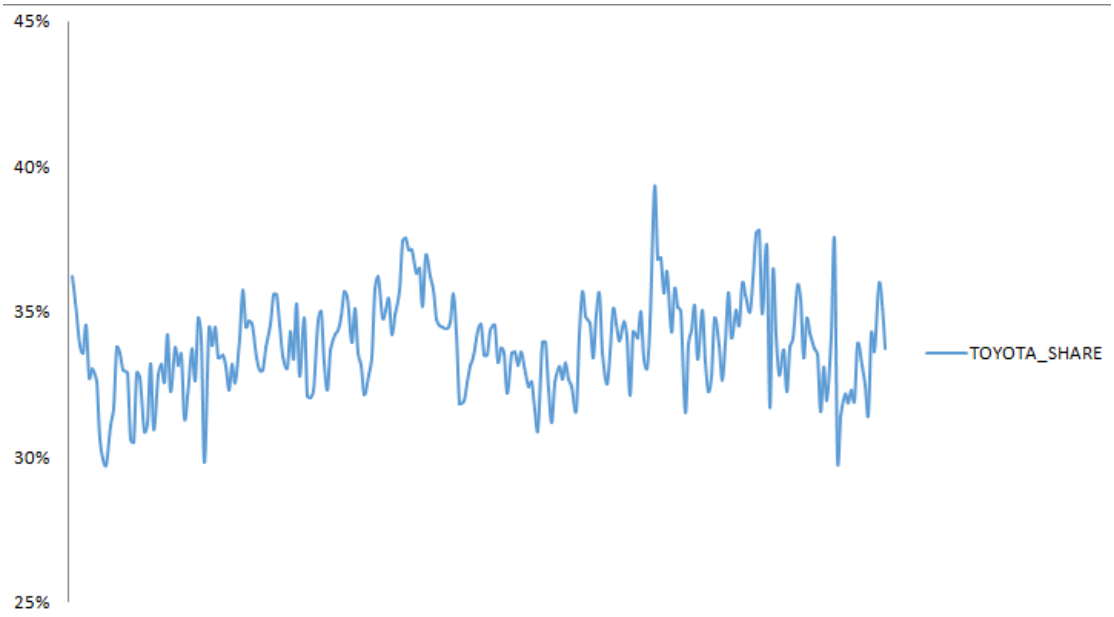
a).

①




Conclusion: there are no significant overall trends for both series.

②




Conclusion: the share series distribute approximately around 34%.

b).

① For the series TOYOTA_SA:

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -2.262284 | 0.1853 |
| Test critical values: | 1% level | -3.457984 | |
| | 5% level | -2.873596 | |
| | 10% level | -2.573270 | |

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(TOYOTA_SA)
Method: Least Squares
Date: 05/11/17 Time: 21:08
Sample (adjusted): 5 240
Included observations: 236 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| TOYOTA_SA(-1) | -0.083219 | 0.036785 | -2.262284 | 0.0246 |
| D(TOYOTA_SA(-1)) | -0.562974 | 0.069879 | -8.056450 | 0.0000 |
| D(TOYOTA_SA(-2)) | -0.324306 | 0.074474 | -4.354644 | 0.0000 |
| D(TOYOTA_SA(-3)) | -0.063922 | 0.064993 | -0.983522 | 0.3264 |
| C | 19281.89 | 8430.410 | 2.287183 | 0.0231 |

Coefficient for $y_{t-1}$: -0.083219;

Standard error: 0.036785;

T-statistic: -2.262284>-2.873596, so $y_t$ is non-stationary.

② For the series OTHER_SA:

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -2.105676 | 0.2427 |
| Test critical values: | 1% level | -3.457984 | |
| | 5% level | -2.873596 | |
| | 10% level | -2.573270 | |

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(OTHER_SA)
Method: Least Squares
Date: 05/11/17 Time: 21:18
Sample (adjusted): 5 240
Included observations: 236 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| OTHER_SA(-1) | -0.069629 | 0.033067 | -2.105676 | 0.0363 |
| D(OTHER_SA(-1)) | -0.511201 | 0.067529 | -7.570088 | 0.0000 |
| D(OTHER_SA(-2)) | -0.361391 | 0.070328 | -5.138674 | 0.0000 |
| D(OTHER_SA(-3)) | -0.102970 | 0.064515 | -1.596055 | 0.1118 |
| C | 31540.36 | 14808.77 | 2.129844 | 0.0342 |

Coefficient for $x_{t-1}$: -0.069629;

Standard error: 0.033067;

T-statistic: -2.105676>-2.873596, so $x_t$ is non-stationary.

c).

$y_t = 26786.43 + 0.45x_t + e_t$

Generate $e_t$ series and report ADF-test for $e_t$:

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -4.305705 | 0.0005 |
| Test critical values: | 1% level | -3.457984 | |
| | 5% level | -2.873596 | |
| | 10% level | -2.573270 | |

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(ET)
Method: Least Squares
Date: 05/11/17 Time: 21:39
Sample (adjusted): 5 240
Included observations: 236 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| ET(-1) | -0.292972 | 0.068043 | -4.305705 | 0.0000 |
| D(ET(-1)) | -0.285835 | 0.078535 | -3.639592 | 0.0003 |
| D(ET(-2)) | -0.141649 | 0.075368 | -1.879447 | 0.0614 |
| D(ET(-3)) | -0.095954 | 0.065689 | -1.460736 | 0.1454 |
| C | 24.99171 | 847.8255 | 0.029477 | 0.9765 |

Coefficient for $e_{t-1}$: -0.292972;

Standard error: 0.068043;

T-statistic: -4.305705<-3.4

So the two series are co-integrated.

d).

$\frac{2}{\sqrt{n}} = \frac{2}{\sqrt{239}} = 0.13$, then an AR(3) model is suggested

Check the significance for an AR(12) model:

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 210.7123 | 310.9685 | 0.677600 | 0.4988 |
| AR(1) | -0.616186 | 0.066677 | -9.241373 | 0.0000 |
| AR(2) | -0.302303 | 0.078864 | -3.833200 | 0.0002 |
| AR(3) | -0.257939 | 0.079313 | -3.252174 | 0.0013 |
| AR(4) | -0.269779 | 0.081194 | -3.322635 | 0.0010 |
| AR(5) | -0.231531 | 0.083573 | -2.770409 | 0.0061 |
| AR(6) | -0.121424 | 0.084462 | -1.437608 | 0.1520 |
| AR(7) | -0.131161 | 0.084369 | -1.554611 | 0.1215 |
| AR(8) | 0.044962 | 0.083311 | 0.539688 | 0.5900 |
| AR(9) | 0.035734 | 0.081863 | 0.436513 | 0.6629 |
| AR(10) | -0.264654 | 0.079810 | -3.316031 | 0.0011 |
| AR(11) | -0.043273 | 0.078774 | -0.549335 | 0.5833 |
| AR(12) | 0.219708 | 0.066243 | 3.316713 | 0.0011 |

Significant only for AR(1) to AR(5), AR(10) and AR(12).

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 225.3147 | 368.1762 | 0.611975 | 0.5412 |
| AR(1) | -0.598336 | 0.061684 | -9.700089 | 0.0000 |
| AR(2) | -0.263441 | 0.075962 | -3.468040 | 0.0006 |
| AR(3) | -0.227296 | 0.074892 | -3.035000 | 0.0027 |
| AR(4) | -0.229657 | 0.071902 | -3.194017 | 0.0016 |
| AR(5) | -0.152029 | 0.060955 | -2.494113 | 0.0134 |
| AR(10) | -0.268302 | 0.052360 | -5.124203 | 0.0000 |
| AR(12) | 0.246490 | 0.054629 | 4.512071 | 0.0000 |

| | | | |
|---|---|---|---|
| R-squared | 0.444685 | Mean dependent var | 145.6979 |
| Adjusted R-squared | 0.426935 | S.D. dependent var | 18261.93 |
| S.E. of regression | 13824.47 | Akaike info criterion | 21.94087 |
| Sum squared resid | 4.19E+10 | Schwarz criterion | 22.06158 |
| Log likelihood | -2482.289 | Hannan-Quinn criter. | 21.98958 |
| F-statistic | 25.05295 | Durbin-Watson stat | 2.071775 |
| Prob(F-statistic) | 0.000000 | | |

Modified model:

$$\Delta y_t = 225.32 - 0.60\Delta y_{t-1} - 0.26\Delta y_{t-2} - 0.23\Delta y_{t-3} - 0.23\Delta y_{t-4} - 0.15\Delta y_{t-5} - 0.27\Delta y_{t-10} + 0.25\Delta y_{t-12} + \varepsilon_t$$

e). ECM:

$$\Delta y_t = 4728.01 - 0.15 \times (y_{t-1} - 0.45x_{t-1}) - 0.52\Delta y_{t-1} - 0.19\Delta y_{t-2} - 0.16\Delta y_{t-3} - 0.18\Delta y_{t-4} - 0.13\Delta y_{t-5} - 0.27\Delta y_{t-10} + 0.25\Delta y_{t-12} + \varepsilon_t$$

T-statistic for the EC term $(y_{t-1} - 0.45x_{t-1}) = -2.16$

As $-2.60(\alpha = 0.01) < -2.16 < -1.97(\alpha = 0.05)$,

the EC term is significant at 5% level, but not at 1% level.

f).

| | AR | ECM |
|---|---|---|
| RMSE | 16992 | 19205 |
| MAE | 14703 | 15556 |

ECM performs even worse than the AR model, so the error correction term does no help for out-of sample forcasting.