**Goal**

1. Predict the stock trend of Thales S.A., Michelin, Renault S.A., Accor S.A., andPernod Ricard S.A over the next 30 days
2. Determine which stocks will appreciate the most over the next 30 days.

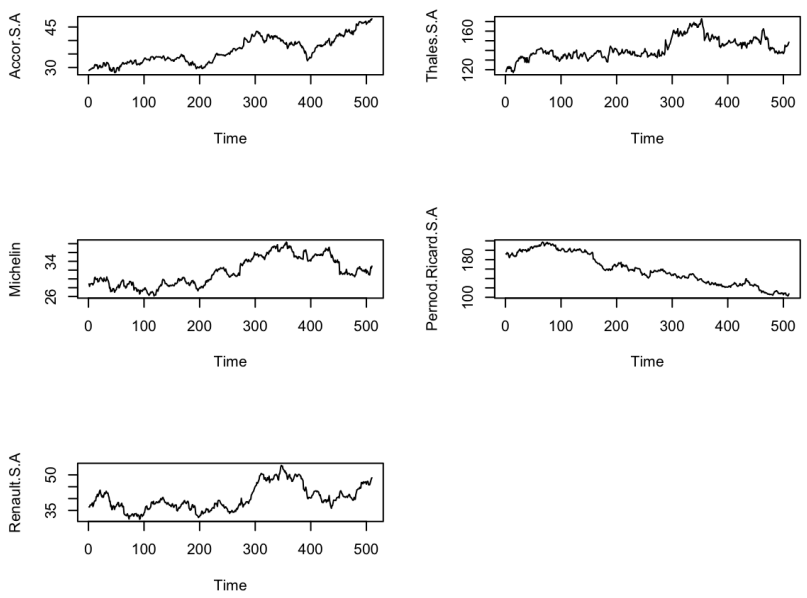
**Method**

Used R to efficiently perform the ARIMA forecasting method to predict the stock prices.
Steps: https://otexts.com/fpp2/arima-r.html

**Analysis results**

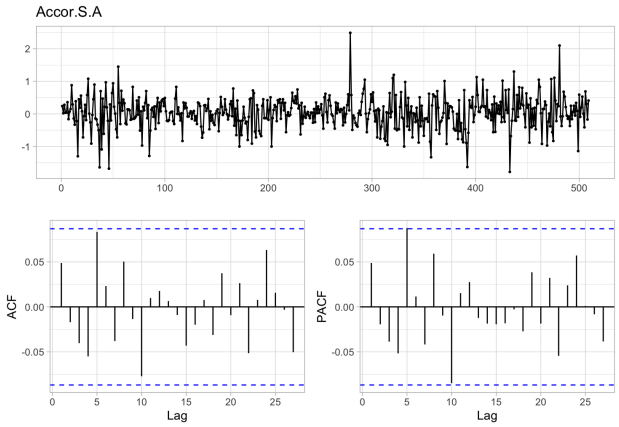
The following graph shows the plotted graph of each stock(See Figure 1). Before starting the analysis, I speculated that Pernod.Ricard.S.A was the least likely to appreciate while Accor.S.A was the most likely by looking at the original time-series data.

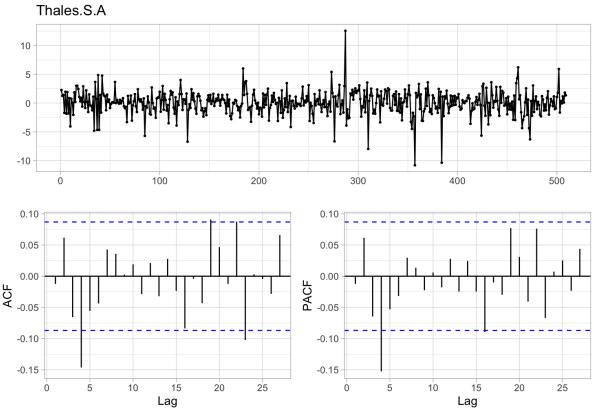
Figure 1. Original time-series data of Thales S.A., Michelin, Renault S.A., Accor S.A., or Pernod Ricard S.A.

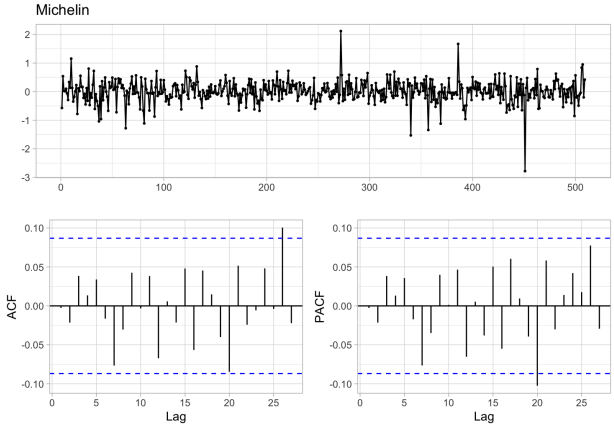


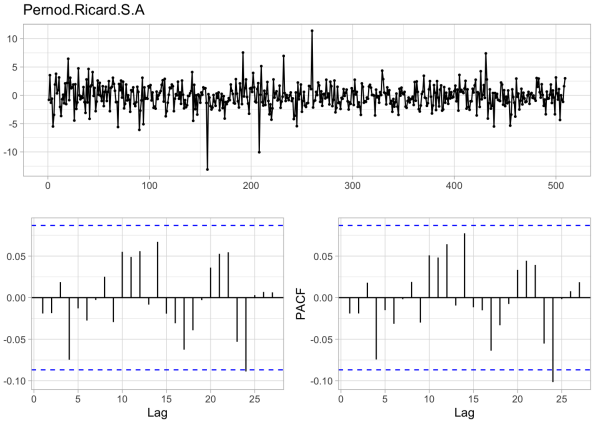

To start, the closing prices of all the five stocks are not stationary, which implies the necessity of differencing to make them stationary for the prediction. Second, there is no evidence of changing variance in each closing price, so the variance stability transformation (like Box-Cox transformation) is not needed.

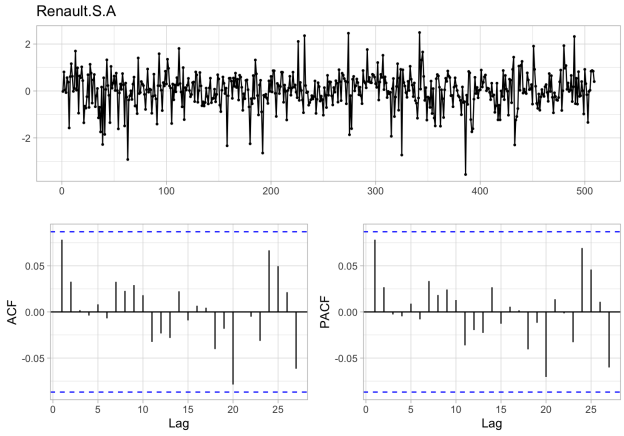
Figure 2. Differenced time-series data and plots of ACF and PACF




After first-differencing them, all the time series data became stationary, but PACF and ACF plots of the differenced closing prices It means that all the time series data except Thales. S. A. may be white noise, which implies that there is no autocorrelation or pattern in those data. To confirm that, the Box-Ljung test(The null hypothesis(Ho) : The first differenced time-series is a white noise vs. The alternative hypothesis(Ha) : Ho is not true) is exploited for each time series data.

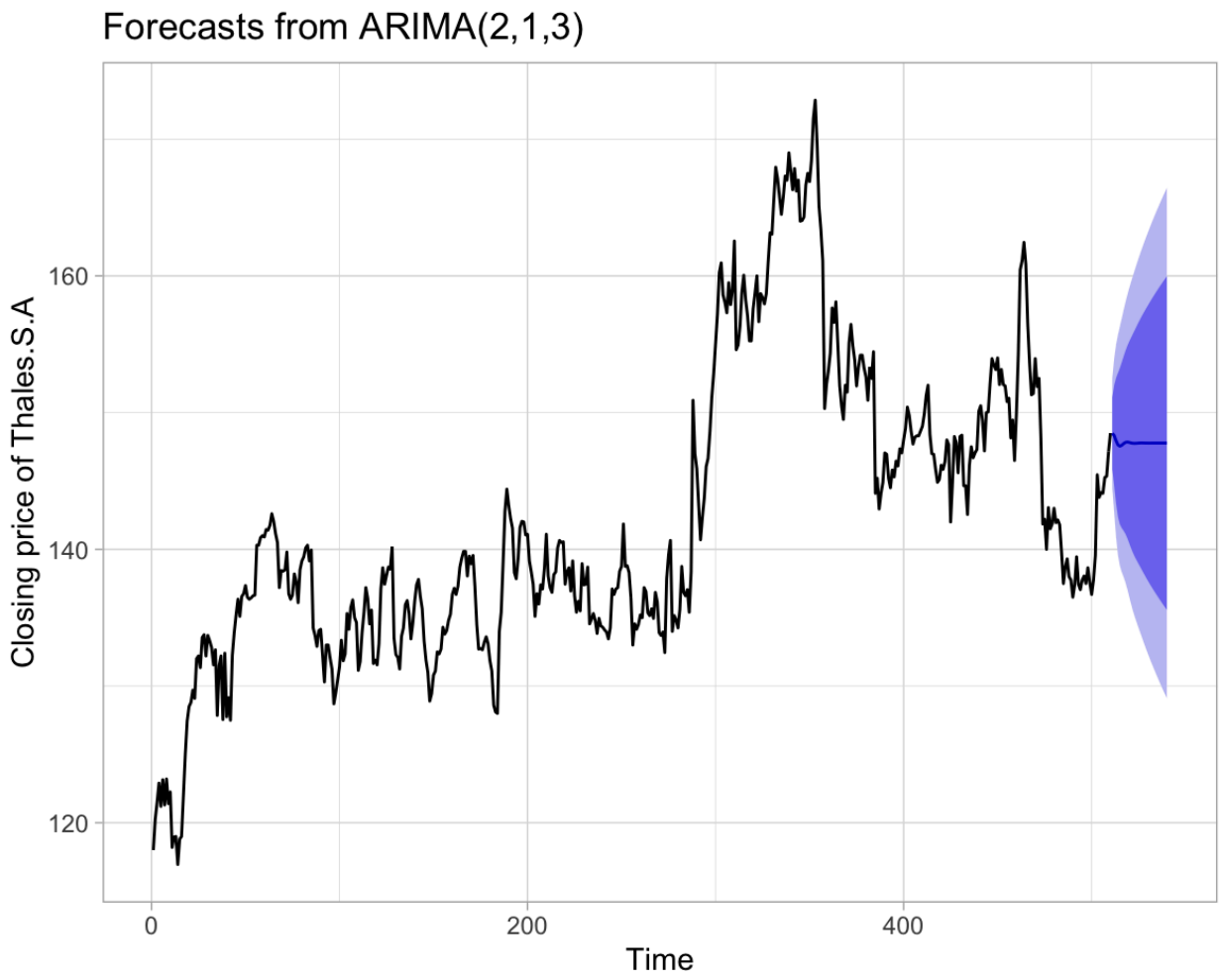
The PACF of Thales. S. A. suggests an AR(4) model. So an initial candidate model is an ARIMA(4,1,0). I fitted ARIMA(4,1,0) along with variations including ARIMA(4,1,1), ARIMA(4,1,2), and etc. Of these, the ARIMA(2,1,3) has the lowest AIC values which is confirmed by the auto.arima function with the option Stepwise=FALSE in R.

Table 1 : Results of the Box-Ljung test

| Time series | X-squared | p-value |
|---|---|---|
| Accor. S.A | 12.898 | 0.2295 |
| Thales.S.A | 19.643 | **0.03281** |
| Michelin | 6.304 | 0.7891 |
| Permod.Richard.S.A | 6.2639 | 0.7926 |
| Renault.S.A | 5.1851 | 0.8785 |

From the results of Table1, it can be safely concluded that all the data except Thales. S. A. are white noises at the significance level 0.05: the p-value of the first differenced time-series data of Thales. S.A. is 0.03281 which is less than 0.05. It is, therefore, natural that only Thales. S. A. will be modelled by the use of traditional ARIMA from now on.

Figure 3. Residuals from ARIMA(2,1,3)




Forecasts from the ARIMA(2,1,3) are displayed in Figure 3. There is no statistical method to accurately predict the closing price after 30 days which is too long a period to forecast: the 80% and 95% confidence intervals get wider and wider, as time goes by. The forecast for the next 30 days are listed in the following table with confidence intervals.

Table2 : Forecasts for the next 30 days of Thales. S. A.

| Point Forecast | Lo 80 | Hi 80 | Lo 95 | Hi 95 |
|---|---|---|---|---|
| **148.4846** | 145.8505 | 151.1186 | 144.4561 | 152.513 |
| **148.3229** | 144.6517 | 151.9941 | 142.7082 | 153.9375 |
| **147.9416** | 143.3529 | 152.5304 | 140.9237 | 154.9596 |
| **147.6403** | 142.3892 | 152.8914 | 139.6095 | 155.6712 |
| **147.5427** | 141.8341 | 153.2513 | 138.8122 | 156.2732 |
| **147.6097** | 141.5516 | 153.6679 | 138.3446 | 156.8749 |
| **147.7326** | 141.3572 | 154.108 | 137.9823 | 157.483 |
| **147.8215** | 141.1216 | 154.5213 | 137.575 | 158.068 |
| **147.8445** | 140.8055 | 154.8835 | 137.0792 | 158.6097 |
| **147.8188** | 140.4382 | 155.1993 | 136.5311 | 159.1064 |
| **147.7796** | 140.0705 | 155.4888 | 135.9895 | 159.5697 |
| **147.7538** | 139.7367 | 155.7708 | 135.4928 | 160.0148 |
| **147.7489** | 139.4435 | 156.0544 | 135.0469 | 160.451 |
| **147.7583** | 139.1785 | 156.3381 | 134.6367 | 160.88 |
| **147.7707** | 138.9251 | 156.6162 | 134.2425 | 161.2988 |
| **147.7781** | 138.6724 | 156.8838 | 133.8521 | 161.704 |
| **147.7788** | 138.418 | 157.1397 | 133.4627 | 162.095 |
| **147.7755** | 138.1653 | 157.3858 | 133.0779 | 162.4731 |
| **147.7717** | 137.9184 | 157.625 | 132.7024 | 162.841 |
| **147.7696** | 137.6798 | 157.8594 | 132.3386 | 163.2006 |
| **147.7696** | 137.4493 | 158.0898 | 131.9861 | 163.5531 |
| **147.7707** | 137.2253 | 158.3162 | 131.6429 | 163.8986 |
| **147.7719** | 137.0059 | 158.5379 | 131.3068 | 164.237 |
| **147.7725** | 136.7902 | 158.7548 | 130.9765 | 164.5684 |
| **147.7724** | 136.5778 | 158.967 | 130.6518 | 164.8931 |
| **147.772** | 136.3691 | 159.175 | 130.3327 | 165.2114 |
| **147.7717** | 136.1641 | 159.3793 | 130.0193 | 165.524 |
| **147.7715** | 135.9629 | 159.5802 | 129.7117 | 165.8313 |
| **147.7716** | 135.7653 | 159.7778 | 129.4095 | 166.1336 |
| **147.7717** | 135.571 | 159.9724 | 129.1124 | 166.431 |

**Conclusion**

It is nearly impossible to predict the stock price patterns of the given data using the ARIMA forecasting method. For a more accurate prediction, use of a more advanced technology like machine learning is necessary.

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