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Course code and name:	F70TS Time Series
Type of assessment:	**Individual**
Coursework Title:	Project
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F70TS Project

Question (a)

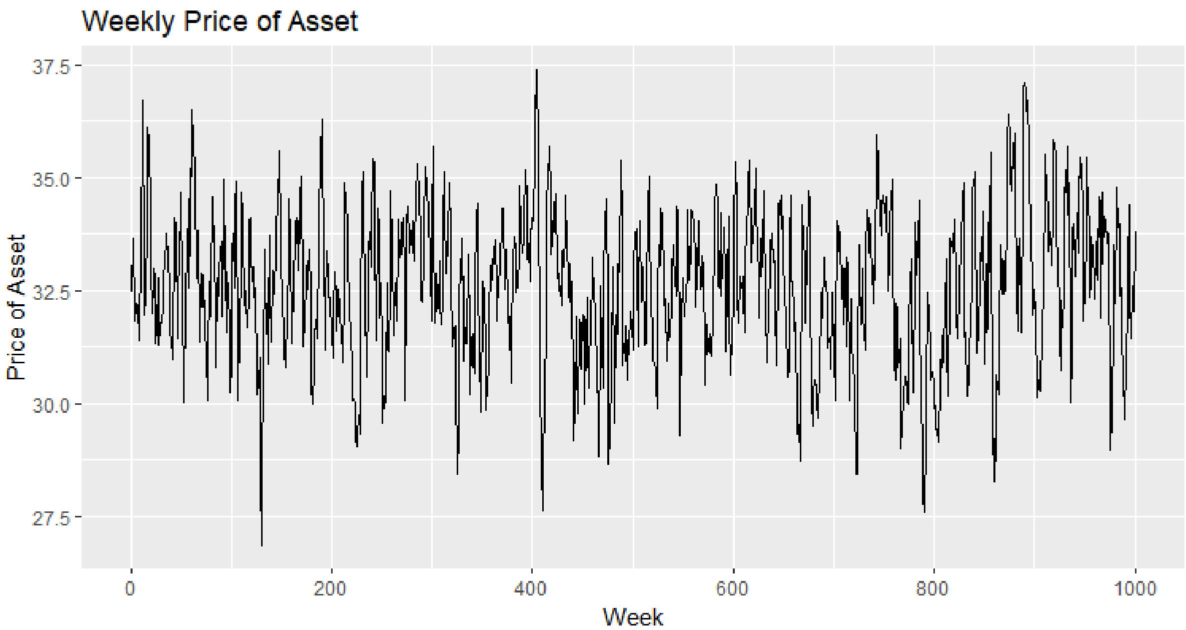

Figure 1. Time-series of weekly price of an asset throughout the last decades (1000 weeks).

The data plot (Figure 1) suggests that the weekly price of the asset is volatile and fluctuates randomly with no obvious trend. The weekly price seems to fluctuate about £32.50.

Question (b)

The mean of the time-series data is £32.593 which supports the observation made from Figure 1.

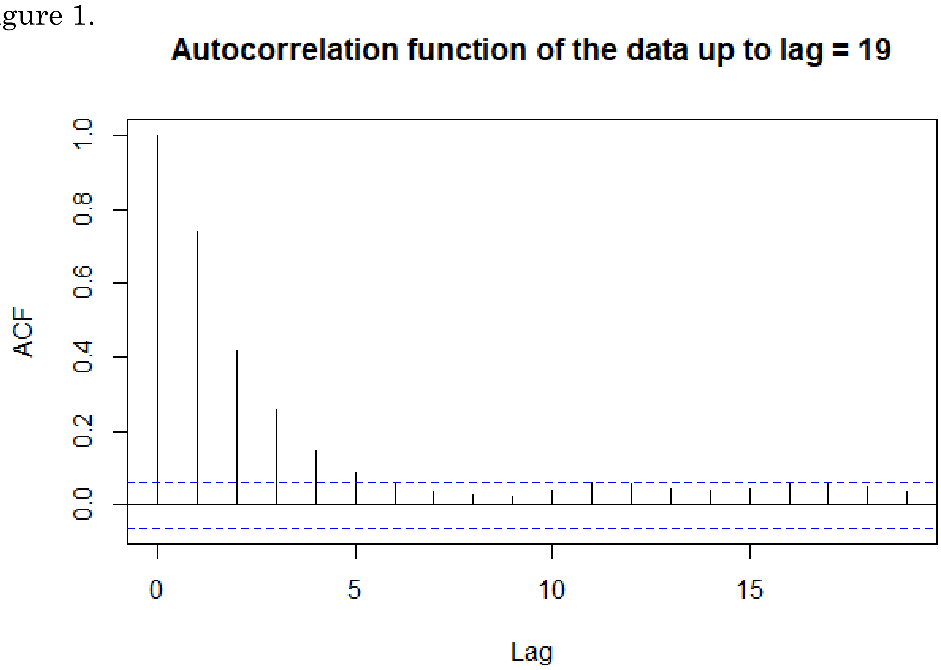

Figure 2. The autocorrelation function (ACF) of the time-series data up to lag = 19.

The autocorrelation function computed and subsequently plotted in R (Figure 2) indicates that the ACF is not significant past a lag of 5. This means that there is little or no correlation between data points beyond 5 time steps apart and indicates that the weekly price of the asset has a short-term dependency structure which suggests that the data can be suitably modelled using moving average (MA) models of order 5 or other similar models with a maximum lag of 5.

Question (c)

Fitting an $\text{ARMA}(p, q)$ model for each of the 16 combinations of (p, q) where $p, q \in \{1, 2, 3, 4\}$ in R and subsequently calculating the Bayesian Information Criterion (BIC) for each combination to obtain the matrix Q_c where the pth row and the qth column represents the $\text{BIC}(p, q)$ value.

$$Q_c = \begin{pmatrix} 0.0910 & 0.0946 & 0.1014 & 0.1081 \\ 0.0946 & 0.1014 & 0.1082 & 0.1146 \\ 0.1014 & 0.1084 & 0.1146 & 0.1128 \\ 0.1080 & 0.1146 & 0.1215 & 0.1284 \end{pmatrix}$$

Question (d)

Similarly, an $\text{ARIMA}(p, 1, q)$ model was fitted for each of the 16 combinations of (p, q) where $p, q \in \{1, 2, 3, 4\}$. The BIC values were then calculated for each combination to obtain the matrix Q_d where the pth row and the qth column represents the $\text{BIC}(p, 1, q)$ value.

$$Q_d = \begin{pmatrix} 0.2770 & 0.0989 & 0.1025 & 0.1093 \\ 0.1401 & 0.1025 & 0.1093 & 0.1162 \\ 0.1197 & 0.1093 & 0.1157 & 0.1228 \\ 0.1145 & 0.1159 & 0.1225 & 0.1294 \end{pmatrix}$$

Question (e)

Comparing the matrices Q_c and Q_d above, the $\text{ARMA}(1,1)$ model has the smallest value of $\text{BIC}(p, q)$ of all 16 combinations of (p, q) even when compared to the $\text{BIC}(p, 1, q)$ values obtained from the $\text{ARIMA}(p, 1, q)$ model. Therefore, we select the $\text{ARMA}(1,1)$ model as it best fits the time-series data and best balances model-fit-to-data and model complexity.

Question (f)

Simulating two realisations of the next 26 time points in the time series using the $\text{ARMA}(p, q)$ model gives us sim1 and sim2 as shown in Figure 3. Under which of the random future results I would invest in the asset depends on the duration of the investment and hence the type of profit desired. If I intend to make a profit in the very short-term, I would invest in the asset under the sim1 realisation as it would result in higher returns if sold before 4 weeks. I would invest in the asset under the sim2 realisation if my objectives were to either obtain the highest possible return at week 9 when the weekly price of the asset is the highest in both realisations or if I desired a short-term profit between week 4 and week 14. In the long-term, past week 14, I would invest in the asset under sim1 realisation as the weekly price of the asset is higher compared to the sim2 realisation and peaks at week 21.

Question (g)

Forecasting the next 52 data points in R and the subsequent visualisation of the prediction mean and 80% as well as 95% prediction intervals can be seen in Figure 4.

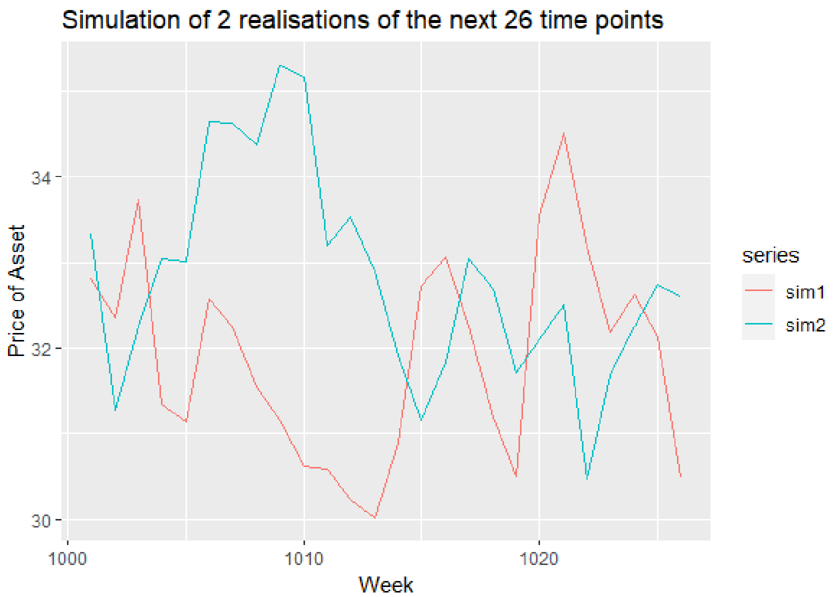

Figure 3. Two simulated realisations following the ARMA(p, q) model.

From Figure 4, we can observe that the prediction mean and the prediction interval remains mostly constant when evaluating at 6 weeks, 6 months (28 weeks) and 1 year. Considering that the current price of the asset is below the prediction mean of £33.81 and is included in both the 80% and 95% prediction interval, it implies that the forecast does not provide evidence that the weekly price of the asset will be much different compared to now. As such, there is significant investment risk associated with purchasing the asset at today's price as the weekly price of the asset in 6 weeks or 6 months or even in a year is highly uncertain and could be the same or lower than the current price which could result in a loss. Therefore, I would not buy the asset at today's price in hopes of selling it in the future for a profit as there is a substantial risk of a loss.

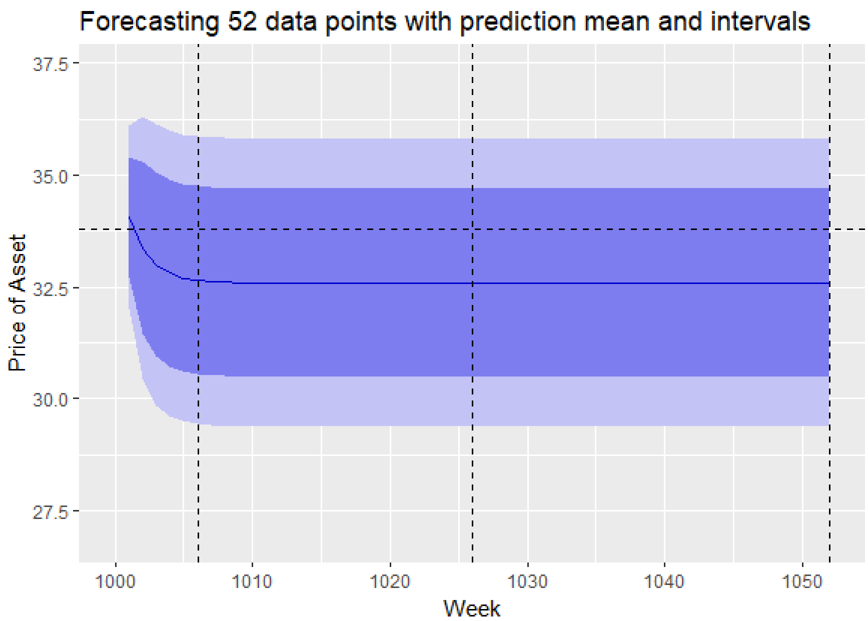

Figure 4. Prediction mean, and 80% and 95% prediction intervals for the next 52 data points forecasted following the ARMA(1,1) model. The three dashed vertical lines represent 6 weeks, 6 months (28 weeks) and 1 year while the dashed horizontal line represents the price of the asset today at £33.81.