5.6: Time Series Analysis & Forecasting

1. Create a time series using the instructions provided in the Exercise.

2. Observe the pattern of the line in your time series and answer the following questions:

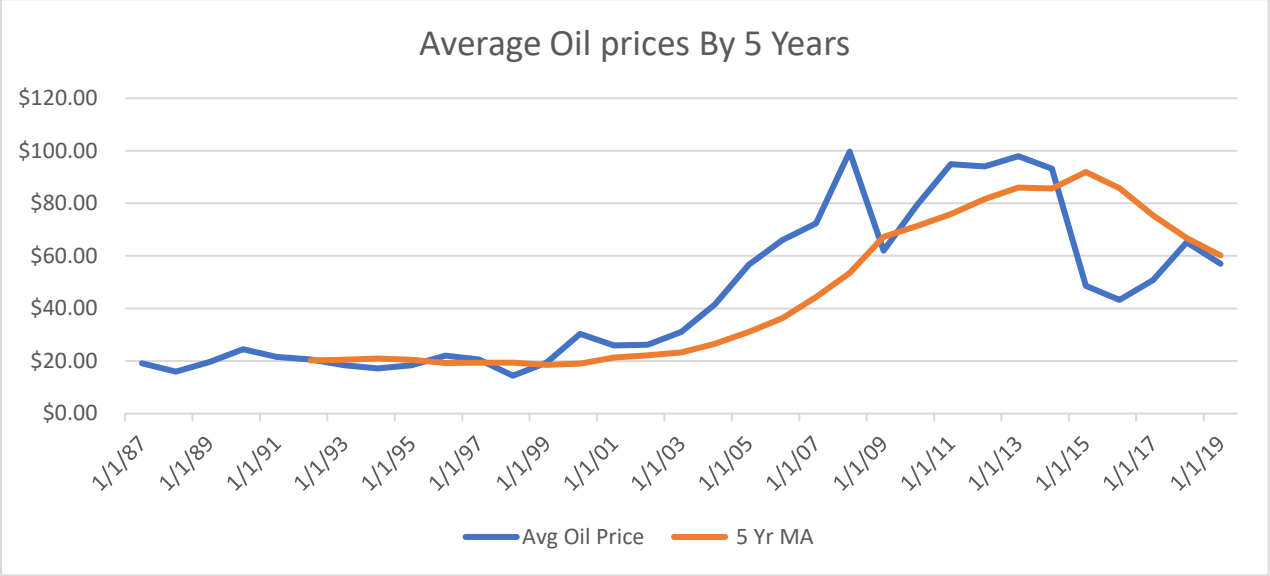
   - What characteristics does the pattern display (e.g., seasonality, stationarity)? Write a short paragraph to explain your answer.

     Seasonality and the non-stationary pattern of income growth over time are both clear. The data peaks in December then drops in January before rising steadily month after month until it peaks once more in December. As monthly revenue varies between high and low levels, indicating a nonstationary time series, the time series graph lacks any discernible pattern. Seasonality is also noticeable, with sales steadily rising over time.

   - What advice might you give your client based on this time series? Why?

     The client needs to keep a careful eye on seasonal patterns and make sure there is enough inventory for the winter, especially in December. They can think about lowering inventory levels from January to September when demand is less strong. To be ready for the increasing demand in November and December, it is essential to have sufficient inventory before October. Inventory levels can be reduced to a predictable degree as consistent sales occur from February to September.

3. Create a simple moving average using the instructions in the Exercise.



4. Observe the pattern/trend of the oil price line in relation to the five-year moving average line and answer the following questions:

   - Is there a certain characteristic to the pattern and trend? Make sure to provide a short explanation for your answer.

     Oil prices were constant from 1987 to 1998, but they then rose from 1999 to 2009, when they underwent a substantial decrease. Following a fall in 2005 and a slight decline in 2016, they then started a steady rise until 2015. It was challenging to forecast future average oil prices due to the market collapses that occurred during the downturns in 2009 and 2015–2016. The collapse or crash of the stock market might have a big effect on oil prices.

   - Explain how the moving average affects oil price volatility and how it makes forecasting easier.

     Given that it takes historical averages and market crashes into account, a moving average is a more stable and trustworthy indication of oil prices. This method reduces volatility and offers a more reliable forecast. A better option for making forecasts about the annual average oil price is the moving average trend line, which rises after 1999 and accounts for the 2008 market crisis.

5. This Exercise mainly looked at non-stationary time series. Briefly explain why you might convert a non-stationary time series into a stationary time series before applying a forecasting model.

   Forecasting non-stationary time series is problematic due to the lack of a clear pattern and the change in mean and variances with time. To achieve effective forecasting, it is crucial to assume stationarity in the data. By recognising and removing trends and seasonality, a model with observations not reliant on time can be developed, making the data easier to model.

Stationary time series are easier to forecast due to their regular nature and reduced variations. Non-stationary time series often incorporate unpredictable behaviours and conditions, making predictions more challenging. Statistical modelling methods presume or require the time series to be stationary for effectiveness. This strategy helps to minimize the impact of trends, seasonality, and other time-dependent structures on the data.

6. There are lots of other forecasting models, such as the Autoregressive Integrated Moving Average (ARIMA) model.
    - Do some research on the ARIMA model and one other model not covered in this Exercise; Facebook Prophet is one example that's become popular in recent years.
    - Imagine you have to explain these models to a colleague who's unfamiliar with them. Write two short paragraphs (1 for each model) without going into the technical details. Include links to the resources you found during research.

      The Autoregressive Integrated Moving Average (ARIMA) model, which combines moving average, autoregression, and differencing components, is a popular forecasting model for time series data. It takes into account previous observations, alters data for stationarity, and accounts for forecasting mistakes.

      Another well-liked forecasting tool is Facebook Prophet, which provides a user-friendly interface, trend estimation, seasonality modelling, and holiday effects. In addition to automatically detecting and modelling seasonality, it can handle missing data, outliers, and changes in growth rates. Based on the qualities of the data, either model can be used and has distinct advantages.

      Source:

1. Brownlee, Jason (2016) '*How to Check if Time Series Data is Stationary with Python*' https://machinelearningmastery.com/time-series-data-stationary-python/
2. Hayes, Adam(2022) '*Autoregressive Integrated Moving Average (ARIMA) Prediction Model*' https://www.investopedia.com/terms/a/autoregressive-integrated-moving-average-arima.asp#:~:text=An%20autoregressive%20integrated%20moving%20average%2C%20or%20ARIMA%2C%20is%20a%20statistical,values%20based%20on%20past%20values