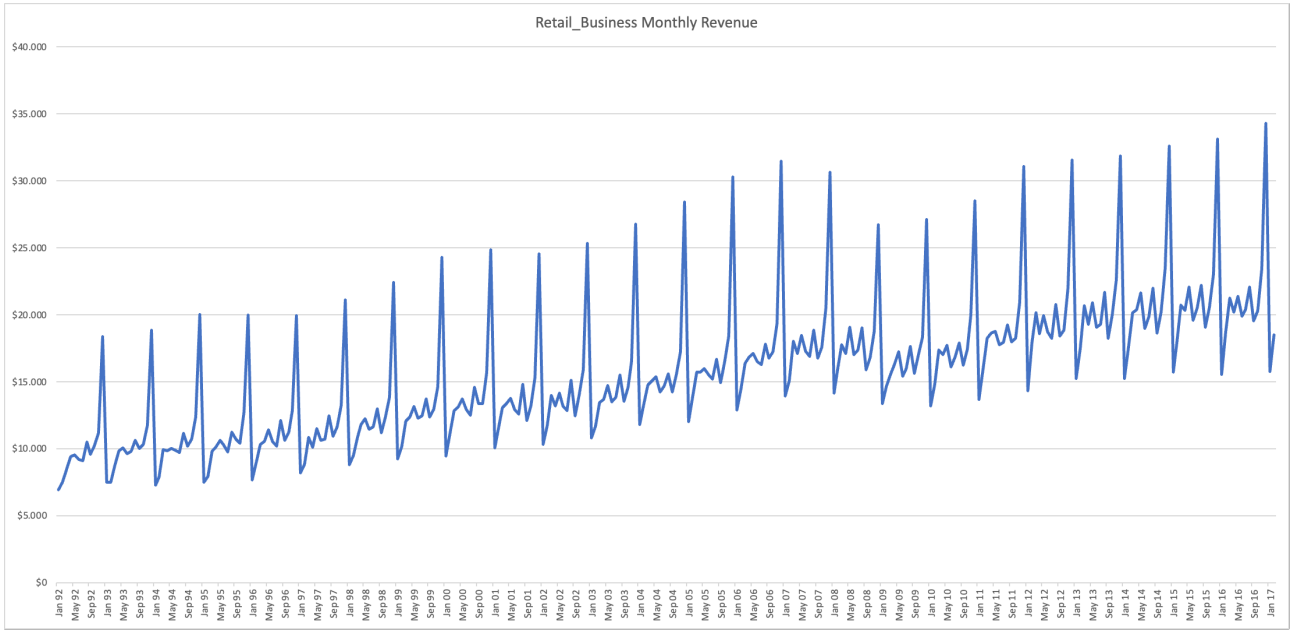
5.6: Time Series Analysis & Forecasting

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.**

This graph represents non-stationarity. We can see the upward trend is there. The mean in this case is not same over the time. However, there is a consistent seasonality shown in this time series, as the pattern repeat itself consistently in the same months every year. For example, each year there is a spike in December that leads to a sharp drop off in January. By using this analysis I would suggest to keep shelves stocked with more inventory in December and reducing stock in the drop off months.

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

The client needs to keep an eye on seasonal patterns and make sure there is enough inventory for the winter, especially in December and and reducing stock in the drop off months which are from January to September, when the demand is less strong. Perhaps they could focus marketing efforts in January to increase sales and reduce the steep decline.

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.**

Answer: The average oil price was stable from 1987-1998 and then began to gradually increase after 1998; however, there was a drop in 2009 and another drop in 2015. This is also a non-stationary time series since there is no obvious pattern and no seasonality is present due to no apparent fluctuations of average oil prices shown throughout the years.

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

  Answer: The moving average provides a more stable illustration of what to expect the average price of oil to be due to the trend line being smoother and less volatile. We can see that the trend line gradually increases upwards after 1999 and it takes into account the 2008 market crash. Therefore, the moving average trend line is the better trend line to look at as it allows us to make better predictions of what the annual average oil price will look like.

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. (If you need help answering this question, check out the Resources above.)**

Answer: . To achieve effective forecasting, it is crucial to assume stationarity in the data. Forecasting non-stationary time series is problematic and not reliable in making predictions due to the lack of a clear pattern and the change in mean and variances with time. This can lead the data to continuously change which is not good for estimating the average over time since it would result in the data being inaccurate. Statistical modelling methods presume or require the time series to be stationary for effectiveness. This strategy helps to minimise 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, which you'll have an opportunity to explore using Python in Achievement 6.**

- **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.**

The Autoregressive Integrated Moving Average (ARIMA) model uses time-series data and statistical analysis to interpret the data and make future predictions. The ARIMA model aims to explain data by using time series data on its past values and uses linear regression to make predictions.
It combines three components: autoregression (AR), differencing (I), and moving average (MA). The AR component captures the relationship between the current observation and its lagged values, the I component handles differencing to make the data stationary, and the MA component models the relationship between the current observation and the residual errors from previous observations. ARIMA is effective for univariate time series data and is widely used in various industries for forecasting.
https://corporatefinanceinstitute.com/resources/data-science/autoregressive-integrated-moving-average-arima/

Facebook Prophet Model:
Facebook Prophet is an open-source forecasting tool for generating time-series models that uses a few old ideas with some new twists.
It is designed to handle time series data with strong seasonal patterns and multiple seasonalities. The model uses an additive regression approach, incorporating components for trend, seasonality, and holidays. It can handle missing data and outliers and provides flexibility in modelling various seasonalities, making it user-friendly for analysts and non-experts alike. Facebook Prophet has gained popularity for its simplicity, ease of use, and ability to produce reliable forecasts with minimal tuning.
https://towardsdatascience.com/time-series-analysis-with-facebook-prophet-how-it-works-and-how-to-use-it-

f15ecf2c0e3a#:~:text=Facebook%20Prophet%20is%20an%20open,above%20drawbacks%20of%20other%20algorithms

In summary, when dealing with time series data with straightforward trend and seasonality, ARIMA can be a good choice. However, for data with multiple seasonal patterns, missing values, or when a user-friendly approach is desired, Facebook Prophet offers an accessible and robust solution for accurate forecasting.

- **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.**

  ARIMA Model:
  The Autoregressive Integrated Moving Average (ARIMA) model is a powerful tool for time series forecasting. It helps us make predictions for data that changes over time, like sales or stock prices. ARIMA captures patterns from the past and combines them to predict future values. It's particularly useful for data with clear trends and seasonal fluctuations. By understanding these patterns, we can make informed decisions and anticipate changes in the future.

  Facebook Prophet Model:
  Facebook Prophet is a user-friendly time series forecasting model that's gained popularity in recent years. It's designed to handle data with multiple seasonal patterns, making it ideal for tasks like predicting customer demand during different times of the year. Prophet automatically detects trends, seasonality, and even holiday effects, which simplifies the forecasting process. Its ease of use and accuracy make it a valuable tool for analysts without extensive expertise in time series modelling, enabling them to generate reliable forecasts and make better-informed decisions.