1. What is the best method of forecasting Costco’s future revenues? This question is important to me because of how many things that my family purchases from the company. It has had a major impact in my life and the company’s unique business model allows Costco to distinguish itself from some of its top competitors.
2. The data that I chose to my forecasting analysis on came from Costco’s 10-Q and 10-K submissions to the SEC. From these documents, I was able to find their quarterly sales starting from Q1 of fiscal year 2002 to Q3 of fiscal year 2024. Later, I also used these documents to find their quarterly membership fees
3. When analyzing the data, it is evident that the data is seasonal with a clear spike in revenue in Q4 of each fiscal year. Overall, the upward trend signals a yearly increase in revenue year after year.
4. The accuracy measure I am using is Mean Absolute Percentage Error (MAPE) because it represents the best accuracy measure to use for my forecast. Additionally, it gives the average absolute percentage error between actual and predicted values so it tells me how far off the forecasted values are from the real values.
5. Forecast Model Insights:
   1. Naïve Forecasting: The naïve forecast that I created predicts the revenues of the next 5 quarters as last quarter’s recorded value. The residual analysis shows most of the lags outside the significance bounds, indicating that the forecast is inaccurate and is not taking into consideration aspects such as seasonality or trend. The MAPE of this model is 18.11429%.
   2. Mean Forecasting: Predicts the revenues of the next 5 quarters using the mean of the dataset. Its residual analysis shows all the lags outside the significance bounds, indicating an inaccurate forecast and not all aspects of the data such as seasonality being taken into consideration. The MAPE of this model is 60.09109%.
   3. Seasonal Naïve Forecasting: Predicts the revenues of the next 5 quarters using naïve forecasting. However, the difference is that this takes into consideration the seasonal aspect of the dataset. This is a much more accurate forecasting method than the regular naïve method and mean forecasting method. Its residual analysis shows most of the lags within the significance bounds, but with some out of the significance bounds, a different forecasting method could make it much more accurate. Its MAPE is 9.116134%.
   4. Holts-Winters Forecasting: I first printed out the plot of the historical data compared with the forecasted values of that data using the Holts-Winters method. As can be seen in the presentation, the plot shows a pretty accurate forecast as it takes into account seasonality and trend. When forecasting the revenue for the next 5 quarters, the Holts-Winters method has been the most accurate thus far. Its residual analysis shows all the lags within the significance bounds, indicating a fairly accurate forecast. Its MAPE is 4.281328%.
   5. Simple Smoothing: This method shoes the forecasted values of the historical data compared to the actual values in the dataset. It is not as accurate as Holts-Winters as it does not include the beta or the gamma (seasonality), a major component in this dataset.
   6. Decomposition: Using this method, I printed out the plots that shows the forecasted values of the historical data in blue compared to the actual values in the dataset. While it does take into consideration some of the seasonality in the data, the forecast for the next 5 quarters is not as accurate as the Holts-Winters method. Its residual analysis shows a couple lags outside the significance bounds, meaning a better method can be used to accurately forecast the revenues in the upcoming quarters. Its MAPE is 8.468954%.
   7. Regression: This method forecasts the sales for Costco using an independent variable in membership fees. By using this method, it is evident that as membership fees increases, so do Costco’s revenues. From its correlation matrix, it can also be seen that sales is highly correlated with membership fees, meaning membership fees highly affect Costco’s sales. Its MAPE is 6.584545%, making Holts-Winters still the most accurate method.
   8. ARIMA: When using this method of forecasting, I cut the data and started it from Q1 of fiscal year 2020. By cutting the data, I was able to use the most relevant values, especially after COVID to predict the revenues for the next 5 quarters. I also plotted the historical values compared to the forecasted values using the best ARIMA model provided. Its residual analysis showed only 1 leg outside the significance bounds meaning the model is mostly accurate but could be better. Its MAPE is 0.9580384%, mainly because the data was cut.
6. Based on the accuracy measures of each forecasting method, ARIMA seems to be the method that provides the best revenue forecast for Costco’s next 5 quarters. This is because it utilizes more recent historical data and accounts for trend and seasonality. Since the MAPE of the ARIMA forecast is 0.9580384% and the MAPE of Holts-Winters method is 4.281328%, ARIMA is the better method. This is because the lower MAPE indicates the more accurate forecast.
7. Improvements:
   1. Cut older data to utilize the more recent data to reduce noise
   2. Utilize the same amount of data for all forecasting methods to ensure accuracy measures are for the same amount of data.