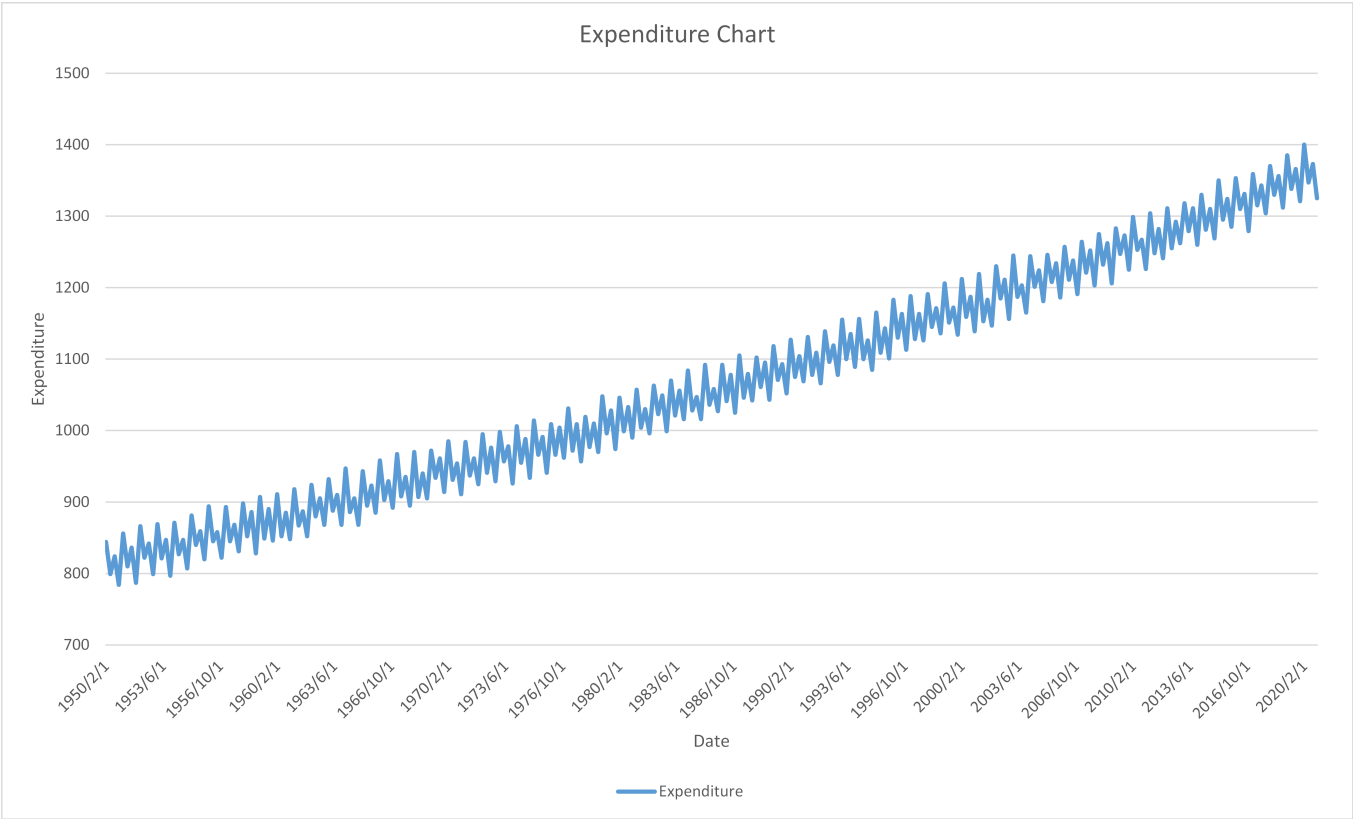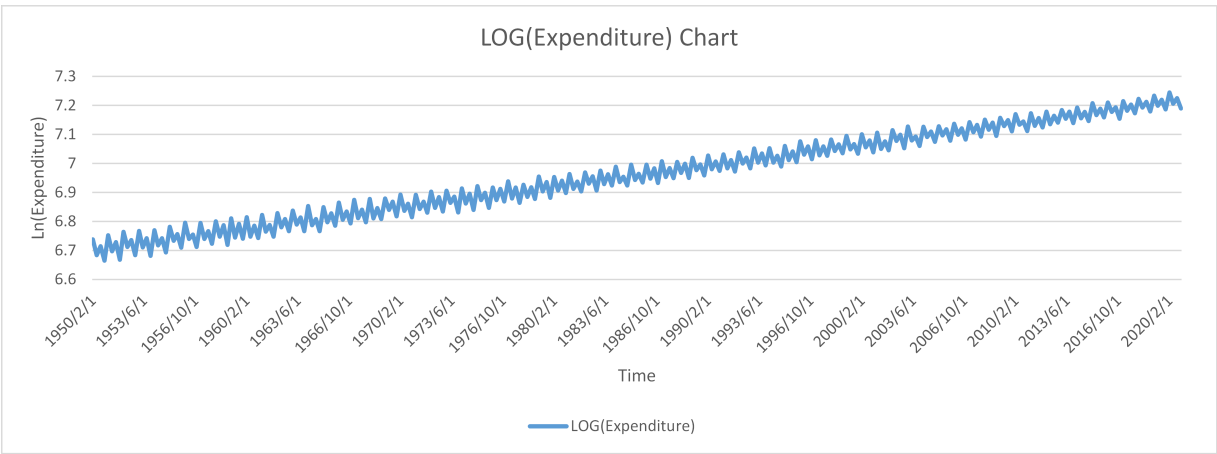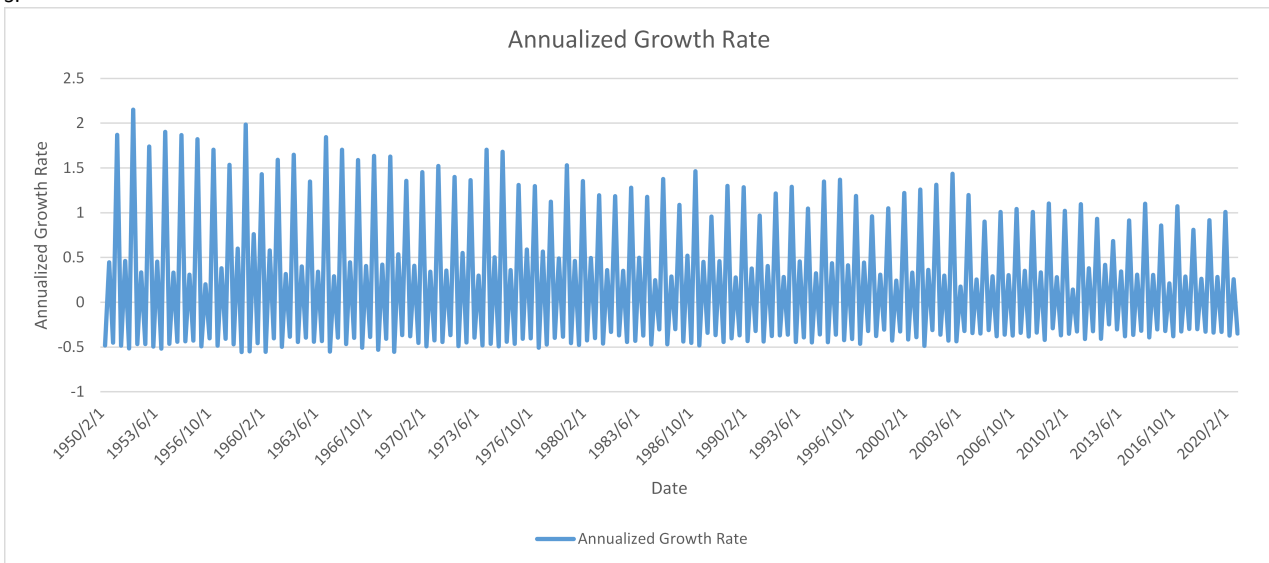Part A: Visualization

1.

From the graph above, the expenditure increases as time increases at a constant rate. It is a positive trend, and the trend is not increasing since the slope of the trend is constant. There are constant short term fluctuation observed on the graph, maybe the fluctuations in short term can be explained by the change in expenditure based on seasons.

2.

From the graph above, the trend of the Ln of expenditure is positive, and since the trend has constant slope, it is not increasing. Similar to the expenditure line chart, the short term fluctuation is constant over the period of a year, and it may be influenced by the change in expenditure based on seasons. Solely from the graph, I cannot tell whether the growth rate is increasing nor is it decreasing over the period since it seems constant in the graph.
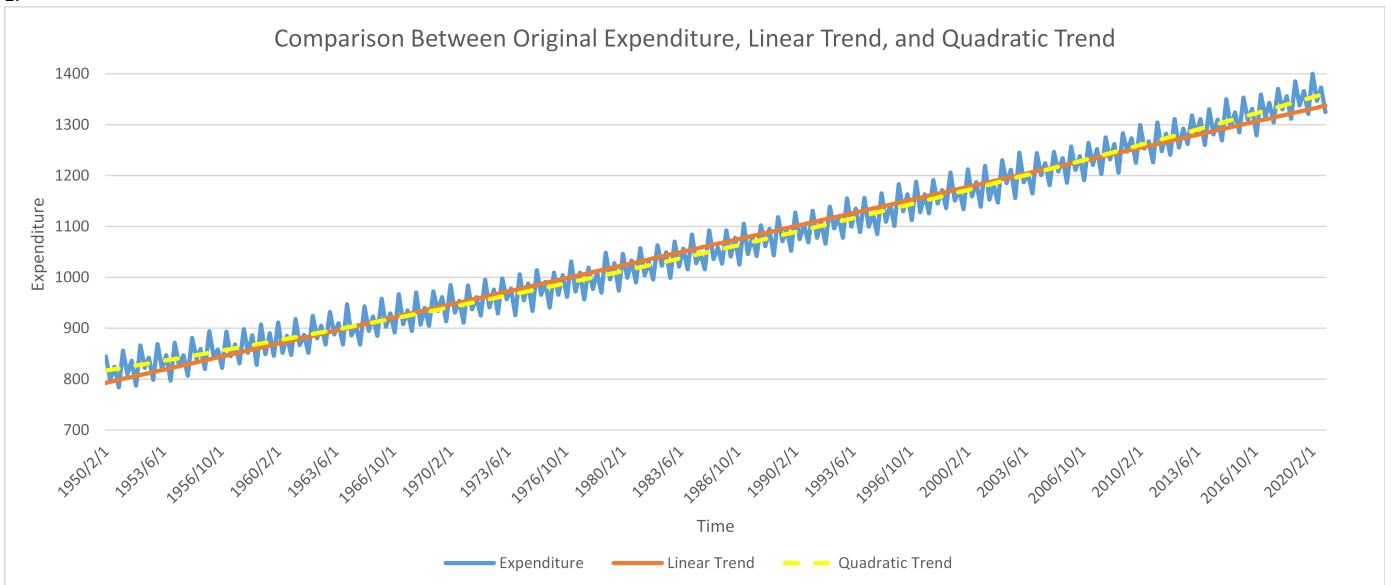
3.

Annualized Growth Rate

From the graph above, we can see the growth rate is decreasing over time since the trend is decreasing.
And it seems like the decreasing rate is decreasing at a constant slope.

Part B: Time Series Decomposition
1.

Comparison Between Original Expenditure, Linear Trend, and Quadratic Trend
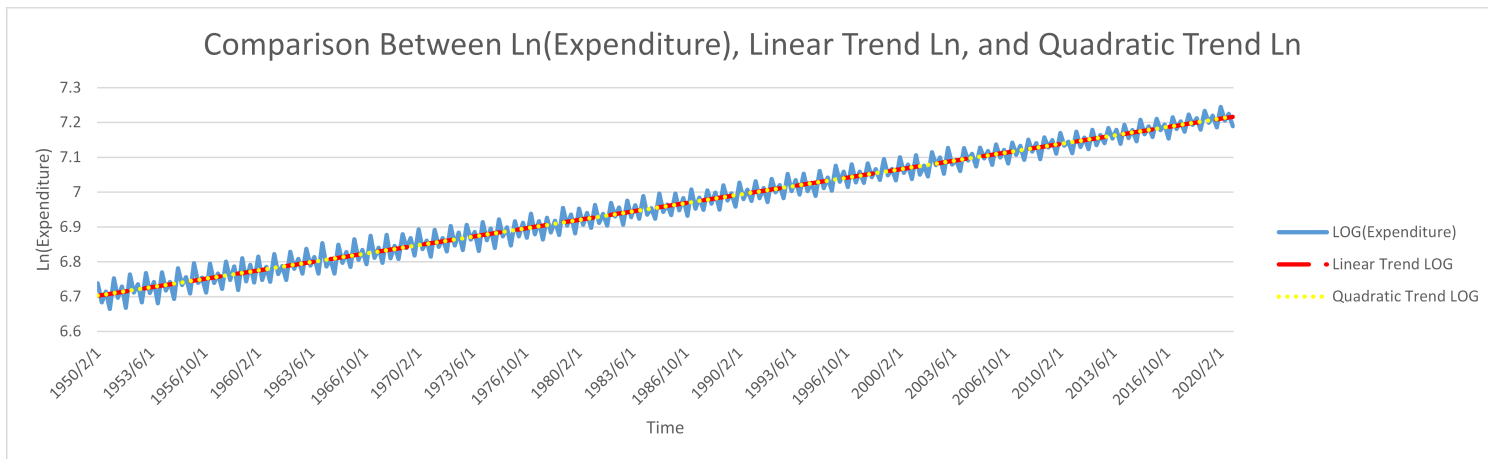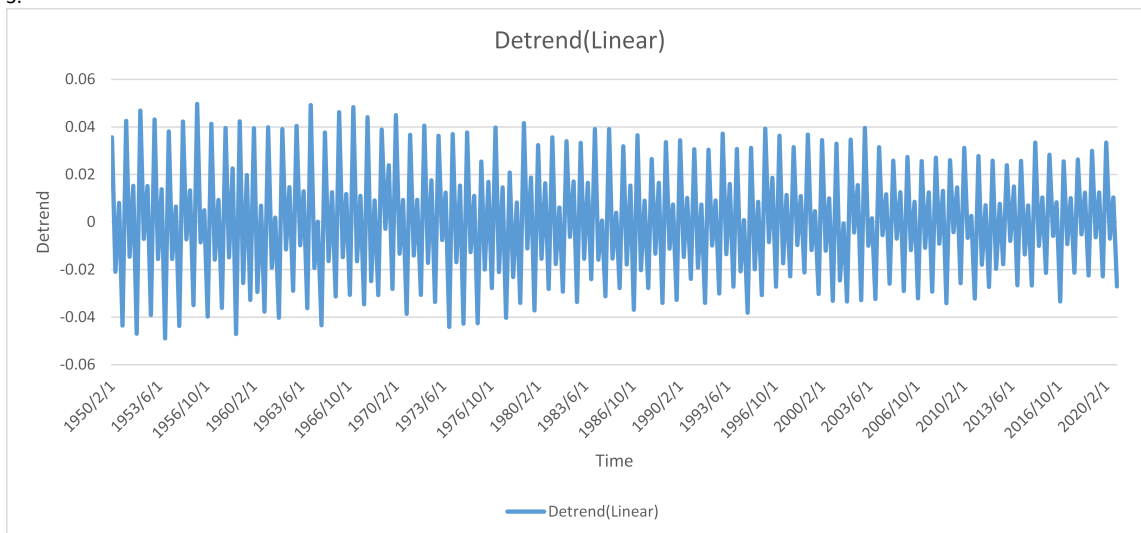
As we can see from the graph above, the quadratic trend is a better fit for the original expenditure's
trend since it lines up the expenditure graph's center better than the linear trend does.
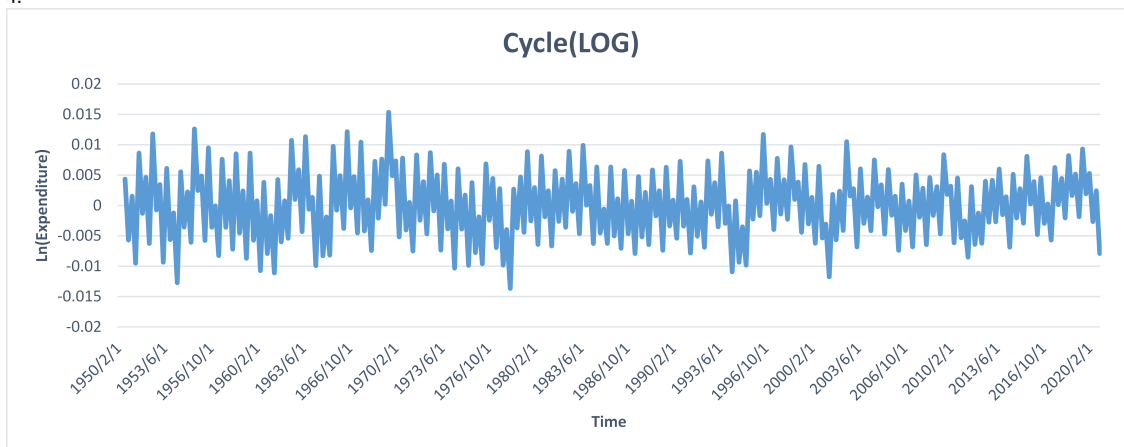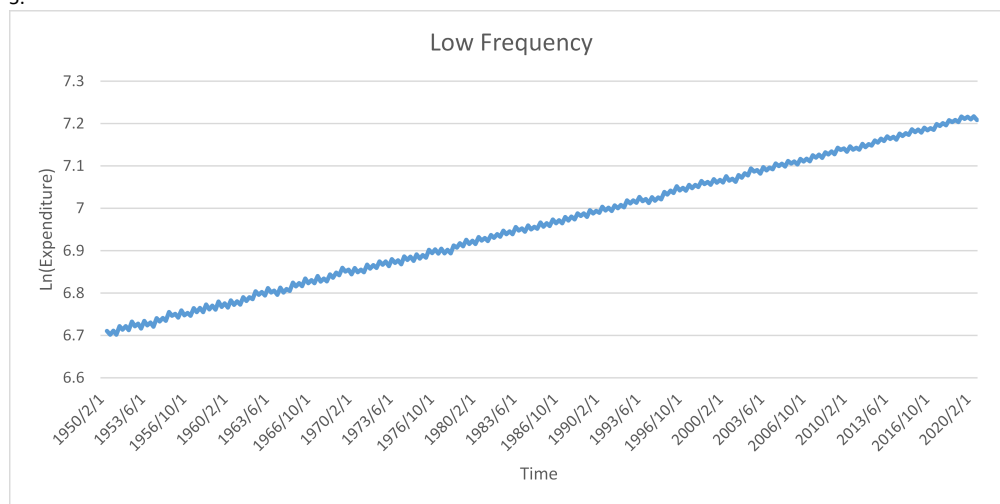
2.

Comparison Between Ln(Expenditure), Linear Trend Ln, and Quadratic Trend Ln

From the graph above, we can see that both linear trend and quadratic trend is very close to the actual trend of Ln(Expenditure), therefore we say that the linear trend is a better approximation for the log of the expenditure. The best trend with log is different than the previous one is because the natural log of the series is used to approximate the percentage of the growth rate, which makes the difference in the growth rate very small, and therefore close to linear trend.

3.

Detrend(Linear)

From the graph above, we can observe that the short term fluctuations better. We can see that the center of the detrended line is at 0, which shows that we chose the right fit for the trend.

4.

Cycle(LOG)

By zooming in the graph above, we can see that the expenditure is high during quarter 1 and 3, and the expenditure is low during quarter 2 and 4.
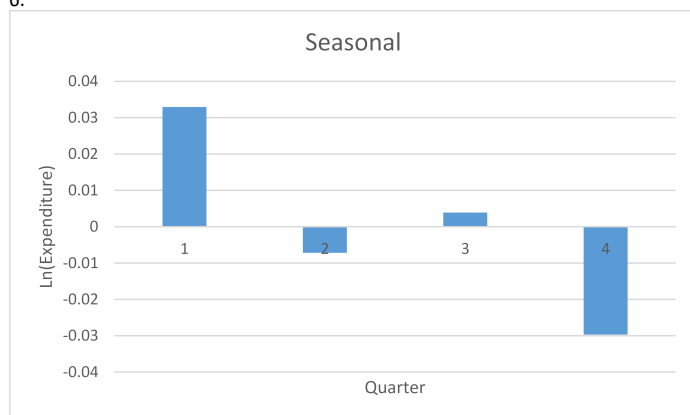
5.

Low Frequency

From the graph above, we can see that the graph looks similar to the natural log of expenditure graph, but this one has lower frequency, which makes the short term fluctuations less visible. We can see clearer that the trend is increasing constantly over time, and the increasing rate is about the same each year.
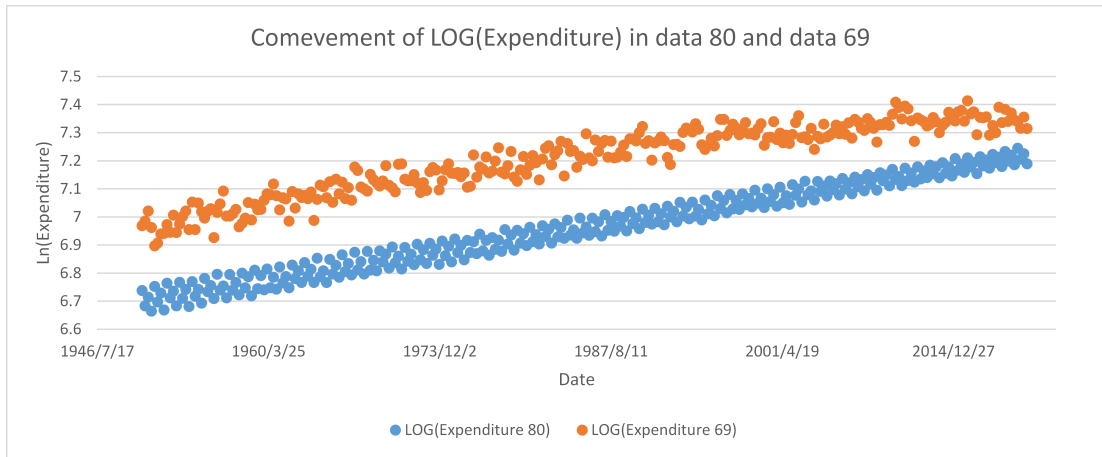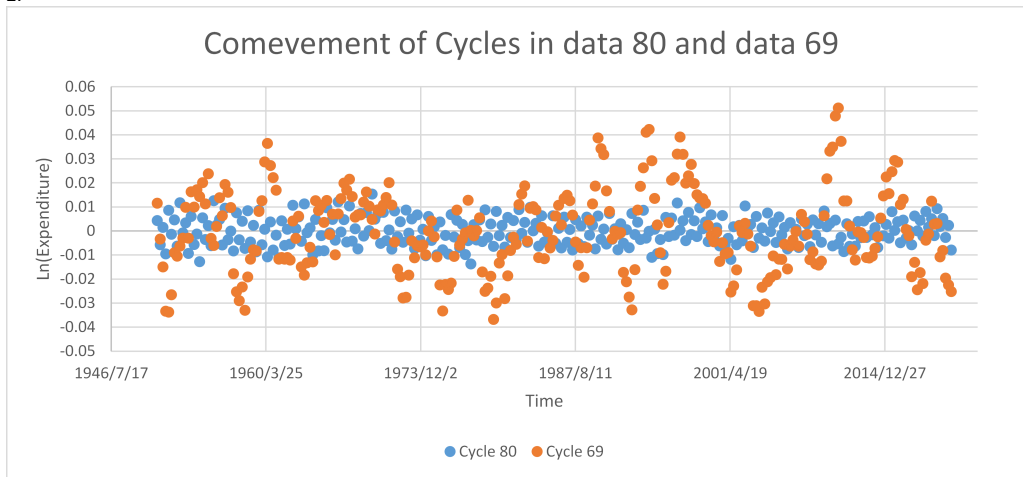
6.

Seasonal

From the bar chart we can say that in the 1st and 4th seasons of the year, expenditure deviates far from the linear and quadratic trends that were fit to the series. In the 1st season, expenditure is higher on average, and in the 4th season expenditure is lower. However, in the 2nd and 3rd seasons expenditure is very near the linear and quadratic trends that were fit to the series.

Part C: Comovement

1.

Comevement of LOG(Expenditure) in data 80 and data 69

2.

Comevement of Cycles in data 80 and data 69

3.
From data 80, the deviations from the predicted trend is constant since in the two graphs above, the dots for data 80 is linear. But for data 69, the deviations varies since the dots are less organized as the dots for data 80.