Time Series Analysis and Models Lab 1 Report

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Tute 1 Dataset

Problem 1

For this problem, we plot a time series of the Sales, Ad Budget and GDP in USD of the business 'Tute1' from March 1981 to June 1981.

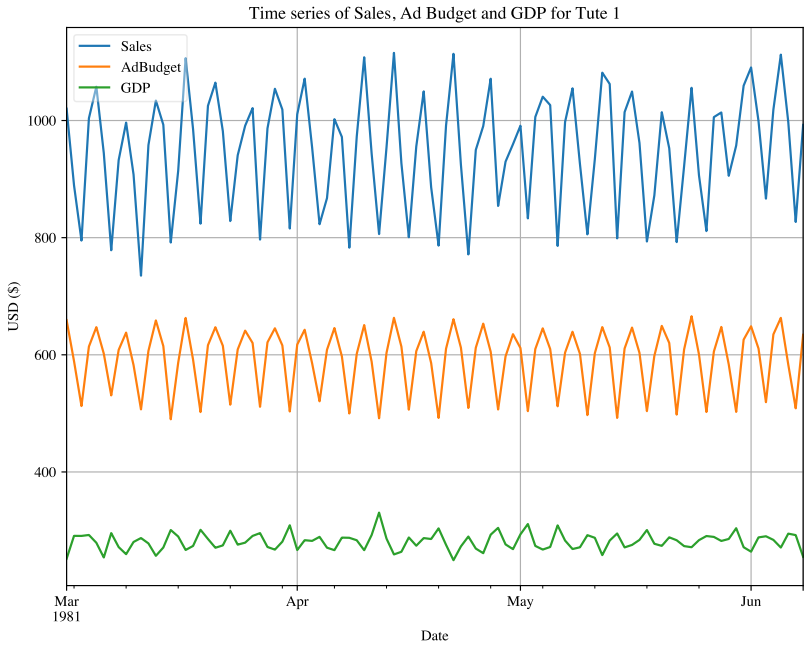

Figure 1: Tute 1 Time series data showing the Sales, the Ad Budget and the GDP from March 1981 to June 1981.

Problem 2

For this problem, we display the descriptive statistics of Sales, AdBudget and GDP as instructed.See the answers below. Note that we have rounded each answer to two decimal figures.

(a) The Sales mean is : 948.74 and the variance is : 9653.49 with standard deviation : 98.25 median: 960.65.

(b) The AdBudget mean is : 591.93 and the variance is : 2953.10 with standard deviation : 54.34 median: 608.50.

(c) The GDP mean is : 281.18 and the variance is : 206.51 with standard deviation : 14.37 median: 282.60.

Problem 3

For this problem, we plot the Rolling mean and variances for the variables Sales, Ad Budget and GDP of 'Tute 1'.

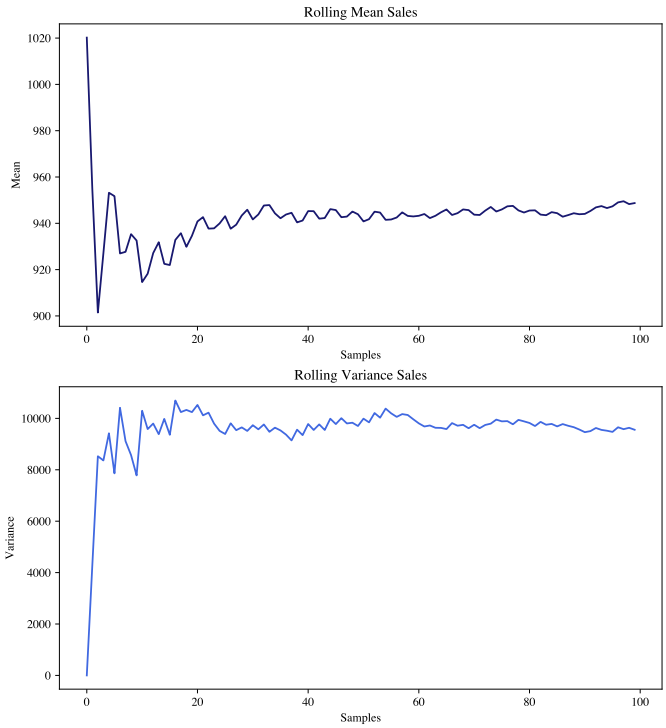

Figure 2: Rolling Mean and Variance of the variable Sales of 'Tute 1' from March 1981 to June 1981.

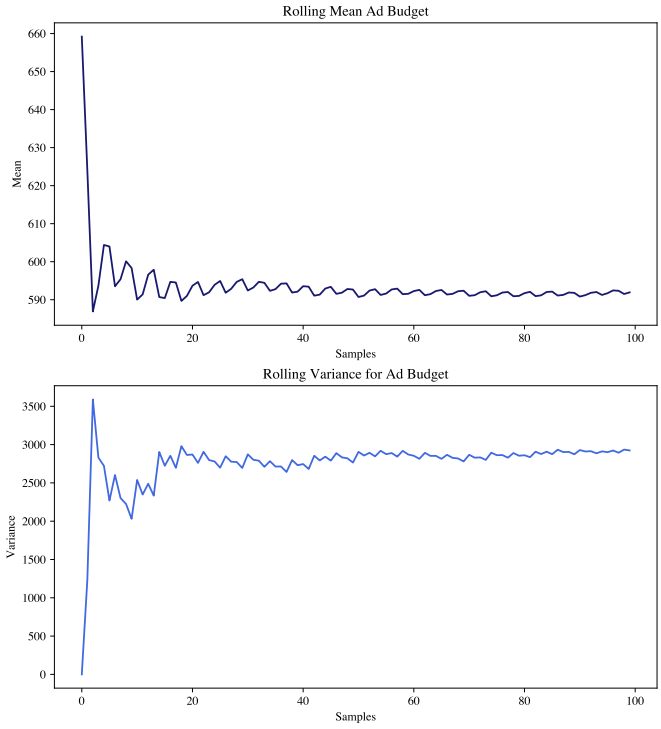

Figure 3: Rolling Mean and Variance of the variable Ad Budget of 'Tute 1' from March 1981 to June 1981.

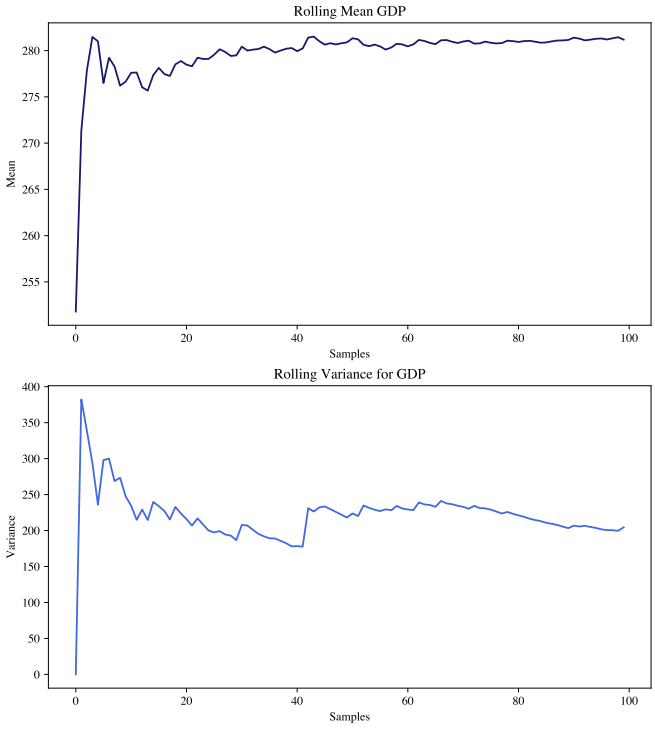

Figure 4: Rolling Mean and Variance of the variable Sales of 'Tute 1' from March 1981 to June 1981.

Problem 4

(a) From Figure 2, we see that the rolling mean and variance of Sales approach a constant value. We therefore conclude that the Sales quantity in this time series is stationary.

(b) From Figure 3, we see that the rolling mean and variance of Ad Budget approach a constant value. We therefore conclude that the Ad Budget in this time series is stationary.

(c) From Figure 4, we see that the rolling mean and variance of the GDP approach a constant value. We therefore conclude that the GDP in this time series is stationary.

Problem 5

For this problem, we will use the ADF test to answer whether Sales, AD Budget and GDP in the 'Tute 1' time series are stationary. The null hypothesis is that the data is non-stationary.

(a) For Sales, we obtain a Test statistics = -3.262755 and Critical value (5%) = -2.894. We reject the null hypothesis and therefore conclude that Sales is stationary. This result is consistent with our observation in Figure 2.

(b) For Ad Budget, we obtain a Test statistics = -2.758605 and Critical value (5%) = -2.894. We do not reject the null hypothesis. However, we could reject the null hypothesis if we lowered the confidence interval to 90% for example.

(c) For GDP, we obtain a Test statistics = -3.227577 and Critical value (5%) = -2.894. We reject the null hypothesis and therefore conclude that Sales is stationary. This result is consistent with our observation in Figure 4.

Problem 6

For this problem, we will use the KPSS test to answer whether Sales, AD Budget and GDP in the 'Tute 1' time series are stationary. The null hypothesis is that the data is stationary. We will use the threshold as 95% as instructed.

(a) For Sales, we obtain a Test statistics = 0.305544 and Critical value (5%) = 0.463000. We do not reject the null hypothesis and therefore conclude that Sales is stationary. This result is consistent with our observation in Figure 2.

(b) For Ad Budget, we obtain a Test statistics = 0.087946 and Critical value (5%) = 0.463000. We do not reject the null hypothesis and therefore conclude that Sales is stationary. This result is consistent with our observation in Figure 3.

(c) For GDP, we obtain a Test statistics = 0.319751 and Critical value (5%) = 0.463000. We do not reject the null hypothesis and therefore conclude that Sales is stationary. This result is consistent with our observation in Figure 4.

Air Passenger Dataset

Problem 1

In this problem, we plot the Air Passenger time series, Figure 5.

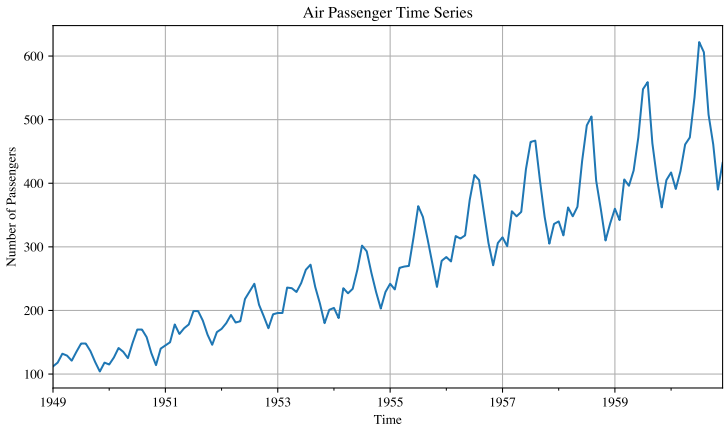

Figure 5: Time series of the Number of Air Passengers in the Provided Dataset

Problem 2

The Number of Passengers mean is : 280.30 and the variance is : 14391.92 with standard deviation : 119.97, median: 265.50.

Problem 3

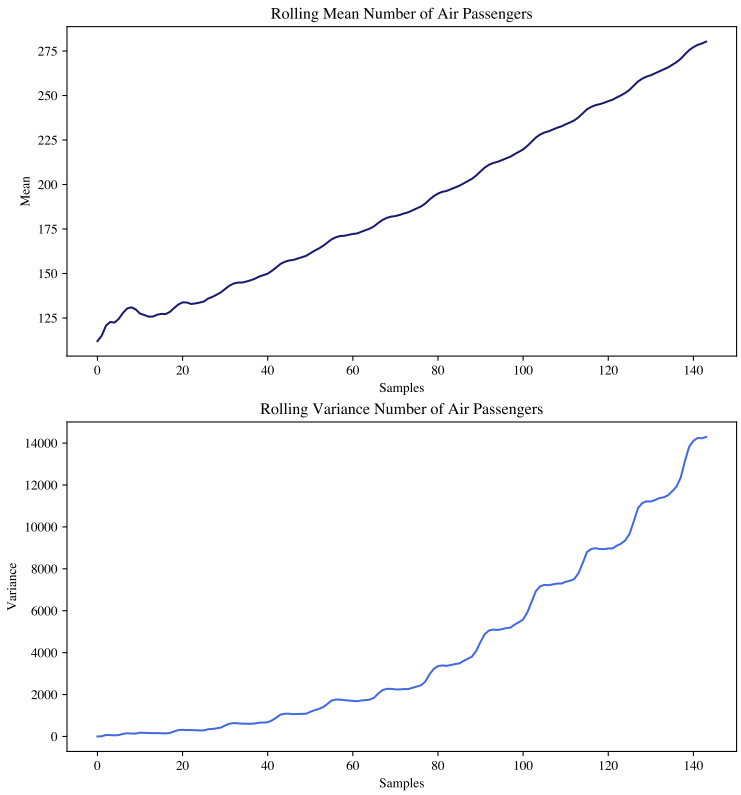

Figure 6: Rolling mean and variance of the variable number of air passengers from the provided dataset.

Problem 4

From Figure 6, we see that both the rolling mean and variance do not approach a constant value. Therefore, this figure suggests that the number of passengers in this time series is not stationary.

Problem 5

We conduct an ADF Test to answer the number of air passengers in this time series is stationary or not. The null hypothesis is that the number of passengers is non-stationary.

- With P-value $0.99 > 0.05$, we fail to reject the null hypothesis. We conclude that the number of passengers in this time series is non-stationary, consistent with Figure 6.

Problem 6

We conduct a KPSS Test to answer the number of air passengers in this time series is stationary or not. The null hypothesis is that the number of passengers is stationary.

- With Test statistics $= 1.651312$ and Critical value $(5\%) = 0.463000$, we reject the null hypothesis and conclude that the number of passengers in this time series is non-stationary, consistent with Figure 6.

Problem 7

First Order Differencing

Figure 7 shows the roll mean and variance after the first seasonal differencing. the figure shows that the both the roll mean and variance do not approach a constant value. Therefore, we conclude that the data is still not stationary after this transformation. Since visually the variable is not stationary, we do not conduct the ADF nor the KPSS test.

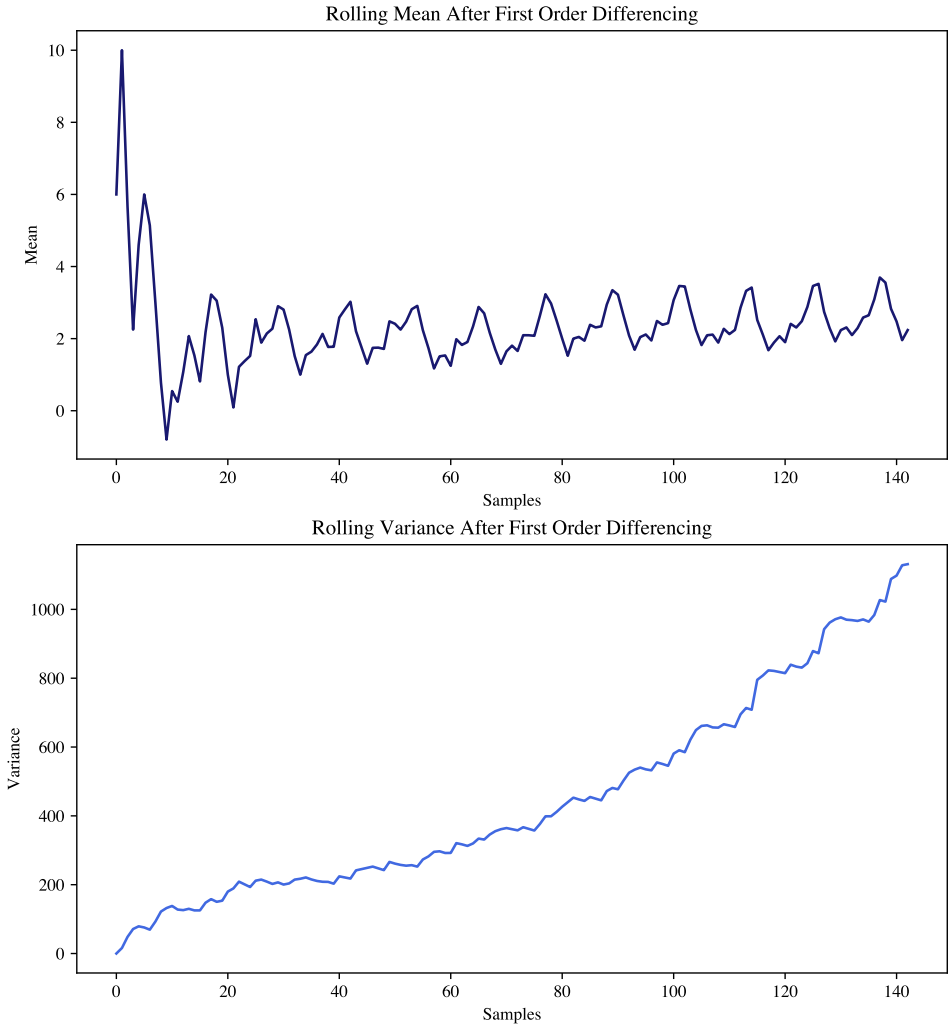

Figure 7: Roll mean and variance after the first seasonal differencing.

Second Order Differencing

Figure 8 shows the roll mean and variance after the second seasonal differencing. the figure shows that the both the roll mean and variance do not approach a constant value. Therefore, we conclude that the data is still not stationary after this transformation. Since visually the variable is not stationary, we do not conduct the ADF nor the KPSS test.

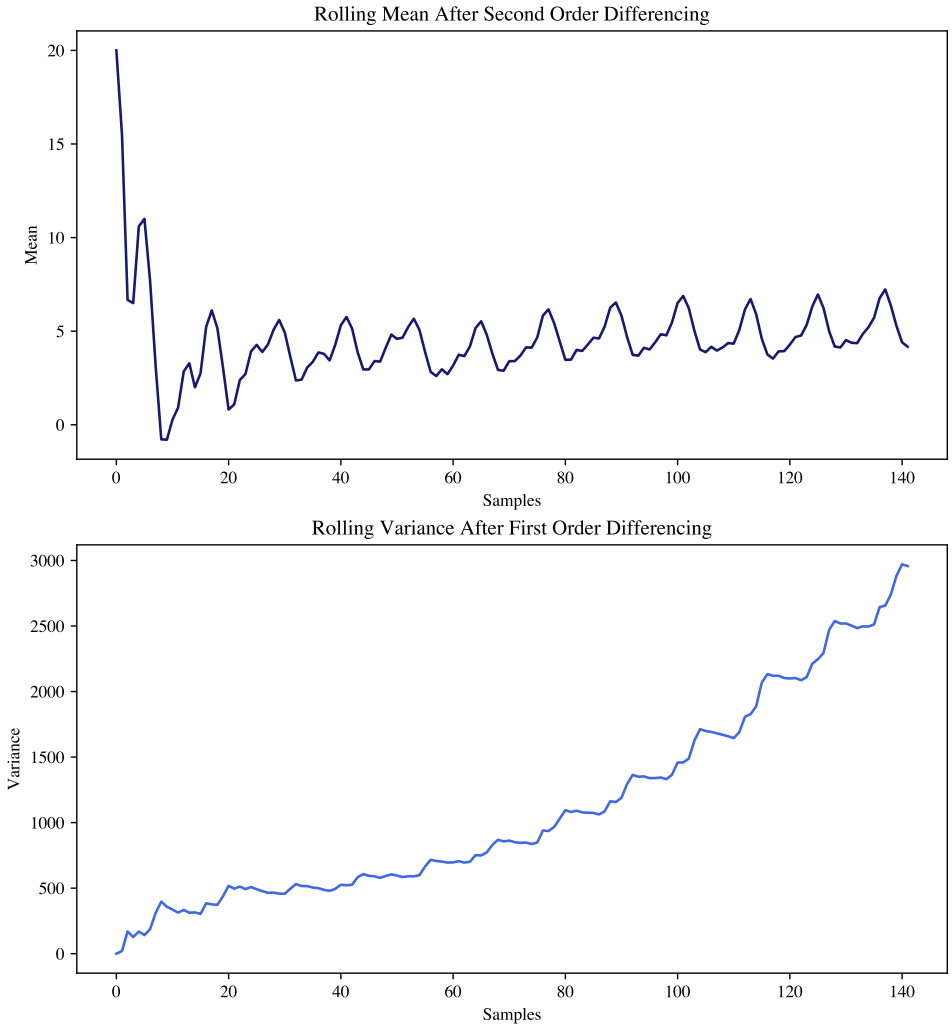

Figure 8: Roll mean and variance after the second seasonal differencing.

Third Order Differencing

Figure 9 shows the roll mean and variance after the third seasonal differencing. the figure shows that the both the roll mean and variance do not approach a constant value. Therefore, we conclude that the data is still not stationary after this transformation. Since visually the variable is not stationary, we do not conduct the ADF nor the KPSS test.

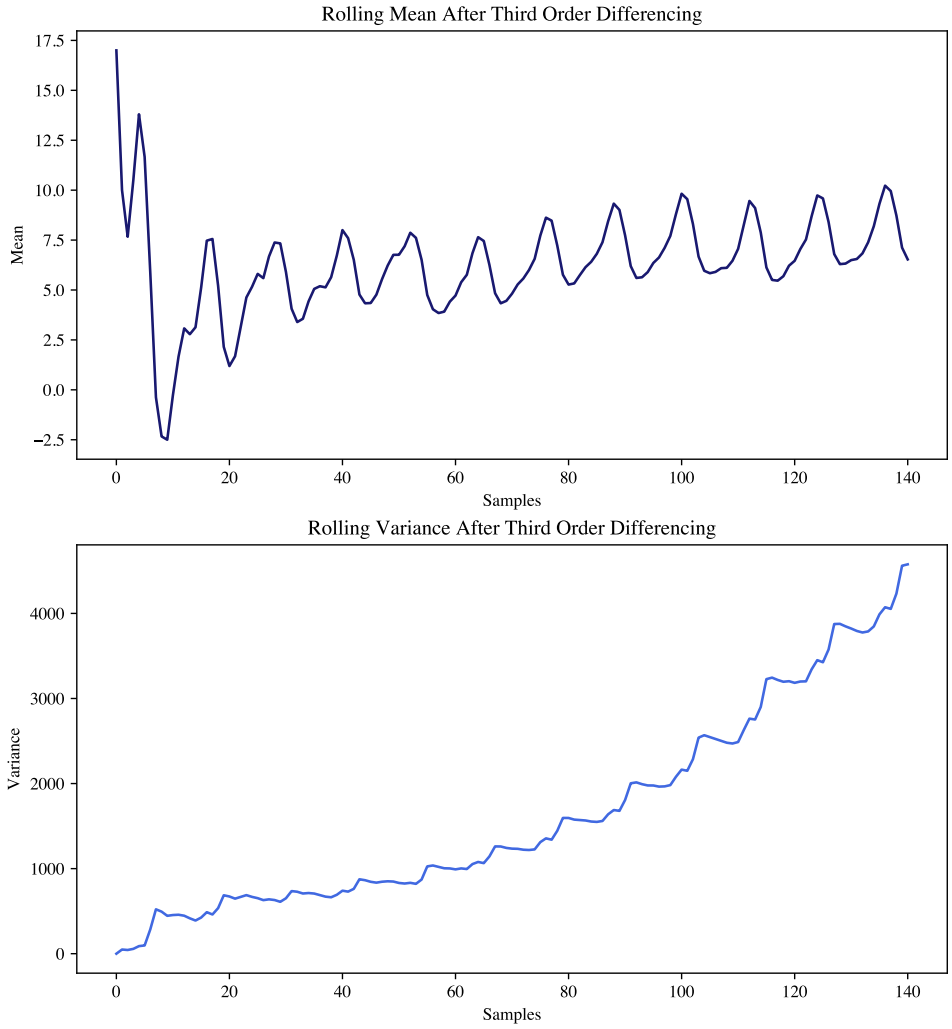

Figure 9: Roll mean and variance after the third seasonal differencing.

Log Transformation followed by First Order Differencing

Figure 10.

The figure shows that the roll mean and variance converge to a constant value, suggesting that the transformed data is stationary. We will now conduct the ADF and KPSS test to verify this.

1. ADF Test:
    - Null Hypothesis: Non-stationary
    - Test statistics $= -2.717131$
    - Critical Value $(5\%) = -2.884$
    - Conclusion: We do not reject the null hypothesis. However, we could accept the null hypothesis if we lowered the confidence interval to 90% for example. That will suggest the data is stationary.

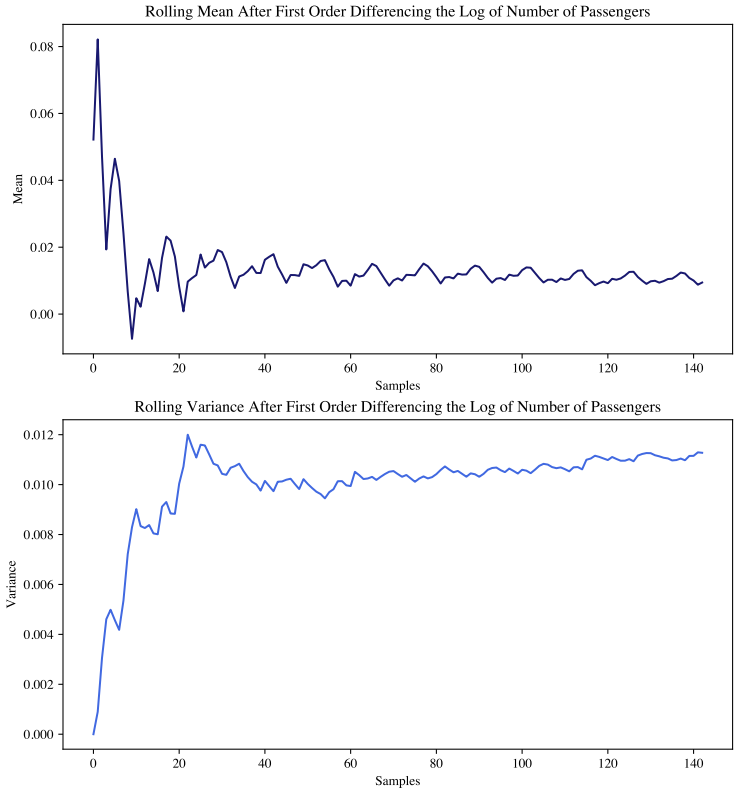

Figure 10: Rolling mean and variance after Log transformation followed by First order differencing.

2. KPSS Test

   - Null Hypothesis: Stationary
   - Test statistics = 0.038304
   - Critical Value (5%) = 0.463000
   - Conclusion: We do not reject the null hypothesis. The transformed variable is stationary, cosistent with figure 10.

References