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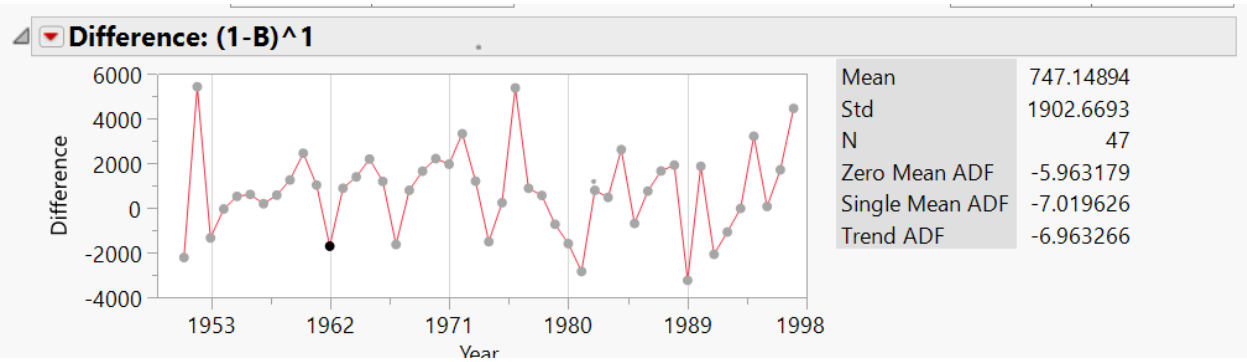
2.2 Consider the data on US production of blue and gorgonzola cheeses in **Table B.4**.

- **b.** Take the first difference of the time series, then find the sample autocorrelation function and the variogram. What conclusions can you draw about the structure and behavior of the time series?



Lag	AutoCorr	-.8 -.6 -.4 -.2 0 .2 .4 .6 .8	Ljung-Box Q	p-Value	Lag	Variogram
0	1.0000		.	.	1	1.0000
1	-0.0683		0.2335	0.6290	2	0.9880
2	-0.0555		0.3910	0.8224	3	1.0071
3	-0.0759		0.6926	0.8749	4	0.9022
4	0.0362		0.7627	0.9434	5	1.1325
5	-0.2098		3.1771	0.6727	6	0.8490
6	0.0930		3.6628	0.7222	7	0.9243
7	0.0126		3.6719	0.8167	8	0.9436
8	-0.0080		3.6757	0.8851	9	1.1069
9	-0.1825		5.6938	0.7701	10	0.9680
10	-0.0341		5.7663	0.8345	11	0.8058
11	0.1392		7.0061	0.7986	12	0.7773
12	0.1697		8.9004	0.7114	13	0.9765
13	-0.0431		9.0264	0.7709	14	0.9697
14	-0.0359		9.1165	0.8235	15	1.1011
15	-0.1762		11.3521	0.7273	16	1.0344
16	-0.1050		12.1714	0.7321	17	1.0084
17	-0.0773		12.6297	0.7606	18	0.8411
18	0.1015		13.4480	0.7643	19	1.0109
19	-0.0799		13.9731	0.7853	20	0.9953
20	-0.0633		14.3149	0.8142	21	0.9302
21	0.0063		14.3184	0.8555	22	1.0057
22	-0.0744		14.8279	0.8695	23	0.9989
23	-0.0671		15.2600	0.8851	24	0.7338
24	0.2161		19.9353	0.7004	25	0.9359
25	0.0002		19.9353	0.7502		

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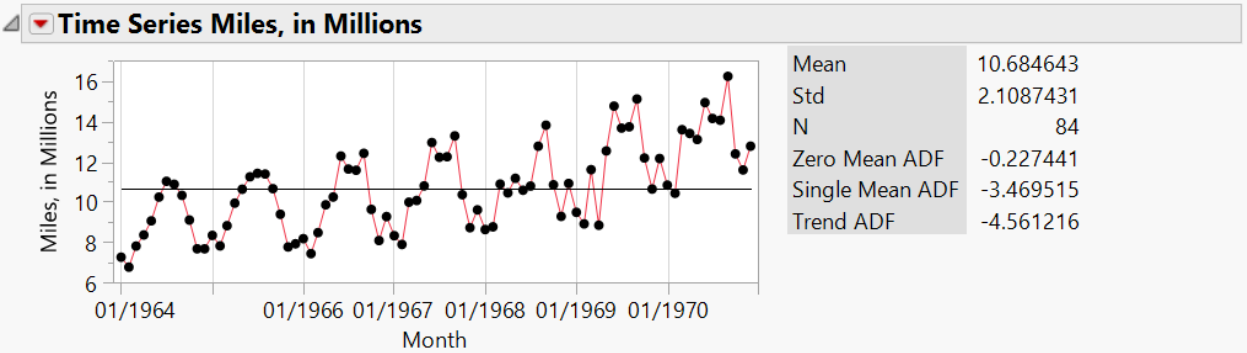
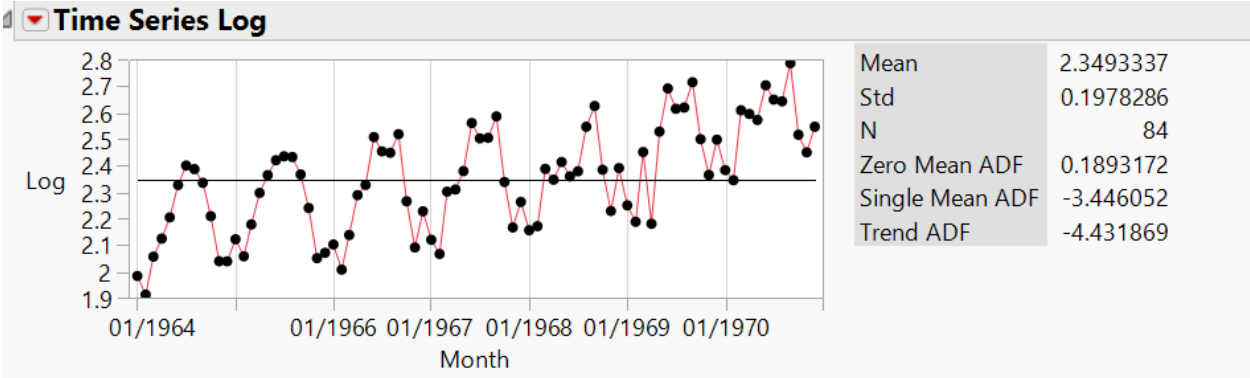
The plot of the time series seems to hover around a fixed value. The autocorrelation function drops to zero very quickly and then oscillates about zero for the rest of the function. The variogram increases to 1 quickly and then stays around that value, not having values too far above or below 1. This suggests that the first difference creates a stationary time series.

2.11 Reconsider the data on the number of airline miles flown in the United Kingdom from **Exercise 2.10**. Take the natural logarithm of the data and plot this new time series.

- **a.** What impact has the log transformation had on the time series?





Taking the natural log of the Plane Data, we can see the Mean and Standard Deviation have dropped considerably. The mean is now around 2.34, where it was at 10.68 previously. It doesn't appear to have changed the pattern or steady increase that the data gave us originally.

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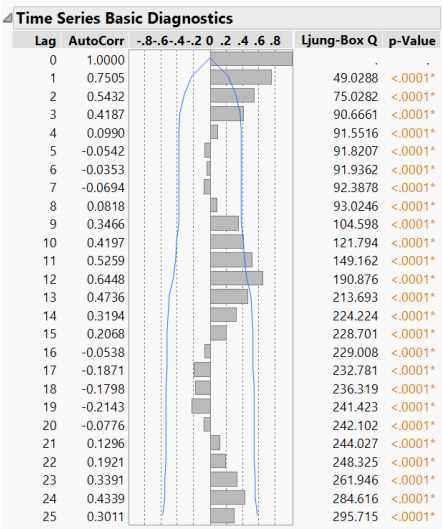
- **b.** Find the autocorrelation function for this time series.



Time Series Basic Diagnostics

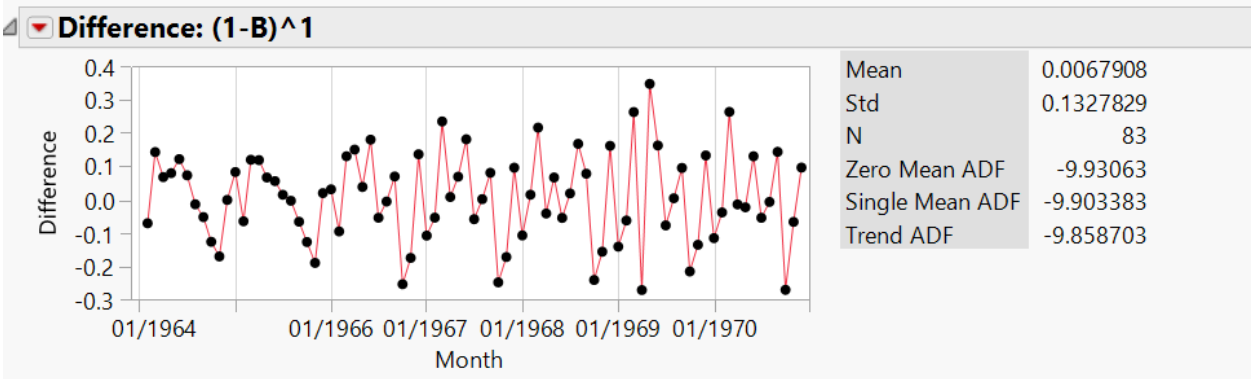
Lag	AutoCorr	-.8 -.6 -.4 -.2 0 .2 .4 .6 .8	Ljung-Box Q	p-Value
0	1.0000		.	.
1	0.7505		49.0288	<.0001*
2	0.5432		75.0282	<.0001*
3	0.4187		90.6661	<.0001*
4	0.0990		91.5516	<.0001*
5	-0.0542		91.8207	<.0001*
6	-0.0353		91.9362	<.0001*
7	-0.0694		92.3878	<.0001*
8	0.0818		93.0246	<.0001*
9	0.3466		104.598	<.0001*
10	0.4197		121.794	<.0001*
11	0.5259		149.162	<.0001*
12	0.6448		190.876	<.0001*
13	0.4736		213.693	<.0001*
14	0.3194		224.224	<.0001*
15	0.2068		228.701	<.0001*
16	-0.0538		229.008	<.0001*
17	-0.1871		232.781	<.0001*
18	-0.1798		236.319	<.0001*
19	-0.2143		241.423	<.0001*
20	-0.0776		242.102	<.0001*
21	0.1296		244.027	<.0001*
22	0.1921		248.325	<.0001*
23	0.3391		261.946	<.0001*
24	0.4339		284.616	<.0001*
25	0.3011		295.715	<.0001*

- **c.** Interpret the sample autocorrelation function.

The sample autocorrelation function shows the data drops to zero very quick but doesn't stay near zero. It oscillates and goes out of the bounds at a few instances. The p values are also very small, which suggests we reject the null hypothesis that the autocorrelation is zero. This suggests that there is autocorrelation in the data, so the time series is not stationary.

2.12 Reconsider the data on the number of airline miles flown in the United Kingdom from **Exercises 2.10** and **2.11**. Take the first difference of the natural logarithm of the data and plot this new time series.

- **a.** What impact has the log transformation had on the time series?



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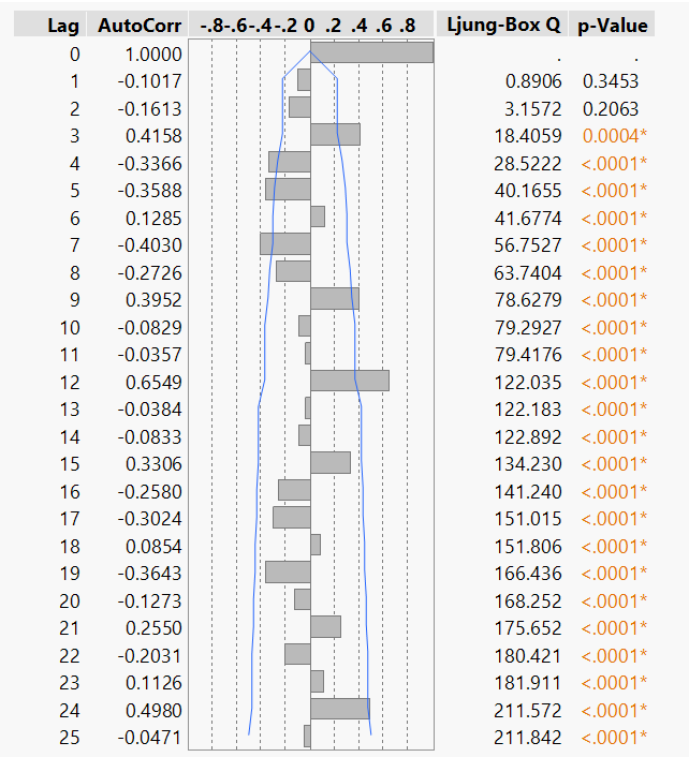
Taking the difference of the natural log of the plane data shows that the linear relation was taken out of the data. The mean dropped near zero and standard deviation became lower. The plot appears to oscillate around zero. It seems that there is seasonality in the data.

- **b.** Find the autocorrelation function for this time series.



Lag	AutoCorr	-.8-.6-.4-.2 0 .2 .4 .6 .8	Ljung-Box Q	p-Value
0	1.0000		.	.
1	-0.1017		0.8906	0.3453
2	-0.1613		3.1572	0.2063
3	0.4158		18.4059	0.0004*
4	-0.3366		28.5222	<.0001*
5	-0.3588		40.1655	<.0001*
6	0.1285		41.6774	<.0001*
7	-0.4030		56.7527	<.0001*
8	-0.2726		63.7404	<.0001*
9	0.3952		78.6279	<.0001*
10	-0.0829		79.2927	<.0001*
11	-0.0357		79.4176	<.0001*
12	0.6549		122.035	<.0001*
13	-0.0384		122.183	<.0001*
14	-0.0833		122.892	<.0001*
15	0.3306		134.230	<.0001*
16	-0.2580		141.240	<.0001*
17	-0.3024		151.015	<.0001*
18	0.0854		151.806	<.0001*
19	-0.3643		166.436	<.0001*
20	-0.1273		168.252	<.0001*
21	0.2550		175.652	<.0001*
22	-0.2031		180.421	<.0001*
23	0.1126		181.911	<.0001*
24	0.4980		211.572	<.0001*
25	-0.0471		211.842	<.0001*

- **c.** Interpret the sample autocorrelation function.

The data drops to zero initially, but it doesn't stay around zero in the rest of the plot. The majority of the p-values are very small, and the data goes out of the bounds multiple times. This suggests that the time series is not stationary and there is probably seasonality in the data.