STAT 560: Time Series Analysis

Date: 09/08/2020

Exercise 2.2

Consider the data on US production of blue and gorgonzola cheeses in Table B.4. a. Find the sample autocorrelation function and the variogram for these data. Is the time series stationary or nonstationary?

Answer: It seems that the variation the US production of blue and gorgonzola cheeses is non-stationary from the time series plot in Figure 1. As we know that a time series can be called stationary if the mean is fixed and the variance is a constant number, but here the values are increasing over time that means the mean is increasing.

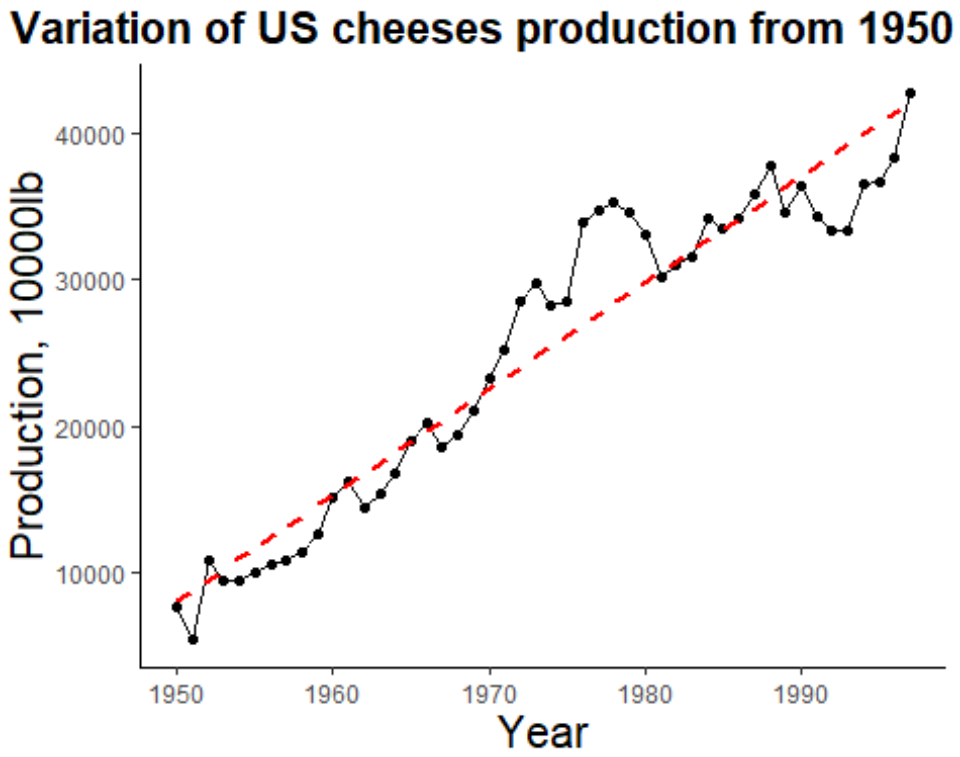


Figure 1: Variation of US blue and gorgonzola cheeses production from 1950 -1997. The red dot line shows the fitted regression line.

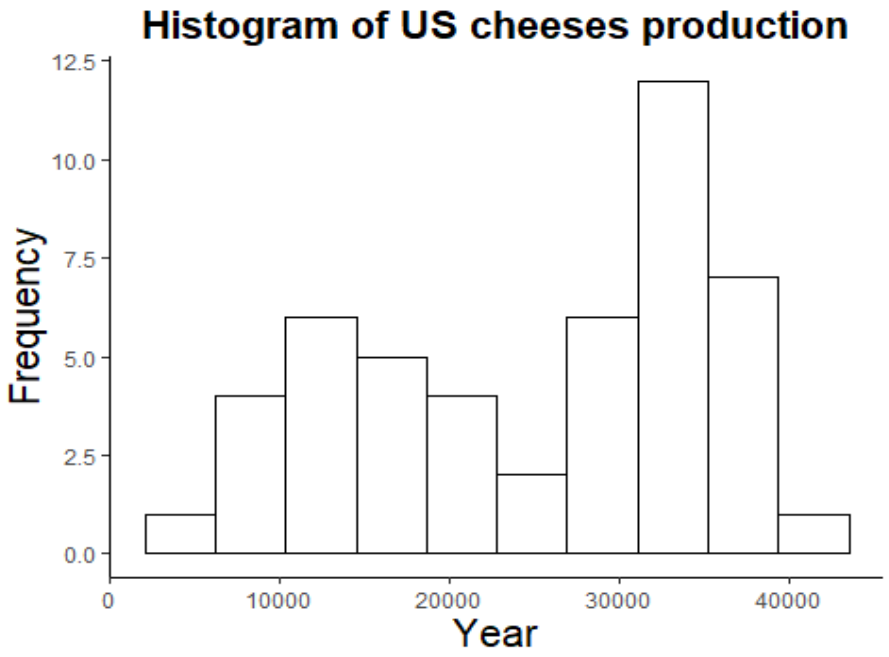


Figure 2: Histogram of US blue and gorgonzola cheeses production for 1950 -1997

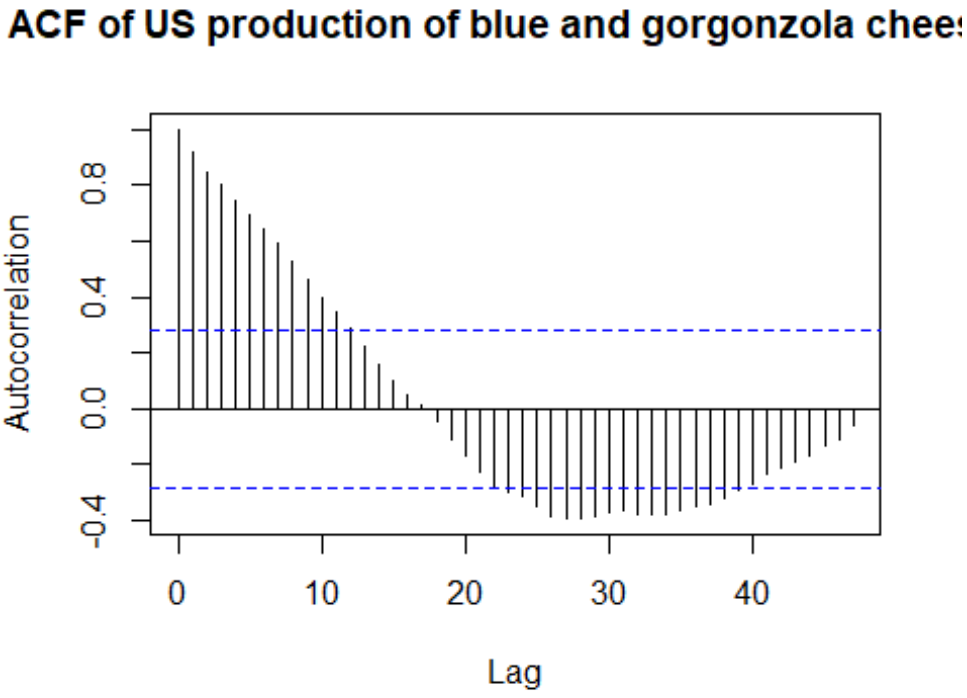


Figure 3: Sample Autocorrelation function (ACF) for the US production of blue and gorgonzola cheeses for 1950 -1997

From Figure 3, the ACF plot depicted above, we can clearly say that, this time series is not stationary as the value of ACF were not decreased to zero over time. In addition, there is no presence of mild sinusoidal pattern. For more clarification, we have checked the variogram for the US production of blue and gorgonzola cheeses (if we are unable to predict the data

to be either stationary or not by means of ACF, then we can analyze further with the help of variogram analysis).

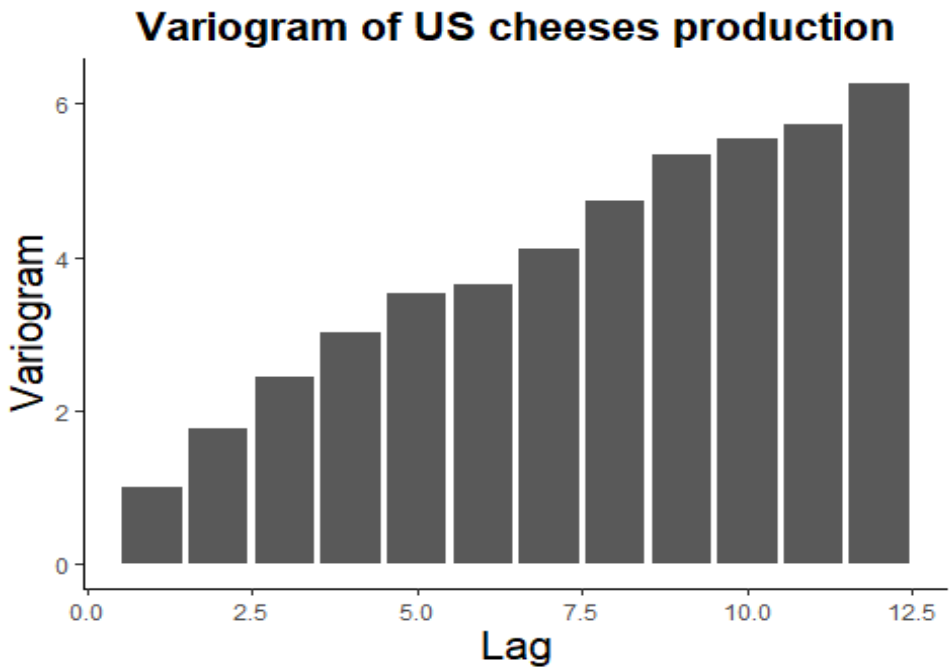


Figure 4: variogram of US blue and gorgonzola cheeses production for 1950 -1997

From Figure 4 and the obtained value of variogram, we can clearly say that the values of variogram were increased over time. So, the time series is not stationary. (Note that the variogram varies around a constant number then we can say that, time series is stationary).

Conclusion: The time series of the US production of blue and gorgonzola cheeses is non-stationary data series.

Time Series Basic Diagnostics

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	0.9226		43.4611	<.0001*	2	1.9338
2	0.8502		81.1785	<.0001*	3	2.5866
3	0.7997		115.285	<.0001*	4	3.3149
4	0.7433		145.421	<.0001*	5	3.9690
5	0.6926		172.197	<.0001*	6	4.5628
6	0.6466		196.091	<.0001*	7	5.2672
7	0.5921		216.613	<.0001*	8	6.1146
8	0.5265		233.244	<.0001*	9	6.9056
9	0.4652		246.562	<.0001*	10	7.7649
10	0.3987		256.601	<.0001*	11	8.4724
11	0.3439		264.271	<.0001*	12	9.1696
12	0.2899		269.873	<.0001*	13	10.0285
13	0.2234		273.295	<.0001*	14	10.9131
14	0.1549		274.988	<.0001*	15	11.6549
15	0.0974		275.678	<.0001*	16	12.2502
16	0.0513		275.876	<.0001*	17	12.7558
17	0.0122		275.887	<.0001*	18	13.4717
18	-0.0433		276.037	<.0001*	19	14.3174
19	-0.1088		277.016	<.0001*	20	15.1422
20	-0.1726		279.571	<.0001*	21	15.8692
21	-0.2289		284.230	<.0001*	22	16.5205
22	-0.2794		291.435	<.0001*	23	16.7939
23	-0.3006		300.107	<.0001*	24	17.0056
24	-0.3169		310.152	<.0001*	25	17.4727
25	-0.3531		323.164	<.0001*		

We have got similar results using JMP software. From ACF value, we assumed that time series was weakly stationary but with further analysis with Variogram, we came to a clear conclusion that, this is a non-stationary time series.

Exercise 2.4

Table B.6 contains two time series: the global mean surface air temperature anomaly and the global CO2 concentration. Find the sample autocorrelation function and the variogram for both of these time series. Is either one of the time series stationary?

Answer: It seems that the variation of the global mean surface air temperature anomaly in ^{o}C from 1880 -2004 is non-stationary from the time series plot in Figure 5. Because, the values are increasing over time.

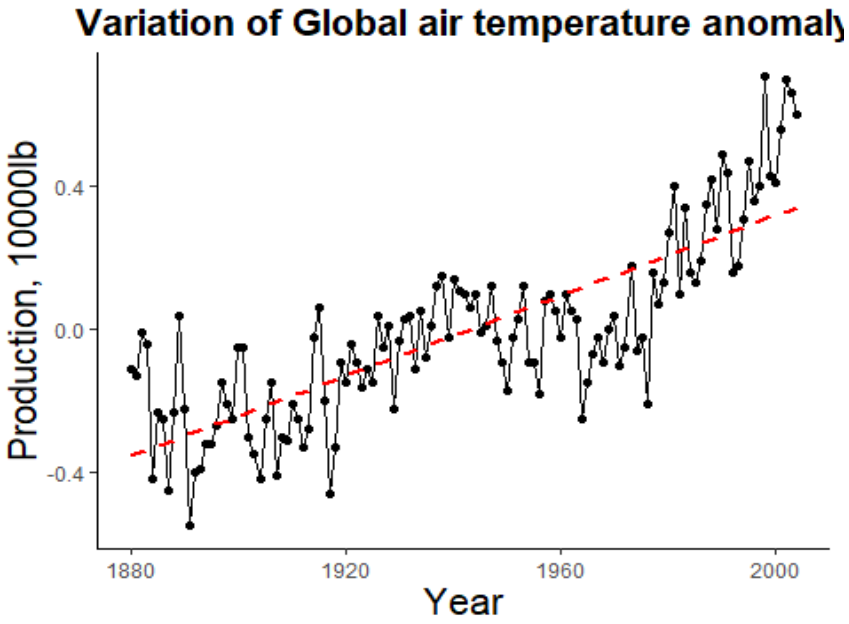


Figure 5: Variation of the global mean surface air temperature anomaly in oC from 1880 - 2004. The red dot line shows the fitted regression line.

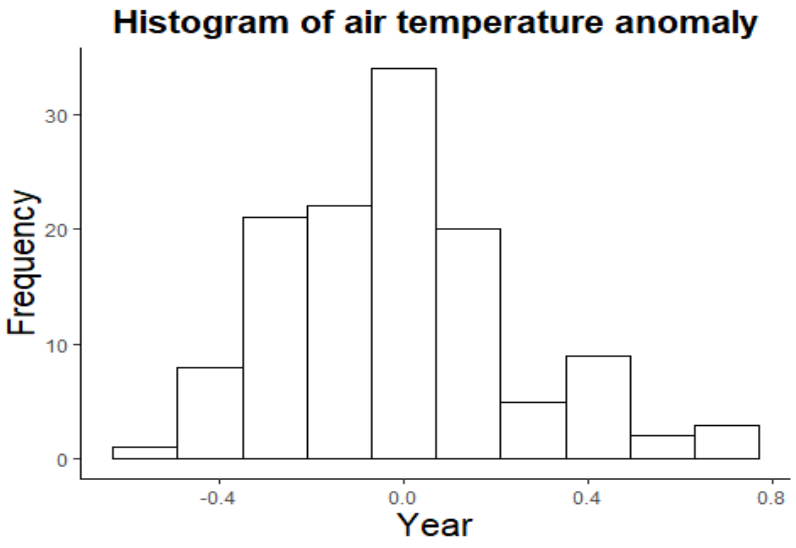


Figure 6: Histogram of Global air temperature anomaly

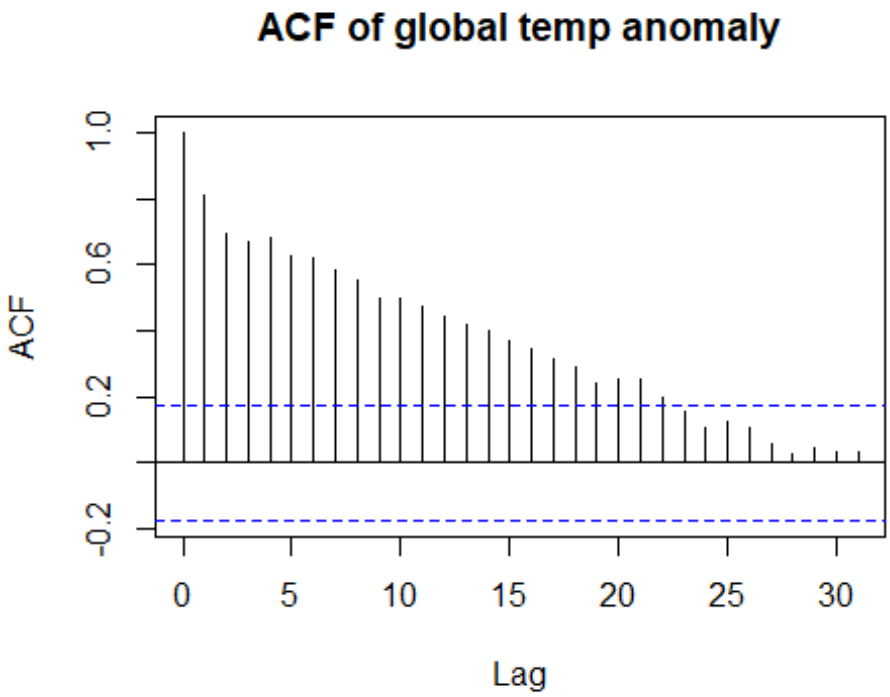


Figure 7: Sample Autocorrelation funciton (ACF) for the global surface temperature anomaly for 1880 -2004

From Figure 7, the ACF plot depicted above, we can clearly say that this time series is stationary as the value of ACF were decreased to zero over time. In addition, there is a presence of mild sinusoidal pattern in lag 24 and 28 which is one of the criteria of a typical time series plot. But it seems that there is a confusion from time series plot and ACF.

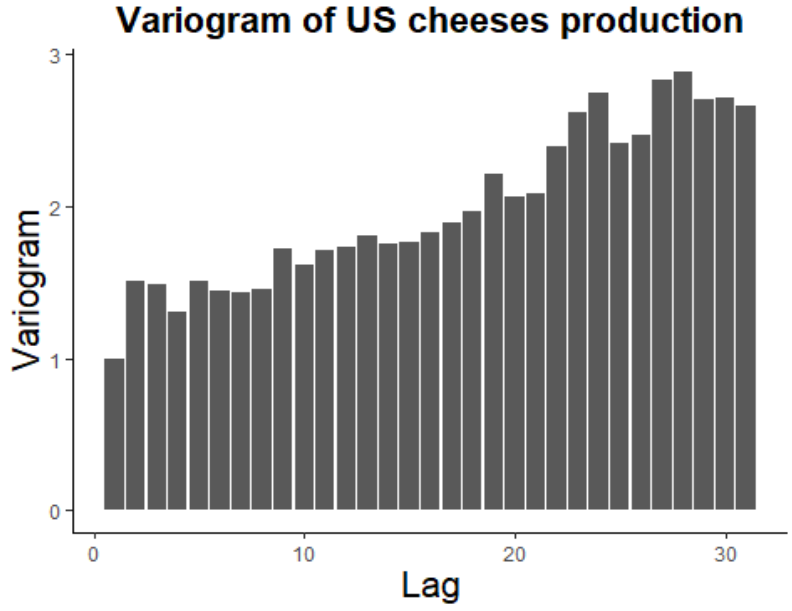
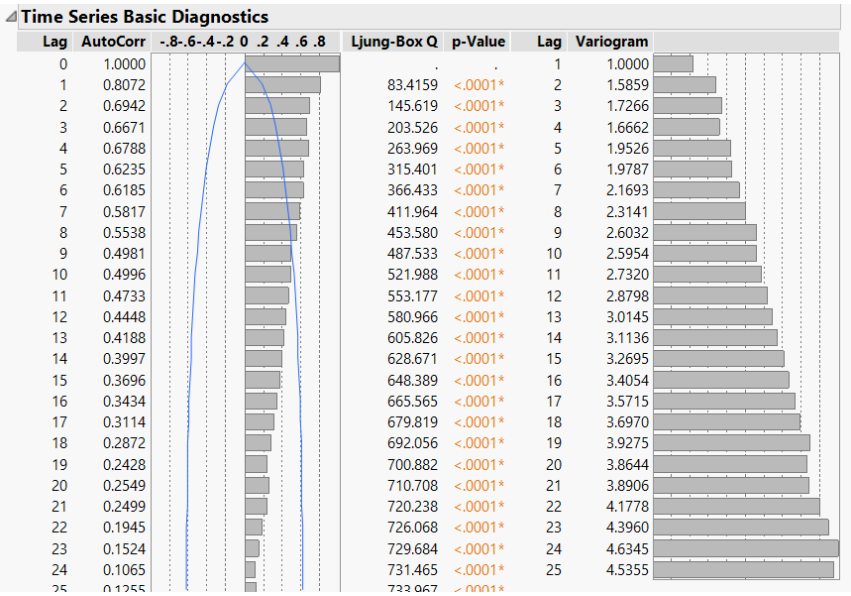


Figure 8: variogram of the global surface temperature anomaly

Therefore, the variogram plot has been analyzed for this data set to predict the data to be either stationary or not as the ACF and visual inspection gives doubt. From Figure 8 and the obtained value of variogram, we can clearly say that the values of variogram were constant over time after lag 28. So, the time series is stationary. However, the values are almost increasing at the beginning up to 25 lag.

Conclusion: We have got similar results using JUMP software. From ACF value, we assumed that time series was stationary and with further analysis with Variogram, we came to a clear conclusion that, this is a stationary time series but weekly stationary.



Time Series Basic Diagnostics

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	0.8072		83.4159	<.0001*	2	1.5859
2	0.6942		145.619	<.0001*	3	1.7266
3	0.6671		203.526	<.0001*	4	1.6662
4	0.6788		263.969	<.0001*	5	1.9526
5	0.6235		315.401	<.0001*	6	1.9787
6	0.6185		366.433	<.0001*	7	2.1693
7	0.5817		411.964	<.0001*	8	2.3141
8	0.5538		453.580	<.0001*	9	2.6032
9	0.4981		487.533	<.0001*	10	2.5954
10	0.4996		521.988	<.0001*	11	2.7320
11	0.4733		553.177	<.0001*	12	2.8798
12	0.4448		580.966	<.0001*	13	3.0145
13	0.4188		605.826	<.0001*	14	3.1136
14	0.3997		628.671	<.0001*	15	3.2695
15	0.3696		648.389	<.0001*	16	3.4054
16	0.3434		665.565	<.0001*	17	3.5715
17	0.3114		679.819	<.0001*	18	3.6970
18	0.2872		692.056	<.0001*	19	3.9275
19	0.2428		700.882	<.0001*	20	3.8644
20	0.2549		710.708	<.0001*	21	3.8906
21	0.2499		720.238	<.0001*	22	4.1778
22	0.1945		726.068	<.0001*	23	4.3960
23	0.1524		729.684	<.0001*	24	4.6345
24	0.1065		731.465	<.0001*	25	4.5355
25	0.1255		733.967	<.0001*		

The global CO2 concentration:

It seems that the variation of the global CO2 concentration from 1880 -2004 is non-stationary from the time series plot in Figure 9. Because, the values are increasing over time.

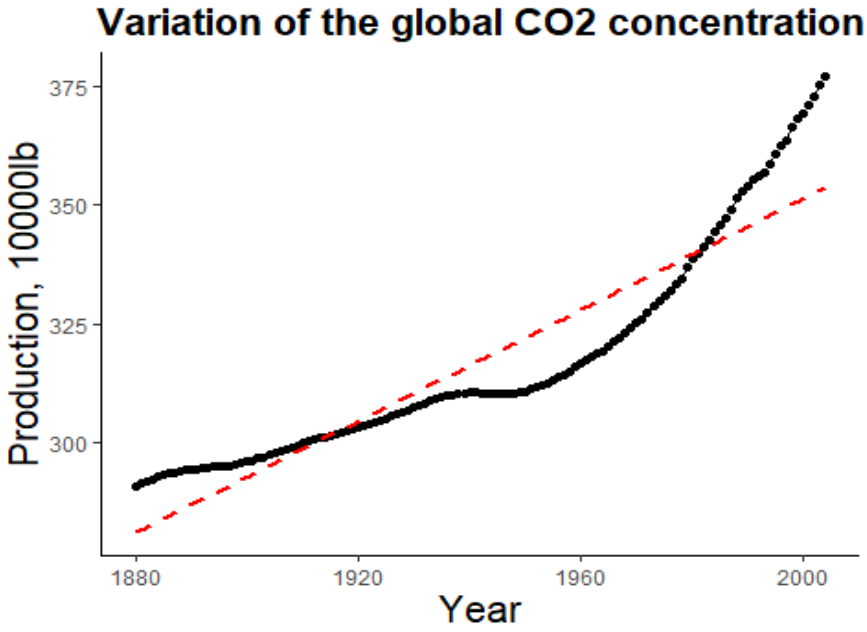


Figure 9: Variation of the global CO2 concentration from 1880 -2004. The red dot line shows the fitted regression line.

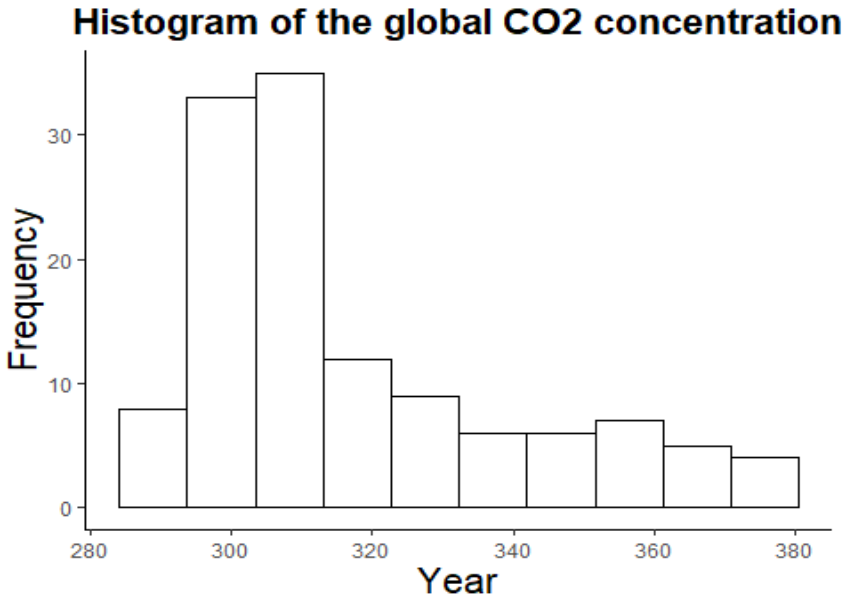


Figure 10: Histogram of the global CO2 concentration

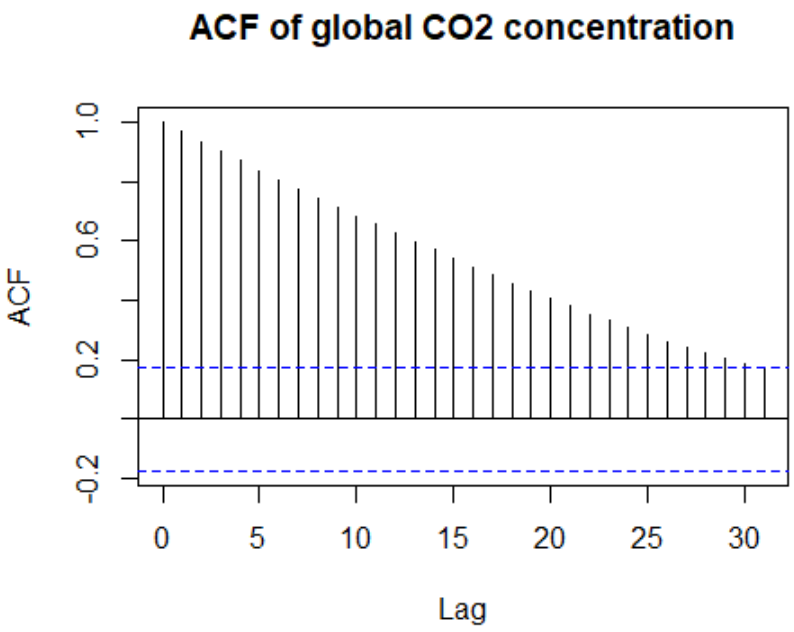


Figure 11: Sample Autocorrelation funciton (ACF) for the the global CO2 concentration

From Figure 11, the ACF plot depicted above, we can clearly say that this time series is not stationary as the value of ACF were not decreased to zero over lag period up to ¼ of the data set. In addition, there is no presence of mild sinusoidal pattern.

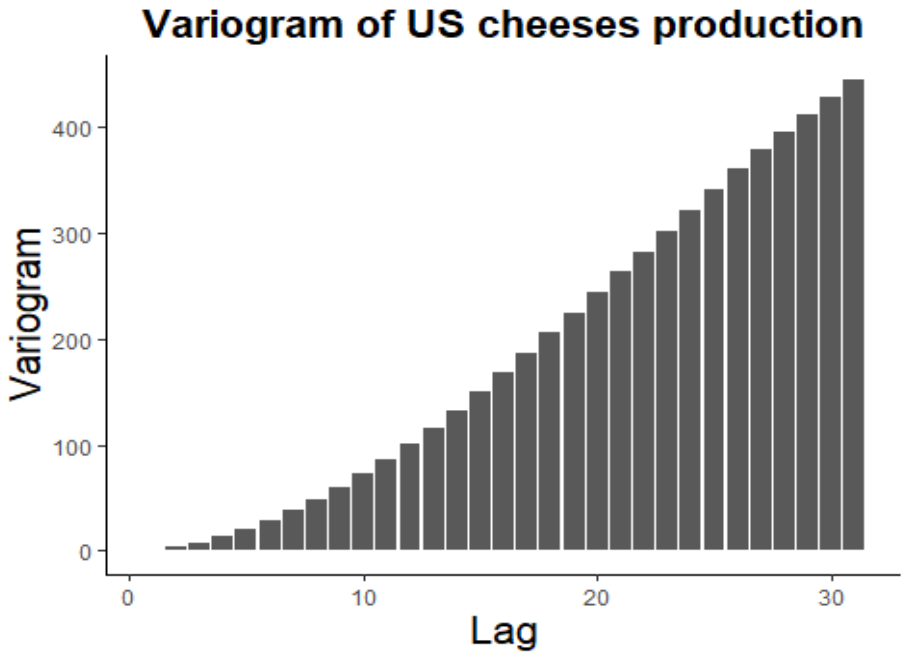


Figure 12: variogram of US blue and gorgonzola cheeses production for 1950 -1997

Moreover, the Figure 12 shows that the variogram values are increasing with increasing the lag value therefore, we can clearly say that the values of variogram were increased over time. So, the time series is not stationary.

Conclusion: From ACF value, we assumed that time series was not stationary and with further analysis with Variogram, we came to a clear conclusion that, this is a non-stationary time series. We have got similar results using JUMP software.