MONTHLY PRODUCTION OF CLAY BRICKS
Grp4 - Project

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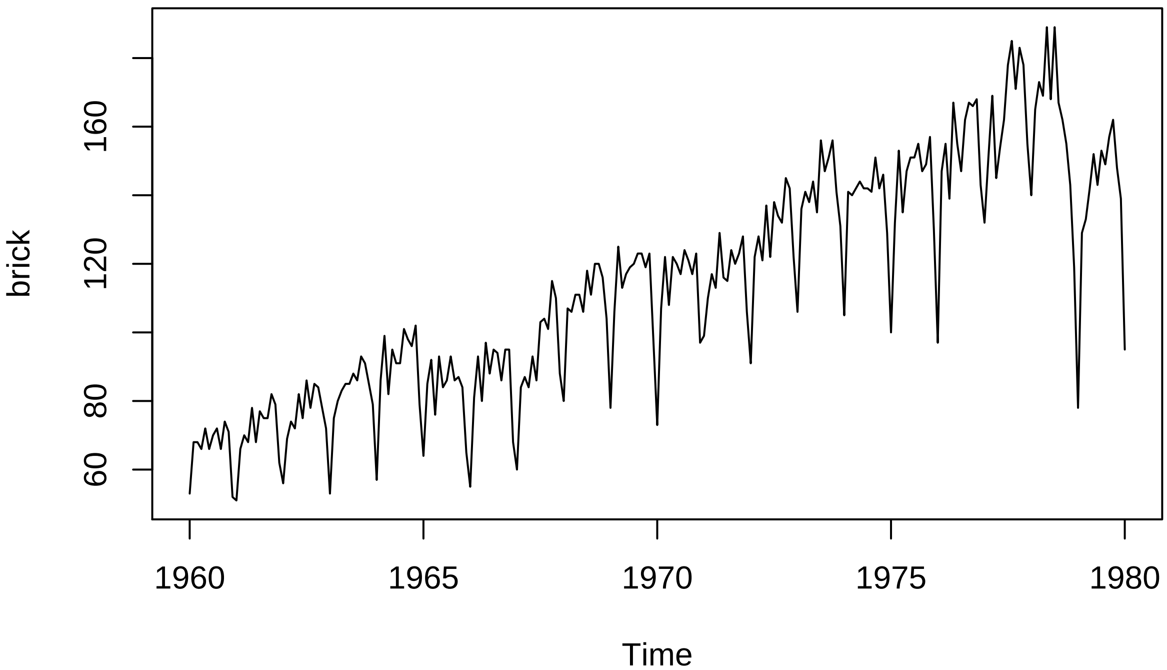
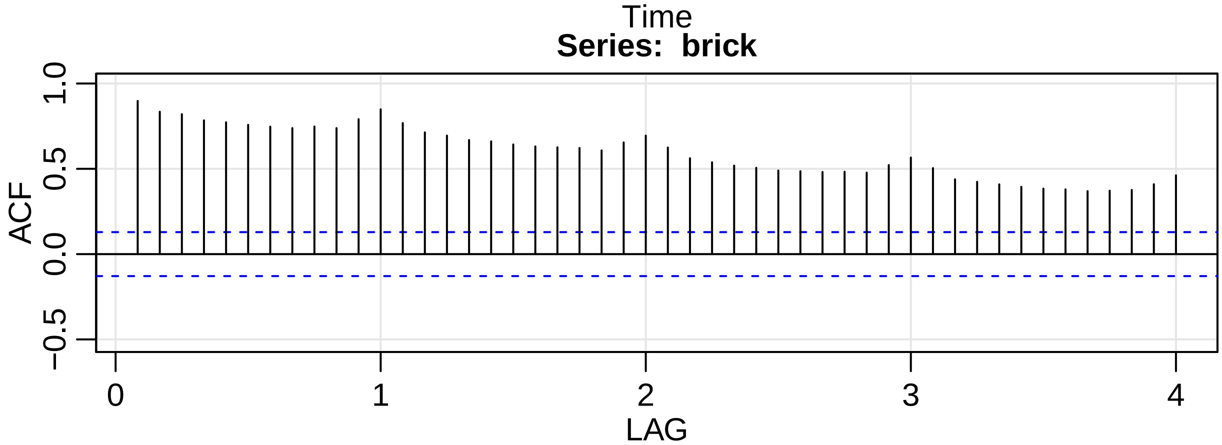
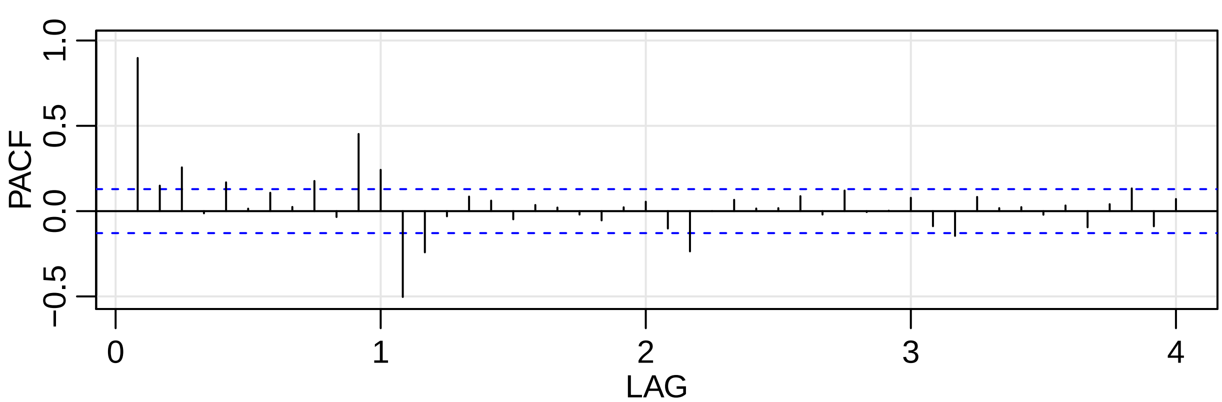
INTRODUCTION:

The aims of this study are to identify and forecast a model best fitting brick production data in the United States. The method of maximum likelihood was used to estimate the parameters and to forecast the number of production in the future. The data is a twenty year period from 1960 to 1980 and was obtained from the Time Series Data library at datamarket.com website.

This project is of utmost importance and relevance because bricks are used for building and pavement all throughout the world. Being made from clay and shale, brick is most abundant and natural material on earth. In the USA, bricks were once used as a pavement material, and now it is more widely used as a decorative surface rather than a roadway material. A healthy living environment especially requires the use of the right building material. In general building materials are strongly influencing the indoor climate and quality of living.

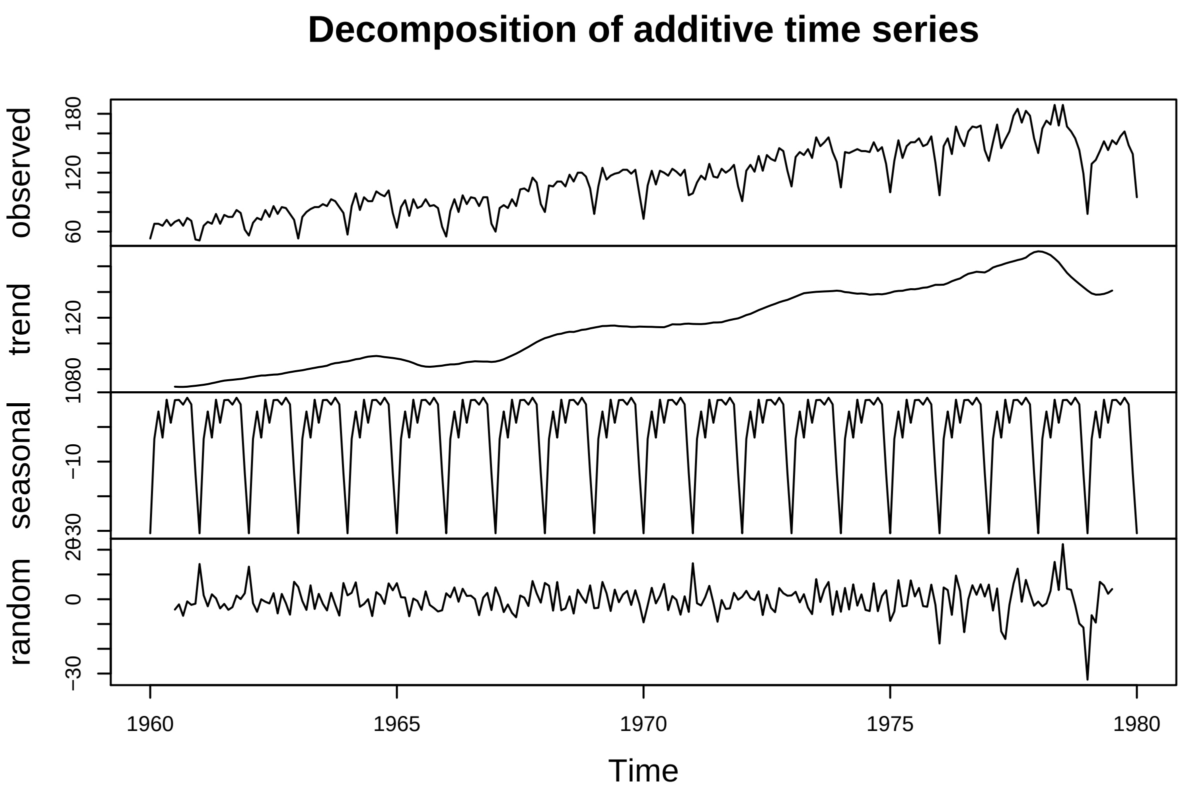

brick
60
80
120
160
1960
1965
1970
1975
1980
Time


Series: brick
ACF
−0.5
0.0
0.5
1.0
0
1
2
3
4
LAG

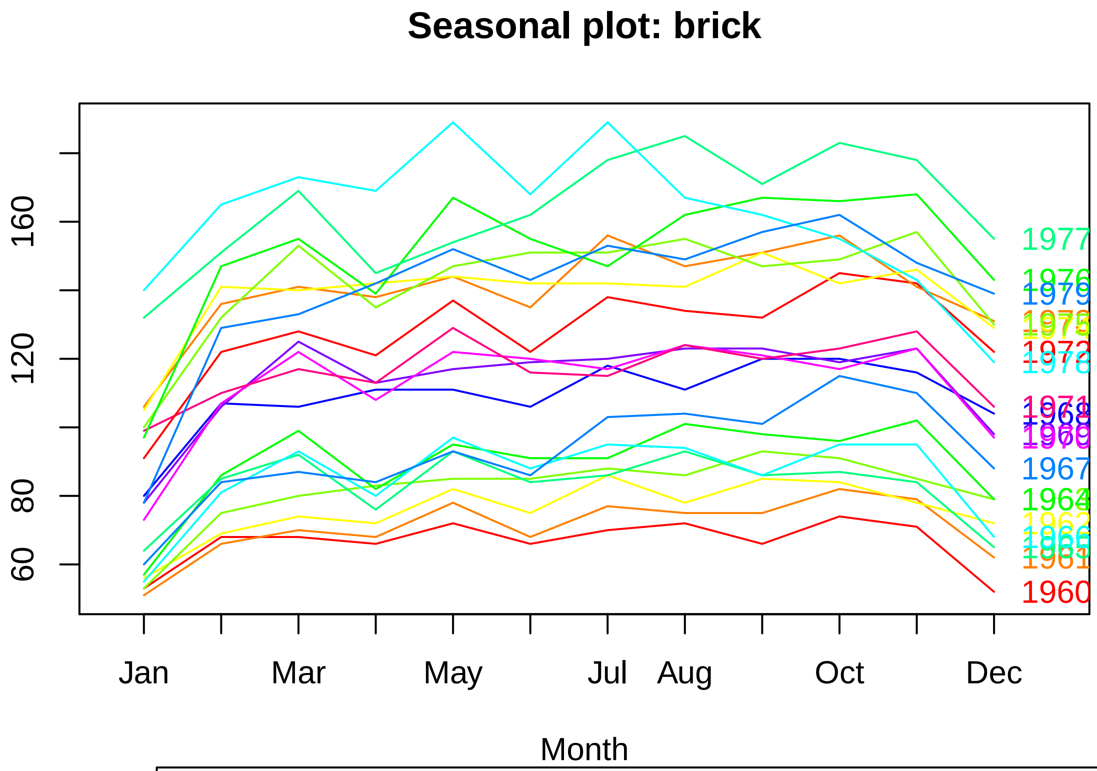

PACF
−0.5
0.0
0.5
1.0
0
1
2
3
4
LAG

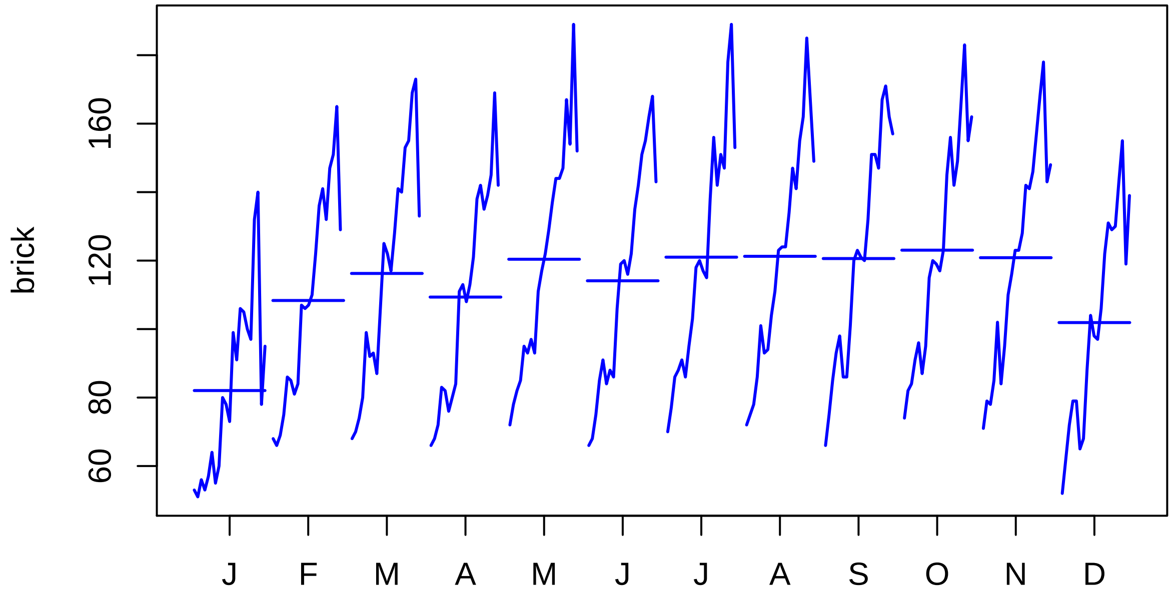
```
## numeric(0)
```

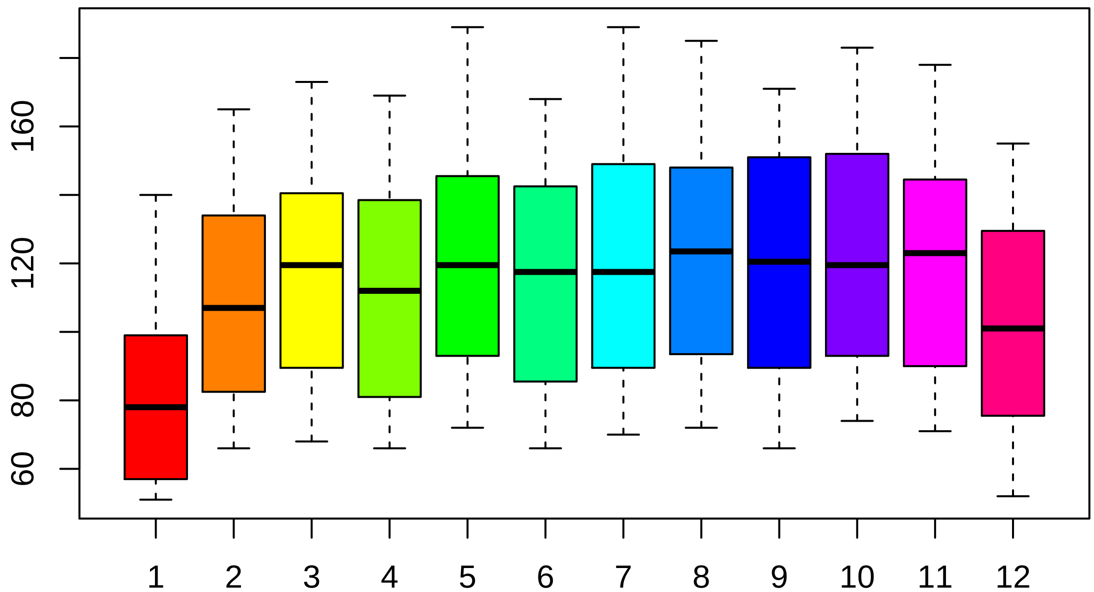
The graph shows a trend and seasonal variations in the number of coal production every year. A distinct trough is shown in 1979. The random fluctuations seem constant over time.

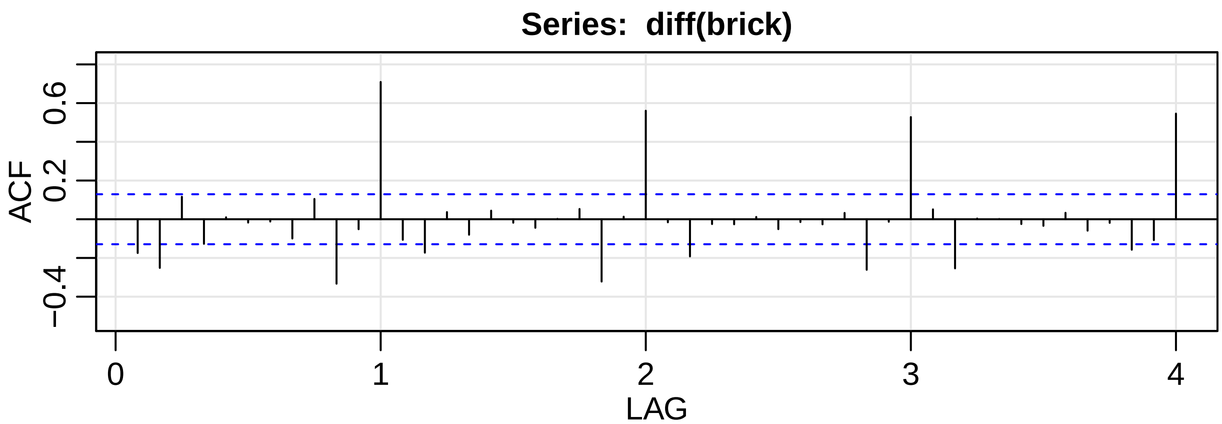


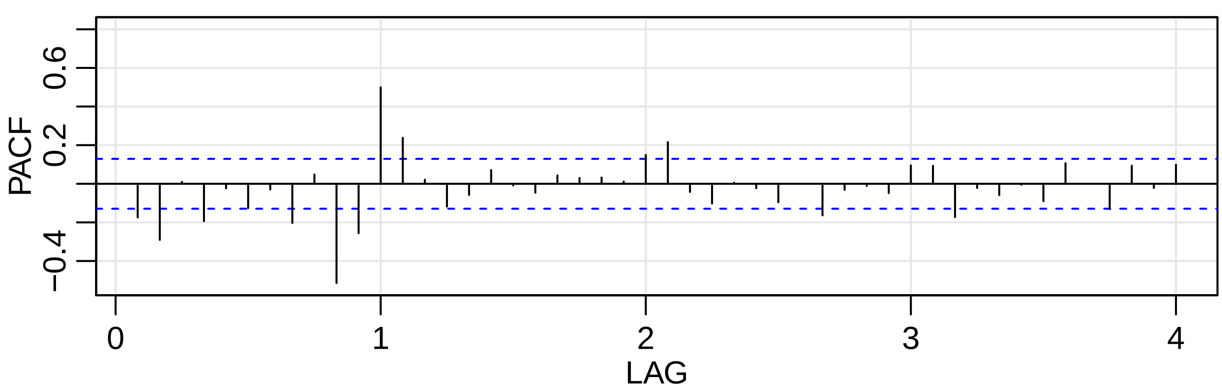

```
## [1] -30.698666  -3.470596   4.476773  -3.073666   7.880281   1.204843
## [7]   7.753308   7.818878   6.437299   8.443878   6.522825 -13.295157
```


Seasonal plot: brick
60
80
120
160
Jan
Mar
May
Jul
Aug
Oct
Dec
Month
1977
1976
1979
1972
1978
1971
1967
1964
1960

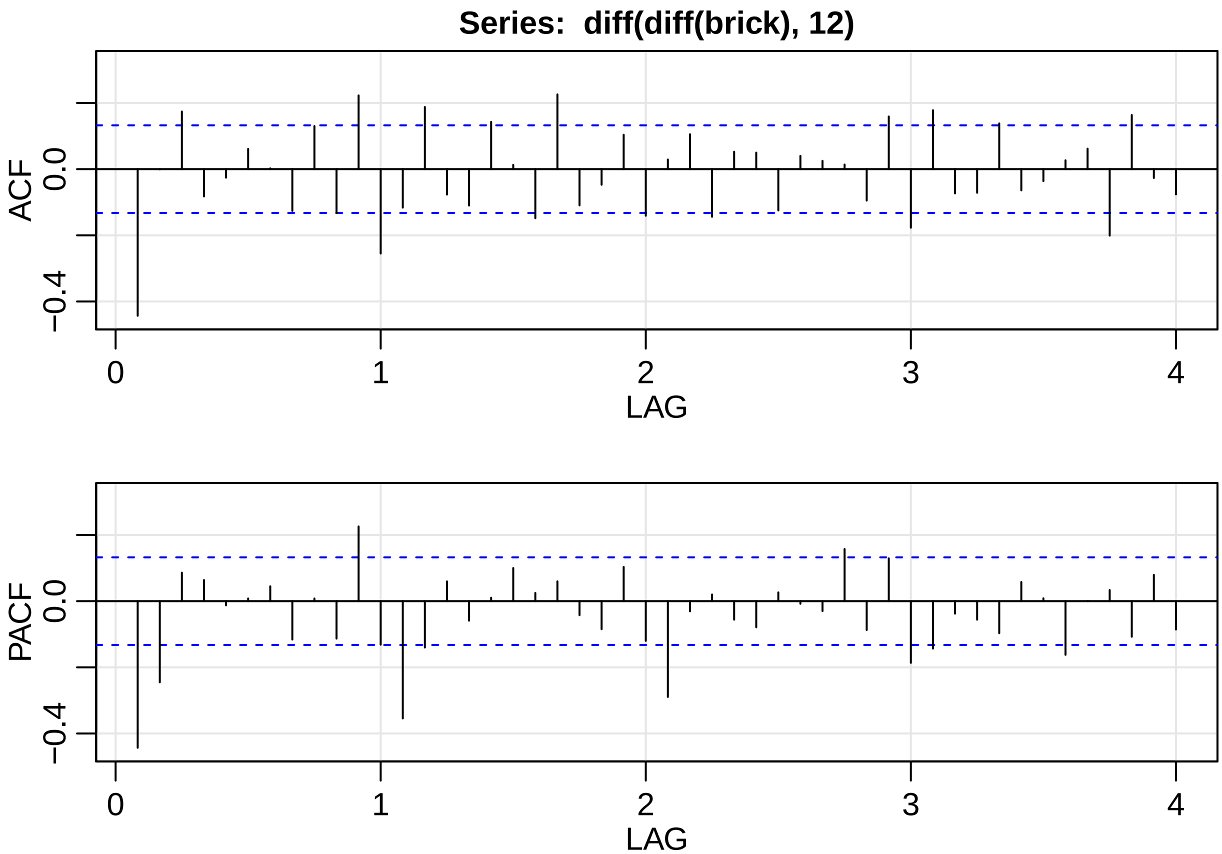

brick
60
80
120
160
J
F
M
A
M
J
J
A
S
O
N
D


160
120
80
60
1
2
3
4
5
6
7
8
9
10
11
12


Series: diff(brick)
ACF
0.6
0.2
−0.4
0
1
2
3
4
LAG


PACF
0.6
0.2
−0.4
0
1
2
3
4
LAG

Even with the first order of differencing, we observe that there is still slow residual decay in the ACF plots at a seasonal lag period of 12. This thus suggest a seasonal difference to be applied.

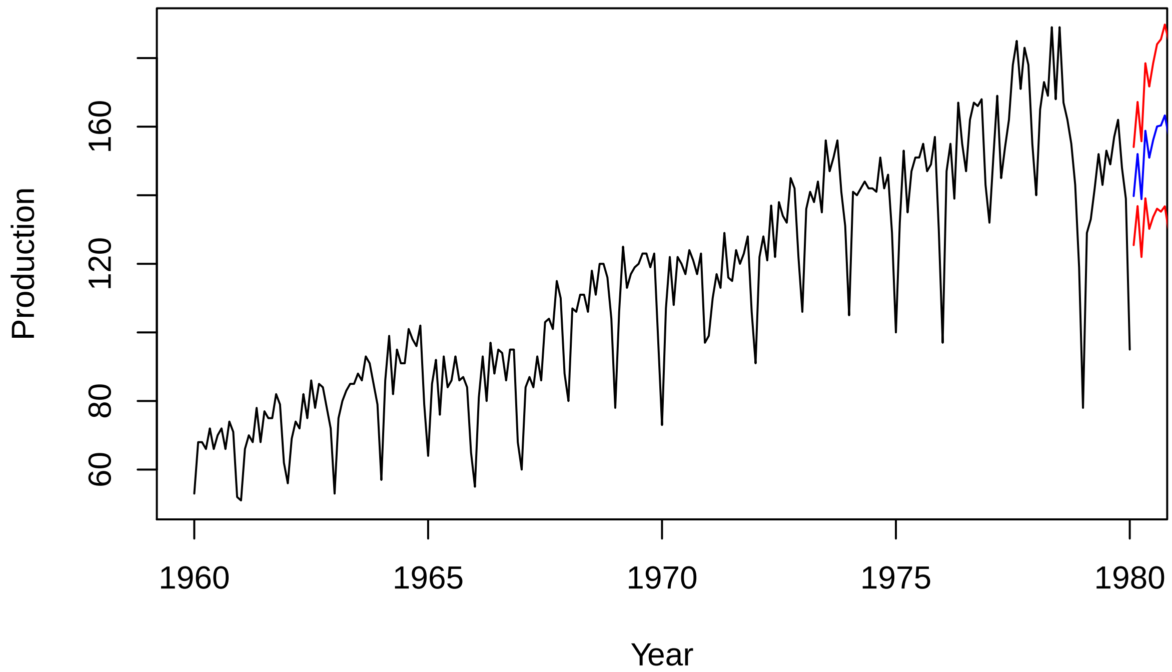


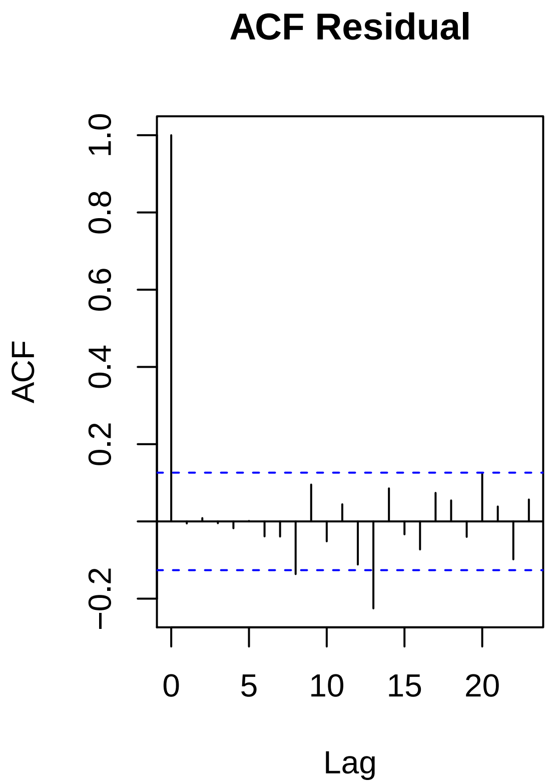

```
## numeric(0)
```

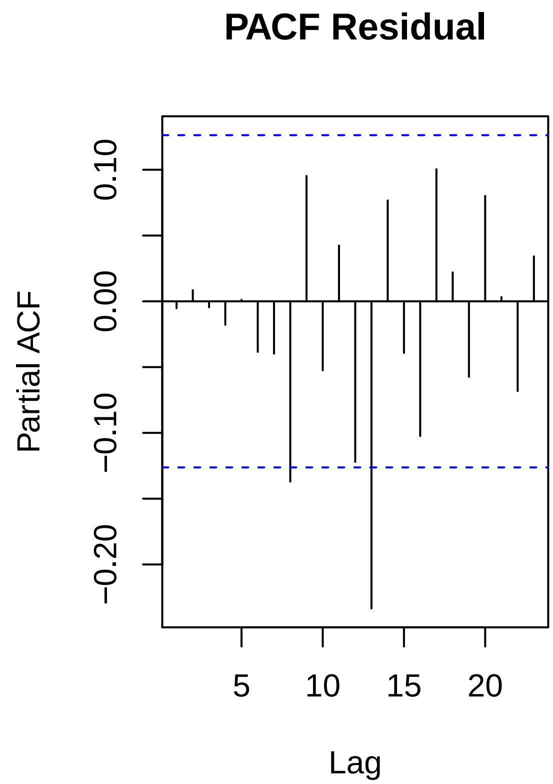
From the seasonal lag perspective, we can see that the ACF cuts off at the 2nd seasonal lag, while the PACF appears to tail off. This would suggest a SARMA model of (0,2).

Within the first seasonal cycle, it can be seen that PACF appears to be cutting off at lag = 3, while the ACF tails off.Thus a proposed model can be ARMA (3,0) x (0,2)__12 for the differenced time series.

```
##
## Call:
## arima(x = brick, order = c(3, 1, 0), seasonal = list(order = c(3, 1, 0), period = 12),
##     include.mean = FALSE)
##
## Coefficients:
##           ar1      ar2     ar3     sar1     sar2     sar3
##       -0.6427  -0.2563  0.1319  -0.6637  -0.5493  -0.3350
## s.e.   0.0706   0.0772  0.0678   0.0723   0.0798   0.0768
##
## sigma^2 estimated as 51.14:  log likelihood = -777.28,  aic = 1568.56
```

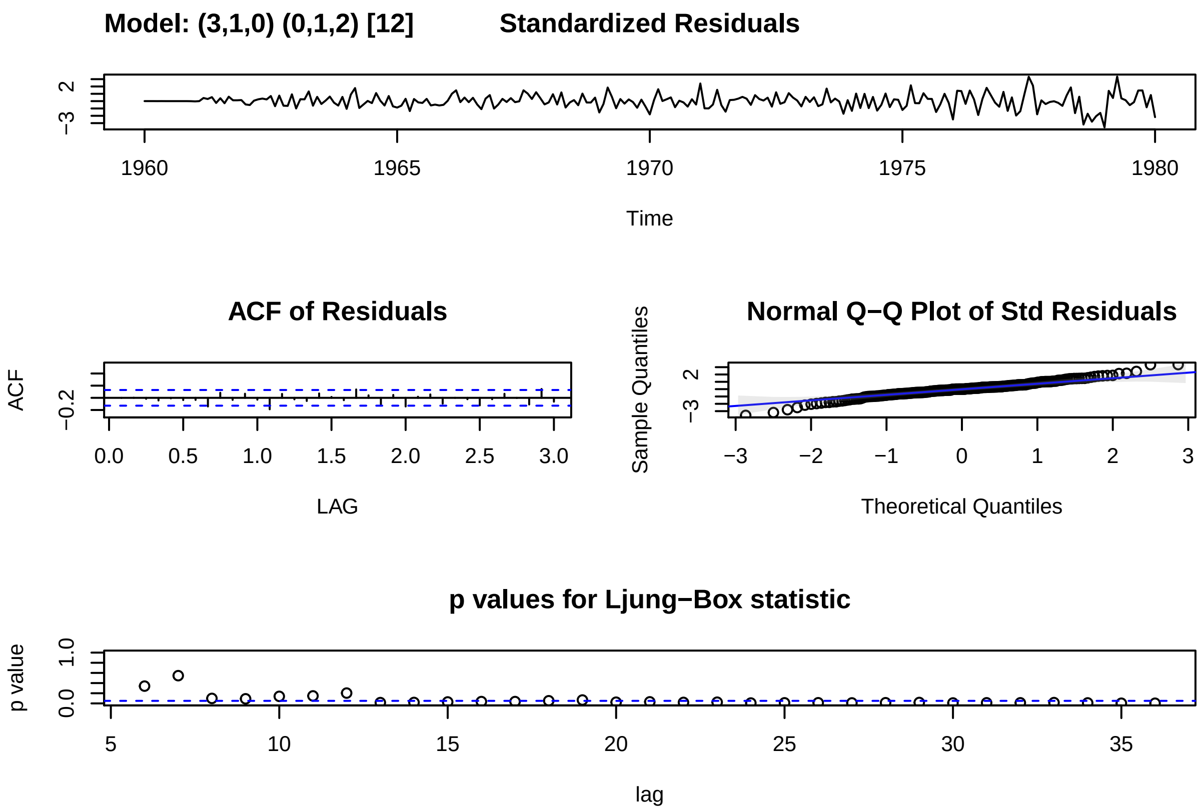







```
## initial  value 2.316501
## iter   2 value 2.082344
## iter   3 value 2.018921
## iter   4 value 1.986378
## iter   5 value 1.964898
## iter   6 value 1.960672
## iter   7 value 1.959212
## iter   8 value 1.959089
```

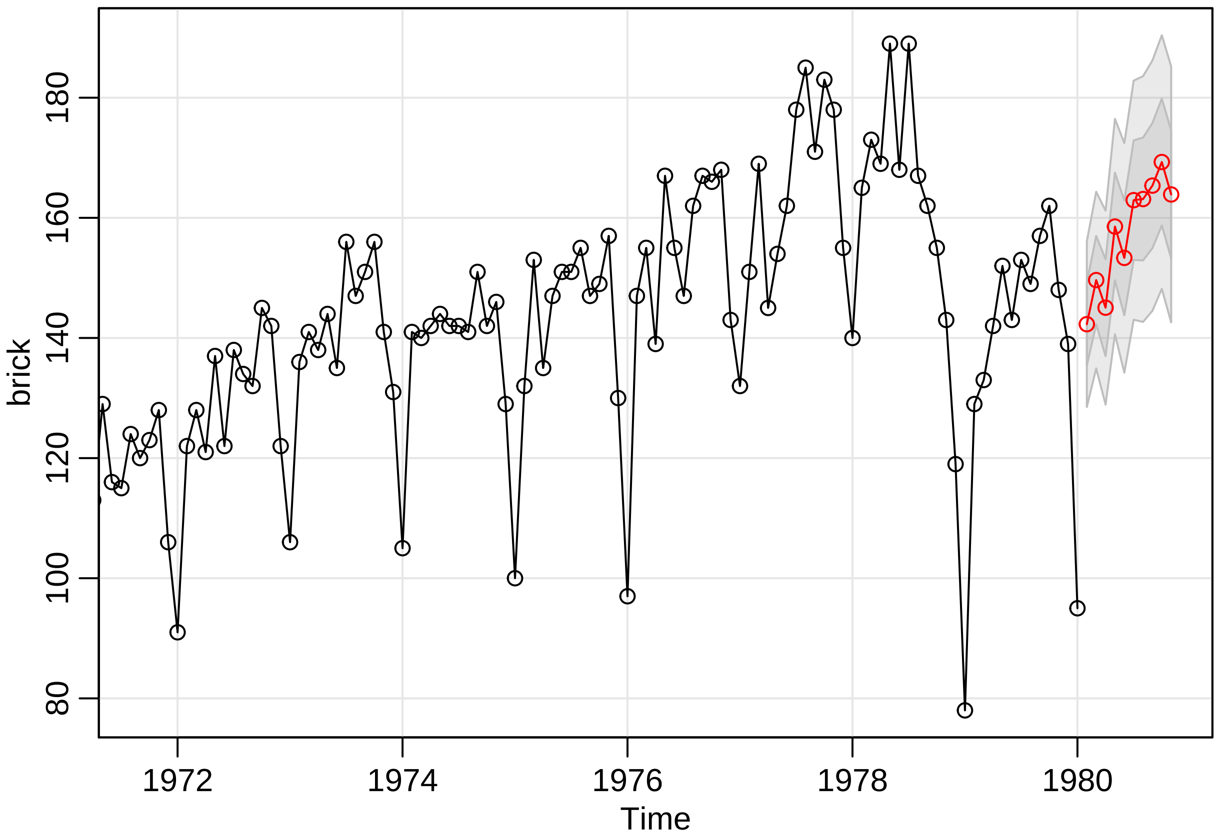
```
## iter   9 value 1.958890
## iter  10 value 1.958870
## iter  11 value 1.958867
## iter  12 value 1.958867
## iter  12 value 1.958867
## final  value 1.958867
## converged
## initial  value 1.969522
## iter   2 value 1.969380
## iter   3 value 1.969078
## iter   4 value 1.968929
## iter   5 value 1.968904
## iter   6 value 1.968903
## iter   6 value 1.968903
## iter   6 value 1.968903
## final  value 1.968903
## converged
```




```
## named list()
```

```
## Series: brick
## ARIMA(1,0,3)(0,1,2)[12] with drift
##
## Coefficients:
##          ar1      ma1     ma2     ma3     sma1     sma2   drift
##       0.8452  -0.4738  0.1683  0.1588  -0.6485  -0.1605  0.3894
## s.e.  0.0566   0.0915  0.0830  0.0910   0.0758   0.0748  0.0546
##
## sigma^2 estimated as 49.01:  log likelihood=-773.31
```

```
## AIC=1562.62   AICc=1563.27   BIC=1590.09
```




```
## $pred
##           Feb      Mar      Apr      May      Jun      Jul      Aug
## 1980 142.2943 149.6362 145.0447 158.5480 153.3325 162.9443 163.1305
##           Sep      Oct      Nov
## 1980 165.3662 169.2914 163.8926
##
## $se
##            Feb       Mar       Apr       May       Jun       Jul       Aug
## 1980  6.894003  7.354126  8.070724  8.965617  9.553698  9.952536 10.227917
##            Sep       Oct       Nov
## 1980 10.420162 10.555319 10.650802
```

CONCLUSION:

In this project, to conclude, there are several things we have done. - Firstly we try to analyze the basic pattern of the unadjusted brick production data in US, which indicates that there are some seasonal pattern and significant long term linear trend. We fit a SARIMA model for our data. We choose the best version of the SARIMA model, and do some prediction for the future. Based on the model diagnostics, we can see that the model does fit fine for earlier lags, although there might still be some outliers in the data with unexplained variance (as shown in the Normal QQ plot, and the standardised residuals).

REFERENCES:

https://www.datamarket.com: SOURCE OF DATA

https://www.eia.gov/totalenergy/data/annual

www.claybrick.org

"Trends in Brick Plant Operation," The American Ceramic Society Bulletin. 1992, pp.69-74

"Brick Manufacturing from Past to Present," The American Ceramic Society Bulletin. May, 1990, pp.807-813