

STA 137 Final Project

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Col Removal

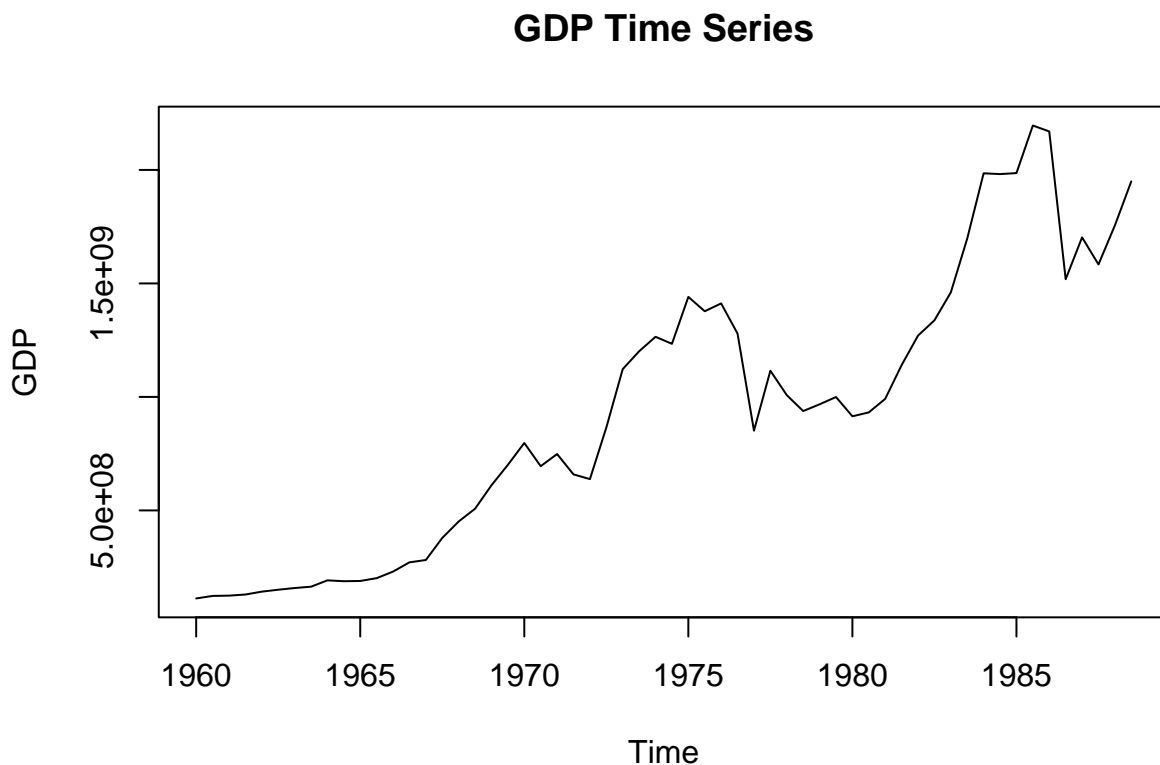
Keep Year, Imports, and GDP columns

```
finalPro_data <- finalPro_data[, c("Year", "GDP")]
```

Plot Time Series

```
# Plot GDP
gdp_ts <- ts(finalPro_data$GDP, start = 1960, frequency = 2)

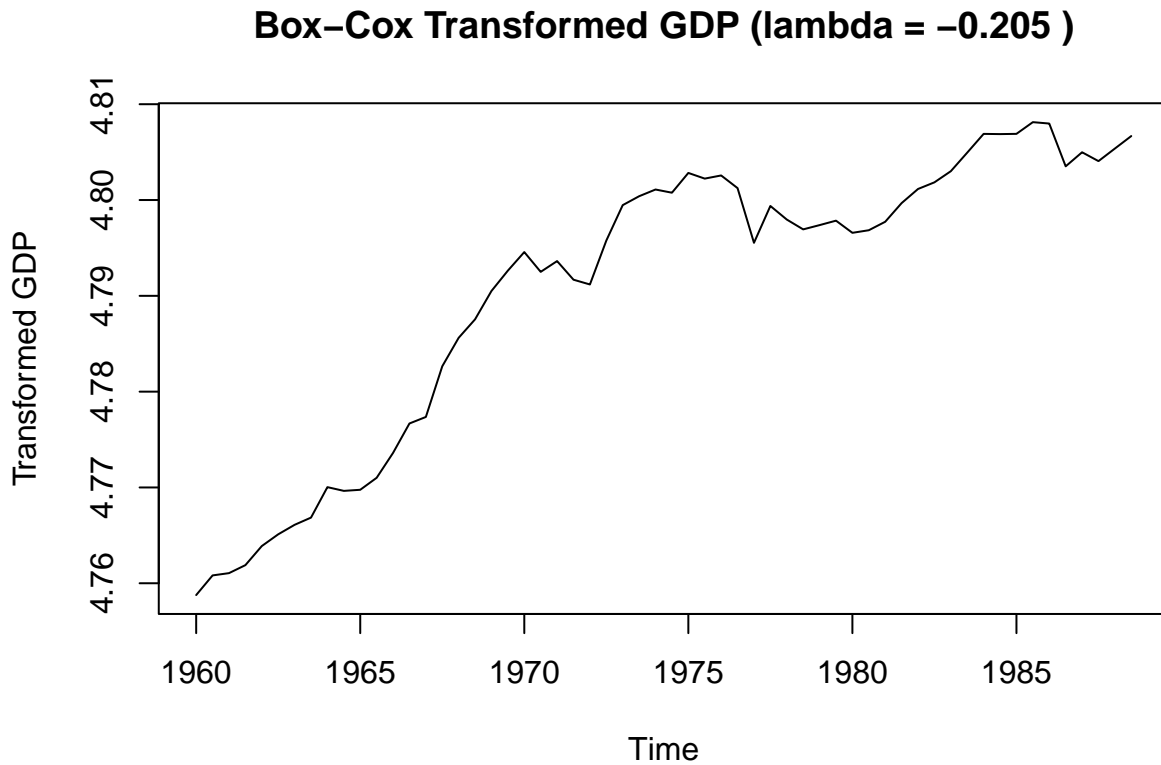
ts.plot(gdp_ts, main="GDP Time Series", ylab="GDP")
```



Summary: - GDP time series has upward trend, this shows this is non-stationary - It has peaks around every 10 year: 1980, 1990, 2010

Transform

```
# Box-Cox transform GDP
lambda <- BoxCox.lambda(gdp_ts)
boxcox_gdp_ts <- BoxCox(gdp_ts, lambda)
ts.plot(boxcox_gdp_ts, main = paste("Box-Cox Transformed GDP (lambda =", round(lambda, 3), ")"), ylab =
```



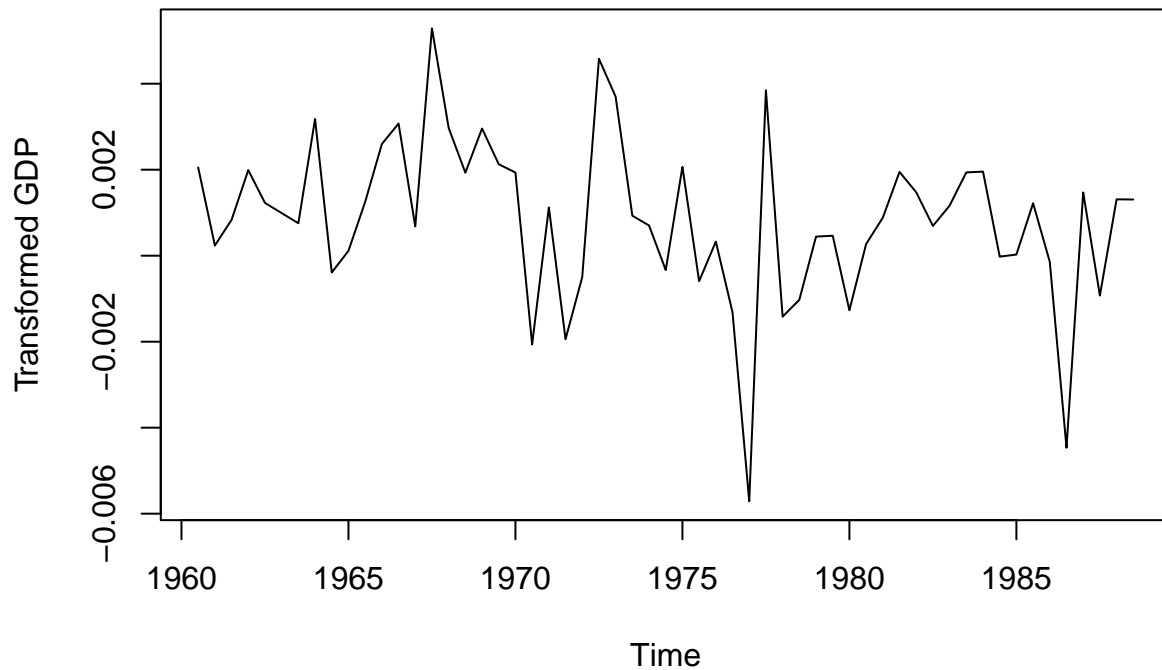
We tried log, but residuals not normal.

Differencing GDP

```
diff_gdp_bc <- diff(boxcox_gdp_ts)

# Plot differenced Box-Cox GDP
ts.plot(diff_gdp_bc, main="Differenced Box-Cox Transformed GDP Time Series", ylab="Transformed GDP")
```

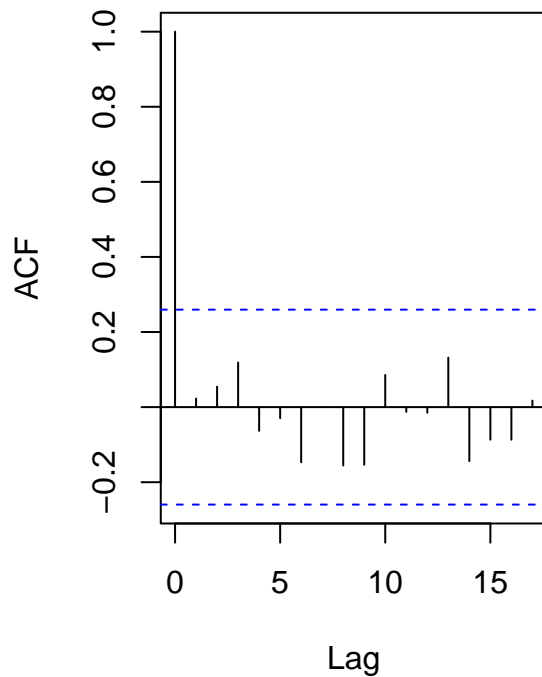
Differenced Box-Cox Transformed GDP Time Series



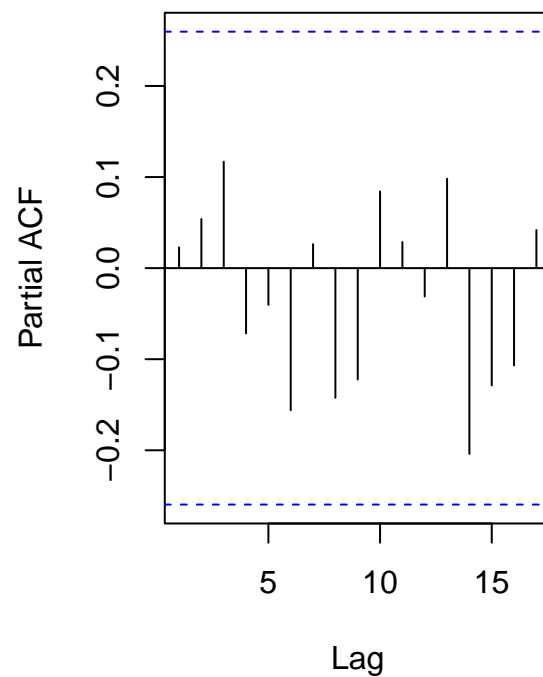
```
# Fit a basic linear model for demonstration
model_gdp_bc <- lm(diff_gdp_bc ~ time(diff_gdp_bc))
resid_gdp_bc <- residuals(model_gdp_bc)

# Plot ACF and PACF of residuals
par(mfrow = c(1, 2)) # Side-by-side plots
acf(resid_gdp_bc, main = "ACF of Residuals")
pacf(resid_gdp_bc, main = "PACF of Residuals")
```

ACF of Residuals



PACF of Residuals



```
par(mfrow = c(1, 1)) # Reset layout
```

```
# Portmanteau (Box-Pierce) test for white noise  
portmanteau_result <- Box.test(resid_gdp_bc, lag = 10, type = "Box-Pierce")  
print(portmanteau_result)
```

```
##  
## Box-Pierce test  
##  
## data: resid_gdp_bc  
## X-squared = 5.6549, df = 10, p-value = 0.8434
```

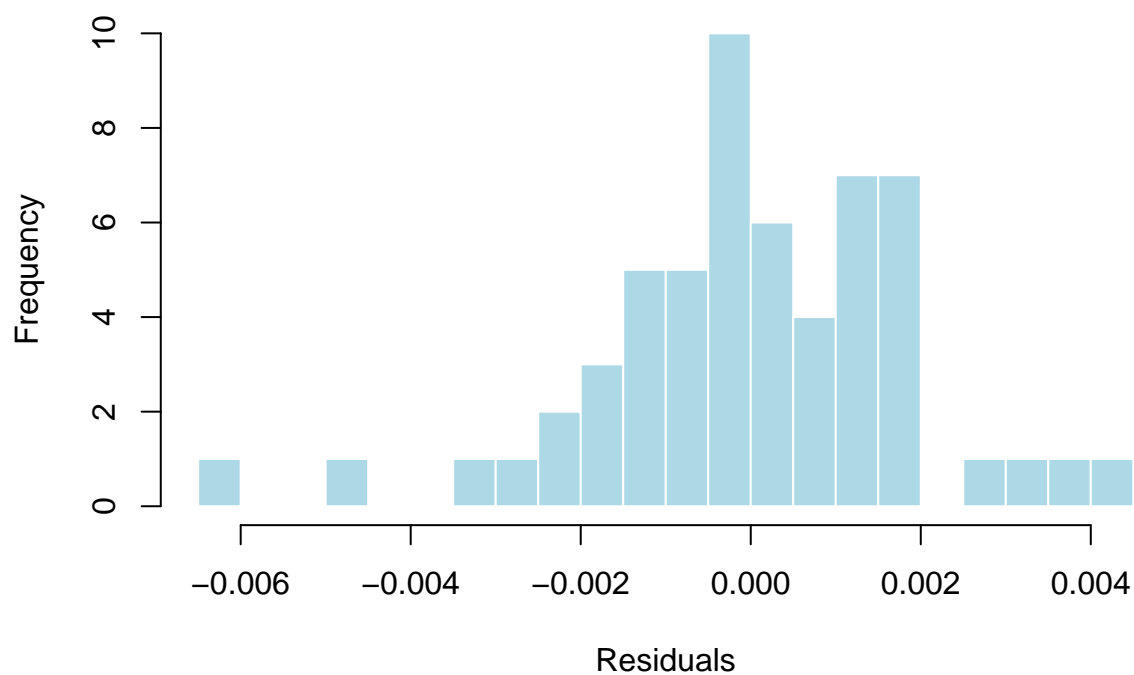
Assess Normality

```
# Assess Normality of Residuals
```

```
# Histogram
```

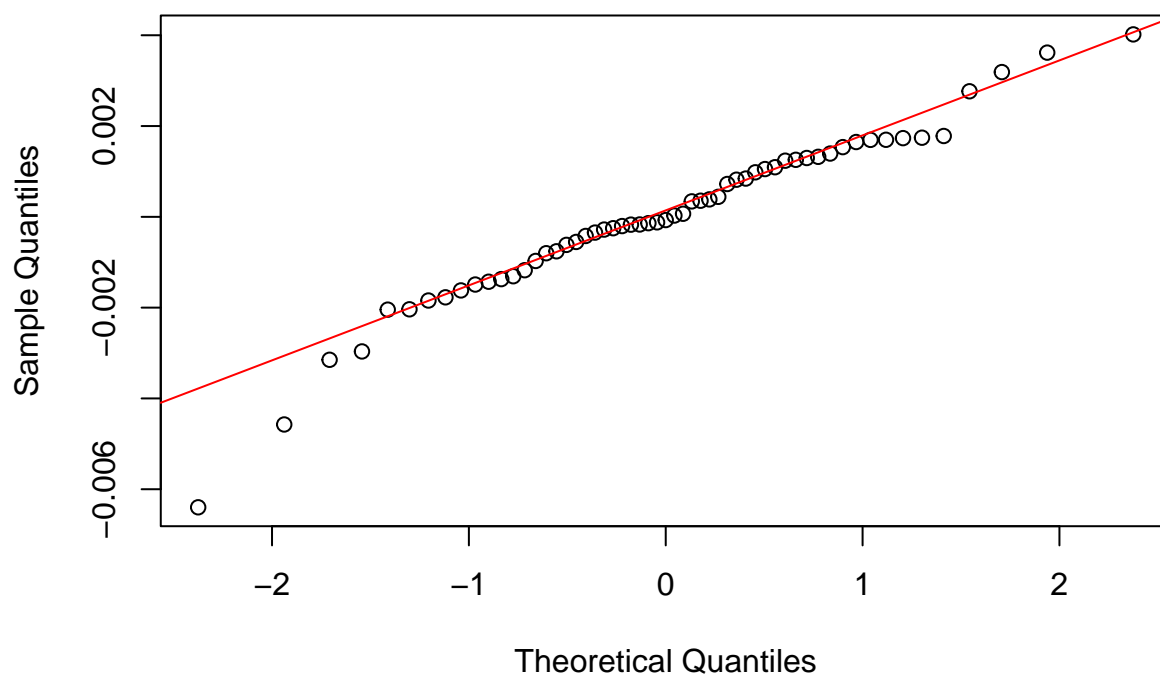
```
hist(resid_gdp_bc, breaks = 15, main = "Histogram of Residuals", xlab = "Residuals", col = "lightblue",
```

Histogram of Residuals



```
# Q-Q Plot  
qqnorm(resid_gdp_bc, main = "Q-Q Plot of Residuals")  
qqline(resid_gdp_bc, col = "red")
```

Q-Q Plot of Residuals



```
# Shapiro-Wilk Test  
shapiro_test <- shapiro.test(resid_gdp_bc)
```

```
print(shapiro_test)

##
##  Shapiro-Wilk normality test
##
## data:  resid_gdp_bc
## W = 0.95939, p-value = 0.05331
# Save differenced GDP data to CSV
write.csv(data.frame(Year = finalPro_data$Year[-1], Differenced_GDP = diff_gdp_bc),
          "differenced_gdp.csv", row.names = FALSE)
```