Practical–7 : Commercial Bank Real Estate Loans Analysis

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1. Title

Time Series Analysis of Monthly Commercial Bank Real Estate Loans

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2. Objective

Practical-7:-

Consider the monthly volume of commercial bank real estate loans (in billions of dollars) data set stored in a text file. Write the R program for the following: (f) Import data into the R environment. (g) Convert the data into a time series object. (h) Plot the data to identify the dominant component. (i) Check stationarity or non-stationarity using ACF/PACF plot. (j) Check stationarity or non-stationarity using the Augmented Dickey-Fuller (ADF) test. (k) If data is non-stationary, make it stationary using an appropriate operator. (l) Based on the dominating component, select the suitable model to fit the data and finalize the order of the model using ACF/PACF plots with model selection criteria such as AIC. (m) Fit the data using the selected model and estimate the parameters of the model. (n) Check the goodness of fit of the model.

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3. R Code

```
############################################################
# Practical-7 : Commercial Bank Real Estate Loans Analysis
############################################################

# Import data from text file
bank_data <- scan("bank_case.txt")
head(bank_data)
```
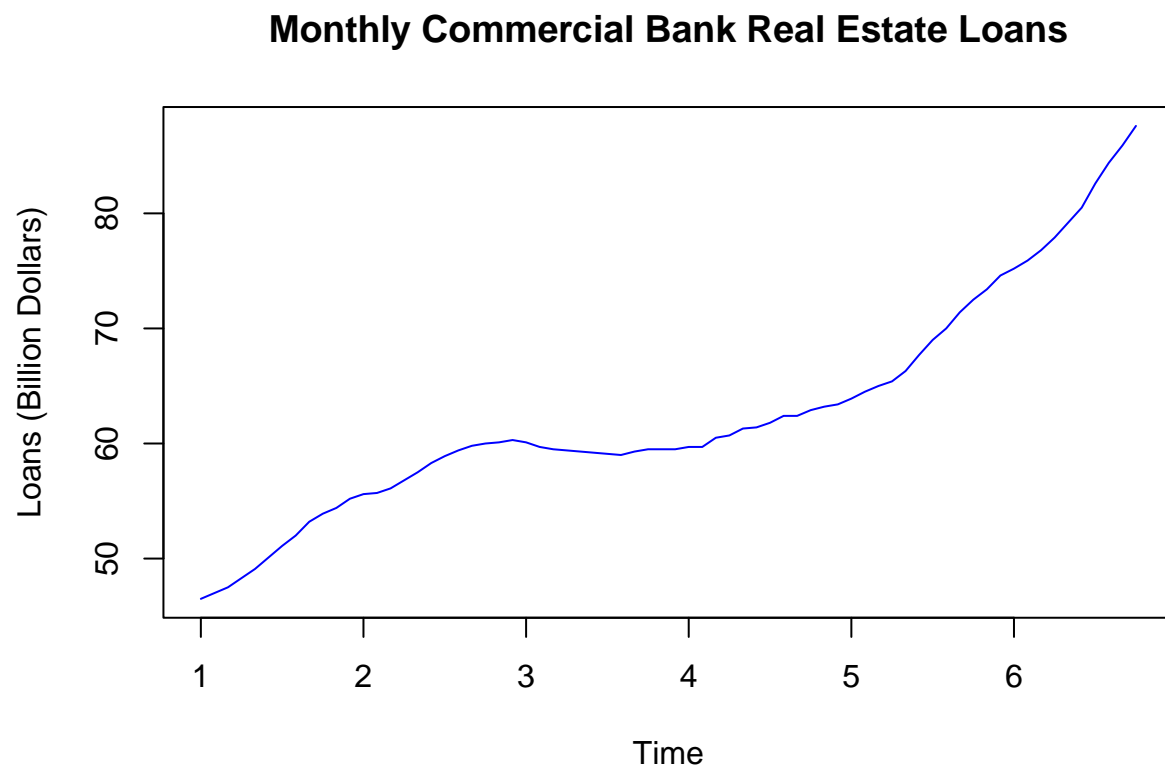
```
## [1] 46.5 47.0 47.5 48.3 49.1 50.1
```

```
# Convert to monthly time series
bank_ts <- ts(bank_data, frequency = 12)

# Plot original series
plot(bank_ts,
     main = "Monthly Commercial Bank Real Estate Loans",
     ylab = "Loans (Billion Dollars)",
     xlab = "Time",
     col = "blue")
```
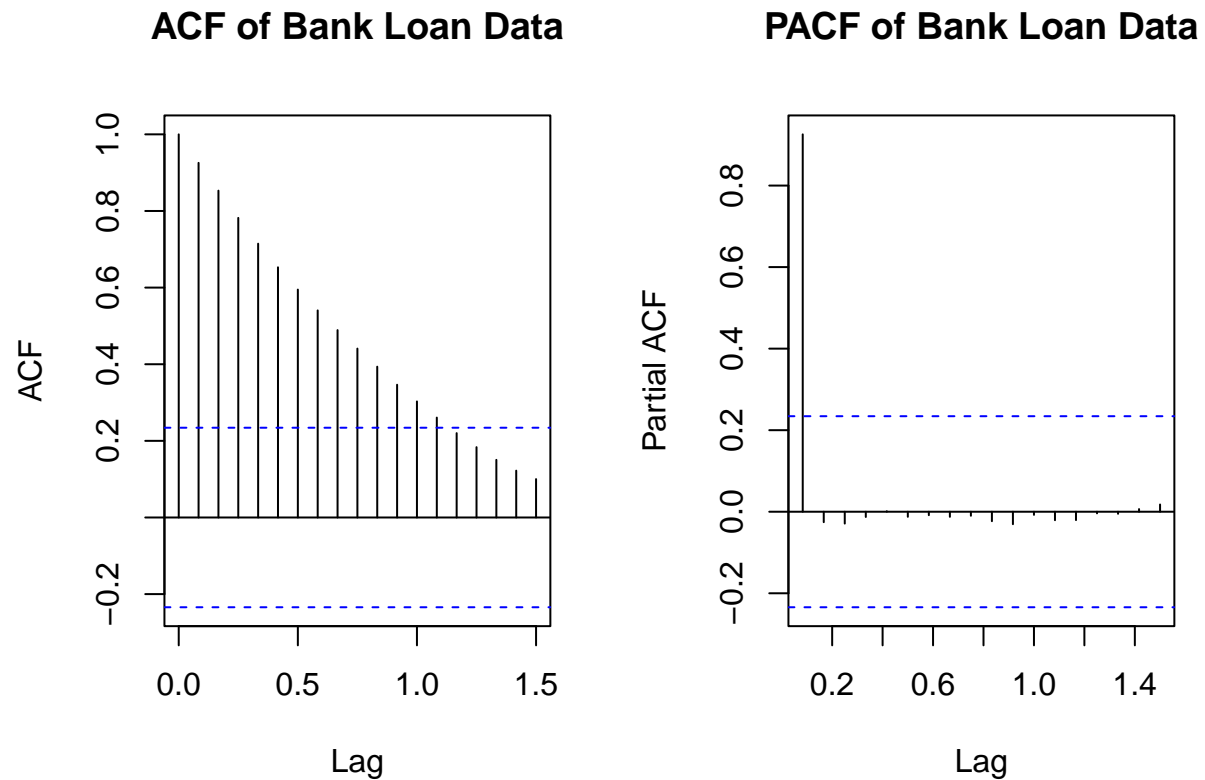
Monthly Commercial Bank Real Estate Loans


```
# ACF and PACF
par(mfrow = c(1, 2))
acf(bank_ts, main = "ACF of Bank Loan Data")
pacf(bank_ts, main = "PACF of Bank Loan Data")
```

ACF of Bank Loan Data

PACF of Bank Loan Data


```r
par(mfrow = c(1, 1))

# ADF Test
library(tseries)
```

```
## Registered S3 method overwritten by 'quantmod':
##   method            from
##   as.zoo.data.frame zoo
```
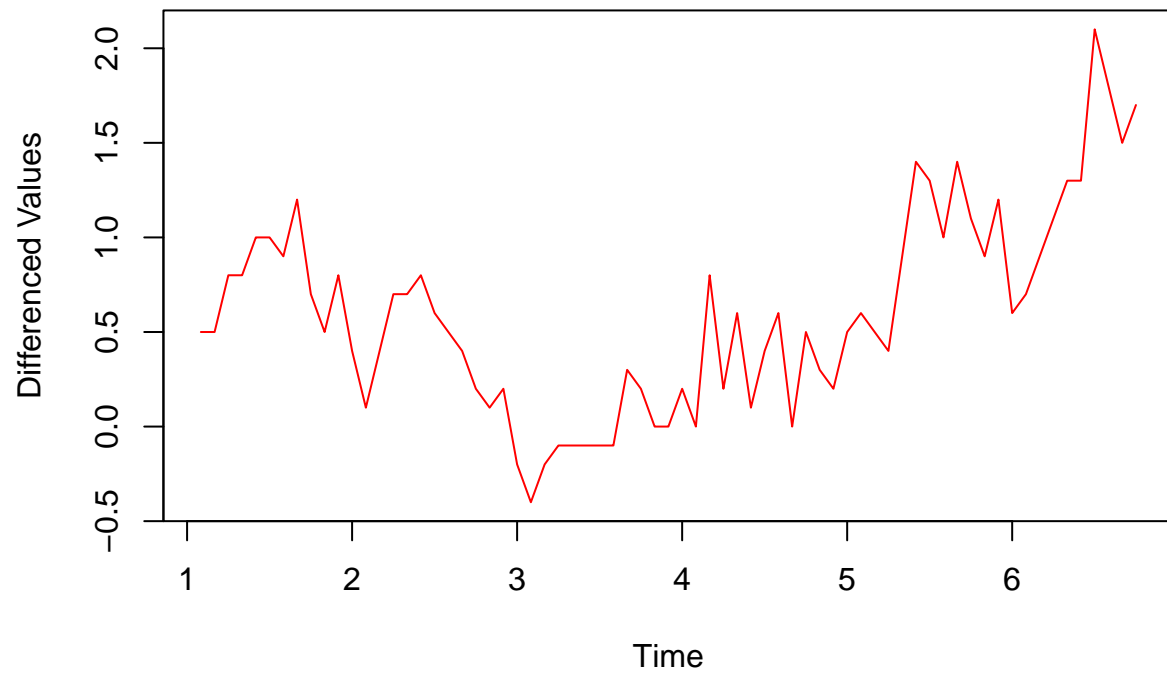
```r
adf.test(bank_ts)
```

```
##
##  Augmented Dickey-Fuller Test
##
## data:  bank_ts
## Dickey-Fuller = -0.26816, Lag order = 4, p-value = 0.9894
## alternative hypothesis: stationary
```

```r
# First differencing
bank_diff <- diff(bank_ts)

plot(bank_diff,
     main = "Differenced Bank Loan Time Series",
     ylab = "Differenced Values",
     col = "red")
```
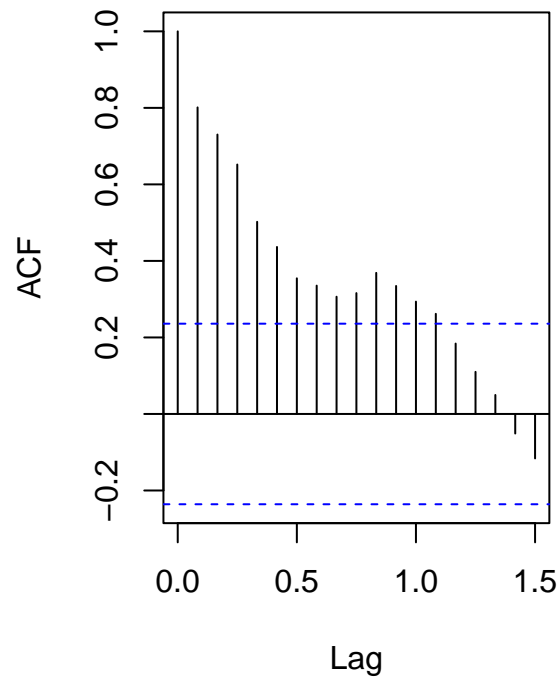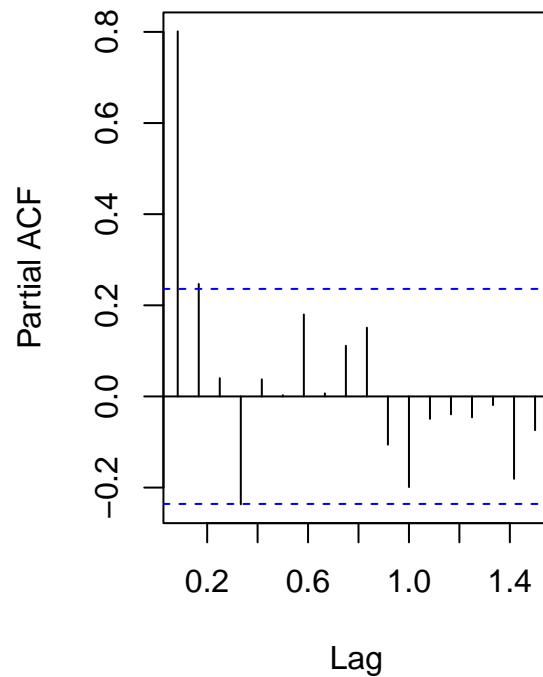
Differenced Bank Loan Time Series


```r
par(mfrow = c(1, 2))
acf(bank_diff, main = "ACF of Differenced Data")
pacf(bank_diff, main = "PACF of Differenced Data")
```

ACF of Differenced Data

PACF of Differenced Data


```r
par(mfrow = c(1, 1))

# ADF test after differencing
adf.test(bank_diff)
```

```
##
##  Augmented Dickey-Fuller Test
##
## data:  bank_diff
## Dickey-Fuller = -1.7533, Lag order = 4, p-value = 0.6755
## alternative hypothesis: stationary
```

```r
# Fit ARIMA model
library(forecast)
best_model <- auto.arima(bank_ts)
summary(best_model)
```
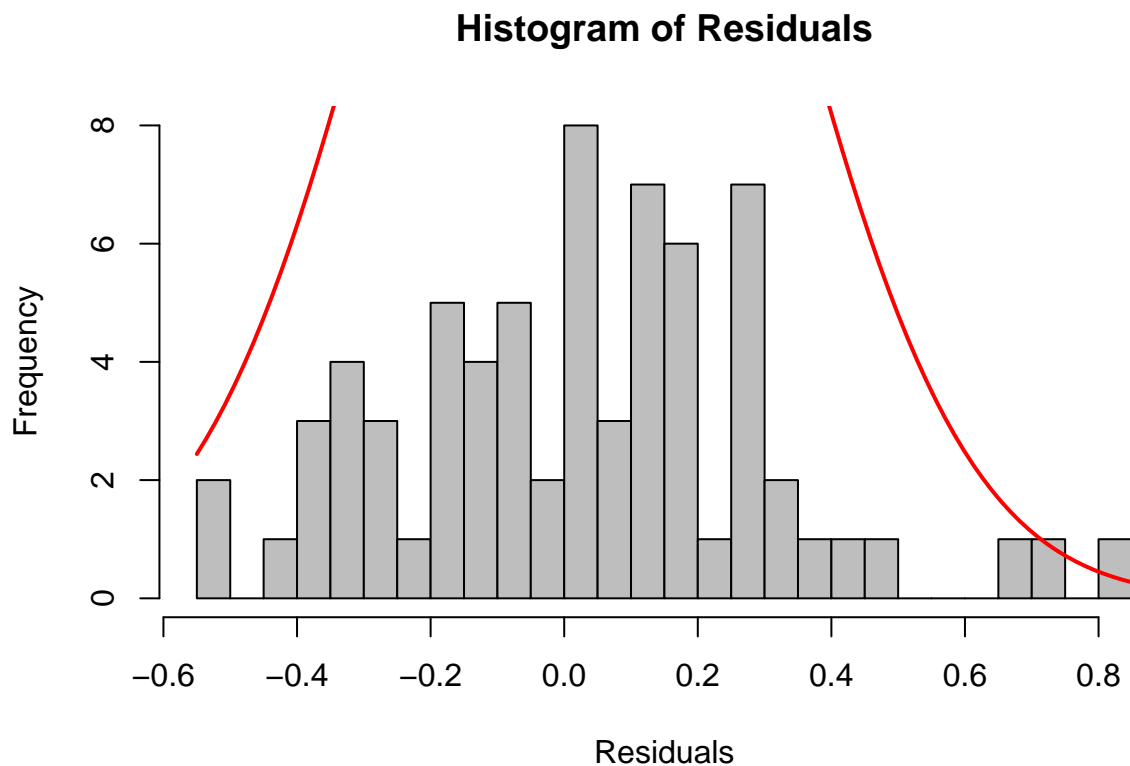
```
## Series: bank_ts
## ARIMA(0,2,1)
##
## Coefficients:
##           ma1
##        -0.3723
## s.e.    0.1074
##
```

```
## sigma^2 = 0.08216:  log likelihood = -11.07
## AIC=26.13   AICc=26.32   BIC=30.57
##
## Training set error measures:
##                       ME       RMSE       MAE        MPE       MAPE        MASE
## Training set 0.02588399 0.2804343 0.221703 0.03642303 0.3527895 0.03652023
##                      ACF1
## Training set -0.03212954
```
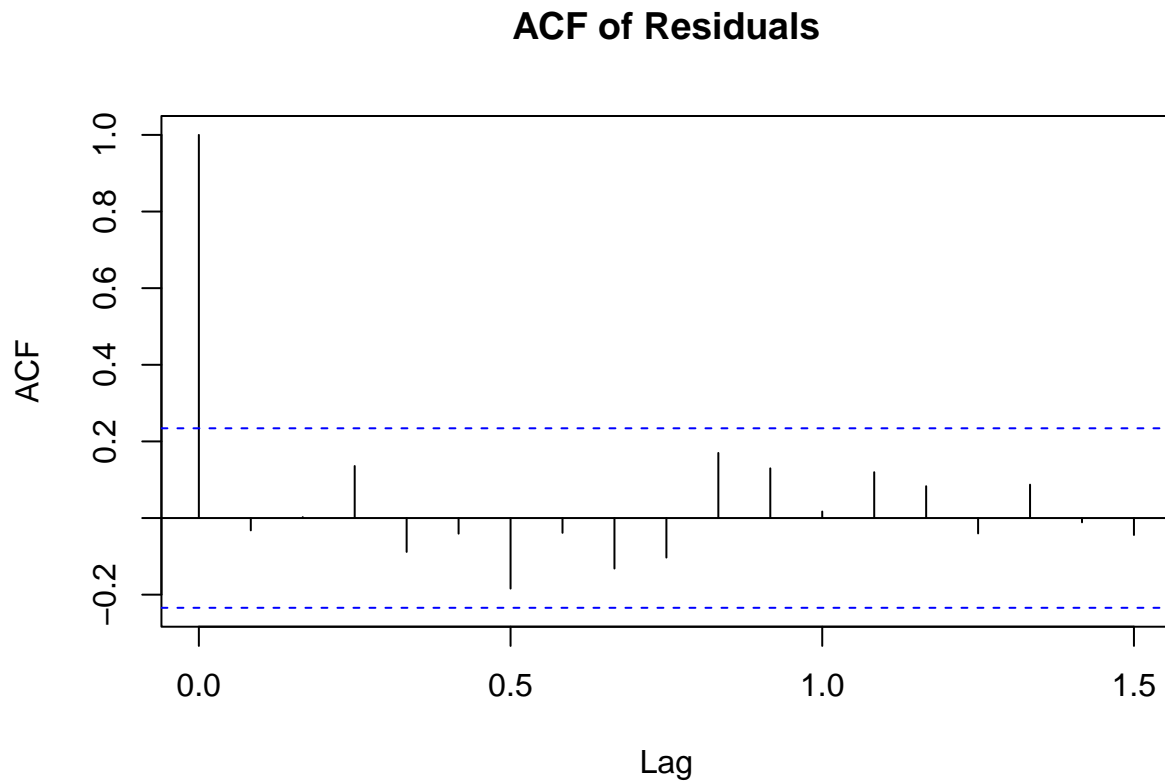
```r
# Residual diagnostics
res <- residuals(best_model)

hist(res,
     breaks = 20,
     freq = TRUE,
     col = "grey",
     main = "Histogram of Residuals",
     xlab = "Residuals",
     ylab = "Frequency")

curve(dnorm(x, mean(res), sd(res)) * length(res) *
        diff(hist(res, plot = FALSE)$breaks)[1],
      add = TRUE, col = "red", lwd = 2)
```

Histogram of Residuals

```r
acf(res, main = "ACF of Residuals")
```

ACF of Residuals


```r
Box.test(res, lag = 12, type = "Ljung-Box")
```

```
##
##   Box-Ljung test
##
## data:  res
## X-squared = 11.154, df = 12, p-value = 0.5158
```

```r
############################################################
# 4. Output
# The time series plot shows a clear trend component.
# ACF and PACF plots indicate non-stationarity.
# Augmented Dickey-Fuller test confirms the series is non-stationary.
# First differencing makes the series stationary.
# ARIMA model is selected using AIC.
# Residuals show no significant autocorrelation.
# Histogram of residuals is approximately normal.
# Ljung-Box test confirms residuals behave like white noise.
#
# 5. Conclusion
# The monthly commercial bank real estate loan data exhibits
# non-stationary behavior due to the presence of a trend component.
```

```
# Stationarity is achieved using first differencing.
# An appropriate ARIMA model is fitted and validated through
# residual diagnostics. The results confirm that the model
# provides a good fit and is suitable for analyzing the given
# time series.
################################################################
```