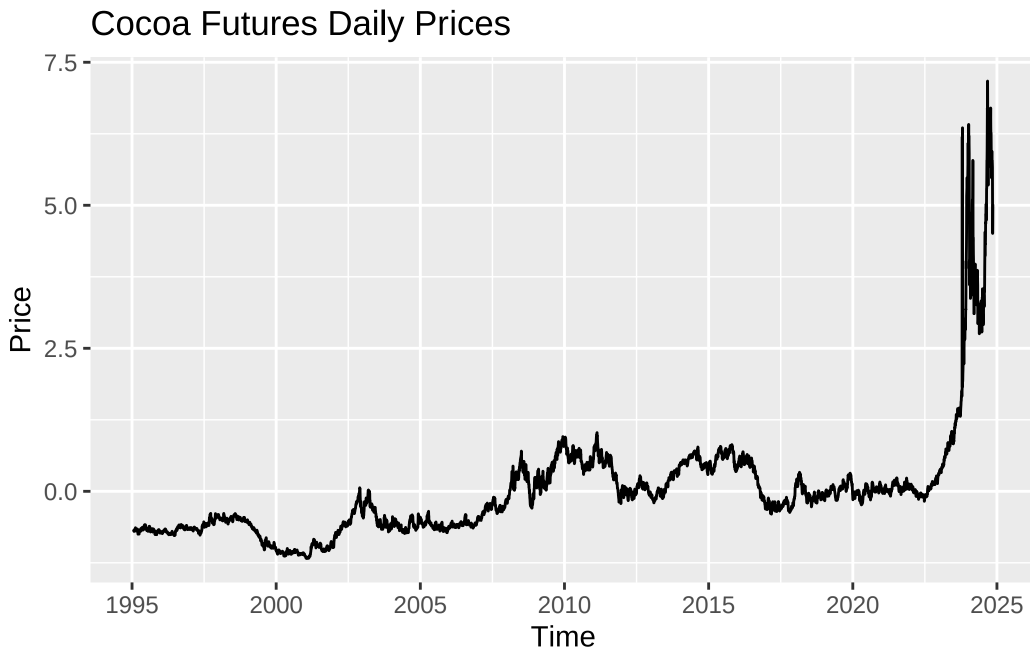
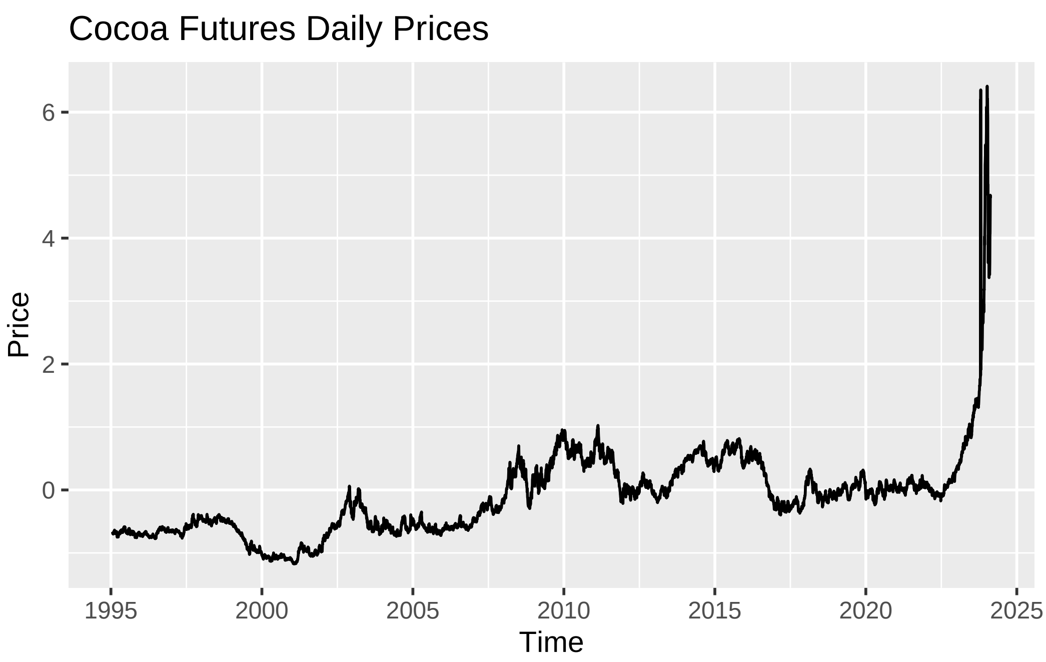
Cocoa future prices arima modelling

```r
# Load libraries
library(readr)
library(lubridate)
library(forecast)
library(ggplot2)
library(tseries)
library(tsoutliers)
library(vars)
```

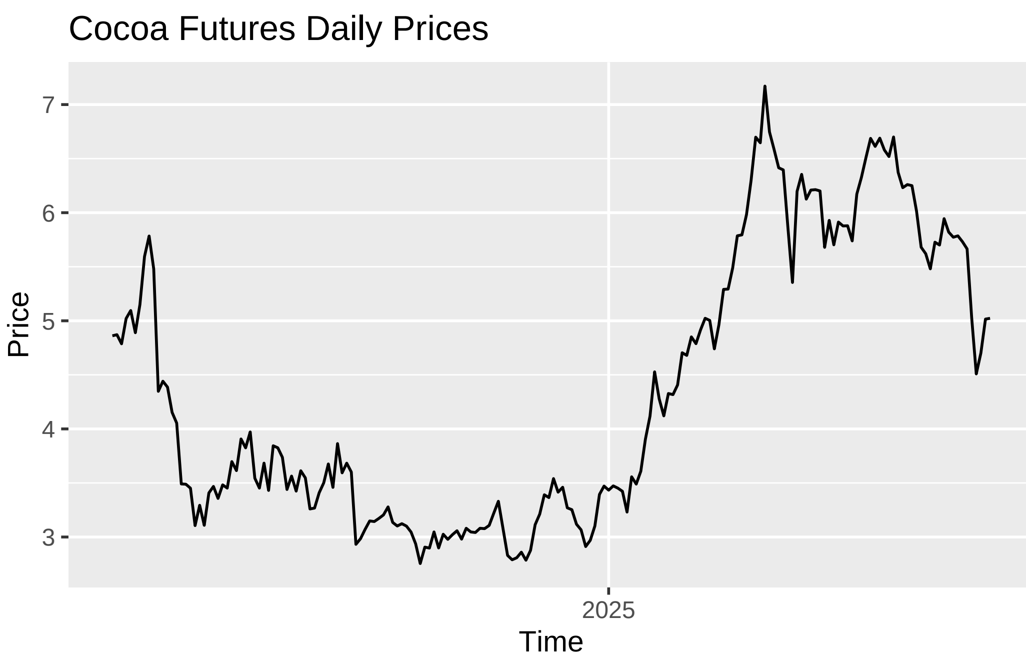
```r
# Read the CSV file
data <- read_csv("Daily Prices_ICCO (1).csv", show_col_types = FALSE)
data$Date <- as.Date(data$Date, format = "%d/%m/%Y")

data <- data[order(data$Date), ]

# Scale the price
data$ScaledPrice <- scale(data$`ICCO daily price (US$/tonne)`, center = TRUE, scale = TRUE)

# Calculate start_year and start_day before creating the time series
start_year <- year(min(data$Date))
start_doy  <- yday(min(data$Date))

# Create a time series
price_ts <- ts(data$ScaledPrice, frequency = 262, start = c(start_year, start_doy))

# Plot time series
autoplot(price_ts) +
  ggtitle("Cocoa Futures Daily Prices") +
  xlab("Time") +
  ylab("Price")
```




```
# Split the Data
# Create training and test subsets from the original data frame
train_data <- data[data$Date < as.Date("2024-06-01"), ]
test_data  <- data[data$Date >= as.Date("2024-06-01"), ]

# Change the training subset into a time series
train_start_year <- year(min(train_data$Date))
train_start_doy  <- yday(min(train_data$Date))
train_ts <- ts(train_data$ScaledPrice, frequency = 262, start = c(train_start_year, train_sta
autoplot(train_ts)+
  ggtitle("Cocoa Futures Daily Prices") +
  xlab("Time") +
  ylab("Price")
```




```
# Change the test subset into a time series
test_start_year <- year(min(test_data$Date))
test_start_doy  <- yday(min(test_data$Date))
test_ts <- ts(test_data$ScaledPrice, frequency = 262, start = c(test_start_year, test_start_c

autoplot(test_ts)+
  ggtitle("Cocoa Futures Daily Prices") +
  xlab("Time") +
  ylab("Price")
```




```
# Check for variance stabilization need using a Box-Cox transformation
lambda <- BoxCox.lambda(train_ts)
cat("Estimated Box-Cox Lambda:", lambda, "\n")
```

```
Estimated Box-Cox Lambda: 0.4932815
```

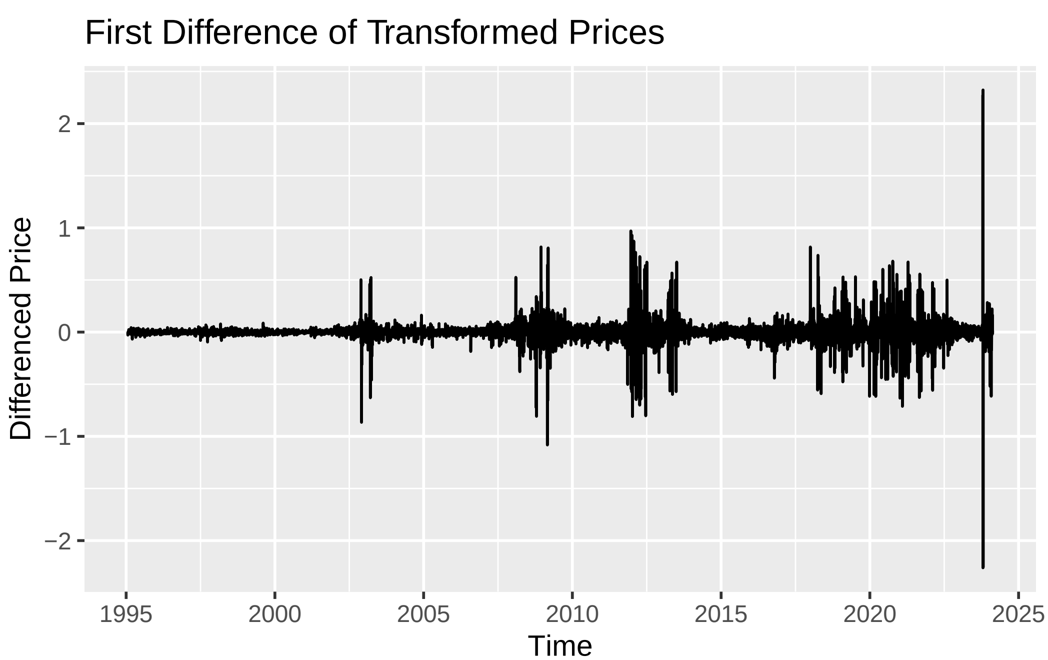
```
# Apply Box-Cox transformation if lambda is not 1
if(abs(lambda - 1) > 0.1){
  train_ts <- BoxCox(train_ts, lambda)
} else {
  train_ts <- train_ts
}
```

```
# 3. Stationarity Check

# ADF Test on the training series
adf_result <- adf.test(train_ts)
print(adf_result)
```

```
    Augmented Dickey-Fuller Test
```

```
data:  train_ts
Dickey-Fuller = -3.1274, Lag order = 19, p-value = 0.1008
alternative hypothesis: stationary
```

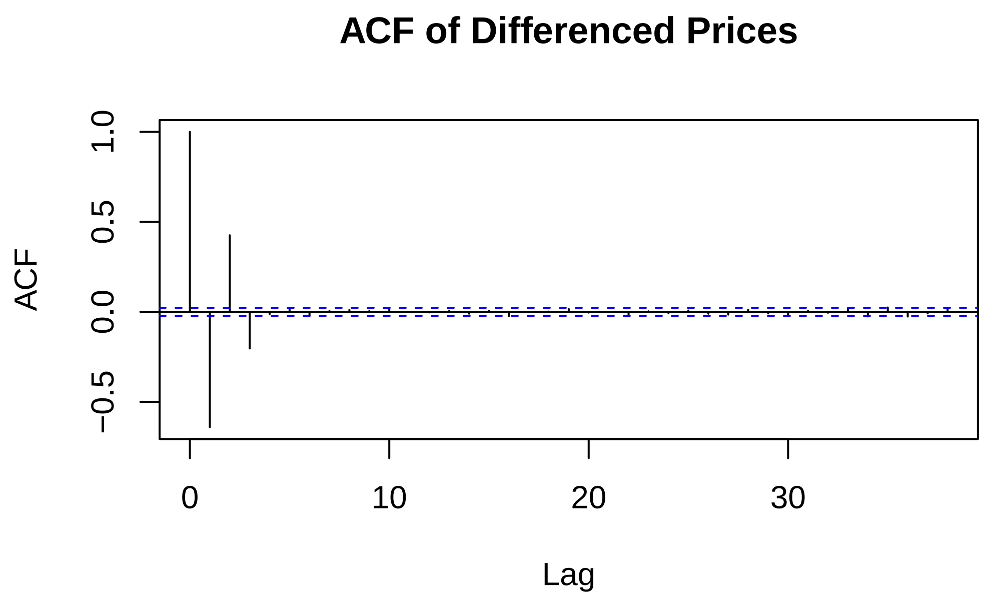
```
# Compute the differenced series if non-stationary
if(adf_result$p.value > 0.05){
  train_diff <- diff(train_ts)
} else {
  train_diff <- train_ts
}

autoplot(train_diff) +
  ggtitle("First Difference of Transformed Prices") +
  xlab("Time") +
  ylab("Differenced Price")
```



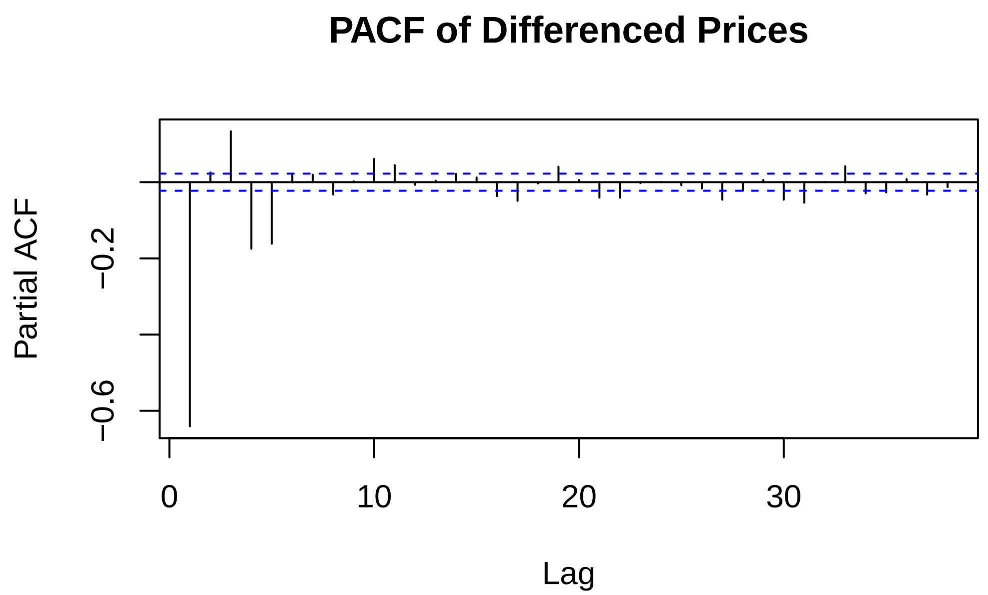

```
# Create new training subset into a time series, frequency = 1
train_ts_acf <- ts(train_data$ScaledPrice, frequency = 1, start = c(train_start_year, train_s
if(adf_result$p.value > 0.05){
  train_diff_acf <- diff(train_ts_acf)
} else {
```

```
  train_diff_acf <- train_ts_acf
}
```

```
# ACF of differenced time series
acf(train_diff_acf, main = "ACF of Differenced Prices")
```




```
# PACF of differenced series
pacf(train_diff_acf, main = "PACF of Differenced Prices")
```



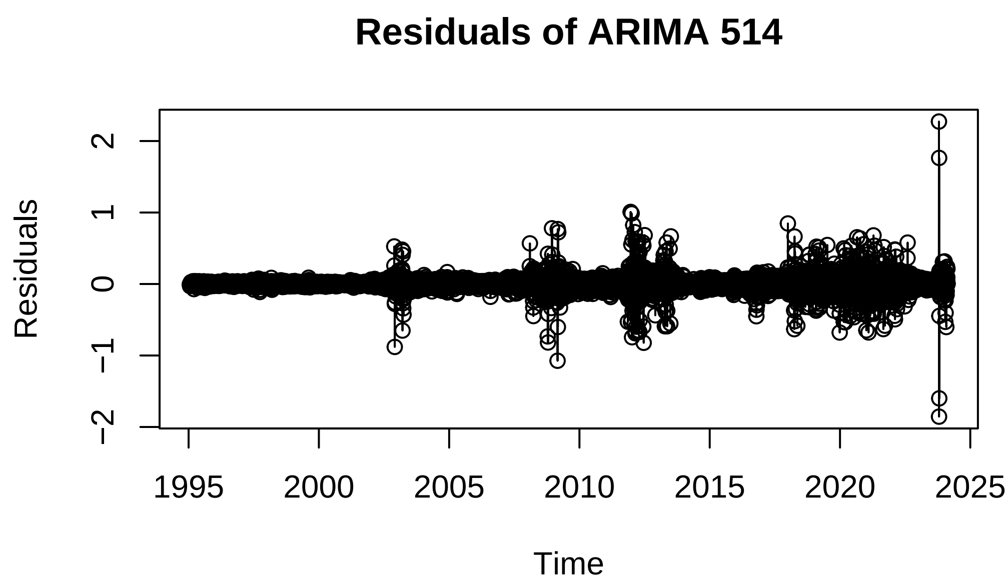

```r
# Candidate models based on ACF/PACF interpretation

candidate_513 <- arima(train_ts_acf, order = c(5, 1, 3))
candidate_514 <- arima(train_ts_acf, order = c(5, 1, 4))
candidate_415 <- arima(train_ts_acf, order = c(4, 1, 5))
candidate_413 <- arima(train_ts_acf, order = c(4, 1, 3))
candidate_414 <- arima(train_ts_acf, order = c(4, 1, 4))
candidate_315 <- arima(train_ts_acf, order = c(3, 1, 5))
candidate_314 <- arima(train_ts_acf, order = c(3, 1, 4))
candidate_311 <- arima(train_ts_acf, order = c(3, 1, 1))
candidate_312 <- arima(train_ts_acf, order = c(3, 1, 2))
candidate_313 <- arima(train_ts_acf, order = c(3, 1, 3))
model_comparison <- data.frame(
  Model = c("ARIMA(513)", "ARIMA(514)", "ARIMA(415)", "ARIMA(413)", "ARIMA(414)", "ARIMA(315
  AIC = c(AIC(candidate_513), AIC(candidate_514), AIC(candidate_415), AIC(candidate_413), AI(
)
print(model_comparison)
```

```
        Model       AIC
1  ARIMA(513) -16695.91
2  ARIMA(514) -16731.24
3  ARIMA(415) -16716.55
```

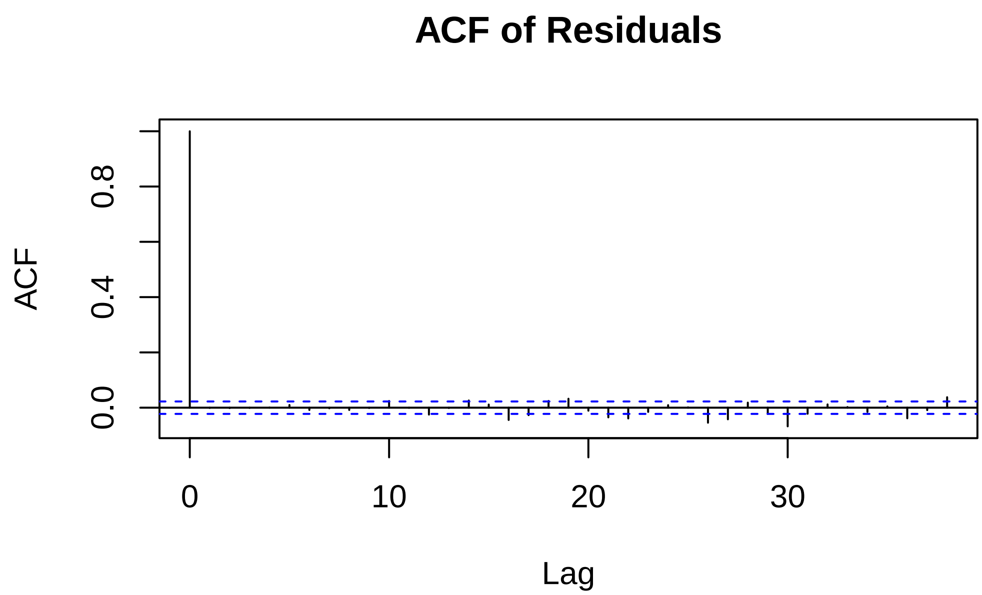
```
4  ARIMA(413) -16694.98
5  ARIMA(414) -16729.21
6  ARIMA(315) -16689.81
7  ARIMA(314) -16691.94
8  ARIMA(311) -16308.81
9  ARIMA(312) -16549.16
10 ARIMA(313) -16693.71
```

```r
best_model <- candidate_514
```

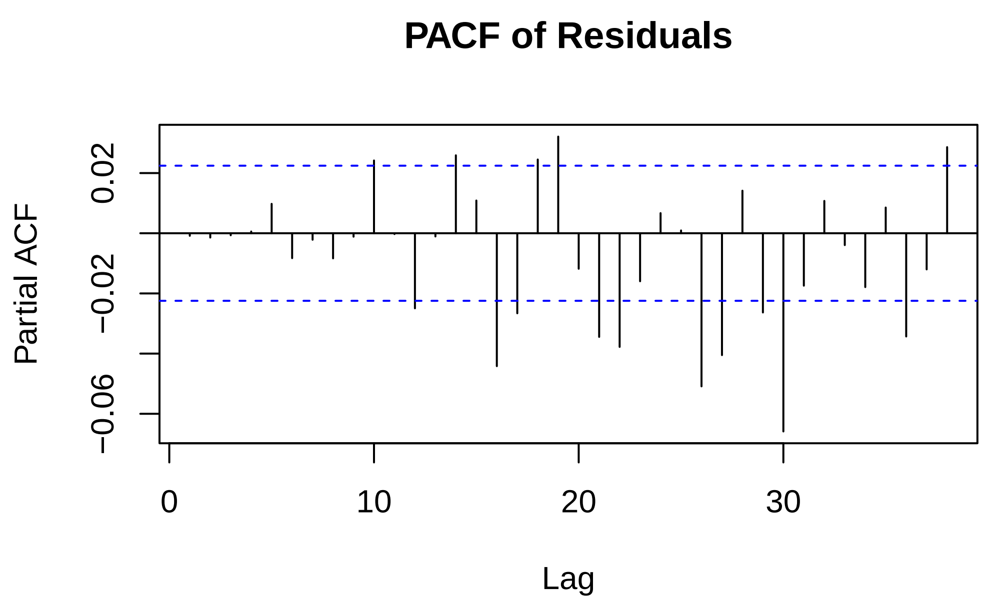
```r
candidate_514_11 <- arima(train_ts, order = c(5, 1, 4))

# Plot residuals of ARIMA(5,1,4) model

plot(residuals(candidate_514_11), type = "o",
     main = "Residuals of ARIMA 514",
     xlab = "Time", ylab = "Residuals")
```



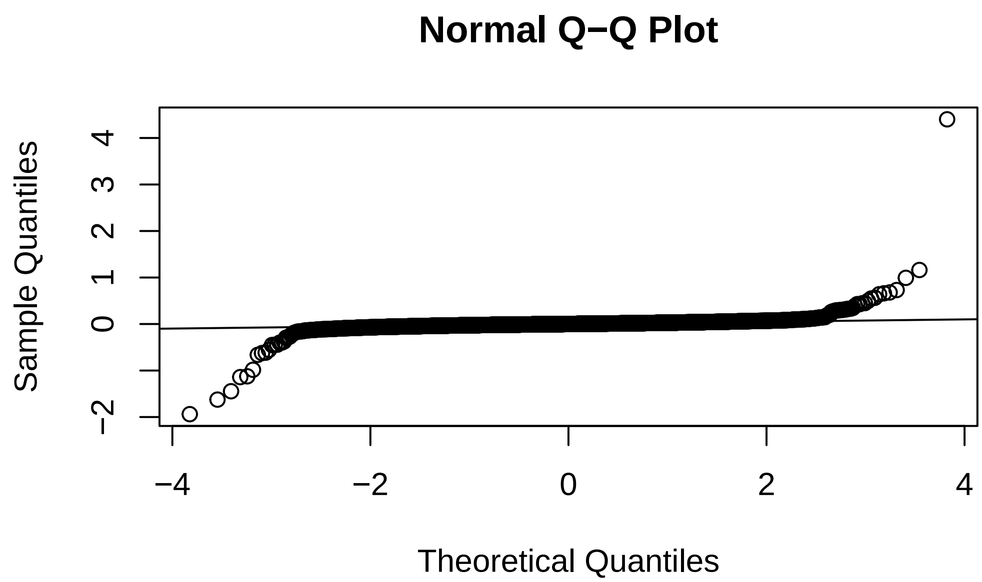

```r
# ACF of residuals of ARIMA(5,1,4) model

acf(residuals(candidate_514), main = "ACF of Residuals")
```




```r
# PACF of residuals of ARIMA(5,1,4)
pacf(residuals(candidate_514), main = "PACF of Residuals")
```



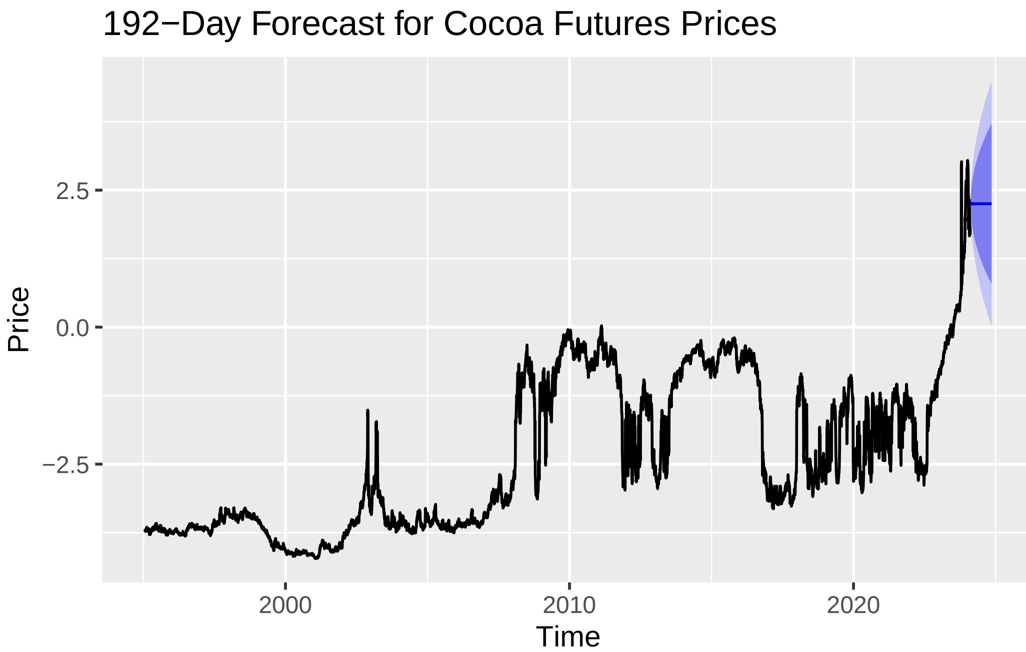
```
# Normal Q-Q plot of ARIMA(5,1,4)
qqnorm(residuals(candidate_514))
qqline(residuals(candidate_514))
```



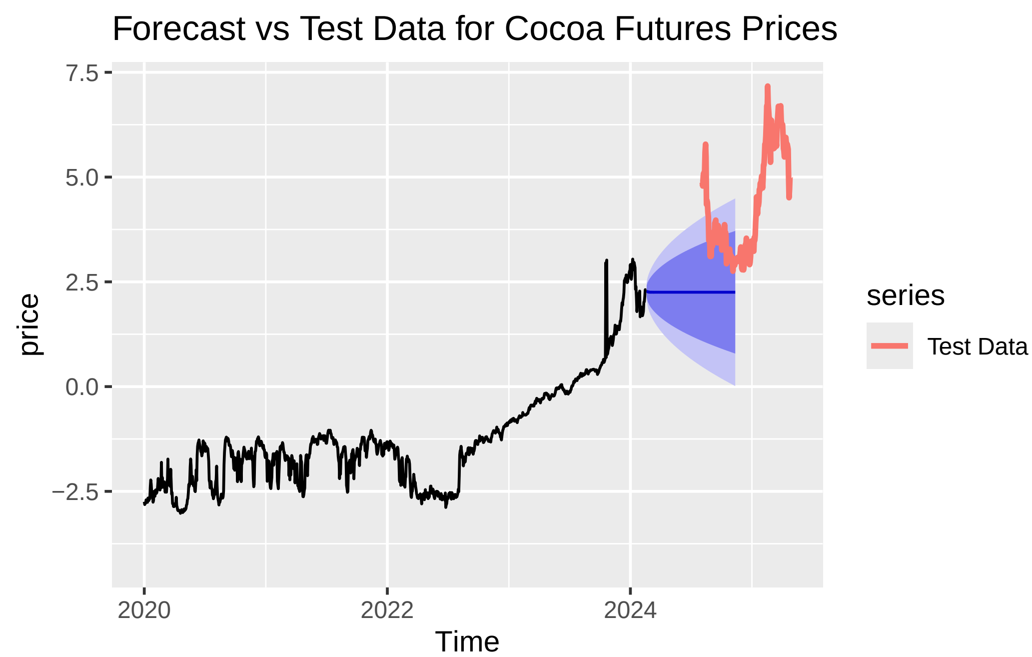

```
# Box-ljung test on residuals of ARIMA(5,1,4) model
lg_test <- Box.test(residuals(candidate_514), lag = 10, type = "Ljung-Box")
print(lg_test)
```

```
    Box-Ljung test

data:  residuals(candidate_514)
X-squared = 6.3583, df = 10, p-value = 0.7843
```

```
# Plot a 192-day forecast

forecast_horizon <- 192
fc <- forecast(candidate_514_11, h = forecast_horizon)
autoplot(fc)+
  ggtitle("192-Day Forecast for Cocoa Futures Prices")+
  xlab("Time")+
  ylab("Price")
```




```r
# Create forecast
horizon <- length(test_ts)
fc <- forecast(candidate_514_11, h = horizon)

# Create plot of the forecast
autoplot(fc, PI = TRUE) +
  autolayer(test_ts, series = "Test Data", size = 1) +
  ggtitle("Forecast vs Test Data for Cocoa Futures Prices")+
  xlab("Time") +
  ylab("price")+
  scale_x_continuous(limits = c(2020, NA))
```




```
# Check both have the same length
length(fc$mean)
```

```
[1] 192
```

```
length(test_ts)
```

```
[1] 192
```

```
# Change both to numeric
fc_vec   <- as.numeric(fc$mean)
test_vec <- as.numeric(test_ts)

# Confirm they match in length
if(length(fc_vec) != length(test_vec)){
  stop("Forecast length != Test set length. Adjust horizon or test split.")
}

# Run accuracy on numeric vectors
accuracy(fc_vec, test_vec)
```

```
                ME     RMSE      MAE      MPE     MAPE
Test set 2.100616 2.451231 2.100616 43.99057 43.99057
```

```r
library(forecast)

# Fit  ARIMA(5,1,4) model
fit <- Arima(train_ts_acf, order = c(5, 1, 4))

# Obtain the in-sample fitted values
fitted_vals <- fitted(fit)

# Use the accuracy function
accuracy(fit)
```

```
                      ME       RMSE        MAE      MPE     MAPE     MASE
Training set 0.001185378 0.08059072 0.02718357 4.186611 30.79338 1.224641
                      ACF1
Training set -0.0008424963
```