

573_HW_1

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```
# Load the Johnson & Johnson data
data("JohnsonJohnson")

jj_data <- data.frame(
  Year = as.numeric(time(JohnsonJohnson)),
  EPS = as.numeric(JohnsonJohnson)
)

jj_data$log_EPS <- log(jj_data$EPS)

jj_data$t <- jj_data$Year
jj_data$Quarter <- as.factor(cycle(JohnsonJohnson))
jj_data$Q1 <- ifelse(jj_data$Quarter == 1, 1, 0)
jj_data$Q2 <- ifelse(jj_data$Quarter == 2, 1, 0)
jj_data$Q3 <- ifelse(jj_data$Quarter == 3, 1, 0)
jj_data$Q4 <- ifelse(jj_data$Quarter == 4, 1, 0)

model <- lm(log_EPS ~ t + Q1 + Q2 + Q3 + Q4 - 1, data = jj_data)

summary(model)

##
## Call:
## lm(formula = log_EPS ~ t + Q1 + Q2 + Q3 + Q4 - 1, data = jj_data)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.29318 -0.09062 -0.01180  0.08460  0.27644
##
## Coefficients:
##      Estimate Std. Error t value Pr(>|t|)
## t    1.672e-01  2.259e-03   74.00  <2e-16 ***
## Q1  -3.283e+02  4.451e+00  -73.76  <2e-16 ***
## Q2  -3.282e+02  4.451e+00  -73.75  <2e-16 ***
## Q3  -3.282e+02  4.452e+00  -73.72  <2e-16 ***
## Q4  -3.284e+02  4.452e+00  -73.77  <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1254 on 79 degrees of freedom
```

```
## Multiple R-squared:  0.9935, Adjusted R-squared:  0.9931
## F-statistic:  2407 on 5 and 79 DF,  p-value: < 2.2e-16

beta <- coef(model)["t"]
cat("Estimated average annual increase in logged earnings per share:", beta,
"\n")

## Estimated average annual increase in logged earnings per share: 0.1671722

alpha3 <- coef(model)["Q3"]
alpha4 <- coef(model)["Q4"]

delta_alpha <- alpha4 - alpha3
cat("Change from Q3 to Q4 in logged earnings:", delta_alpha, "\n")

## Change from Q3 to Q4 in logged earnings: -0.2687577

percentage_change <- (delta_alpha)/abs(alpha3)
cat("Percentage change from Q3 to Q4:", percentage_change, "%\n")

## Percentage change from Q3 to Q4: -0.0008189384 %
```

The average Log earnings rate decreases slightly from Q3 to Q4

```
model_with_intercept <- lm(log_EPS ~ t + Q1 + Q2 + Q3 + Q4, data = jj_data)
summary(model_with_intercept)

##
## Call:
## lm(formula = log_EPS ~ t + Q1 + Q2 + Q3 + Q4, data = jj_data)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.29318 -0.09062 -0.01180  0.08460  0.27644
##
## Coefficients: (1 not defined because of singularities)
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) -3.284e+02  4.452e+00 -73.771  < 2e-16 ***
## t           1.672e-01  2.259e-03  73.999  < 2e-16 ***
## Q1           1.705e-01  3.873e-02   4.403 3.31e-05 ***
## Q2           1.986e-01  3.871e-02   5.132 2.01e-06 ***
## Q3           2.688e-01  3.870e-02   6.945 9.50e-10 ***
## Q4                    NA         NA      NA      NA
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1254 on 79 degrees of freedom
## Multiple R-squared:  0.9859, Adjusted R-squared:  0.9852
## F-statistic:  1379 on 4 and 79 DF,  p-value: < 2.2e-16

jj_data$fitted <- fitted(model)
```

```
# Plot the data and fitted values
```

```
library(ggplot2)
```

```
ggplot(jj_data, aes(x = t, y = log_EPS)) +  
  geom_line(color = "blue", size = 1) +  
  geom_line(aes(y = fitted), color = "red", size = 1, linetype = "dashed") +  
  labs(title = "Logged Earnings per Share with Fitted Values",  
       x = "Time (Years)",  
       y = "Log(Earnings per Share)") +  
  theme_minimal()
```

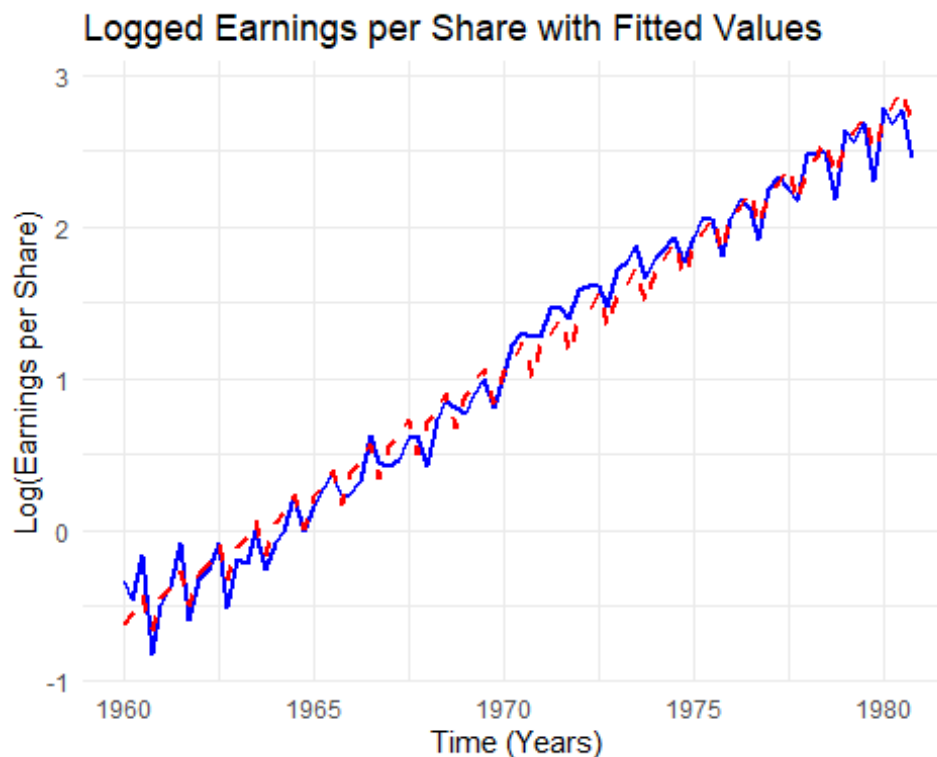
```
## Warning: Using `size` aesthetic for lines was deprecated in ggplot2 3.4.0.
```

```
## i Please use `linewidth` instead.
```

```
## This warning is displayed once every 8 hours.
```

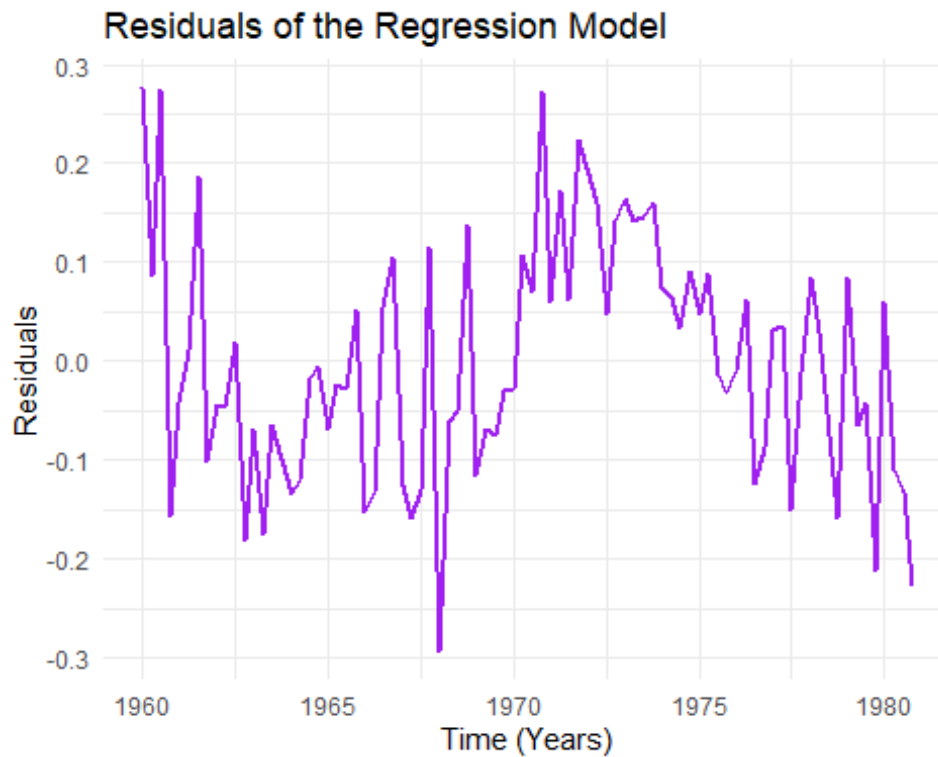
```
## Call `lifecycle::last_lifecycle_warnings()` to see where this warning was
```

```
## generated.
```

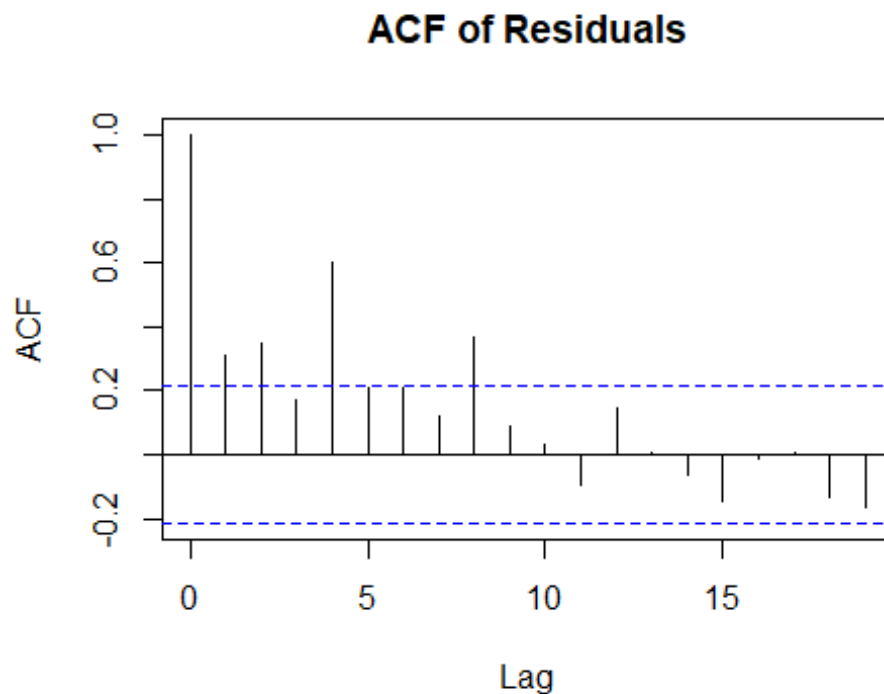


```
jj_data$residuals <- resid(model)
```

```
ggplot(jj_data, aes(x = t, y = residuals)) +  
  geom_line(color = "purple", size = 1) +  
  labs(title = "Residuals of the Regression Model",  
       x = "Time (Years)",  
       y = "Residuals") +  
  theme_minimal()
```



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



The Residuals do not look like white noise in between 1970 and 1975 where we seem to systematically under predict. This model is OK but not great