QMB Exercise 3 - Regression for Wal Mart Dataset

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Introduction

The following report is based on the QMB Exercise 3 - Multiple Regression. The task description pdf file is Exercise-Walmart-20150520.pdf.

Requirements

Please make sure that you the following packages loaded in your workspace.

```
library("dplyr")
library("ggplot2")
library("leaps")
library("car")
```

Data Set

Please make sure you have the file housingrents.csv in the subdirectoy Data in your workspace.

```
walmart <- read.csv("./data/Wal-Mart_revenue.csv",sep=";")
```

Problem 1

Problem 2

In Task 2 we continue the multiple regression but introduce an indicator variable December.

1.

Calculate the regression model with the four explanatory variables RetailSalesIndex, PersonalConsumption, CPI and December. Discuss the individual coefficients including their significance and explain what the coefficient for December means.

```
walmartLm <- lm(WalMartRevenue~RetailSalesIndex+PersonalConsumption+CPI+December, data = walmart)
summary(walmartLm)
```

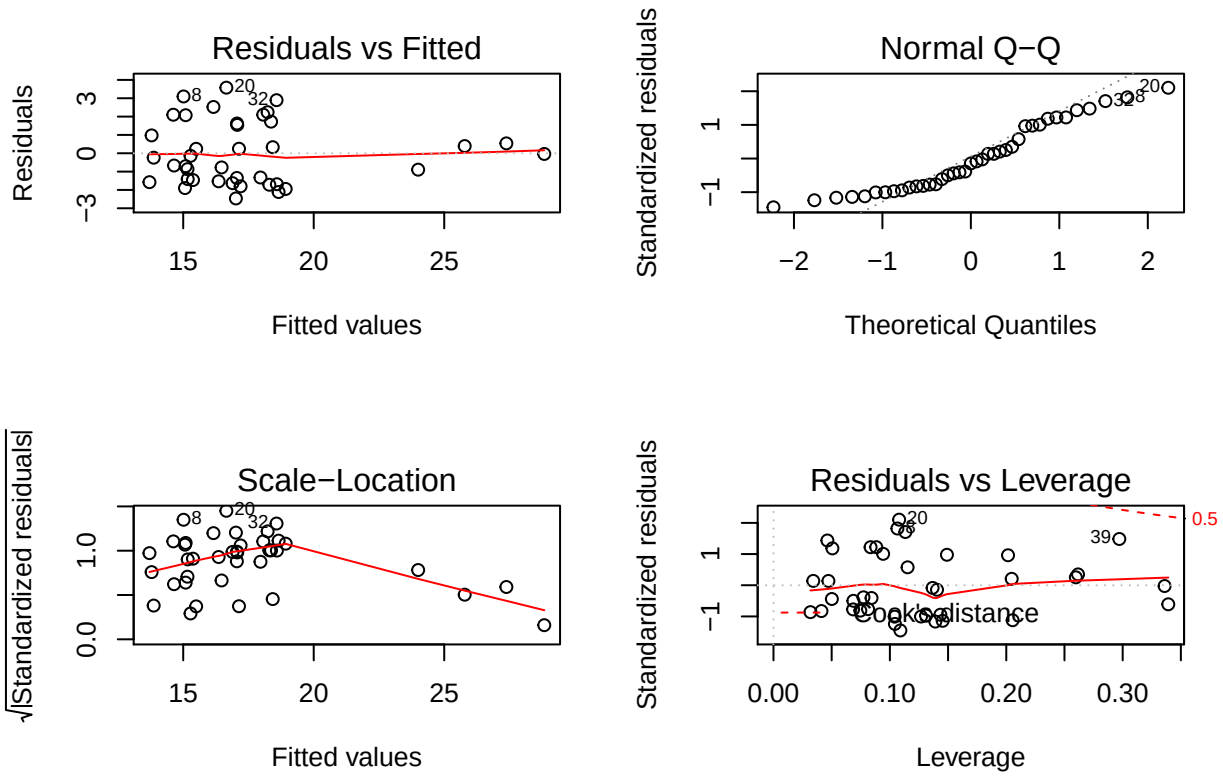
```
##
## Call:
## lm(formula = WalMartRevenue ~ RetailSalesIndex + PersonalConsumption +
##     CPI + December, data = walmart)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -2.4639 -1.4941 -0.2417  1.5851  3.5764
##
## Coefficients:
##                         Estimate Std. Error t value Pr(>|t|)
## (Intercept)         -2.094e+01  3.395e+01  -0.617    0.542
## RetailSalesIndex     1.471e-05  2.152e-05   0.684    0.499
## PersonalConsumption  1.145e-06  3.956e-06   0.289    0.774
## CPI                  3.851e-02  1.212e-01   0.318    0.753
## December             9.385e+00  1.898e+00   4.944 2.03e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.801 on 34 degrees of freedom
## Multiple R-squared:  0.806,  Adjusted R-squared:  0.7832
## F-statistic: 35.32 on 4 and 34 DF,  p-value: 1.146e-11
```

The coefficients for RetailSalesIndex, PersonalConsumption and CPI are in the Range of 0.00001 to 0.03 which means that a small change in these indexes have an impact on Wal Marts sales revenue. However their significance is far above 0.05, which means that the coefficients value for this sample could be due to chance. The indicator variable December adds 9.39 to the Intercept, which means that the revenue is nearly 10 units higher in December than for non December month. The adjusted R^2 is 0.7832, which means that the model explains the variance to a large degree.

2.

Check the diagnostic plots. Comments?

```
par(mfrow = c(2, 2))
plot(walmartLm)
```



The Normal Q-Q plot shows that the distribution is not normal distributed and has some outliers. The residual vs. fitted plot are sparse on the right bottom. Additionally outliers 23, 28 and 21 pull the fitted line up respectively down, which means they have a high leverage. In the residuals vs.leverage plot the points 23, 26 and 39 are shown again. These outliers would have to be checked and dealt with.

3.

Does it seem that Wal-Marts's revenue is closely related to the general state of the economy? The general state of the economy here is represented by the variables in the regression equation?

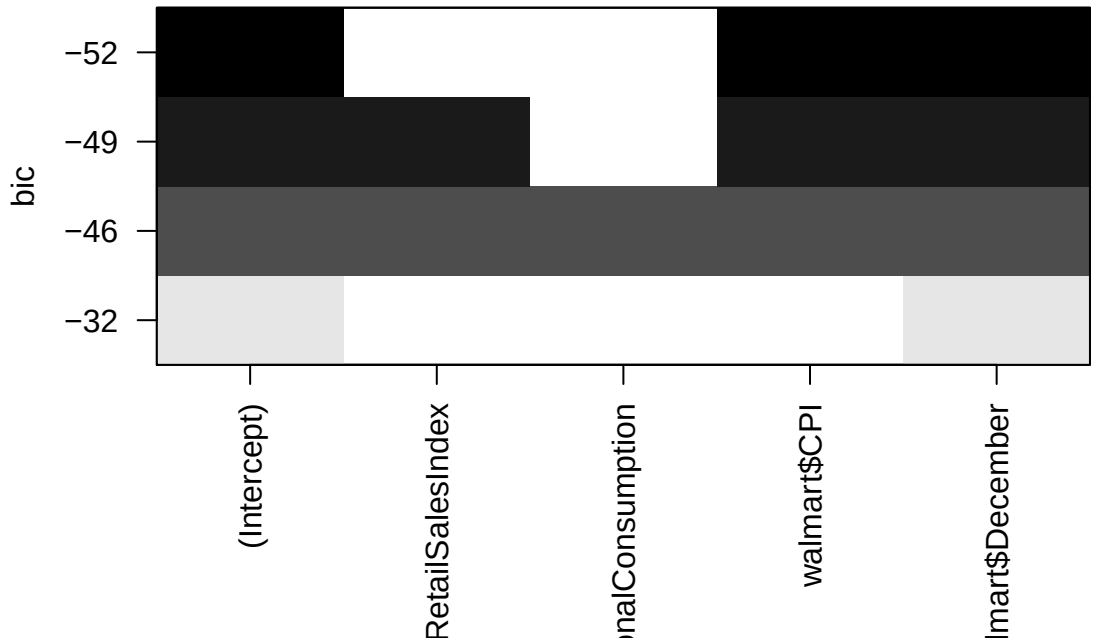
Yes, the F statistic and R^2 is rather large. The p-value for the F-statistic allows to reject that $H_0 = 0$.

Problem 3

1.

*Use the full model with all variables to find a best subset model with the BIC criterion (Use Models/subset model selection . . .).

```
le <- regsubsets(walmart$WalMartRevenue~walmart$RetailSalesIndex+walmart$PersonalConsumption+walmart$CPI
plot(le,scale="bic")
```



The model with the coeficient CPI and December do have the smallest BCI value and is therefore the best suited model measured with the Bayesian Information Criteria.

2.

Drop the variables RetailSalesIndex and PersonalConsumption from the regression, i.e. recalculate the regression with just CPI and December as explanatory variables.

```
walmartLm <- lm(WalMartRevenue~CPI+December, data = walmart)
summary(walmartLm)
```

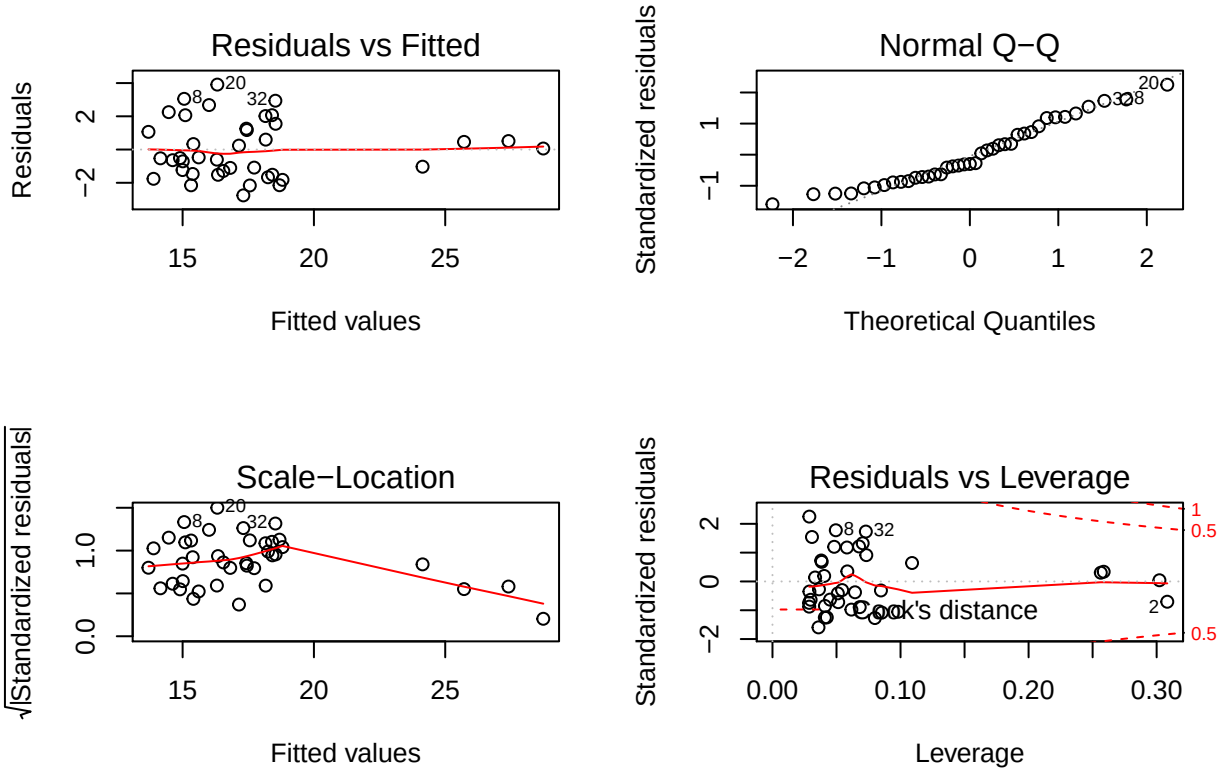
```
##
## Call:
## lm(formula = WalMartRevenue ~ CPI + December, data = walmart)
##
```

```
## Residuals:
##     Min      1Q  Median      3Q     Max
## -2.7586 -1.3798 -0.5137  1.2146  3.9075
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) -34.77553    9.23825  -3.764 0.000596 ***
## CPI           0.08771    0.01580   5.550 2.77e-06 ***
## December     10.49054    0.93367  11.236 2.53e-13 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.762 on 36 degrees of freedom
## Multiple R-squared:  0.8033, Adjusted R-squared:  0.7924
## F-statistic: 73.53 on 2 and 36 DF,  p-value: 1.937e-13
```

3.

Check the diagnostic plots. Comments?

```
par(mfrow = c(2, 2))
plot(walmartLm)
```



The plots do show a much better fit of residuals to fitted respectively leverage. Additionally the model follows much more a normal distribution than the previous model.

4.

Does it seem that Wal-Marts's revenue is closely related to the general state of the economy? Yes, compared to the previous models this model coefficients show high significance. The R^2 value is very high, meaning the model explains the variability ad the F-Statistic is large and also highly significant.

5.

*Compare this last model with two explanatory variables with the full model containing four explanatory variables with an F-test.

```
walmartBestLm <- lm(WalMartRevenue~CPI+December, data = walmart)
walmartFullLm <- lm(WalMartRevenue~RetailSalesIndex+PersonalConsumption+CPI+December, data = walmart)
anova(walmartBestLm,walmartFullLm)
```

```
## Analysis of Variance Table
##
## Model 1: WalMartRevenue ~ CPI + December
## Model 2: WalMartRevenue ~ RetailSalesIndex + PersonalConsumption + CPI +
##     December
##   Res.Df    RSS Df Sum of Sq      F Pr(>F)
## 1     36 111.75
## 2     34 110.22  2    1.5264 0.2354 0.7915
```

Given the F value of 0.2354 and the high p-value of 0.7915. We cannot reject the H_0 so that the full model with the variables RetailSalesIndex and PersonalConsumption do contribute additional information.

6.

Use the Durbin-Watson test to see whether the residuals exhibit autocorrelation.

```
durbinWatsonTest(walmartBestLm)
```

```
##  lag Autocorrelation D-W Statistic p-value
##    1      -0.4395516      2.830718   0.006
##  Alternative hypothesis: rho != 0
```

Given that the D-W Statistic is outside the [1.5-2.5] and the p-value is < 0.05, we fail to reject H_0 that the residuals are not autocorrelated. Therefore a time series model might be a better fit.