Analysis

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Multiple Linear Regression

Data preview

Read in data

```
dt = read.csv("data&figures/dt.csv")
summary(dt)
```

```
##     State              County               HPI         Personal_Income
##  Length:2168        Length:2168        Min.   : 96.64   Min.   : 27415
##  Class :character   Class :character   1st Qu.:138.98   1st Qu.: 38812
##  Mode  :character   Mode  :character   Median :152.19   Median : 43976
##                                        Mean   :159.19   Mean   : 46355
##                                        3rd Qu.:175.13   3rd Qu.: 50669
##                                        Max.   :395.90   Max.   :229825
##  Poverty_Percentage   Population      HighSchoolLess  HighSchoolOnly
##  Min.   : 2.70      Min.   :   1129   Min.   : 1.50   Min.   : 7.80
##  1st Qu.: 9.70      1st Qu.:  18913   1st Qu.: 8.10   1st Qu.:29.10
##  Median :12.65      Median :  37068   Median :11.10   Median :33.90
##  Mean   :13.36      Mean   : 123587   Mean   :12.14   Mean   :33.64
##  3rd Qu.:16.02      3rd Qu.:  93783   3rd Qu.:15.12   3rd Qu.:38.60
##  Max.   :38.20      Max.   :5150233   Max.   :43.10   Max.   :54.50
##   SomeCollege    BachelorAndHigher Unemployment_Rate
##  Min.   :11.20   Min.   : 8.20     Min.   : 1.600
##  1st Qu.:27.90   1st Qu.:16.30     1st Qu.: 3.100
##  Median :31.00   Median :20.80     Median : 3.700
##  Mean   :31.08   Mean   :23.14     Mean   : 3.888
##  3rd Qu.:34.20   3rd Qu.:28.12     3rd Qu.: 4.500
##  Max.   :47.30   Max.   :75.30     Max.   :18.300
```

Correlation Check

```
cor(scale(as.matrix(dt[,c(7,8,9,10)])))
```

Education parameters

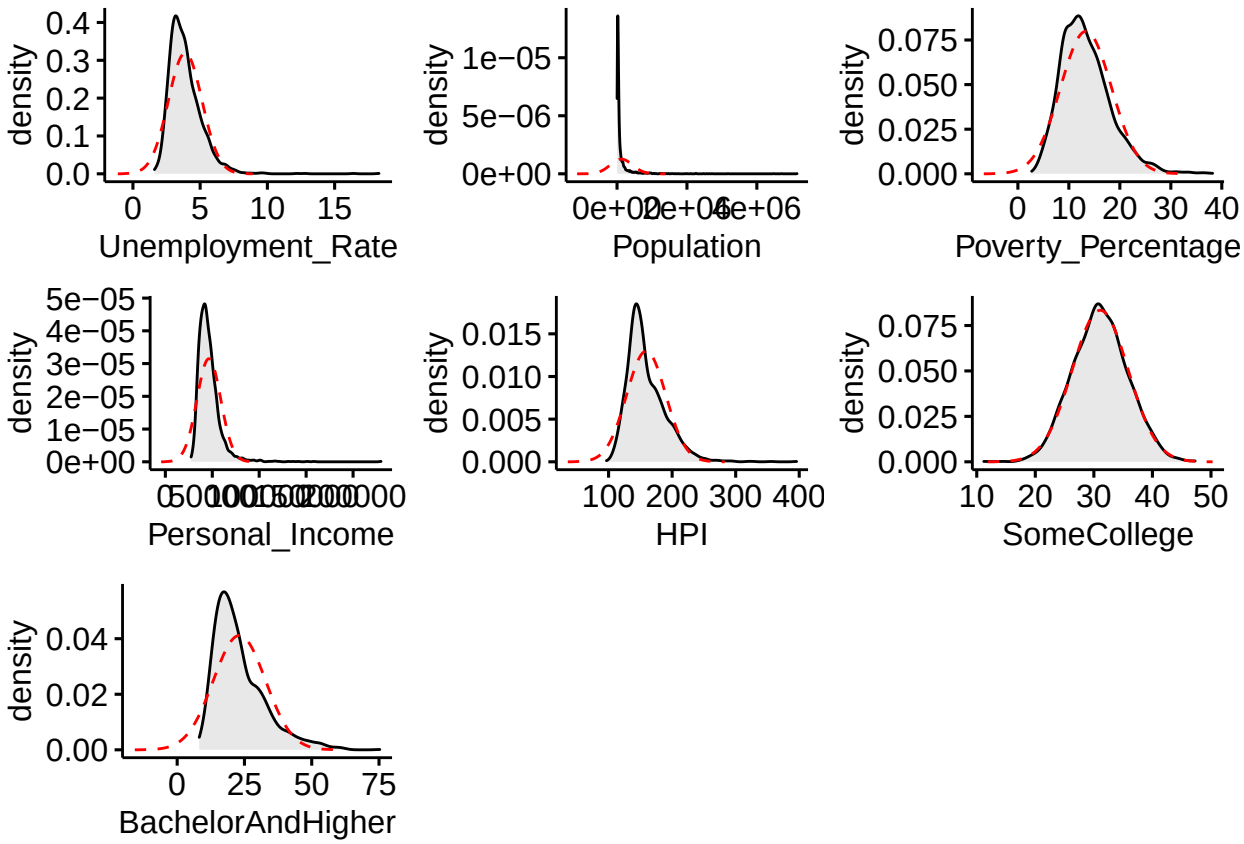
```
##                   HighSchoolLess HighSchoolOnly SomeCollege BachelorAndHigher
## HighSchoolLess         1.0000000      0.2768850  -0.3538971        -0.5983478
## HighSchoolOnly         0.2768850      1.0000000  -0.2113544        -0.7972454
## SomeCollege           -0.3538971     -0.2113544   1.0000000        -0.1358199
## BachelorAndHigher     -0.5983478     -0.7972454  -0.1358199         1.0000000
```

Histogram

```
library(ggpubr)
```

```
## Loading required package: ggplot2
```

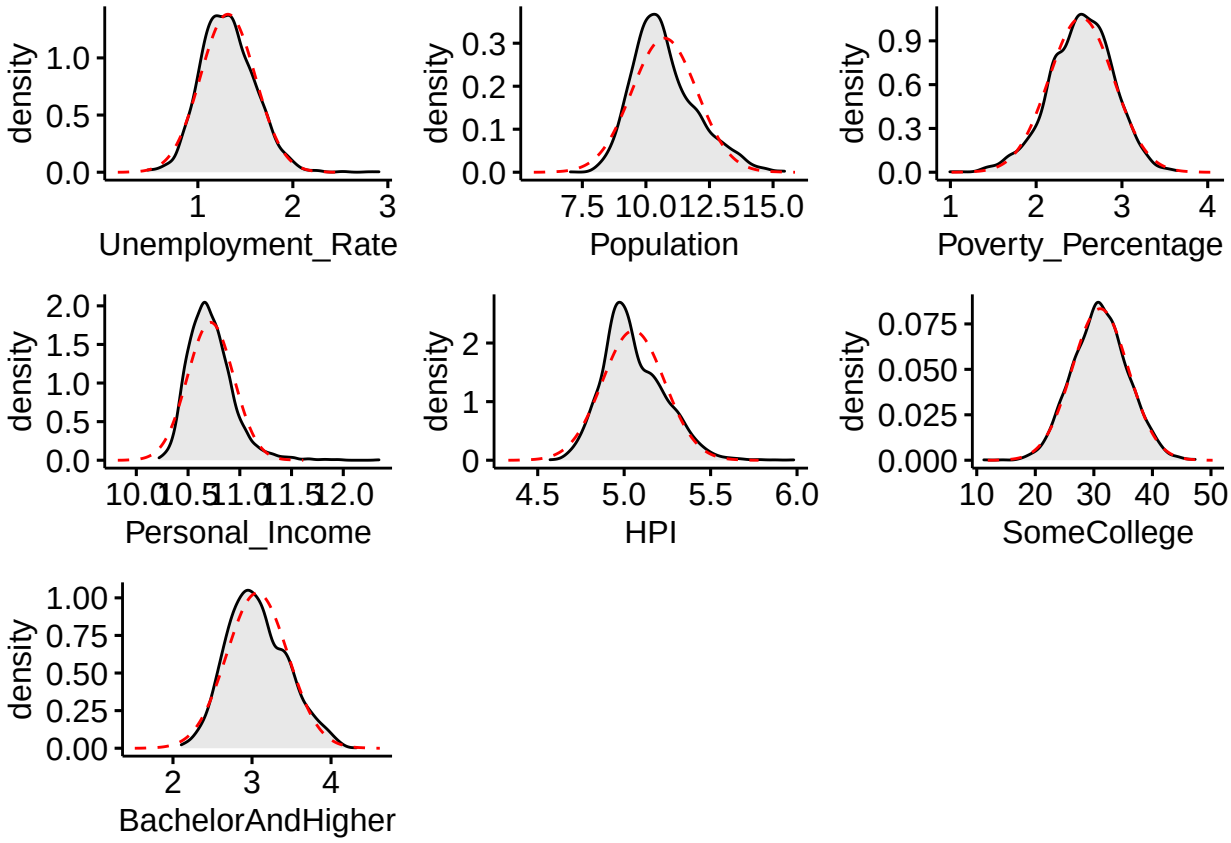
```
a<-ggdensity(dt, x = "Unemployment_Rate", fill = "lightgray") +
  stat_overlay_normal_density(color = "red", linetype = "dashed")
b<-ggdensity(dt, x = "Population", fill = "lightgray") +
  stat_overlay_normal_density(color = "red", linetype = "dashed")
c<-ggdensity(dt, x = "Poverty_Percentage", fill = "lightgray") +
  stat_overlay_normal_density(color = "red", linetype = "dashed")
d<-ggdensity(dt, x = "Personal_Income", fill = "lightgray") +
  stat_overlay_normal_density(color = "red", linetype = "dashed")
e<-ggdensity(dt, x = "HPI", fill = "lightgray") +
  stat_overlay_normal_density(color = "red", linetype = "dashed")
f<-ggdensity(dt, x = "SomeCollege", fill = "lightgray") +
  stat_overlay_normal_density(color = "red", linetype = "dashed")
g<-ggdensity(dt, x = "BachelorAndHigher", fill = "lightgray") +
  stat_overlay_normal_density(color = "red", linetype = "dashed")
ggarrange(a,b,c,d,e,f,g, ncol = 3, nrow = 3)
```



Histogram for logtransformation

```
temp=dt
temp$HPI <- log(dt$HPI)
temp$Personal_Income <- log(dt$Personal_Income)
temp$Poverty_Percentage <- log(dt$Poverty_Percentage)
temp$Population <- log(dt$Population)
temp$HighSchoolLess <- log(dt$HighSchoolLess)
temp$BachelorAndHigher <- log(dt$BachelorAndHigher)
temp$Unemployment_Rate <- log(dt$Unemployment_Rate)
```

```
library(ggpubr)
a<-ggdensity(temp, x = "Unemployment_Rate", fill = "lightgray") +
  stat_overlay_normal_density(color = "red", linetype = "dashed")
b<-ggdensity(temp, x = "Population", fill = "lightgray") +
  stat_overlay_normal_density(color = "red", linetype = "dashed")
c<-ggdensity(temp, x = "Poverty_Percentage", fill = "lightgray") +
  stat_overlay_normal_density(color = "red", linetype = "dashed")
d<-ggdensity(temp, x = "Personal_Income", fill = "lightgray") +
  stat_overlay_normal_density(color = "red", linetype = "dashed")
e<-ggdensity(temp, x = "HPI", fill = "lightgray") +
  stat_overlay_normal_density(color = "red", linetype = "dashed")
f<-ggdensity(temp, x = "SomeCollege", fill = "lightgray") +
  stat_overlay_normal_density(color = "red", linetype = "dashed")
g<-ggdensity(temp, x = "BachelorAndHigher", fill = "lightgray") +
  stat_overlay_normal_density(color = "red", linetype = "dashed")
ggarrange(a,b,c,d,e,f,g, ncol = 3, nrow = 3)
```



Model fitting

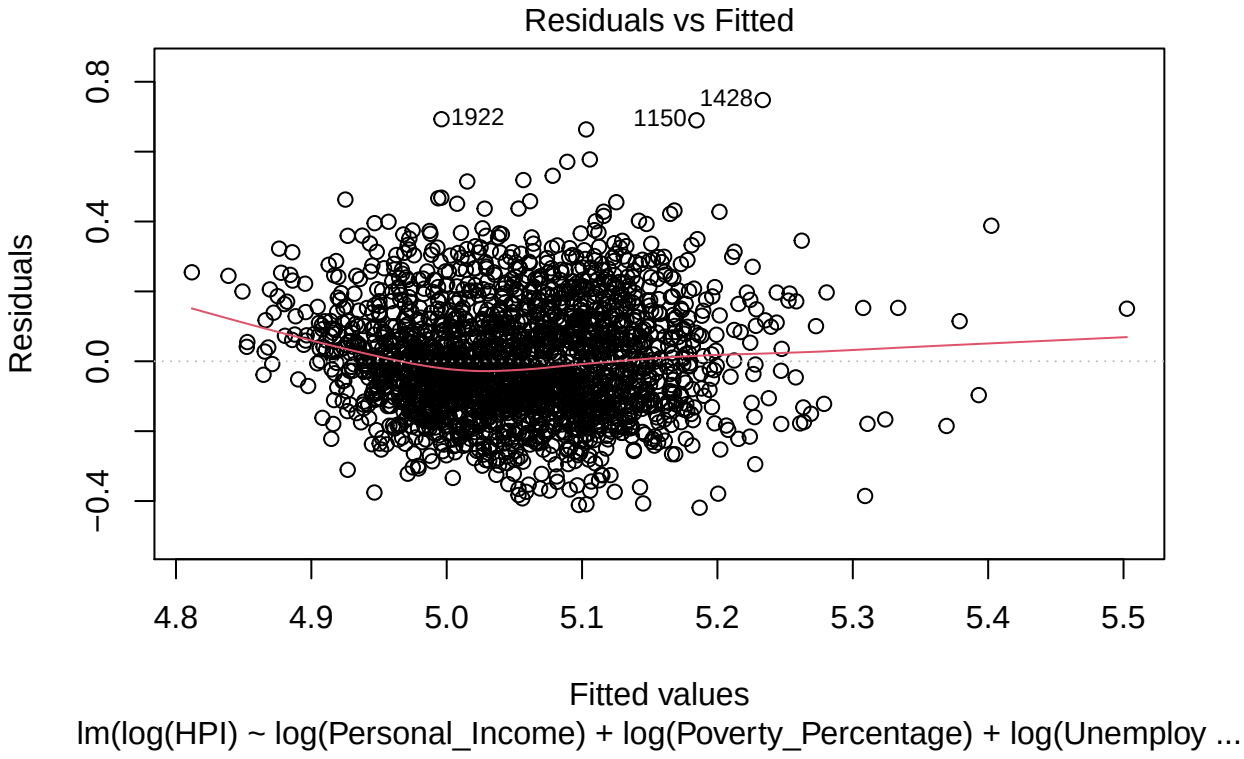
```
attach(dt)
m1 = lm(log(HPI)~log(Personal_Income)+log(Poverty_Percentage)+log(Unemployment_Rate)+log(Population)+So
summary(m1)
```

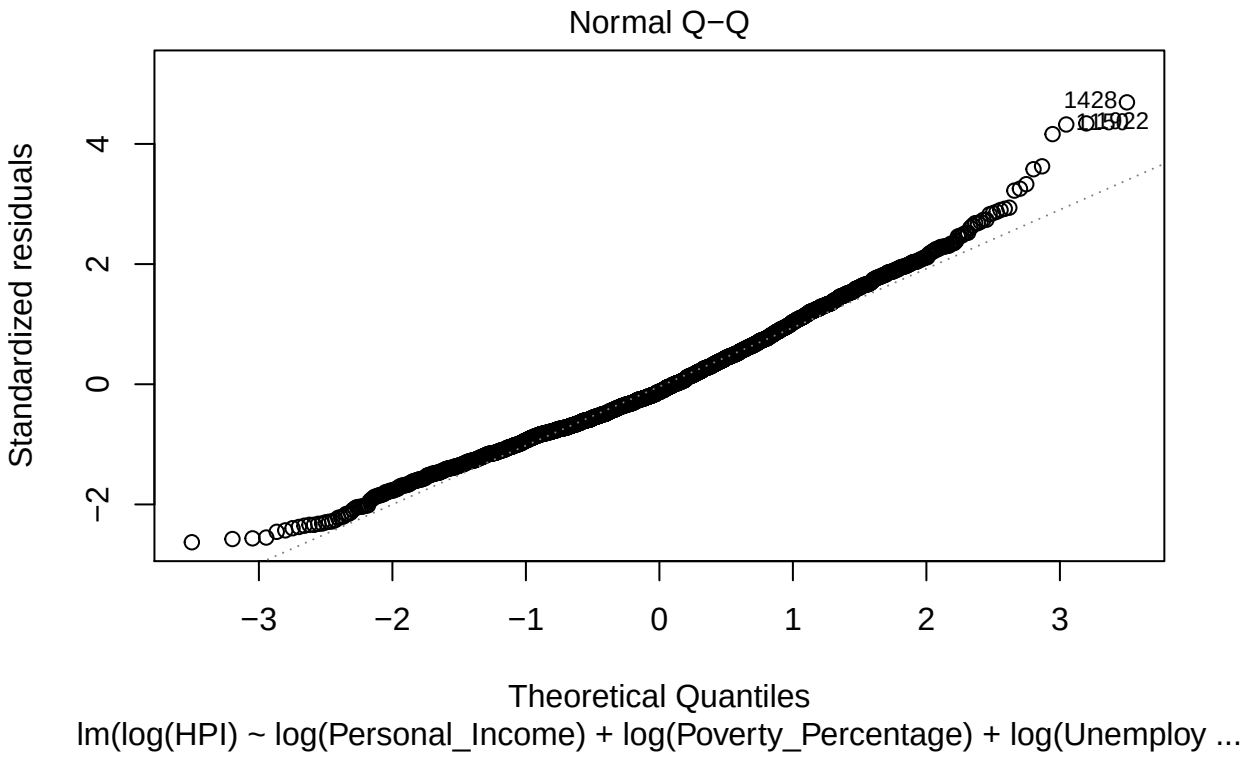
```
##
## Call:
## lm(formula = log(HPI) ~ log(Personal_Income) + log(Poverty_Percentage) +
##     log(Unemployment_Rate) + log(Population) + SomeCollege +
##     log(BachelorAndHigher))
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.41914 -0.11184 -0.02073  0.09933  0.74766
##
## Coefficients:
##                            Estimate Std. Error t value Pr(>|t|)
## (Intercept)               1.5982142  0.2873397   5.562 3.00e-08 ***
## log(Personal_Income)      0.2841528  0.0261091  10.883  < 2e-16 ***
## log(Poverty_Percentage)   0.0658601  0.0140051   4.703 2.73e-06 ***
```

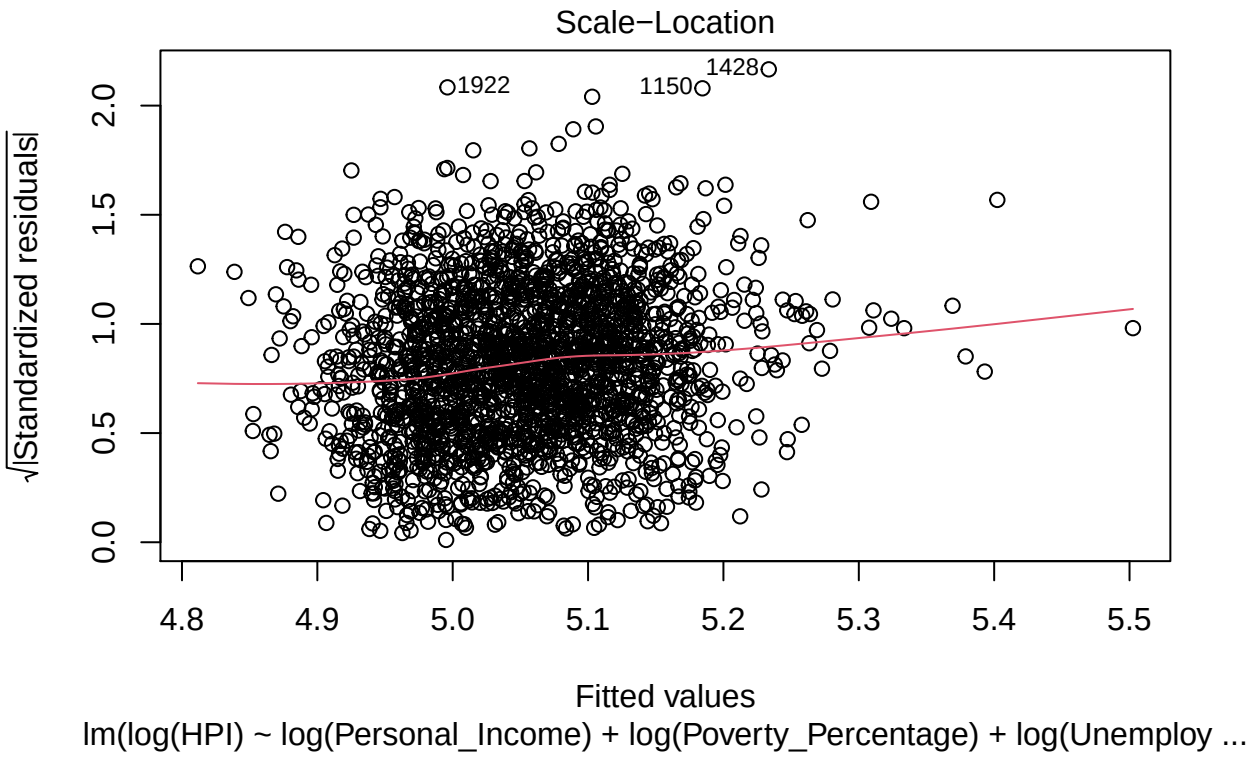
```
## log(Unemployment_Rate)  -0.0760410  0.0144298  -5.270 1.50e-07 ***
## log(Population)          0.0017443  0.0032963   0.529 0.596751
## SomeCollege              0.0052240  0.0007657   6.823 1.15e-11 ***
## log(BachelorAndHigher)   0.0530982  0.0145109   3.659 0.000259 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1599 on 2161 degrees of freedom
## Multiple R-squared:  0.1883, Adjusted R-squared:  0.186
## F-statistic: 83.53 on 6 and 2161 DF,  p-value: < 2.2e-16
```

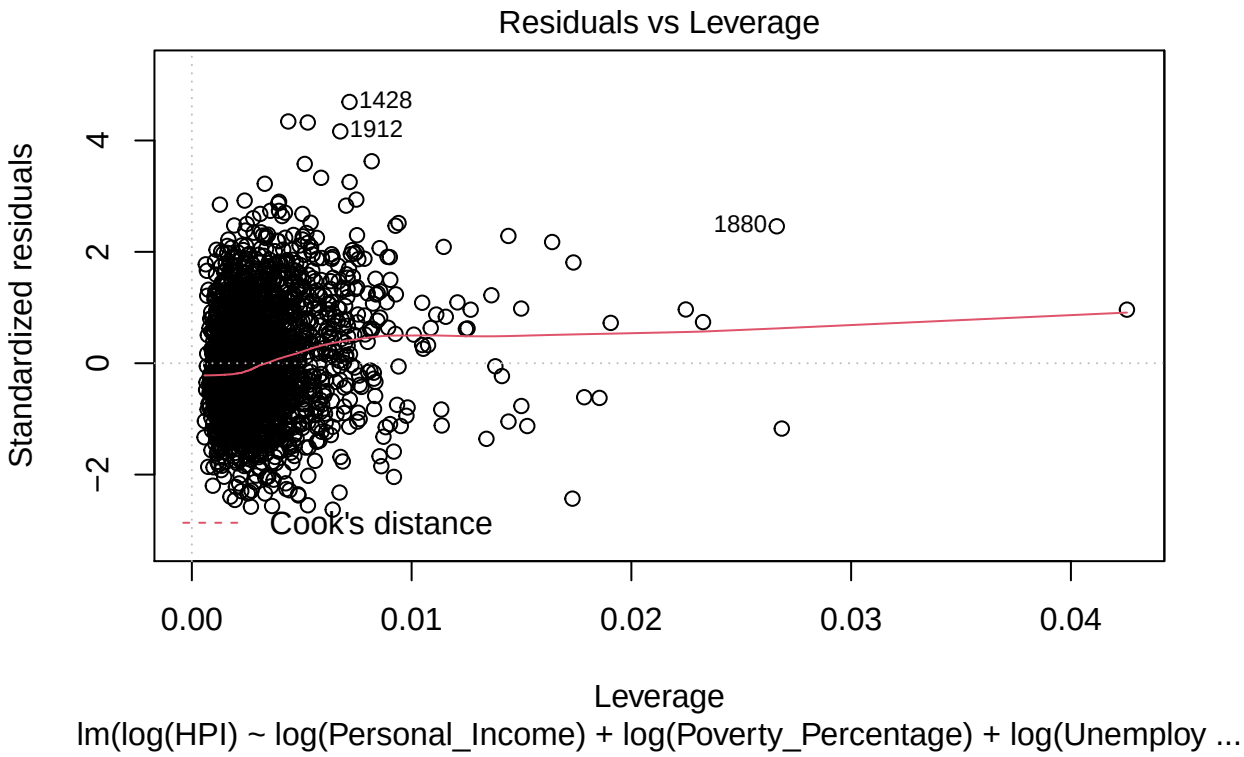
Diagnostic Plots

```
plot(m1)
```




Normal Q−Q
Standardized residuals
Theoretical Quantiles
lm(log(HPI) ~ log(Personal_Income) + log(Poverty_Percentage) + log(Unemploy ...
1428
−3
−2
−1
0
1
2
3
−2
0
2
4


Scale−Location
√|Standardized residuals|
0.0
0.5
1.0
1.5
2.0
1922
1150
1428
4.8
4.9
5.0
5.1
5.2
5.3
5.4
5.5
Fitted values
lm(log(HPI) ~ log(Personal_Income) + log(Poverty_Percentage) + log(Unemploy ...


Residuals vs Leverage
1428
1912
1880
Cook's distance
Standardized residuals
4
2
0
−2
0.00
0.01
0.02
0.03
0.04
Leverage
lm(log(HPI) ~ log(Personal_Income) + log(Poverty_Percentage) + log(Unemploy ...