```
data(LifeCycleSavings)
attach(LifeCycleSavings)
names(LifeCycleSavings)
```

```
## [1] "sr"    "pop15" "pop75" "dpi"   "ddpi"
```

```
mod1=lm(LifeCycleSavings$pop15~LifeCycleSavings$pop75)
mod2=lm(LifeCycleSavings$pop15~LifeCycleSavings$dpi)
mod3=lm(LifeCycleSavings$pop15~LifeCycleSavings$ddpi)
mod4=lm(LifeCycleSavings$pop75~LifeCycleSavings$dpi)
mod5=lm(LifeCycleSavings$pop75~LifeCycleSavings$ddpi)
mod6=lm(LifeCycleSavings$dpi~LifeCycleSavings$ddpi)
summary(mod1)
```

```
##
## Call:
## lm(formula = LifeCycleSavings$pop15 ~ LifeCycleSavings$pop75)
##
## Residuals:
##      Min      1Q  Median      3Q     Max
## -10.5466 -2.3602  0.3677  2.5504  8.2894
##
## Coefficients:
##                        Estimate Std. Error t value Pr(>|t|)
## (Intercept)             49.8593     1.1227   44.41   <2e-16 ***
## LifeCycleSavings$pop75  -6.4412     0.4277  -15.06   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 3.864 on 48 degrees of freedom
## Multiple R-squared:  0.8253, Adjusted R-squared:  0.8217
## F-statistic: 226.8 on 1 and 48 DF,  p-value: < 2.2e-16
```

```
summary(mod2)
```

```
##
## Call:
## lm(formula = LifeCycleSavings$pop15 ~ LifeCycleSavings$dpi)
##
## Residuals:
##       Min       1Q   Median       3Q      Max
## -11.1172  -4.1982   0.3813   4.4910  14.9406
##
## Coefficients:
##                        Estimate Std. Error t value Pr(>|t|)
## (Intercept)          42.8194228  1.2900704  33.192  < 2e-16 ***
## LifeCycleSavings$dpi -0.0069842  0.0008723  -8.006 2.15e-10 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 6.051 on 48 degrees of freedom
## Multiple R-squared:  0.5718, Adjusted R-squared:  0.5629
## F-statistic:  64.1 on 1 and 48 DF,  p-value: 2.154e-10
```

```
summary(mod3)
```

```
##
## Call:
## lm(formula = LifeCycleSavings$pop15 ~ LifeCycleSavings$ddpi)
##
## Residuals:
##     Min     1Q  Median     3Q     Max
## -13.764  -8.664  -2.334   9.474  12.404
##
## Coefficients:
##                        Estimate Std. Error t value Pr(>|t|)
## (Intercept)            35.6627     2.1658  16.467   <2e-16 ***
## LifeCycleSavings$ddpi  -0.1525     0.4598  -0.332    0.742
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 9.236 on 48 degrees of freedom
## Multiple R-squared:  0.002287,   Adjusted R-squared:  -0.0185
## F-statistic:  0.11 on 1 and 48 DF,  p-value: 0.7415
```

```
summary(mod4)
```

```
##
## Call:
## lm(formula = LifeCycleSavings$pop75 ~ LifeCycleSavings$dpi)
##
## Residuals:
##      Min      1Q  Median      3Q     Max
## -1.8311 -0.5093 -0.1994  0.4785  1.8630
##
## Coefficients:
##                        Estimate Std. Error t value Pr(>|t|)
## (Intercept)            1.158354   0.171553   6.752 1.76e-08 ***
## LifeCycleSavings$dpi   0.001025   0.000116   8.838 1.23e-11 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.8046 on 48 degrees of freedom
## Multiple R-squared:  0.6194, Adjusted R-squared:  0.6114
## F-statistic: 78.11 on 1 and 48 DF,  p-value: 1.23e-11
```
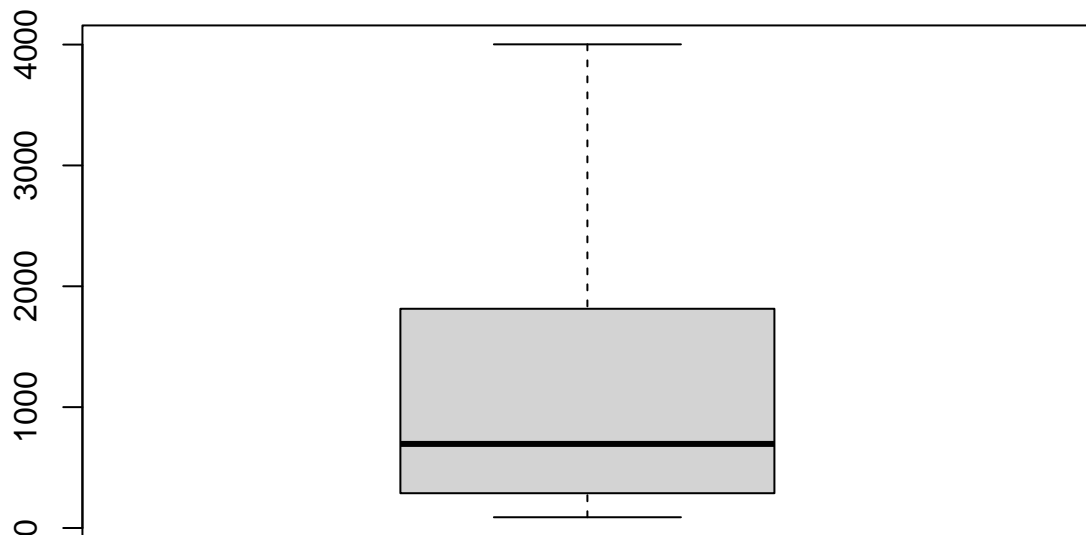
```
summary(mod5)
```

```
##
## Call:
## lm(formula = LifeCycleSavings$pop75 ~ LifeCycleSavings$ddpi)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -1.7487 -1.1503 -0.1828  1.0236  2.3983
```

```
## 
## Coefficients:
##                        Estimate Std. Error t value Pr(>|t|)
## (Intercept)            2.25021    0.30571   7.360 2.06e-09 ***
## LifeCycleSavings$ddpi  0.01139    0.06490   0.175    0.861
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## 
## Residual standard error: 1.304 on 48 degrees of freedom
## Multiple R-squared:  0.0006412,  Adjusted R-squared:  -0.02018
## F-statistic: 0.0308 on 1 and 48 DF,  p-value: 0.8614
```

```
summary(mod6)
```

```
## 
## Call:
## lm(formula = LifeCycleSavings$dpi ~ LifeCycleSavings$ddpi)
## 
## Residuals:
##     Min      1Q  Median      3Q     Max
## -1117.0  -830.6  -382.5   663.8  2836.7
## 
## Coefficients:
##                        Estimate Std. Error t value Pr(>|t|)
## (Intercept)            1274.75     232.78   5.476 1.57e-06 ***
## LifeCycleSavings$ddpi   -44.71      49.42  -0.905     0.37
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## 
## Residual standard error: 992.7 on 48 degrees of freedom
## Multiple R-squared:  0.01677,    Adjusted R-squared:  -0.003718
## F-statistic: 0.8185 on 1 and 48 DF,  p-value: 0.3701
```

```
boxplot(LifeCycleSavings$dpi)
```

```
pop15=LifeCycleSavings$pop15
pop75=LifeCycleSavings$pop75
dpi=LifeCycleSavings$dpi
ddpi=LifeCycleSavings$ddpi
```

```
Model1 = lm(sr ~ pop15 + pop75 + dpi + ddpi, data = LifeCycleSavings)
summary(Model1)
```

```
##
## Call:
## lm(formula = sr ~ pop15 + pop75 + dpi + ddpi, data = LifeCycleSavings)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -8.2422 -2.6857 -0.2488  2.4280  9.7509
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept) 28.5660865  7.3545161   3.884 0.000334 ***
## pop15       -0.4611931  0.1446422  -3.189 0.002603 **
## pop75       -1.6914977  1.0835989  -1.561 0.125530
## dpi         -0.0003369  0.0009311  -0.362 0.719173
## ddpi         0.4096949  0.1961971   2.088 0.042471 *
## ---
```

```
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 3.803 on 45 degrees of freedom
## Multiple R-squared:  0.3385, Adjusted R-squared:  0.2797
## F-statistic: 5.756 on 4 and 45 DF,  p-value: 0.0007904
```

```
Model2 <- lm(sr~ pop15 * ddpi, data = LifeCycleSavings)
summary(Model2)
```

```
##
## Call:
## lm(formula = sr ~ pop15 * ddpi, data = LifeCycleSavings)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -7.5198 -2.2376 -0.1007  2.1628 11.0307
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  7.59867    4.49133   1.692   0.0974 .
## pop15       -0.01520    0.11373  -0.134   0.8942
## ddpi         2.59309    1.05993   2.446   0.0183 *
## pop15:ddpi  -0.05465    0.02652  -2.061   0.0450 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 3.734 on 46 degrees of freedom
## Multiple R-squared:  0.348,  Adjusted R-squared:  0.3055
## F-statistic: 8.183 on 3 and 46 DF,  p-value: 0.00018
```
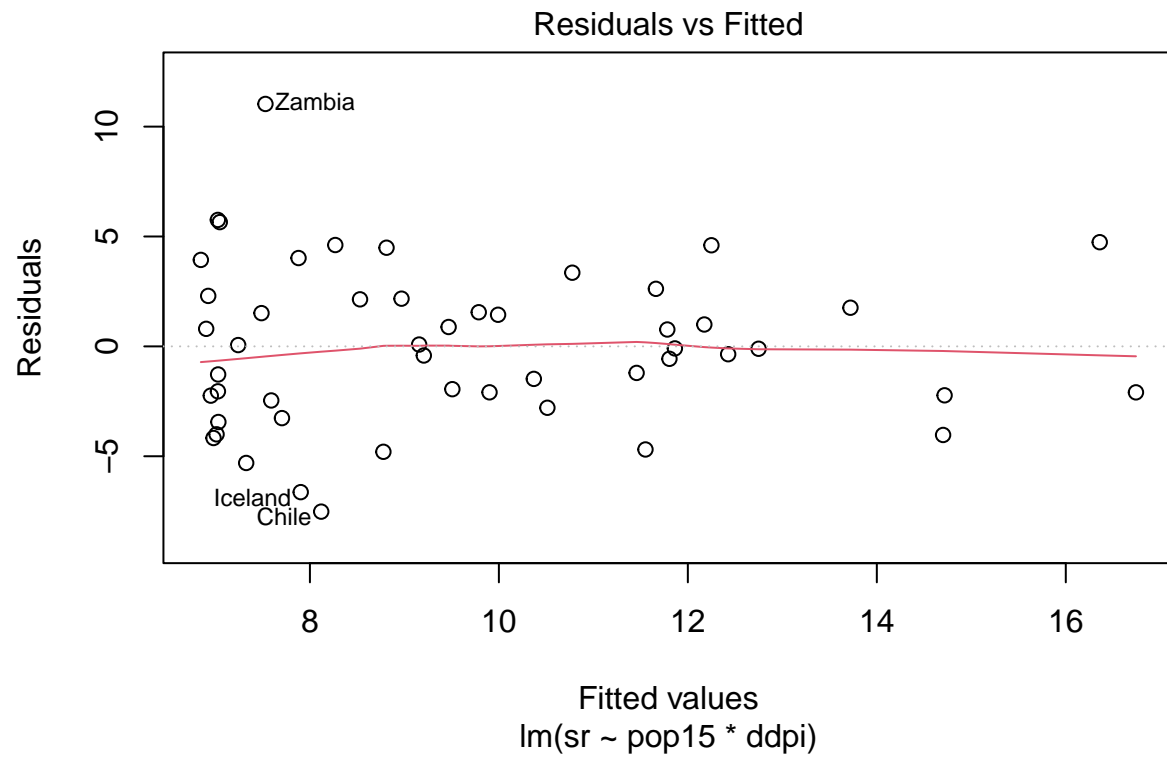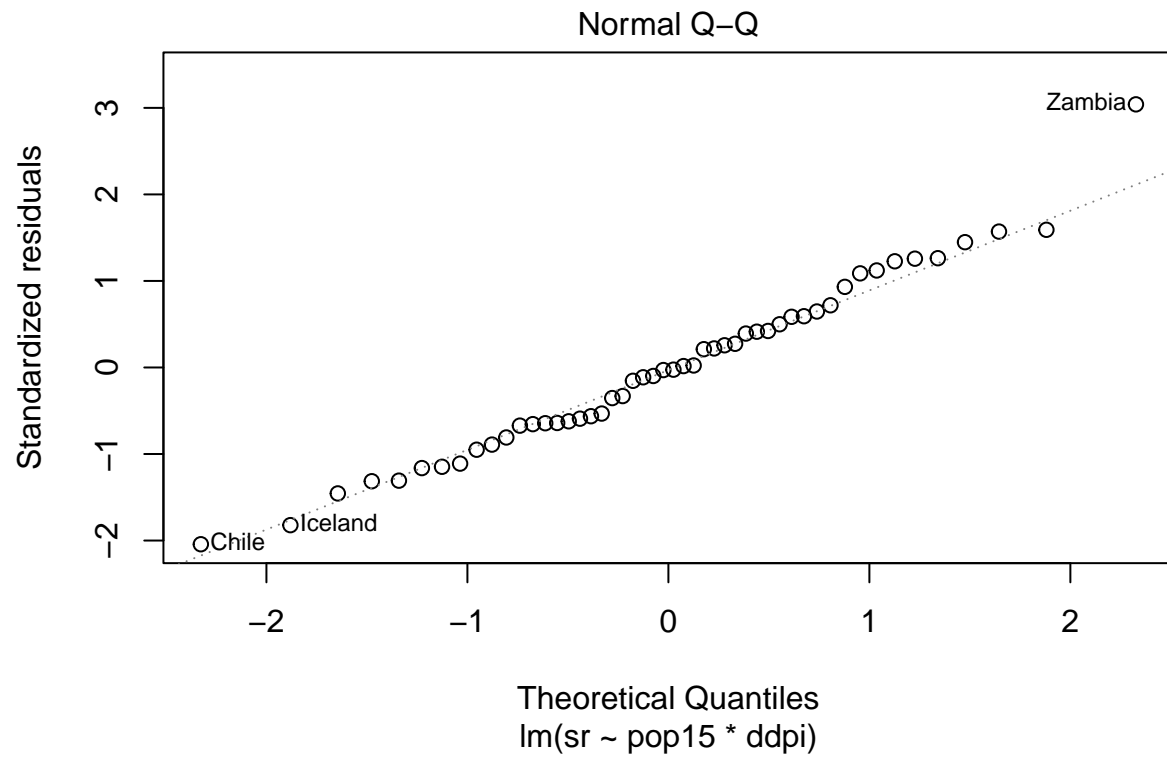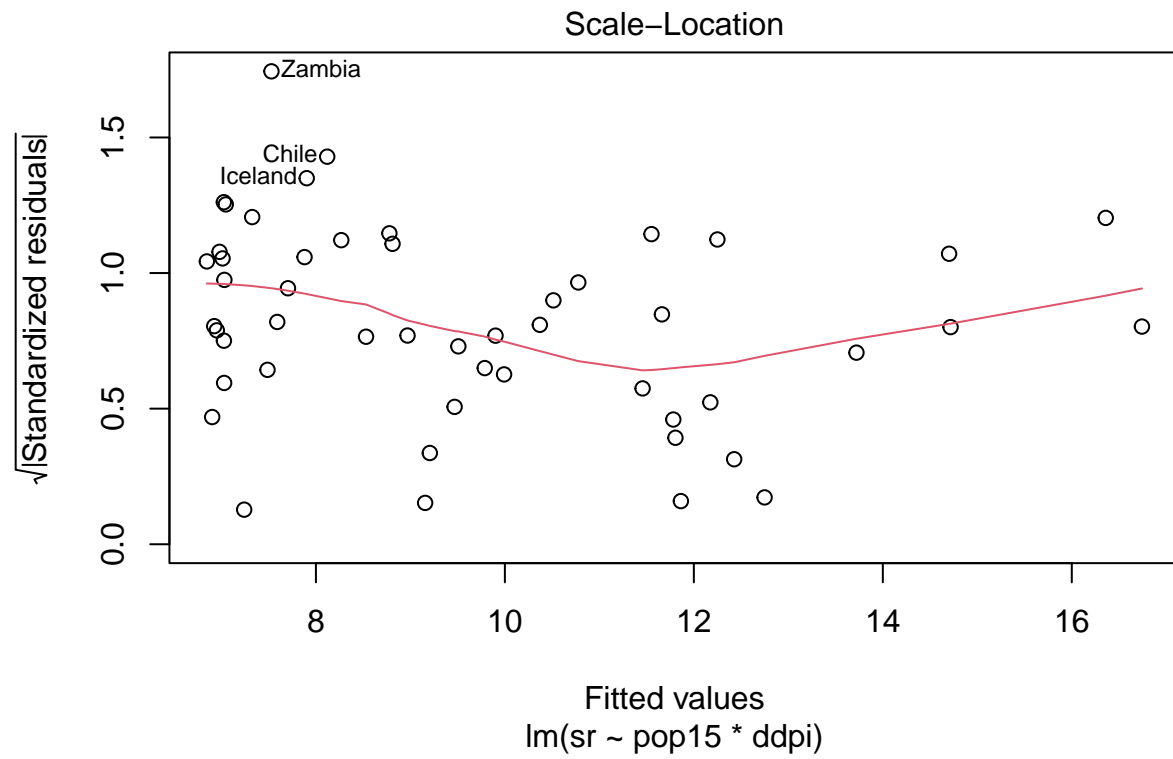
```
plot(Model2)
```

Residuals vs Fitted

Residuals

Zambia

Iceland
Chile

8   10   12   14   16

Fitted values
lm(sr ~ pop15 * ddpi)

6

Normal Q–Q

Standardized residuals

Theoretical Quantiles
lm(sr ~ pop15 * ddpi)

Scale–Location

√|Standardized residuals|

Fitted values
lm(sr ~ pop15 * ddpi)

Residuals vs Leverage

Leverage
lm(sr ~ pop15 * ddpi)
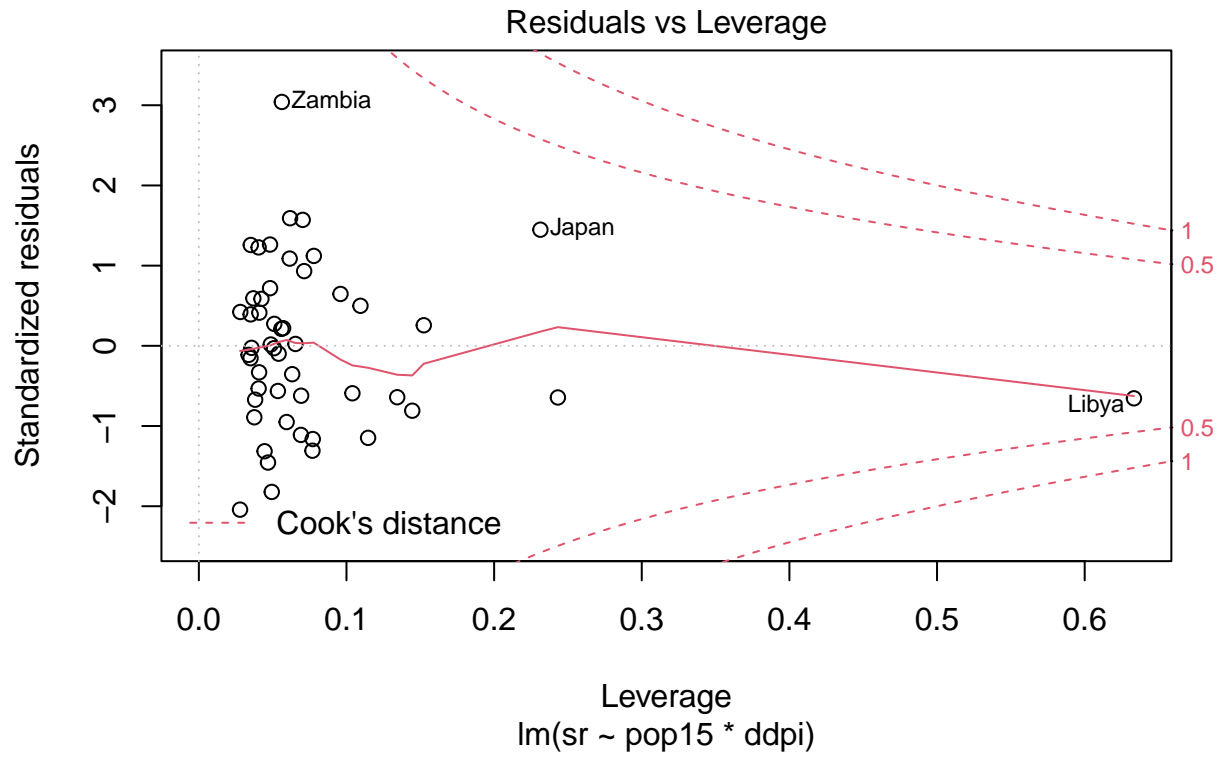
```
predict(Model2,se.fit= T,interval=c("confidence"),level=0.99)
```

```
## $fit
##                    fit       lwr       upr
## Australia     9.991519  8.111904 11.871134
## Austria      12.426777 10.094173 14.759381
## Belgium      12.174218  9.906122 14.442314
## Bolivia       7.028657  4.505822  9.551491
## Brazil        8.268539  6.387104 10.149973
## Canada        9.205514  7.363663 11.047364
## Chile         8.119750  6.443568  9.795932
## China         7.879665  5.079710 10.679620
## Colombia      7.026299  4.704680  9.347918
## Costa Rica    6.845656  4.357121  9.334190
## Denmark      12.249335 10.046105 14.452565
## Ecuador       7.031299  4.584585  9.478013
## Finland      11.805322  9.928000 13.682644
## France       12.748599 10.484450 15.012748
## Germany      11.782625  9.410401 14.154849
## Greece       14.701543 11.304423 18.098663
## Guatamala     7.011956  4.373681  9.650232
## Honduras      6.902305  4.504904  9.299707
## Iceland       7.902786  5.673227 10.132345
## India         7.487516  5.456245  9.518787
## Ireland       9.786967  8.105510 11.468425
```

```
## Italy            11.662086  9.458315 13.865857
## Japan            16.359392 11.533725 21.185058
## Korea             8.777714  6.661038 10.894390
## Luxembourg        9.468062  5.551732 13.384392
## Malta            13.720966 10.401382 17.040550
## Norway           11.457716  9.430457 13.484975
## Netherlands      16.742713 11.794910 21.690516
## New Zealand       8.530376  6.464656 10.596095
## Nicaragua         7.240825  5.026823  9.454827
## Panama            7.704255  5.759710  9.648800
## Paraguay          7.325624  5.154013  9.497234
## Peru              7.046261  4.384856  9.707666
## Philippines       7.025662  4.531609  9.519716
## Portugal         14.717194 11.039424 18.394963
## South Africa      8.969509  7.042014 10.897004
## South Rhodesia    8.810937  6.792008 10.829866
## Spain            11.862766  9.967527 13.758004
## Sweden           11.551349  8.768156 14.334542
## Switzerland      10.777056  8.097364 13.456749
## Turkey            7.590772  5.631623  9.549920
## Tunisia           6.979747  4.192639  9.766856
## United Kingdom    9.901044  6.665329 13.136758
## United States     9.507464  7.488527 11.526401
## Venezuela         6.923695  3.816090 10.031300
## Zambia            7.529308  5.150482  9.908135
## Jamaica          10.513486  6.698802 14.328169
## Uruguay           9.156070  6.589249 11.722892
## Libya            10.369991  2.385177 18.354805
## Malaysia          6.951115  4.310242  9.591987
##
## $se.fit
##  [1] 0.6995183 0.8681028 0.8440954 0.9388989 0.7001954 0.6854640 0.6238086
##  [8] 1.0420323 0.8640146 0.9261339 0.8199550 0.9105701 0.6986651 0.8426267
## [15] 0.8828479 1.2642735 0.9818617 0.8922178 0.8297536 0.7559586 0.6257718
## [22] 0.8201563 1.7959220 0.7877428 1.4575030 1.2354178 0.7544655 1.8413762
## [29] 0.7687791 0.8239638 0.7236825 0.8081874 0.9904695 0.9281879 1.3687201
## [36] 0.7173373 0.7513655 0.7053327 1.0357942 0.9972754 0.7291174 1.0372515
## [43] 1.2042049 0.7513684 1.1565274 0.8853050 1.4196741 0.9552692 2.9716317
## [50] 0.9828283
##
## $df
## [1] 46
##
## $residual.scale
## [1] 3.733941
```