In [29]:
```
library(psych)
library(ggplot2)
library(car)
library(fmsb)
library(dplyr)
```

In [18]:
```
library(Hmisc)  #Only load this after using psych; it overrides psych
```

In [3]:
```
# Read data
path = "C:/Users/Administrator/Documents/Master/MSIS-5223-70250 - Programming
 for Data Sci - 8282017 - 159 PM/Homework"
data = paste( path,'\\CaliforniaHospitalData.csv', sep ='')
df = read.csv(data,header =T,sep =',')
```

In [14]:
```
library(Hmisc) #Only load this after using psych; it overrides psych
```

```
Warning message:
"package 'Hmisc' was built under R version 3.4.2"Loading required package: la
ttice
Loading required package: survival
Loading required package: Formula

Attaching package: 'Hmisc'

The following objects are masked from 'package:dplyr':

    combine, src, summarize

The following object is masked from 'package:psych':

    describe

The following objects are masked from 'package:base':

    format.pval, round.POSIXt, trunc.POSIXt, units
```

In [4]:
```
str(df)
```

```
'data.frame':   61 obs. of  14 variables:
 $ HospitalID : int  45740 12145 25667 46996 37393 17741 20277 45736 29823 13
738 ...
 $ Name       : Factor w/ 61 levels "Alameda Hospital",..: 26 61 36 38 3 47 6
0 32 11 49 ...
 $ Zip        : Factor w/ 61 levels "90033","90048",..: 28 16 9 29 12 56 44 1
4 51 11 ...
 $ Website    : Factor w/ 60 levels "coloradorivermedical.org",..: 28 60 39 4
1 6 2 59 31 11 50 ...
 $ TypeControl: Factor w/ 4 levels "City/County",..: 2 4 2 4 3 4 4 2 4 4 ...
 $ Teaching   : Factor w/ 2 levels "Small/Rural",..: 1 1 1 1 1 1 1 1 1 1 ...
 $ DonorType  : Factor w/ 2 levels "Alumni","Charity": 2 2 2 2 2 2 2 2 2 2
 ...
 $ NoFTE      : num  327 345 601 400 262 ...
 $ NetPatRev  : num  135520 136157 197094 139170 116798 ...
 $ InOperExp  : num  20523426 33447543 37254179 23385570 13684502 ...
 $ OutOperExp : num  34916220 20348596 37832448 24661356 15159987 ...
 $ OperRev    : int  49933713 53351748 72933707 51087341 42845642 85808509 79
005075 11947133 19445901 199873795 ...
 $ OperInc    : int  -5505933 -444391 -2152920 3040415 14001153 12386360 2724
001 -4514239 21025 7943967 ...
 $ AvlBeds    : int  15 99 107 55 42 66 65 35 48 186 ...
```

In [ ]:
```
# for multiple regression model I am using only numerical variable
```

In [ ]:
```
Filter(is.numeric, df)
```

In [86]:
```
#Covert to numeric data for number
df_lg <- sapply(df, as.numeric)
df_lg
```

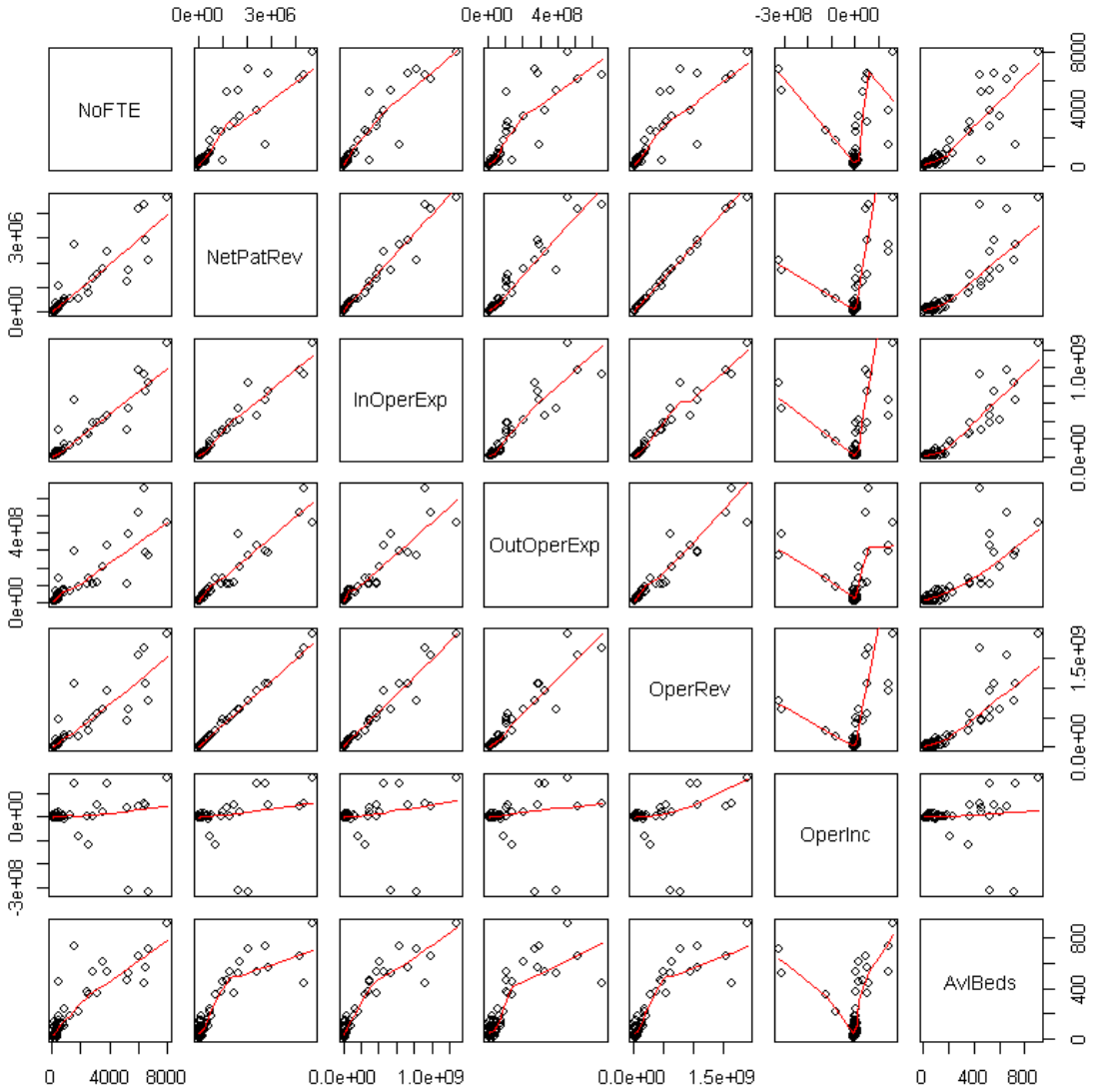
HospitalID	Name	Zip	Website	TypeControl	Teaching	DonorType	NoFTE	NetPatRev
45740	26	28	28	2	1	2	327.00	135520.22
12145	61	16	60	4	1	2	345.00	136156.69
25667	36	9	39	2	1	2	601.20	197094.25
46996	38	29	41	4	1	2	400.00	139170.38
37393	3	12	6	3	1	2	262.00	116797.83
17741	47	56	2	4	1	2	397.50	232503.02
20277	60	44	59	4	1	2	503.50	214516.45
45736	32	14	31	2	1	2	158.00	30786.20
29823	11	51	11	4	1	2	168.00	51726.49
13738	49	11	50	4	1	2	1216.00	540975.12
38798	18	20	42	4	1	2	288.00	335179.56
46348	4	60	7	4	1	2	750.00	335179.56
33207	29	30	33	4	1	2	235.00	105166.89
44817	14	57	16	4	1	2	250.00	108162.91
17718	30	55	34	4	1	2	215.50	123480.27
33283	53	42	54	4	1	2	353.00	173227.49
20231	19	22	20	4	1	2	777.00	363127.60
46985	54	61	55	2	1	2	374.32	209348.94
37043	10	15	1	3	1	2	75.00	33593.68
46342	9	21	10	2	1	2	160.00	65792.43
33242	51	48	52	4	1	2	318.00	161745.22
33251	52	46	53	4	1	2	363.00	172398.86
13722	37	47	49	4	1	2	193.00	103189.40
17700	27	38	29	4	1	2	236.50	116609.82
20225	16	45	24	4	1	2	226.00	94015.91
37285	55	26	56	3	1	2	359.00	240737.96
20266	45	40	48	4	1	2	779.00	367540.66
37436	15	5	17	2	1	2	501.00	108960.42
17736	44	52	47	4	1	2	524.50	295579.23
38802	42	25	42	4	1	2	67.00	28773.45
...	...	...	...	...	...	...	...	...
46844	35	43	38	2	1	2	191.0	61816.76

HospitalID	Name	Zip	Website	TypeControl	Teaching	DonorType	NoFTE	NetPatRev
28283	21	10	21	2	1	2	451.5	145733.58
11875	40	8	45	2	1	2	259.0	14313.05
22181	28	49	30	4	1	2	900.0	404802.83
34959	5	53	18	4	1	2	170.0	40498.73
28812	33	39	37	2	1	2	503.0	137280.71
43437	46	27	46	2	1	2	121.0	17566.93
45771	13	59	15	2	1	2	219.0	52983.86
46838	31	58	35	1	1	2	170.0	26260.51
44982	20	41	36	2	1	2	150.0	64759.04
43353	7	3	8	4	1	2	55.0	14172.24
10767	23	23	26	2	1	2	159.0	57728.56
19868	34	19	9	4	1	2	180.0	59504.62
39076	57	18	23	4	2	1	3151.0	1476284.84
17757	48	33	51	4	2	1	871.5	503894.96
34454	24	1	27	1	2	1	6753.0	2070024.44
26206	2	13	5	1	2	1	2554.0	723744.82
22598	22	24	25	1	2	1	1850.0	500659.69
36569	39	17	40	1	2	1	2403.0	968917.50
21053	41	37	44	1	2	1	5314.0	1665619.30
29805	1	36	4	1	2	1	450.0	1021054.09
35512	12	31	12	4	2	1	3500.0	1710382.42
39050	56	50	57	4	2	1	6525.0	2901254.51
39102	58	7	22	4	2	1	3892.0	2428730.28
39110	59	34	58	4	2	1	6062.0	4168988.81
32930	43	6	43	4	2	1	2814.0	1321031.80
31032	25	4	32	4	2	1	5218.0	1187021.87
22460	50	35	3	4	2	1	6392.0	4333934.42
33192	6	32	13	4	2	1	1565.1	2736281.42
38900	8	2	14	4	2	1	8000.0	4662581.62

In [5]:
```
#Chose numeric data
dfnew <- df[-c(1,2,3,4,5,6,7)]
```

In [6]:
```
attach(dfnew)
```

In [7]:
```
pairs(dfnew, panel=panel.smooth)
```



In [ ]:
```
#See how quickly a scatter plot helps see the relationships between the variab
les.
#Operating Revenue increase with increase in number of NoFTE, NetPatRev, InOpe
rExp, OutOper
#increases with acceleration (the variable acceleration represents time taken
 to acceleration from range $1906944100
```

In [8]:
```
ozone_corr = cor(dfnew)
ozone_corr
```

	NoFTE	NetPatRev	InOperExp	OutOperExp	OperRev	OperInc
NoFTE	1.00000000	0.9038272	0.93805150	0.88029546	0.8963870	-0.07231425
NetPatRev	0.90382720	1.0000000	0.97910894	0.96023198	0.9987650	0.22014898
InOperExp	0.93805150	0.9791089	1.00000000	0.93586293	0.9798165	0.07178052
OutOperExp	0.88029546	0.9602320	0.93586293	1.00000000	0.9552386	0.05621751
OperRev	0.89638699	0.9987650	0.97981651	0.95523858	1.0000000	0.23427007
OperInc	-0.07231425	0.2201490	0.07178052	0.05621751	0.2342701	1.00000000
AvlBeds	0.88133305	0.8877273	0.92552054	0.82689246	0.8900175	0.04185734

In [9]:
```
describe(OperRev)
```

	vars	n	mean	sd	median	trimmed	mad	min	max
X1	1	61	256273311	424985115	63398216	150743632	75765201	5235317	19121794

In [101]:
```
dfnew.fit <- lm(OperRev~.,data = dfnew)
summary(dfnew.fit)
```

```
Call:
lm(formula = OperRev ~ ., data = dfnew)

Residuals:
      Min        1Q    Median        3Q       Max
-0.041060 -0.005439 -0.000379  0.001926  0.045131

Coefficients:
              Estimate Std. Error    t value Pr(>|t|)
(Intercept) -4.249e-03  2.776e-03 -1.530e+00  0.13177
NoFTE       -1.021e-05  3.032e-06 -3.367e+00  0.00141 **
NetPatRev    3.429e-07  3.925e-08  8.735e+00 6.54e-12 ***
InOperExp    1.000e+00  9.319e-11  1.073e+10  < 2e-16 ***
OutOperExp   1.000e+00  1.206e-10  8.290e+09  < 2e-16 ***
OperInc      1.000e+00  1.018e-10  9.822e+09  < 2e-16 ***
AvlBeds      9.789e-05  2.199e-05  4.451e+00 4.32e-05 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.01356 on 54 degrees of freedom
Multiple R-squared:      1,     Adjusted R-squared:      1
F-statistic: 9.82e+21 on 6 and 54 DF,  p-value: < 2.2e-16
```

In [100]:
```
dfnew2 = step(dfnew)
summary(dfnew2)
```

```
Error in terms.default(object): no terms component nor attribute
Traceback:

1. step(dfnew)
2. terms(object)
3. terms.default(object)
4. stop("no terms component nor attribute")
```

In [ ]:
```
#P-values for coefficients of cylinders, horsepower and acceleratio NoFTE, Net
PatRev, InOperExp, OutOper  are all less than 0.05.
#This means that the relationship between the dependent and these independent
 variables is significant at the 95% certainty level
#I will inclide all variable in dfnew dataset.
# Model is not really good.
```

In [22]:
```
#### What about significance of the correlations?
#### This shows the correlation values (rounded) and their associated p-values
rcorr(as.matrix(dfnew))
```

```
           NoFTE NetPatRev InOperExp OutOperExp OperRev OperInc AvlBeds
NoFTE       1.00      0.90      0.94       0.88    0.90   -0.07    0.88
NetPatRev   0.90      1.00      0.98       0.96    1.00    0.22    0.89
InOperExp   0.94      0.98      1.00       0.94    0.98    0.07    0.93
OutOperExp  0.88      0.96      0.94       1.00    0.96    0.06    0.83
OperRev     0.90      1.00      0.98       0.96    1.00    0.23    0.89
OperInc    -0.07      0.22      0.07       0.06    0.23    1.00    0.04
AvlBeds     0.88      0.89      0.93       0.83    0.89    0.04    1.00

n= 61


P
           NoFTE  NetPatRev InOperExp OutOperExp OperRev OperInc AvlBeds
NoFTE             0.0000    0.0000    0.0000     0.0000  0.5797  0.0000
NetPatRev  0.0000            0.0000    0.0000     0.0000  0.0882  0.0000
InOperExp  0.0000 0.0000              0.0000     0.0000  0.5825  0.0000
OutOperExp 0.0000 0.0000    0.0000              0.0000  0.6670  0.0000
OperRev    0.0000 0.0000    0.0000    0.0000             0.0692  0.0000
OperInc    0.5797 0.0882    0.5825    0.6670     0.0692          0.7487
AvlBeds    0.0000 0.0000    0.0000    0.0000     0.0000  0.7487
```

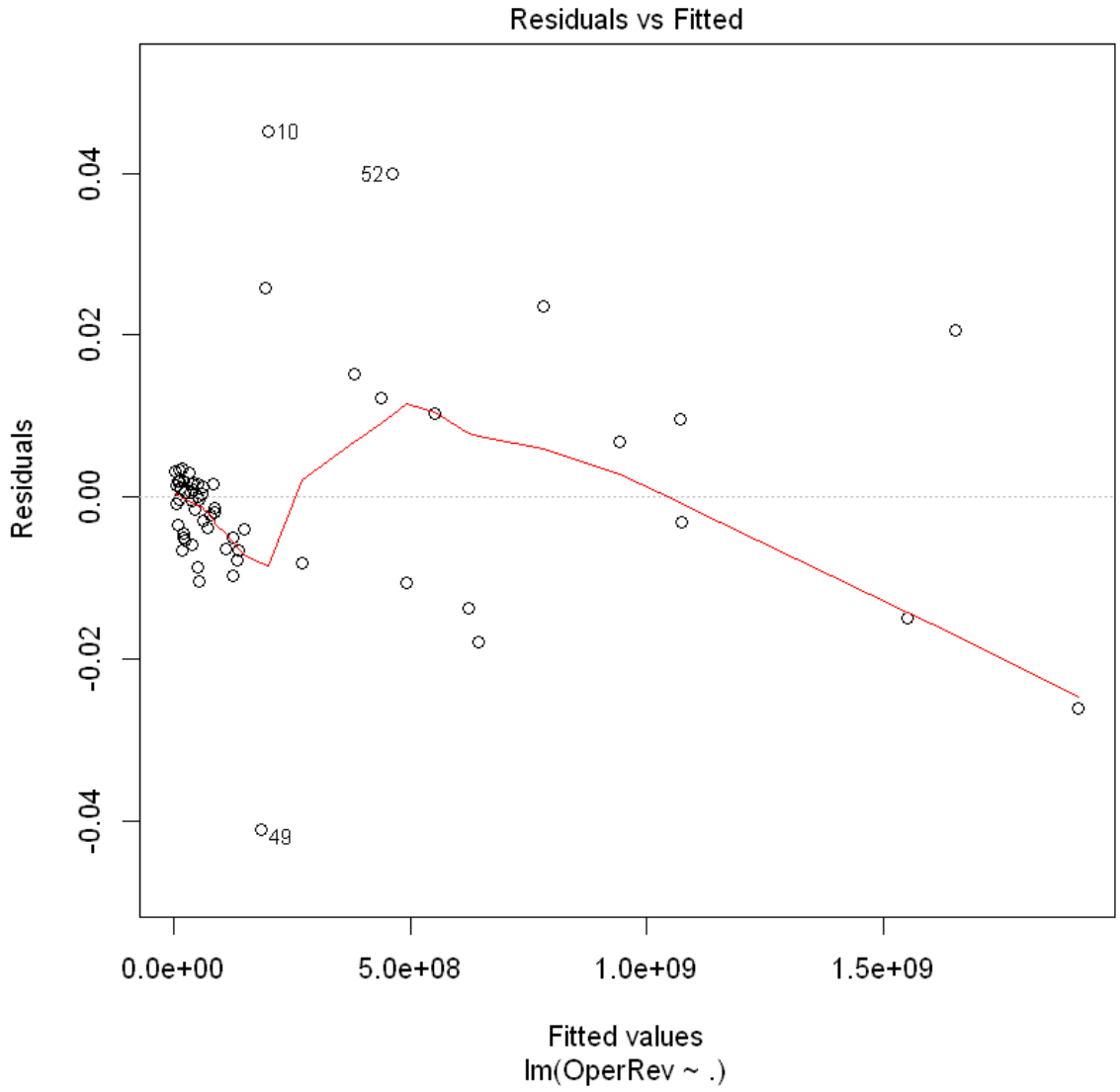
In [95]:
```
dfnew.fit <- lm(OperRev~ InOperExp+ OutOperExp +OperInc ,data = dfnew)
summary(dfnew.fit)
```

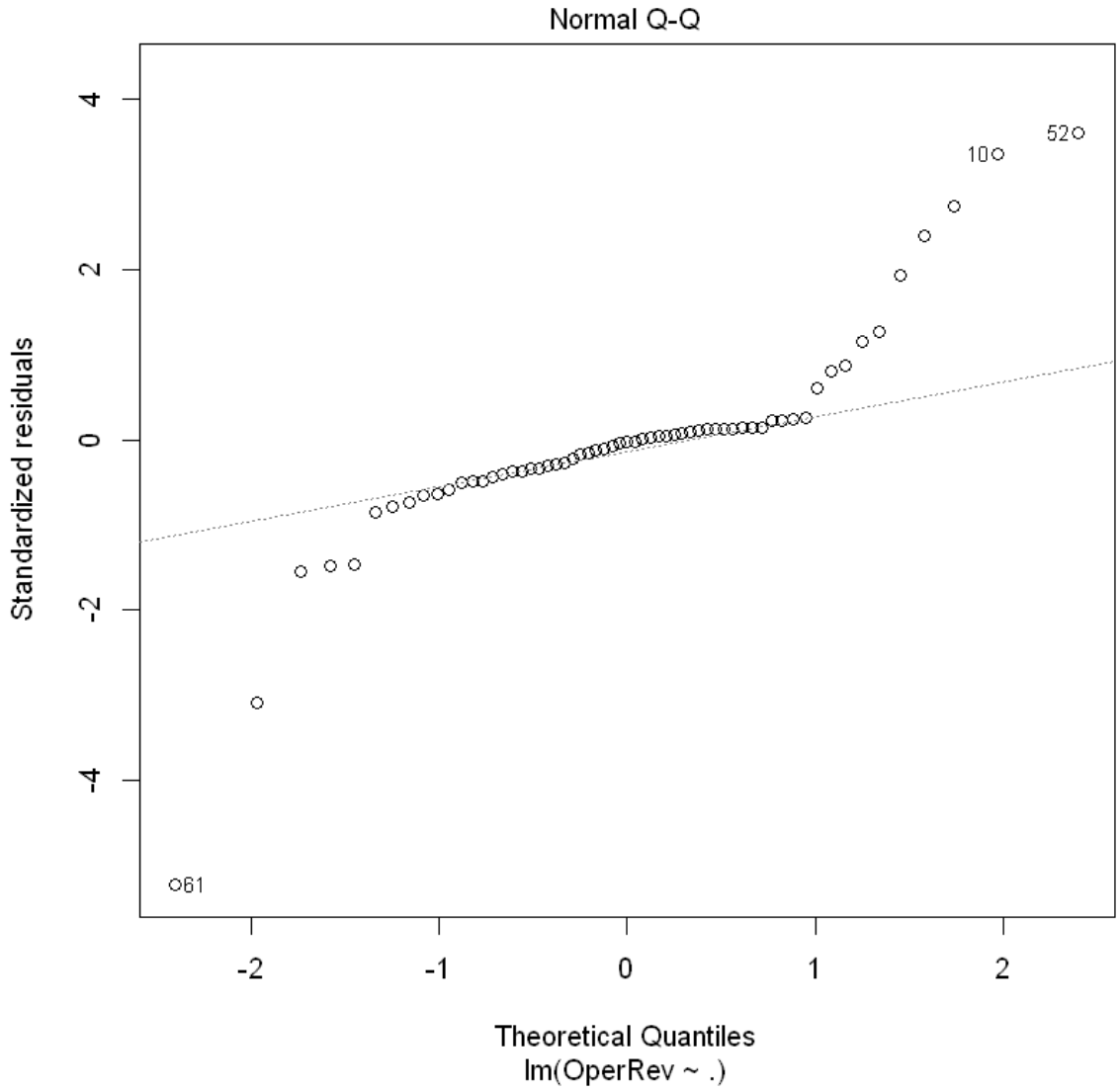
```
Call:
lm(formula = OperRev ~ InOperExp + OutOperExp + OperInc, data = dfnew)

Residuals:
      Min        1Q    Median        3Q       Max 
-0.107604 -0.005145 -0.003345  0.000336  0.052252 

Coefficients:
             Estimate Std. Error   t value Pr(>|t|)    
(Intercept) 2.263e-03  3.348e-03 6.760e-01    0.502    
InOperExp   1.000e+00  2.822e-11 3.544e+10   <2e-16 ***
OutOperExp  1.000e+00  5.807e-11 1.722e+10   <2e-16 ***
OperInc     1.000e+00  3.936e-11 2.540e+10   <2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.02175 on 57 degrees of freedom
Multiple R-squared:      1,     Adjusted R-squared:      1 
F-statistic: 7.637e+21 on 3 and 57 DF,  p-value: < 2.2e-16
```

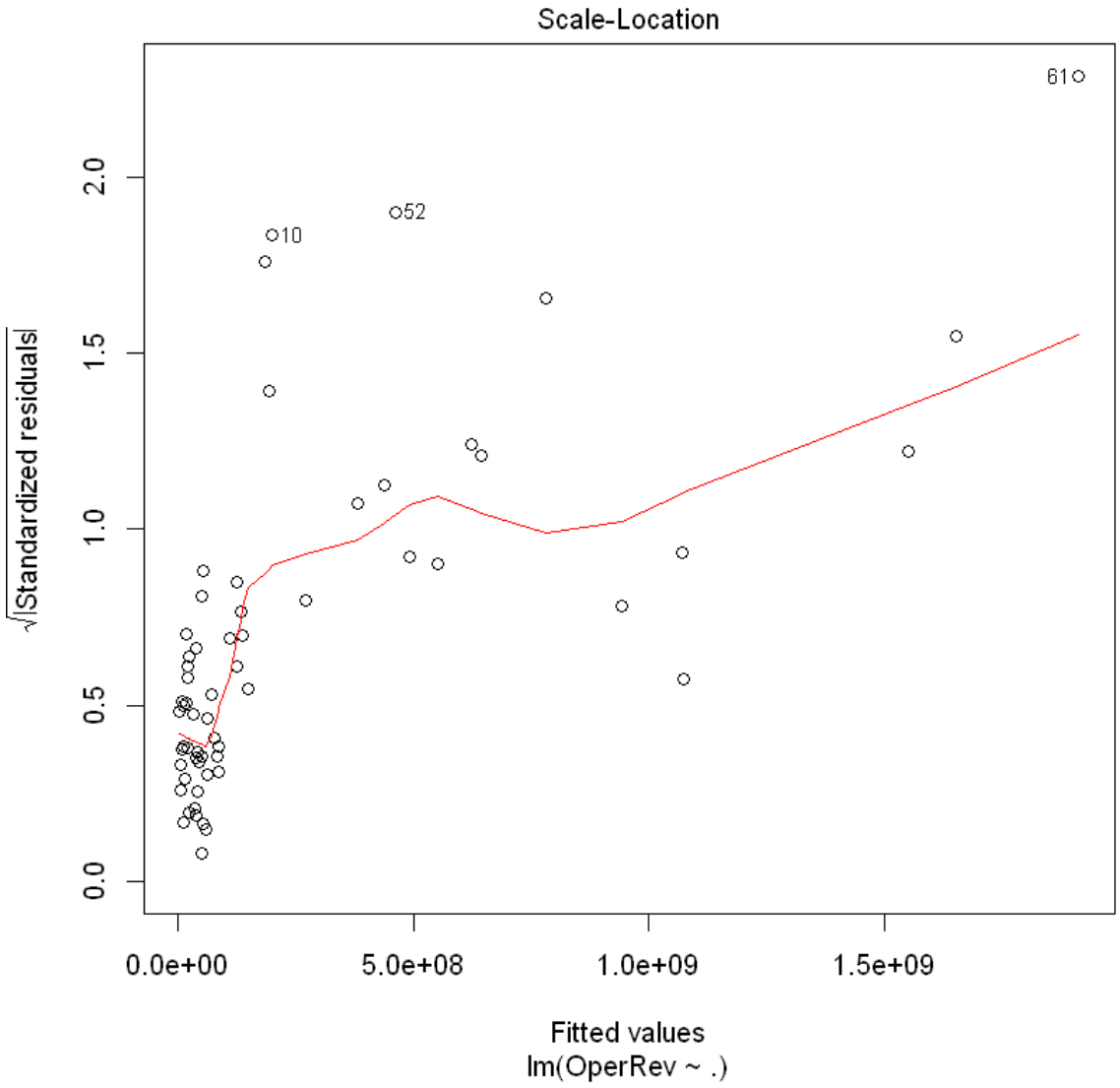
In [45]:
```
#Test Independence Assumption
durbinWatsonTest(dfnew)
```

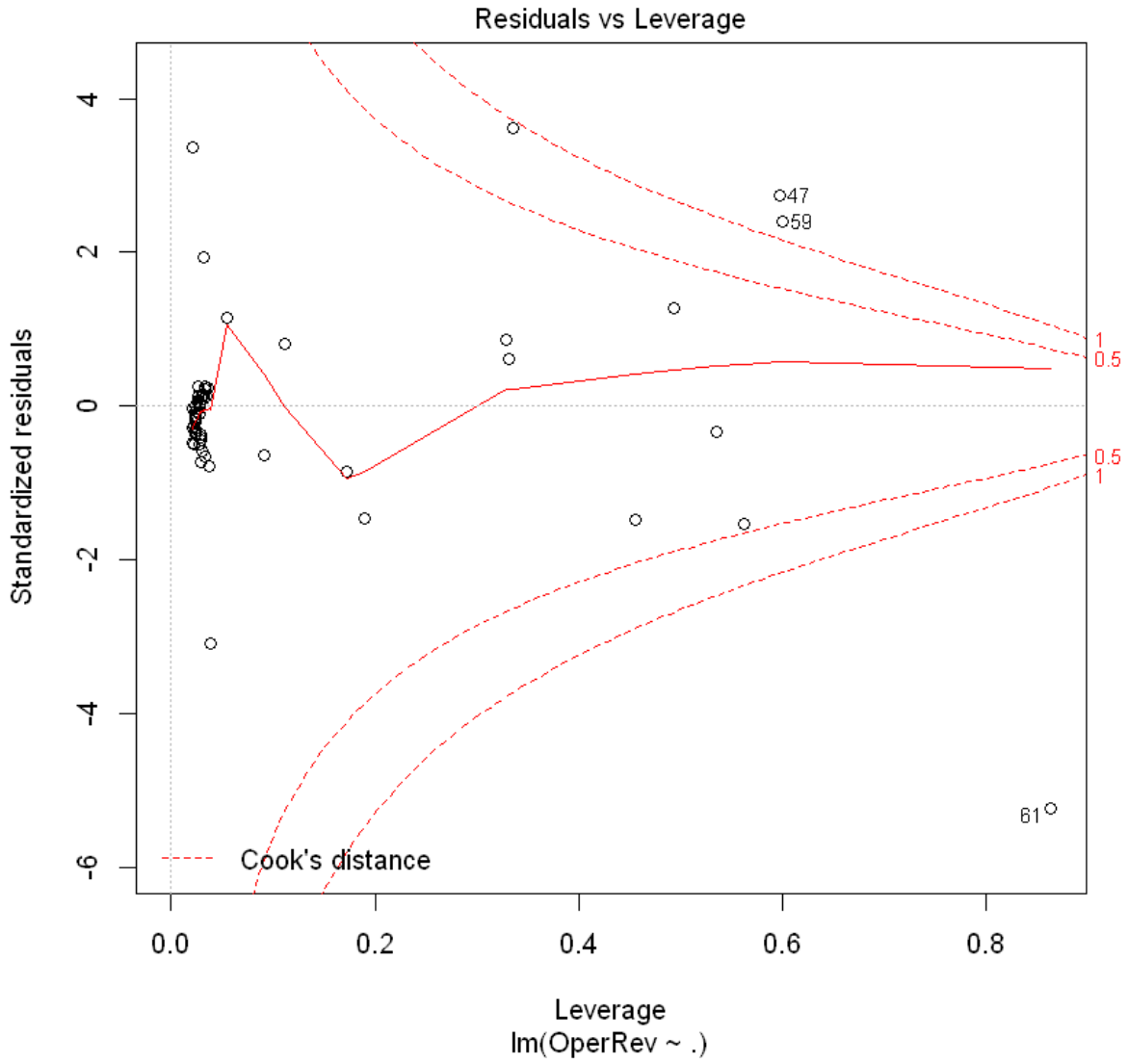
```
Error in durbinWatsonTest.default(dfnew): requires vector of residuals
Traceback:

1. durbinWatsonTest(dfnew)
2. durbinWatsonTest.default(dfnew)
3. stop("requires vector of residuals")
```

In [102]:
```
plot(dfnew.fit)
```


Residuals vs Fitted
Residuals
0.04
0.02
0.00
-0.02
-0.04
10
52
49
0.0e+00
5.0e+08
1.0e+09
1.5e+09
Fitted values
lm(OperRev ~ .)

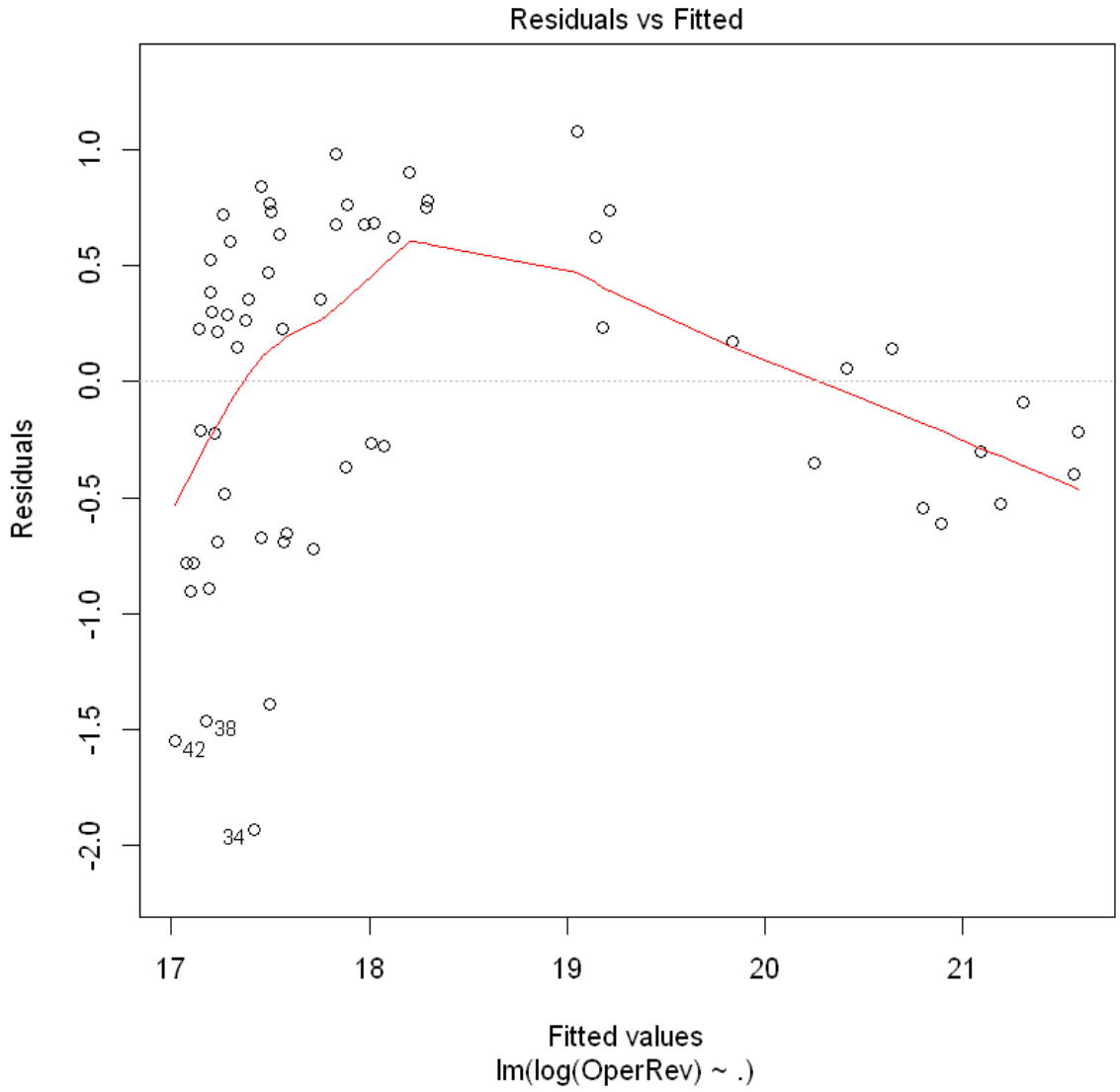

Normal Q-Q
Standardized residuals
Theoretical Quantiles
lm(OperRev ~ .)
52
10
61
4
2
0
-2
-4
-2
-1
0
1
2

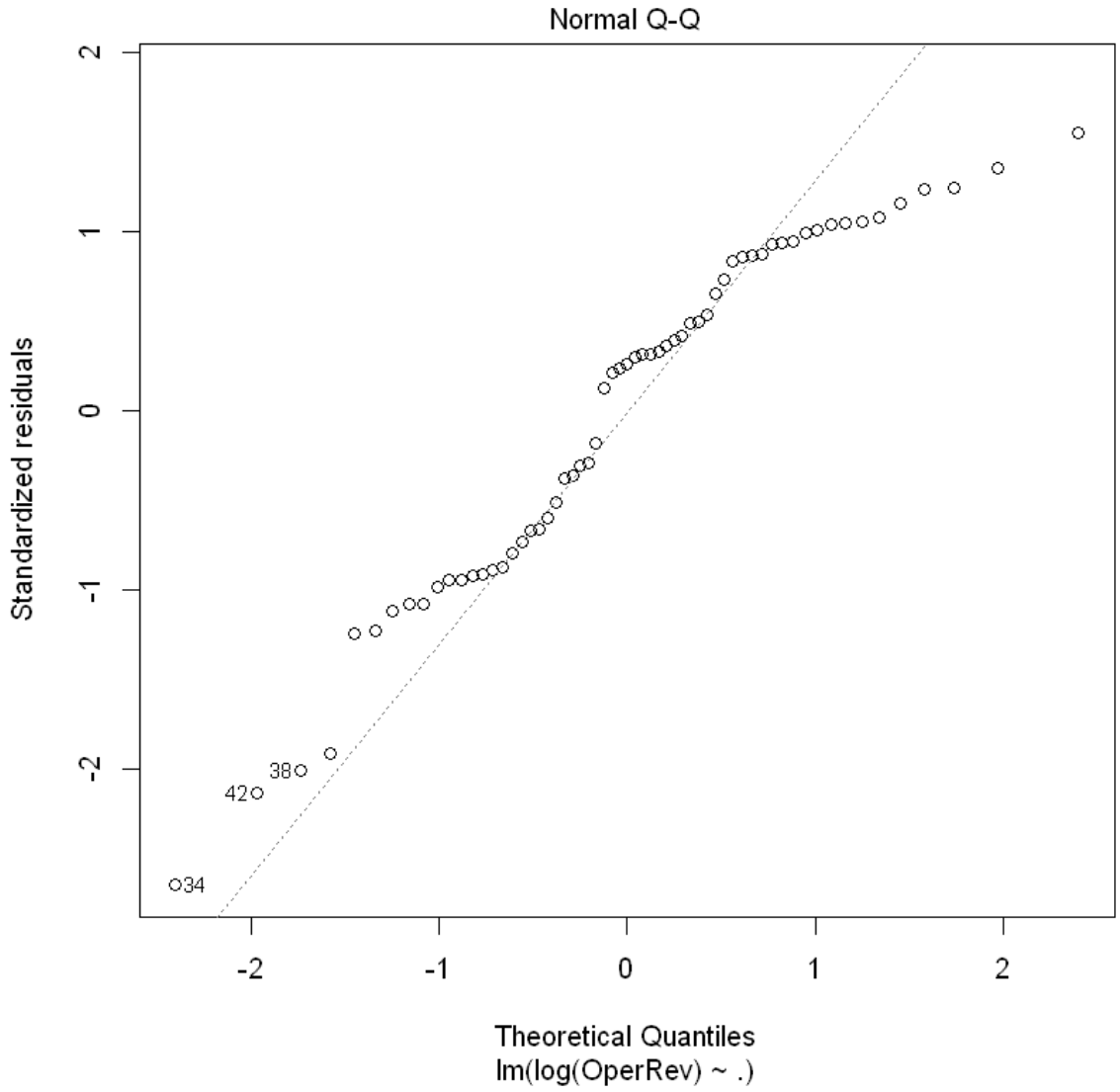

Scale-Location
√|Standardized residuals|
Fitted values
lm(OperRev ~ .)
0.0
0.5
1.0
1.5
2.0
0.0e+00
5.0e+08
1.0e+09
1.5e+09
61
52
10

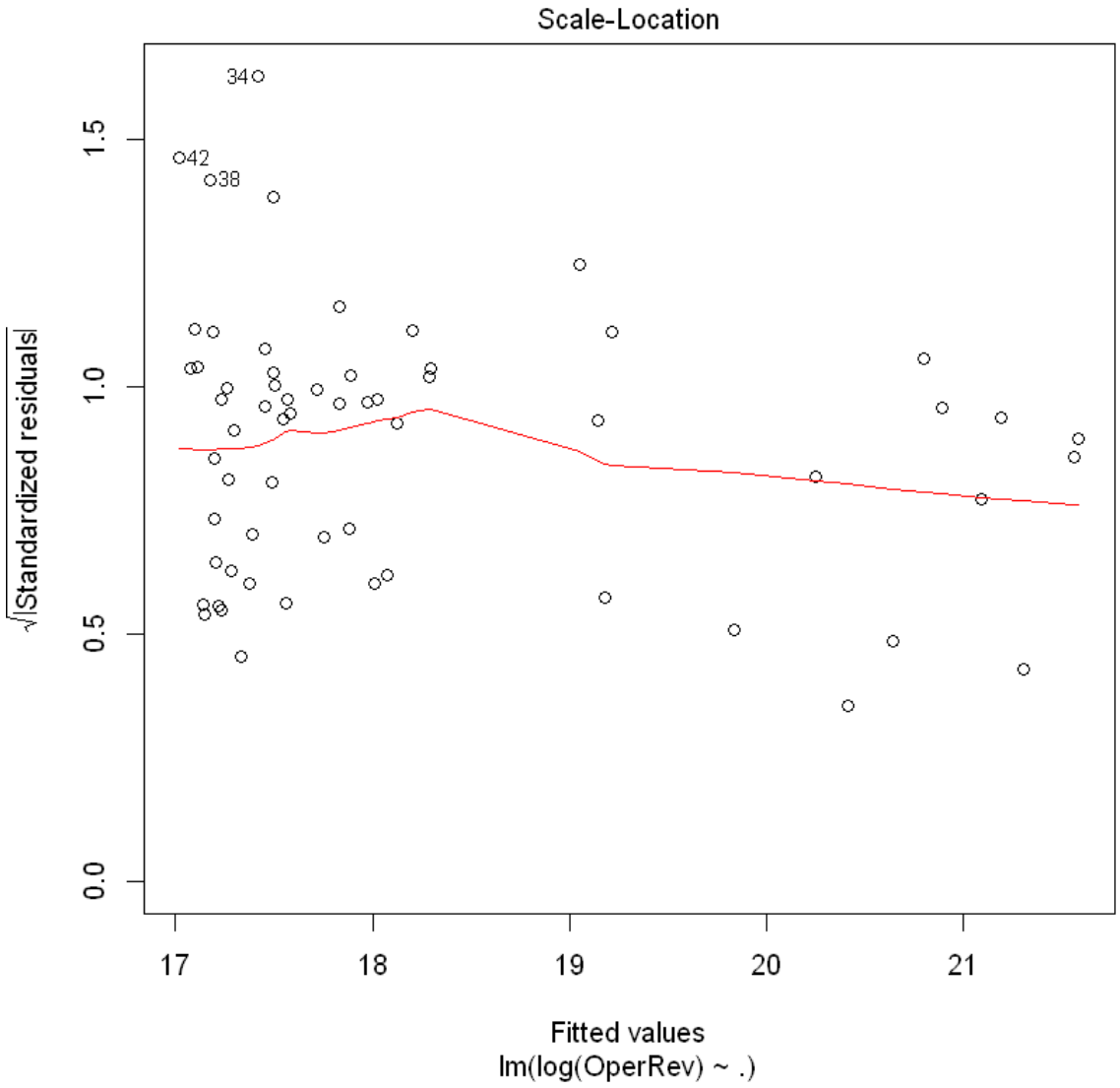


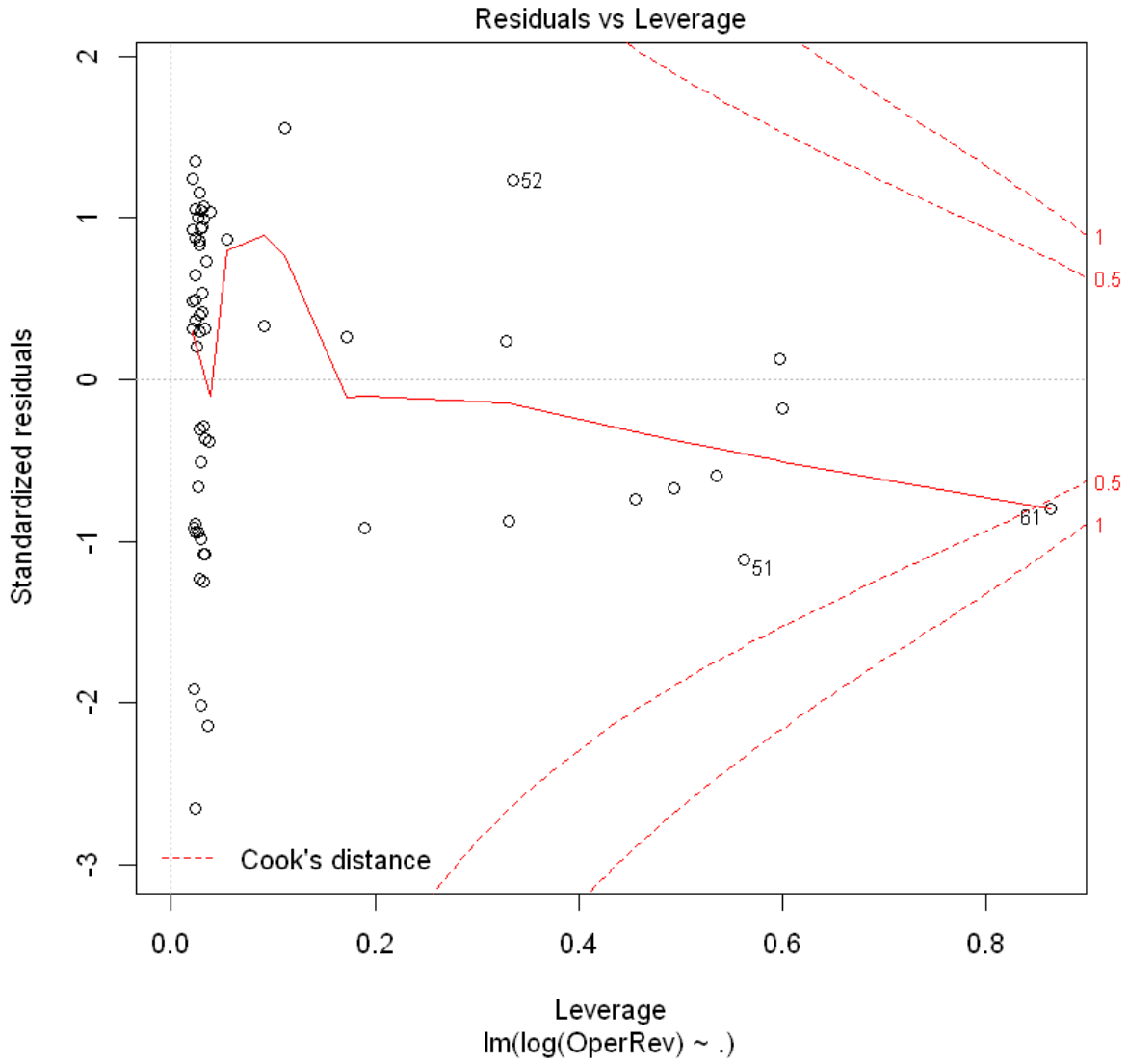
In [97]:
```
dfnew1.fit = lm(log(OperRev)~.,data = dfnew)
```

In [98]:
```
plot(dfnew1.fit)
```


Residuals vs Fitted
Residuals
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
38
42
34
17
18
19
20
21
Fitted values
lm(log(OperRev) ~ .)


Normal Q-Q
Standardized residuals
Theoretical Quantiles
lm(log(OperRev) ~ .)
34
42
38
-2
-1
0
1
2


Scale-Location
34
42
38
√|Standardized residuals|
0.0
0.5
1.0
1.5
17
18
19
20
21
Fitted values
lm(log(OperRev) ~ .)



In [55]:
```
#Logistic Regression
```

In [130]:
```
df_lg <- df
```

In [131]:
```
names(df_lg)
```

'HospitalID' 'Name' 'Zip' 'Website' 'TypeControl' 'Teaching' 'DonorType' 'NoFTE' 'NetPatRev' 'InOperExp' 'OutOperExp' 'OperRev' 'OperInc' 'AvlBeds'

In [128]:
```
df_lg <- sapply(df, as.numeric)
df_lg
```

HospitalID	Name	Zip	Website	TypeControl	Teaching	DonorType	NoFTE	NetPatRev
45740	26	28	28	2	1	2	327.00	135520.22
12145	61	16	60	4	1	2	345.00	136156.69
25667	36	9	39	2	1	2	601.20	197094.25
46996	38	29	41	4	1	2	400.00	139170.38
37393	3	12	6	3	1	2	262.00	116797.83
17741	47	56	2	4	1	2	397.50	232503.02
20277	60	44	59	4	1	2	503.50	214516.45
45736	32	14	31	2	1	2	158.00	30786.20
29823	11	51	11	4	1	2	168.00	51726.49
13738	49	11	50	4	1	2	1216.00	540975.12
38798	18	20	42	4	1	2	288.00	335179.56
46348	4	60	7	4	1	2	750.00	335179.56
33207	29	30	33	4	1	2	235.00	105166.89
44817	14	57	16	4	1	2	250.00	108162.91
17718	30	55	34	4	1	2	215.50	123480.27
33283	53	42	54	4	1	2	353.00	173227.49
20231	19	22	20	4	1	2	777.00	363127.60
46985	54	61	55	2	1	2	374.32	209348.94
37043	10	15	1	3	1	2	75.00	33593.68
46342	9	21	10	2	1	2	160.00	65792.43
33242	51	48	52	4	1	2	318.00	161745.22
33251	52	46	53	4	1	2	363.00	172398.86
13722	37	47	49	4	1	2	193.00	103189.40
17700	27	38	29	4	1	2	236.50	116609.82
20225	16	45	24	4	1	2	226.00	94015.91
37285	55	26	56	3	1	2	359.00	240737.96
20266	45	40	48	4	1	2	779.00	367540.66
37436	15	5	17	2	1	2	501.00	108960.42
17736	44	52	47	4	1	2	524.50	295579.23
38802	42	25	42	4	1	2	67.00	28773.45
...	...	...	...	...	...	...	...	...
46844	35	43	38	2	1	2	191.0	61816.76

HospitalID	Name	Zip	Website	TypeControl	Teaching	DonorType	NoFTE	NetPatRev
28283	21	10	21	2	1	2	451.5	145733.58
11875	40	8	45	2	1	2	259.0	14313.05
22181	28	49	30	4	1	2	900.0	404802.83
34959	5	53	18	4	1	2	170.0	40498.73
28812	33	39	37	2	1	2	503.0	137280.71
43437	46	27	46	2	1	2	121.0	17566.93
45771	13	59	15	2	1	2	219.0	52983.86
46838	31	58	35	1	1	2	170.0	26260.51
44982	20	41	36	2	1	2	150.0	64759.04
43353	7	3	8	4	1	2	55.0	14172.24
10767	23	23	26	2	1	2	159.0	57728.56
19868	34	19	9	4	1	2	180.0	59504.62
39076	57	18	23	4	2	1	3151.0	1476284.84
17757	48	33	51	4	2	1	871.5	503894.96
34454	24	1	27	1	2	1	6753.0	2070024.44
26206	2	13	5	1	2	1	2554.0	723744.82
22598	22	24	25	1	2	1	1850.0	500659.69
36569	39	17	40	1	2	1	2403.0	968917.50
21053	41	37	44	1	2	1	5314.0	1665619.30
29805	1	36	4	1	2	1	450.0	1021054.09
35512	12	31	12	4	2	1	3500.0	1710382.42
39050	56	50	57	4	2	1	6525.0	2901254.51
39102	58	7	22	4	2	1	3892.0	2428730.28
39110	59	34	58	4	2	1	6062.0	4168988.81
32930	43	6	43	4	2	1	2814.0	1321031.80
31032	25	4	32	4	2	1	5218.0	1187021.87
22460	50	35	3	4	2	1	6392.0	4333934.42
33192	6	32	13	4	2	1	1565.1	2736281.42
38900	8	2	14	4	2	1	8000.0	4662581.62

In [129]:
```
ozone_corr = cor(df_lg)
ozone_corr
```

	HospitalID	Name	Zip	Website	TypeControl	Teach
HospitalID	1.000000000	-0.2209509162	0.06170773	-0.15080674	-0.16832901	-0.007
Name	-0.220950916	1.0000000000	0.08101534	0.75750613	0.21288317	0.0498
Zip	0.061707727	0.0810153358	1.00000000	0.12520673	0.18565393	-0.305
Website	-0.150806740	0.7575061254	0.12520673	1.00000000	0.08832879	-0.103
TypeControl	-0.168329011	0.2128831711	0.18565393	0.08832879	1.00000000	-0.113
Teaching	-0.007624498	0.0498401793	-0.30527110	-0.10331109	-0.11367513	1.0000
DonorType	0.007624498	-0.0498401793	0.30527110	0.10331109	0.11367513	-1.000
NoFTE	0.026803614	0.1505627626	-0.28884921	-0.01329261	0.01942510	0.8075
NetPatRev	0.049684436	0.1362126391	-0.20426033	-0.07478736	0.14546848	0.7725
InOperExp	0.047947972	0.0875500800	-0.25001864	-0.07183951	0.05036315	0.8037
OutOperExp	-0.010441430	0.1554772125	-0.14552864	-0.08133554	0.06778846	0.7447
OperRev	0.051768084	0.1169629083	-0.20957028	-0.08891799	0.13971091	0.7692
OperInc	0.138026885	0.0503741938	0.02260832	-0.08815439	0.50075535	-0.036
AvlBeds	0.018320732	-0.0007787004	-0.34385124	-0.09945757	-0.03570584	0.8888

In [132]:
```
#### Perform logistic regression using Project as
#### a predictor of Teaching
df_lg.fit = glm(Teaching~DonorType+NoFTE+NetPatRev+InOperExp+OutOperExp+OperRe
v+AvlBeds, binomial, data=df_lg)
summary(df_lg.fit)
```

```
Call:
glm(formula = Teaching ~ DonorType + NoFTE + NetPatRev + InOperExp +
    OutOperExp + OperRev + AvlBeds, family = binomial, data = df_lg)

Deviance Residuals:
       Min          1Q      Median          3Q         Max
-2.409e-06  -2.409e-06  -2.409e-06   2.409e-06   2.409e-06

Coefficients:
                   Estimate Std. Error z value Pr(>|z|)
(Intercept)       2.657e+01  2.754e+05       0        1
DonorTypeCharity -5.313e+01  2.369e+05       0        1
NoFTE             6.265e-10  8.072e+01       0        1
NetPatRev        -2.663e-12  1.033e+00       0        1
InOperExp        -5.750e-15  1.289e-03       0        1
OutOperExp       -1.223e-15  1.292e-03       0        1
OperRev           8.194e-15  2.683e-03       0        1
AvlBeds           4.581e-10  7.705e+02       0        1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 7.2189e+01  on 60  degrees of freedom
Residual deviance: 3.5390e-10  on 53  degrees of freedom
AIC: 16

Number of Fisher Scoring iterations: 25
```

In [133]:
```
anova(df_lg.fit, test="Chisq")
```

	Df	Deviance	Resid. Df	Resid. Dev	Pr(>Chi)
NULL	NA	NA	60	7.218867e+01	NA
DonorType	1	72.18867	59	3.538965e-10	1.955754e-17
NoFTE	1	0.00000	58	3.538965e-10	1.000000e+00
NetPatRev	1	0.00000	57	3.538965e-10	1.000000e+00
InOperExp	1	0.00000	56	3.538965e-10	1.000000e+00
OutOperExp	1	0.00000	55	3.538965e-10	1.000000e+00
OperRev	1	0.00000	54	3.538965e-10	1.000000e+00
AvlBeds	1	0.00000	53	3.538965e-10	1.000000e+00