

RTSM_Error_analysis.R

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```
# Model adequacy checking  
library("sde")
```

```
## Loading required package: MASS
```

```
## Loading required package: stats4
```

```
## Loading required package: fda
```

```
## Loading required package: splines
```

```
## Loading required package: Matrix
```

```
##  
## Attaching package: 'fda'
```

```
## The following object is masked from 'package:graphics':  
##  
##      matplot
```

```
## Loading required package: zoo
```

```
##  
## Attaching package: 'zoo'
```

```
## The following objects are masked from 'package:base':  
##  
##      as.Date, as.Date.numeric
```

```
## sde 2.0.15
```

```
## Companion package to the book
```

```
## 'Simulation and Inference for Stochastic Differential Equations With R Examples'
```

```
## Iacus, Springer NY, (2008)
```

```
## To check the errata corriege of the book, type vignette("sde.errata")
```

```
#####      MODEL 1      #####
k<-3 # independent variables
n<- 1000 # number of observations
X<-array(0,dim=c(n,(k+1)))
bt<-c(1,2.3, 1.5,0.05)

x1<-rgamma(n,2,3)
x2<-rbinom(n,10,0.7)
x3<-rbeta(n,0.5,0.5)
X[,1]<-1
X[,2]<-x1
X[,3]<-x2
X[,4]<-x3
sigma<-2
eps<-rnorm(n,0,sigma)
y<-X%*%bt+eps
d<- data.frame(y,X[,2],X[,3],X[,4])

bth<-lm(y~X[,2]+X[,3]+X[,4],data=d)

cat("trur beta=",bt, "sigma=",sigma,'\n')
```

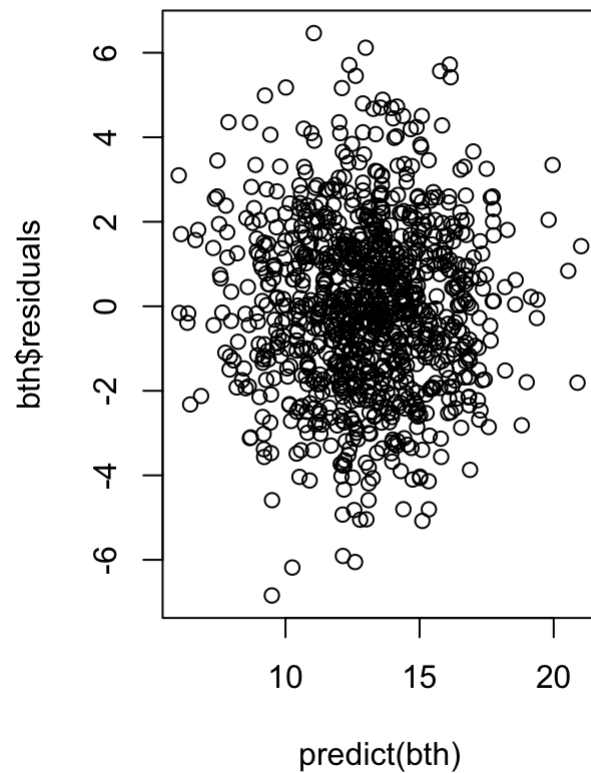
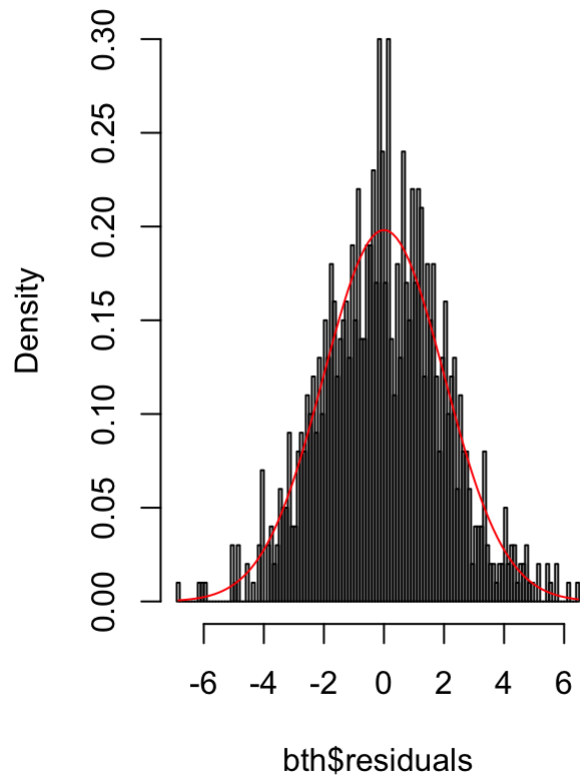
```
## trur beta= 1 2.3 1.5 0.05 sigma= 2
```

```
cat("beta_hat=",coefficients(bth), "sigma_hat=",summary(bth)$sigma,'\n') # model coef
ficients
```

```
## beta_hat= 1.216331 2.280402 1.45387 0.2396212 sigma_hat= 2.016307
```

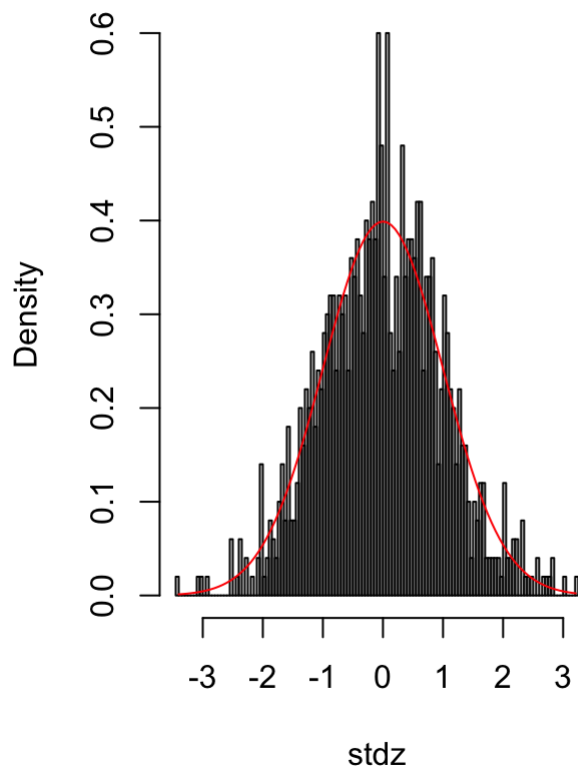
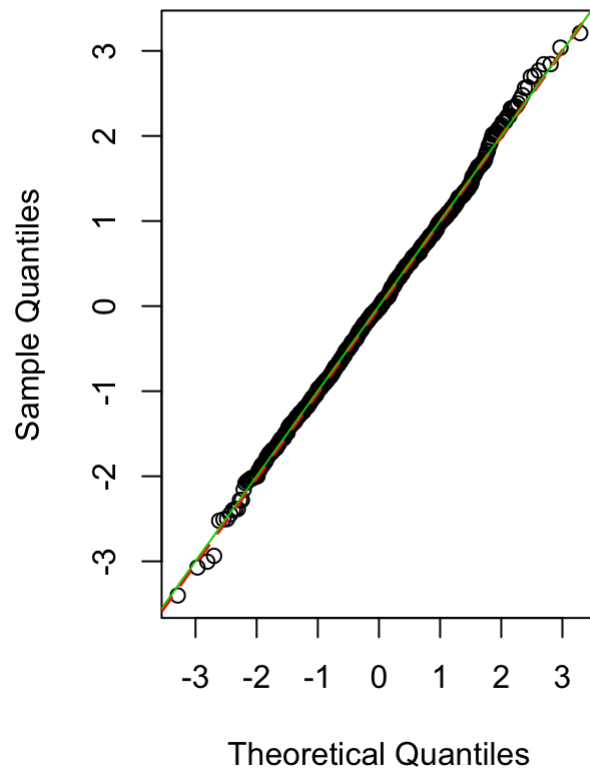
```
par(mfrow=c(1,2))
hist(bth$residuals, breaks = 100, probability = T )
s<-seq(min(bth$residuals), max(bth$residuals), length=100)
lines(dnorm(s, mean(bth$residuals),sd(bth$residuals))~s, col=2)
plot(predict(bth),bth$residuals)
```

Histogram of bth\$residuals



```
#qqnorm(y = bth$residuals, plot.it = T )
#qqline(y=bth$residuals, col=2, lwd=2,lty=2)

stdz<-(stdres(bth))
hist(stdz, breaks = 100, probability = T )
s<-seq(min(stdz), max(stdz), length=100)
lines(dnorm(s, 0,1)~s, col=2)
qqnorm(y = stdz, plot.it = T )
qqline(y=stdz, col=2, lwd=2,lty=2)
abline(a = 0,b = 1, col=3)
```

Histogram of stdz**Normal Q-Q Plot**

```
print(ks.test(x=bth$residuals, y="pnorm",alternative = c("two.sided")))
```

```
##
## One-sample Kolmogorov-Smirnov test
##
## data:  bth$residuals
## D = 0.16961, p-value < 2.2e-16
## alternative hypothesis: two-sided
```

```
print(ks.test(x=stdz, y="pnorm",alternative = c("two.sided")))
```

```
##
## One-sample Kolmogorov-Smirnov test
##
## data:  stdz
## D = 0.016154, p-value = 0.9566
## alternative hypothesis: two-sided
```

```
#####      MODEL 2 # Normal with non zero mean      #####
k<-3 # independent variables
n<- 1000 # number of observations
X<-array(0,dim=c(n,(k+1)))
bt<-c(1,2.3, 1.5,0.05)

x1<-rgamma(n,2,3)
x2<-rbinom(n,10,0.7)
x3<-rbeta(n,0.5,0.5)
X[,1]<-1
X[,2]<-x1
X[,3]<-x2
X[,4]<-x3
sigma<-2
eps<-rnorm(n,3,sigma)
y<-X%*%bt+eps
d<- data.frame(y,X[,2],X[,3],X[,4])

bth<-lm(y~X[,2]+X[,3]+X[,4],data=d)

cat("trur beta=",bt, "sigma=",sigma,'\n')
```

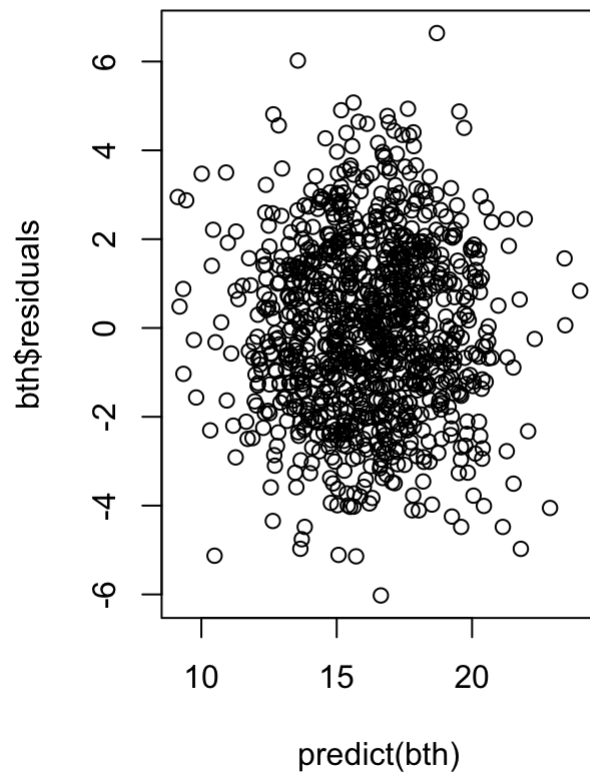
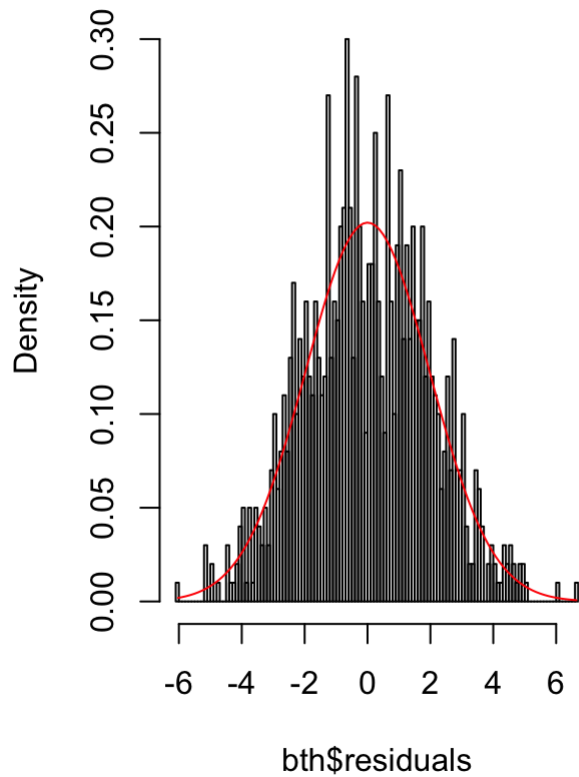
```
## trur beta= 1 2.3 1.5 0.05 sigma= 2
```

```
cat("beta_hat=",coefficients(bth), "sigma_hat=",summary(bth)$sigma,'\n') # model coef
ficients
```

```
## beta_hat= 4.292785 2.394685 1.461973 0.02515 sigma_hat= 1.977013
```

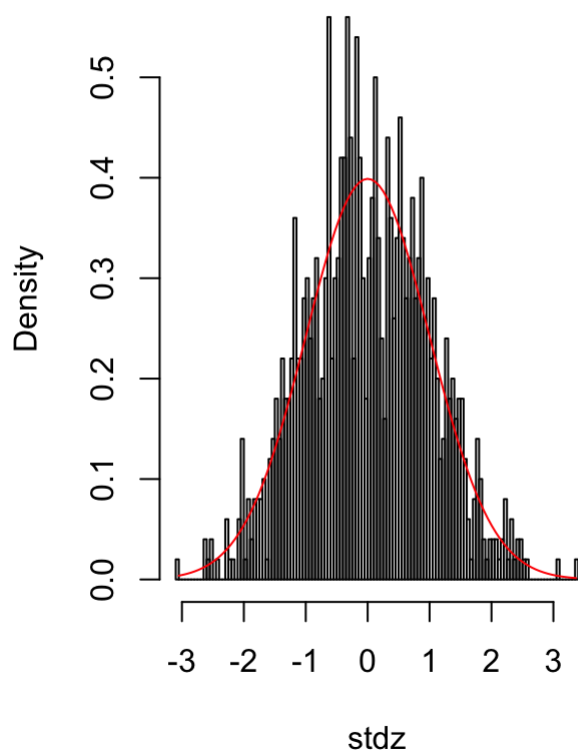
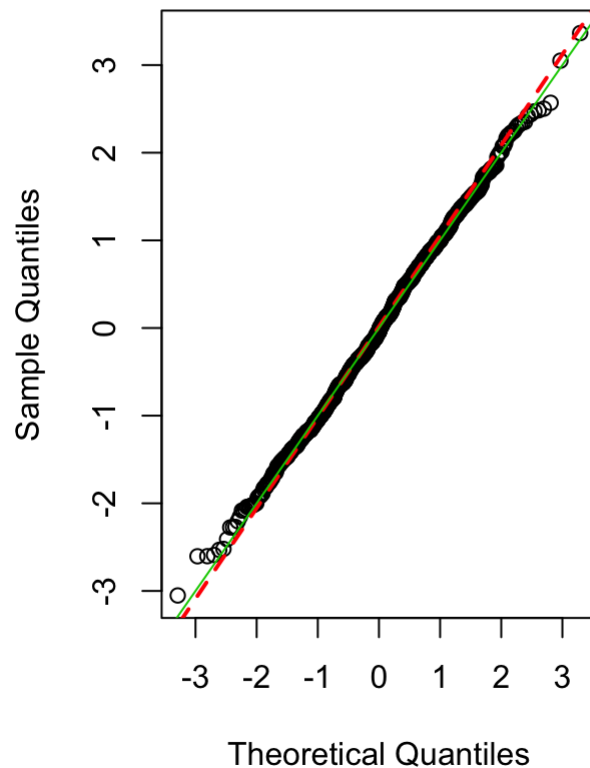
```
par(mfrow=c(1,2))
hist(bth$residuals, breaks = 100, probability = T )
s<-seq(min(bth$residuals), max(bth$residuals), length=100)
lines(dnorm(s, mean(bth$residuals),sd(bth$residuals))~s, col=2)
plot(predict(bth),bth$residuals)
```

Histogram of bth\$residuals



```
# qqnorm(y = bth$residuals, plot.it = T )
# qqline(y=bth$residuals, col=2, lwd=2,lty=2)

stdz<-(stdres(bth))
hist(stdz, breaks = 100, probability = T )
s<-seq(min(stdz), max(stdz), length=100)
lines(dnorm(s, 0,1)~s, col=2)
qqnorm(y = stdz, plot.it = T )
qqline(y=stdz, col=2, lwd=2,lty=2)
abline(a = 0,b = 1, col=3)
```

Histogram of stdz**Normal Q-Q Plot**

```
print(ks.test(x=bth$residuals, y="pnorm",alternative = c("two.sided")))
```

```
##
## One-sample Kolmogorov-Smirnov test
##
## data:  bth$residuals
## D = 0.17472, p-value < 2.2e-16
## alternative hypothesis: two-sided
```

```
print(ks.test(x=stdz, y="pnorm",alternative = c("two.sided")))
```

```
##
## One-sample Kolmogorov-Smirnov test
##
## data:  stdz
## D = 0.023654, p-value = 0.6305
## alternative hypothesis: two-sided
```

```
#####      MODEL 3  # Heavy tailed distribution      #####
k<-3 # independent variables
n<- 1000 # number of observations
X<-array(0,dim=c(n,(k+1)))
bt<-c(1,2.3, 1.5,0.05)

x1<-rgamma(n,2,3)
x2<-rbinom(n,10,0.7)
x3<-rbeta(n,0.5,0.5)
X[,1]<-1
X[,2]<-x1
X[,3]<-x2
X[,4]<-x3
sigma<-2
eps<-rt(n,df = 3)  # Heavy tailed distribution
y<-X%*%bt+eps
d<- data.frame(y,X[,2],X[,3],X[,4])

bth<-lm(y~X[,2]+X[,3]+X[,4],data=d)

cat("trur beta=",bt, "sigma=",sigma,'\n')
```

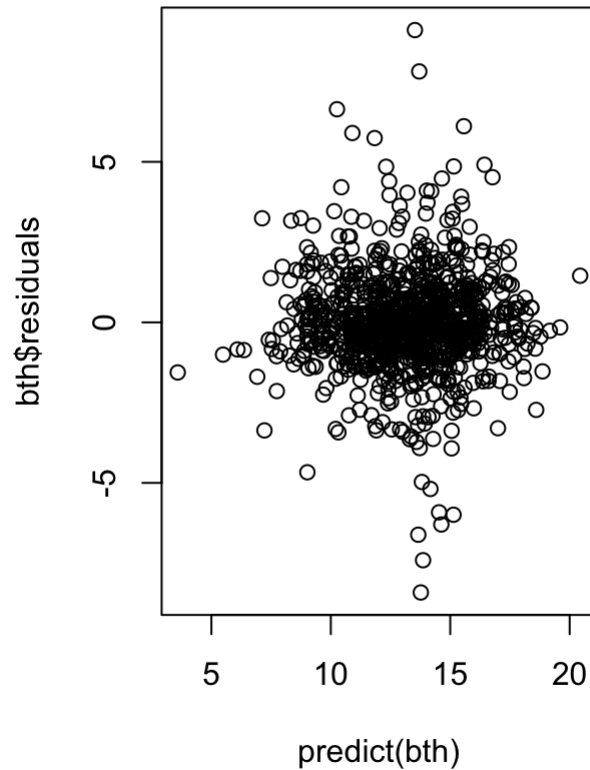
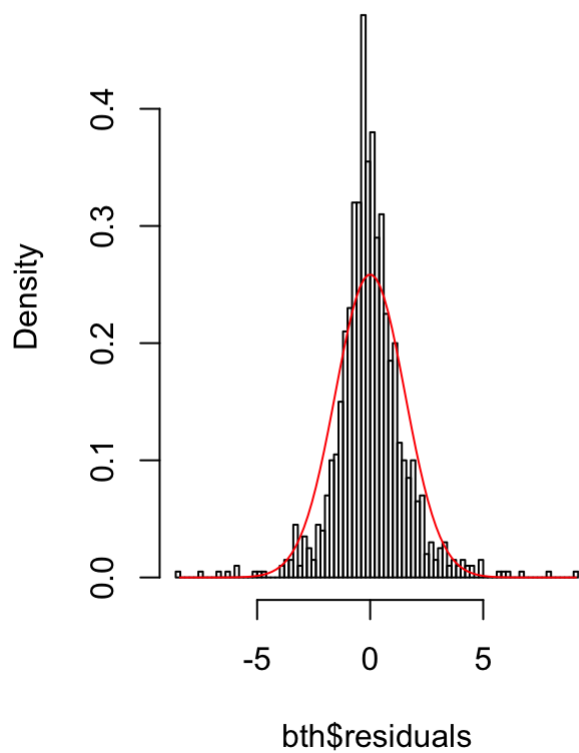
```
## trur beta= 1 2.3 1.5 0.05 sigma= 2
```

```
cat("beta_hat=",coefficients(bth), "sigma_hat=",summary(bth)$sigma,'\n') # model coef
ficients
```

```
## beta_hat= 1.215887 2.22745 1.488538 -0.004132992 sigma_hat= 1.544559
```

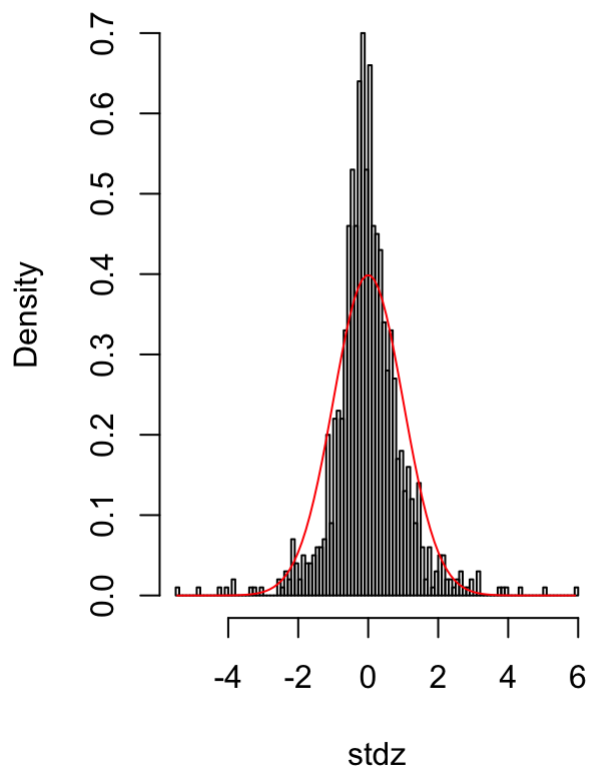
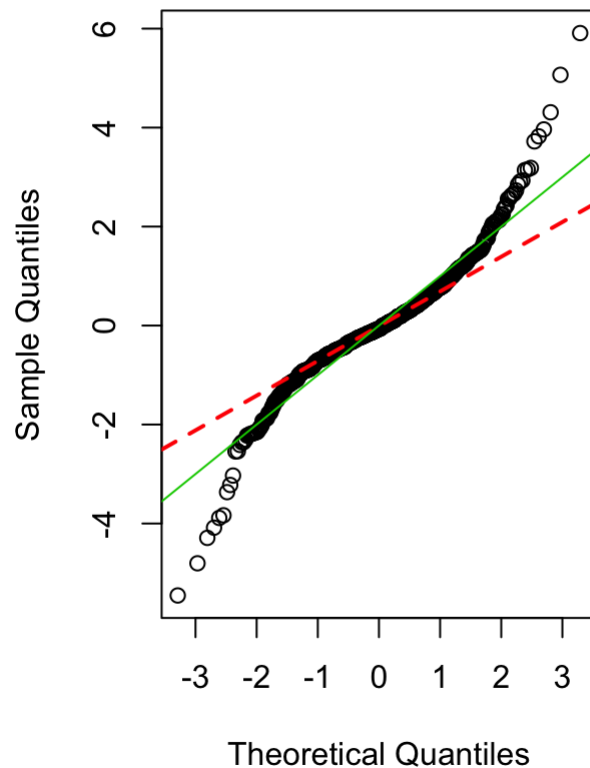
```
par(mfrow=c(1,2))
hist(bth$residuals, breaks = 100, probability = T )
s<-seq(min(bth$residuals), max(bth$residuals), length=100)
lines(dnorm(s, mean(bth$residuals),sd(bth$residuals))~s, col=2)
plot(predict(bth),bth$residuals)
```


Histogram of bth\$residuals



```
#qqnorm(y = bth$residuals, plot.it = T )
#qqline(y=bth$residuals, col=2, lwd=2,lty=2)

stdz<-(stdres(bth))
hist(stdz, breaks = 100, probability = T )
s<-seq(min(stdz), max(stdz), length=100)
lines(dnorm(s, 0,1)~s, col=2)
qqnorm(y = stdz, plot.it = T )
qqline(y=stdz, col=2, lwd=2,lty=2)
abline(a = 0,b = 1, col=3)
```

Histogram of stdz**Normal Q-Q Plot**

```
print(ks.test(x=bth$residuals, y="pnorm",alternative = c("two.sided")))
```

```
##
## One-sample Kolmogorov-Smirnov test
##
## data:  bth$residuals
## D = 0.059392, p-value = 0.001727
## alternative hypothesis: two-sided
```

```
print(ks.test(x=stdz, y="pnorm",alternative = c("two.sided")))
```

```
##
## One-sample Kolmogorov-Smirnov test
##
## data:  stdz
## D = 0.080359, p-value = 4.92e-06
## alternative hypothesis: two-sided
```

```
#####      MODEL 4  # thin tailed distribution      #####
k<-3 # independent variables
n<- 1000 # number of observations
X<-array(0,dim=c(n,(k+1)))
bt<-c(1,2.3, 1.5,0.05)

x1<-rgamma(n,2,3)
x2<-rbinom(n,10,0.7)
x3<-rbeta(n,0.5,0.5)
X[,1]<-1
X[,2]<-x1
X[,3]<-x2
X[,4]<-x3
sigma<-2
eps<-rexp(n,rate =500)*(rbinom(n,1,0.5)-0.5)*2 # thin tailed distribution
y<-X%*%bt+eps
d<- data.frame(y,X[,2],X[,3],X[,4])

bth<-lm(y~X[,2]+X[,3]+X[,4],data=d)

cat("trur beta=",bt, "sigma=",sigma,'\n')
```

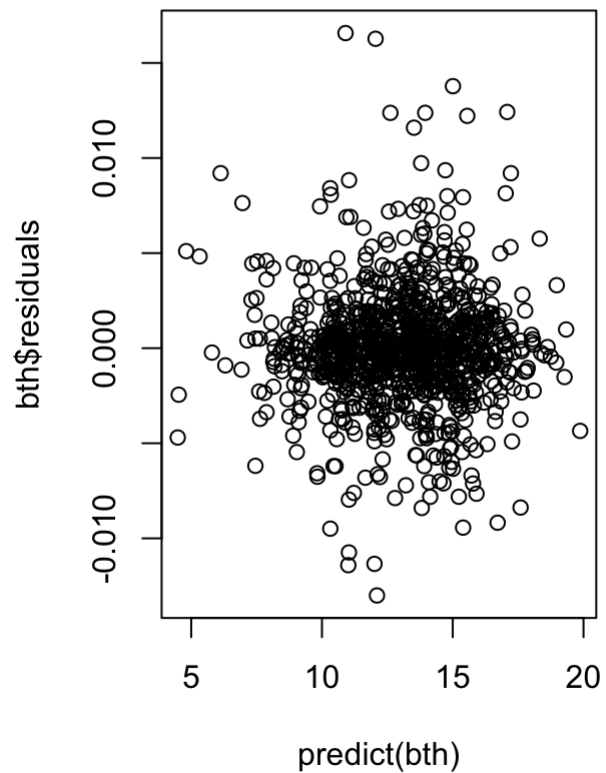
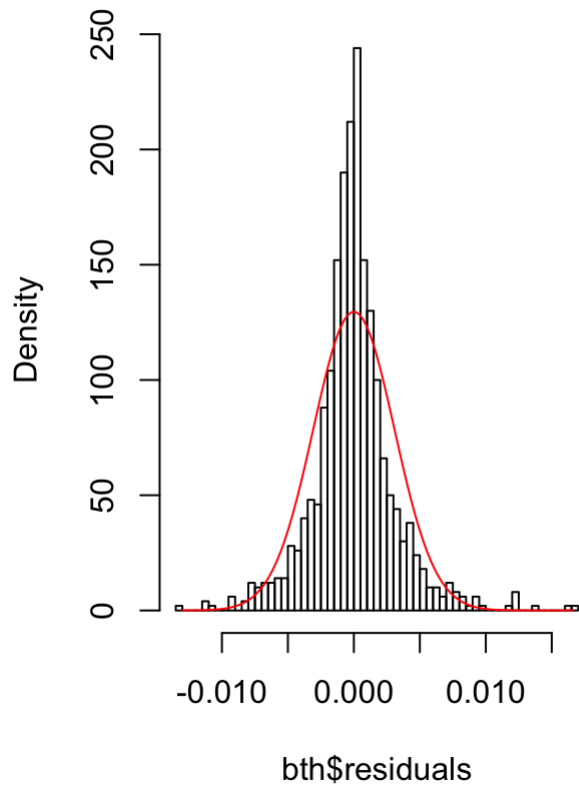
```
## trur beta= 1 2.3 1.5 0.05 sigma= 2
```

```
cat("beta_hat=",coefficients(bth), "sigma_hat=",summary(bth)$sigma,'\n') # model coef
ficients
```

```
## beta_hat= 0.9997061 2.300246 1.500031 0.04999736 sigma_hat= 0.003082326
```

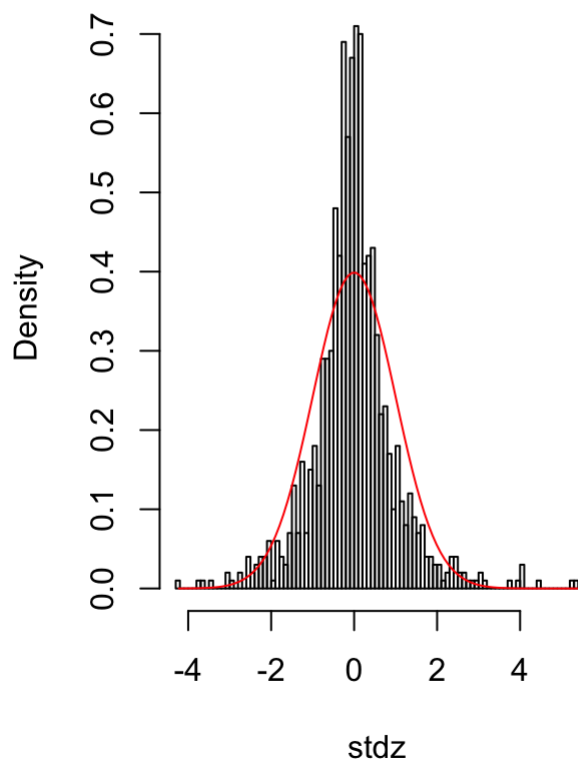
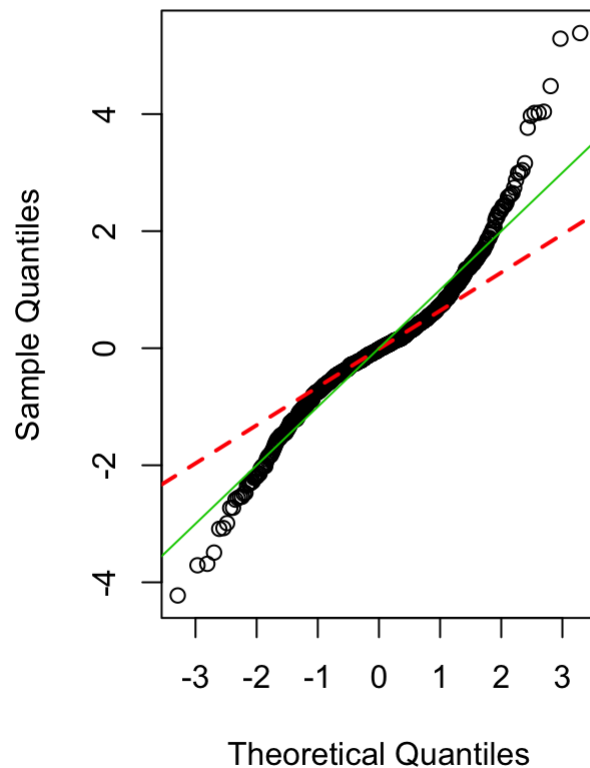
```
par(mfrow=c(1,2))
hist(bth$residuals, breaks = 100, probability = T )
s<-seq(min(bth$residuals), max(bth$residuals), length=100)
lines(dnorm(s, mean(bth$residuals),sd(bth$residuals))~s, col=2)
plot(predict(bth),bth$residuals)
```

Histogram of bth\$residuals



```
#qqnorm(y = bth$residuals, plot.it = T )
#qqline(y=bth$residuals, col=2, lwd=2,lty=2)

stdz<-(stdres(bth))
hist(stdz, breaks = 100, probability = T )
s<-seq(min(stdz), max(stdz), length=100)
lines(dnorm(s, 0,1)~s, col=2)
qqnorm(y = stdz, plot.it = T )
qqline(y=stdz, col=2, lwd=2,lty=2)
abline(a = 0,b = 1, col=3)
```

Histogram of stdz**Normal Q-Q Plot**

```
print(ks.test(x=bth$residuals, y="pnorm",alternative = c("two.sided")))
```

```
##
## One-sample Kolmogorov-Smirnov test
##
## data:  bth$residuals
## D = 0.49481, p-value < 2.2e-16
## alternative hypothesis: two-sided
```

```
print(ks.test(x=stdz, y="pnorm",alternative = c("two.sided")))
```

```
##
## One-sample Kolmogorov-Smirnov test
##
## data:  stdz
## D = 0.090302, p-value = 1.653e-07
## alternative hypothesis: two-sided
```

```
#####      MODEL 5  # Asymmetric distribution #####
k<-3 # independent variables
n<- 1000 # number of observations
X<-array(0,dim=c(n,(k+1)))
bt<-c(1,2.3, 1.5,0.05)

x1<-rgamma(n,2,3)
x2<-rbinom(n,10,0.7)
x3<-rbeta(n,0.5,0.5)
X[,1]<-1
X[,2]<-x1
X[,3]<-x2
X[,4]<-x3
sigma<-2
eps<-rgamma(n,shape = 2, rate = sigma)  # positively skewed
y<-X%*%bt+eps
d<- data.frame(y,X[,2],X[,3],X[,4])

bth<-lm(y~X[,2]+X[,3]+X[,4],data=d)

cat("trur beta=",bt, "sigma=",sigma,'\n')
```

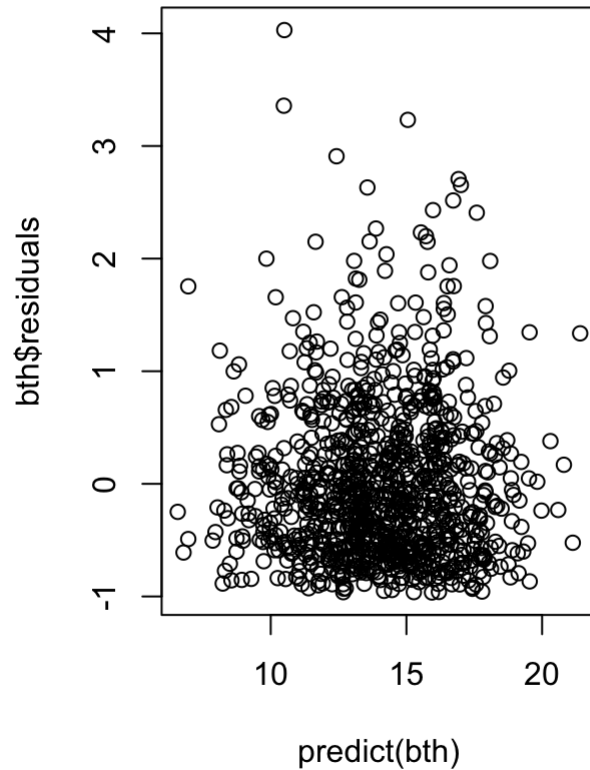
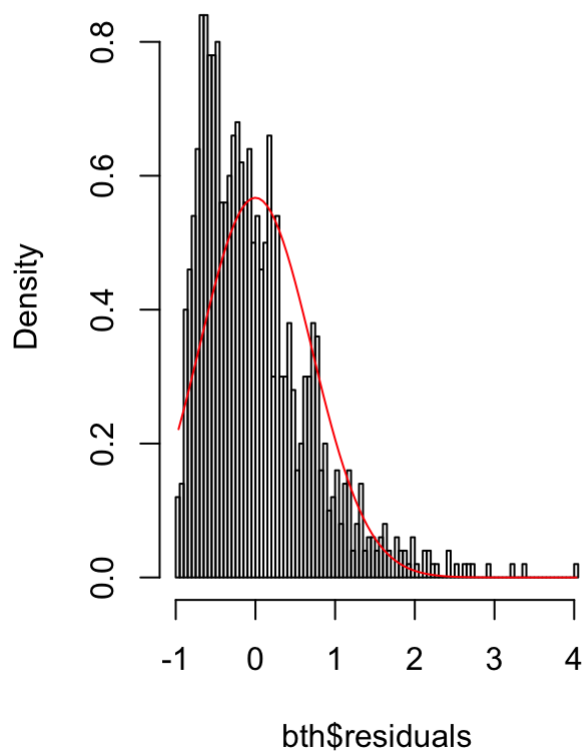
```
## trur beta= 1 2.3 1.5 0.05 sigma= 2
```

```
cat("beta_hat=",coefficients(bth), "sigma_hat=",summary(bth)$sigma,'\n') # model coef
ficients
```

```
## beta_hat= 1.922114 2.284543 1.511539 0.02955286 sigma_hat= 0.7044242
```

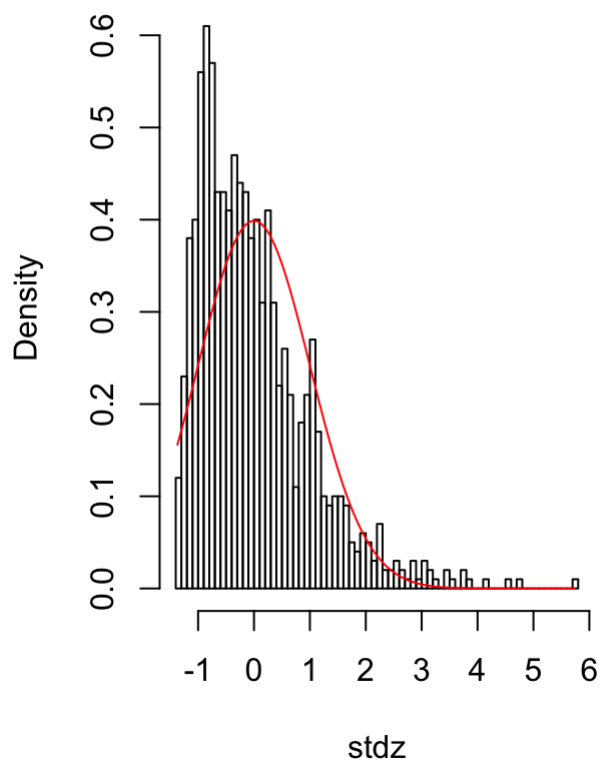
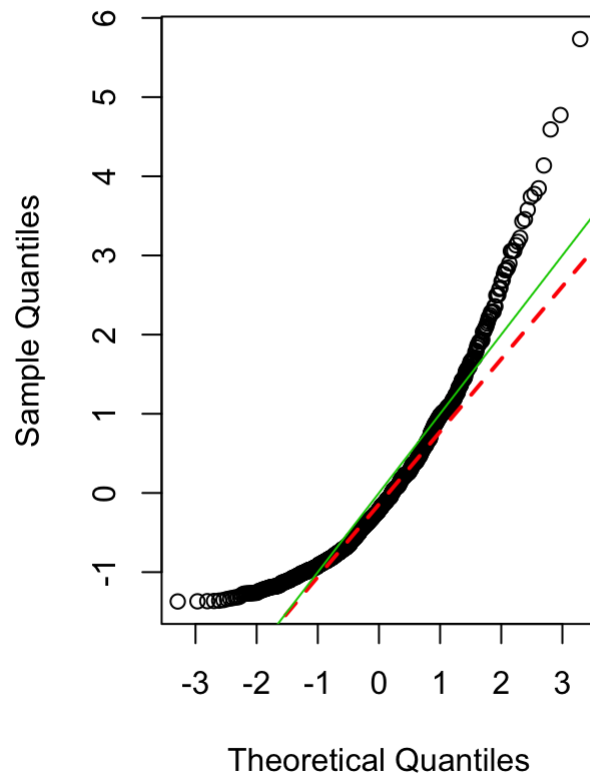
```
par(mfrow=c(1,2))
hist(bth$residuals, breaks = 100, probability = T )
s<-seq(min(bth$residuals), max(bth$residuals), length=100)
lines(dnorm(s, mean(bth$residuals),sd(bth$residuals))~s, col=2)
plot(predict(bth),bth$residuals)
```

Histogram of bth\$residuals



```
#qqnorm(y = bth$residuals, plot.it = T )
#qqline(y=bth$residuals, col=2, lwd=2,lty=2)

stdz<-(stdres(bth))
hist(stdz, breaks = 100, probability = T )
s<-seq(min(stdz), max(stdz), length=100)
lines(dnorm(s, 0,1)~s, col=2)
qqnorm(y = stdz, plot.it = T )
qqline(y=stdz, col=2, lwd=2,lty=2)
abline(a = 0,b = 1, col=3)
```

Histogram of stdz**Normal Q-Q Plot**

```
print(ks.test(x=bth$residuals, y="pnorm",alternative = c("two.sided")))
```

```
##
## One-sample Kolmogorov-Smirnov test
##
## data:  bth$residuals
## D = 0.17285, p-value < 2.2e-16
## alternative hypothesis: two-sided
```

```
print(ks.test(x=stdz, y="pnorm",alternative = c("two.sided")))
```

```
##
## One-sample Kolmogorov-Smirnov test
##
## data:  stdz
## D = 0.09405, p-value = 4.15e-08
## alternative hypothesis: two-sided
```



```
#####      MODEL 6  # Asymmetric distribution #####
k<-3 # independent variables
n<- 1000 # number of observations
X<-array(0,dim=c(n,(k+1)))
bt<-c(1,2.3, 1.5,0.05)

x1<-rgamma(n,2,3)
x2<-rbinom(n,10,0.7)
x3<-rbeta(n,0.5,0.5)
X[,1]<-1
X[,2]<-x1
X[,3]<-x2
X[,4]<-x3
sigma<-2
eps<- rgamma(n,shape = 2, rate = sigma)
y<-X%*%bt-eps # negatively skewed
d<- data.frame(y,X[,2],X[,3],X[,4])

bth<-lm(y~X[,2]+X[,3]+X[,4],data=d)

cat("trur beta=",bt, "sigma=",sigma,'\n')
```

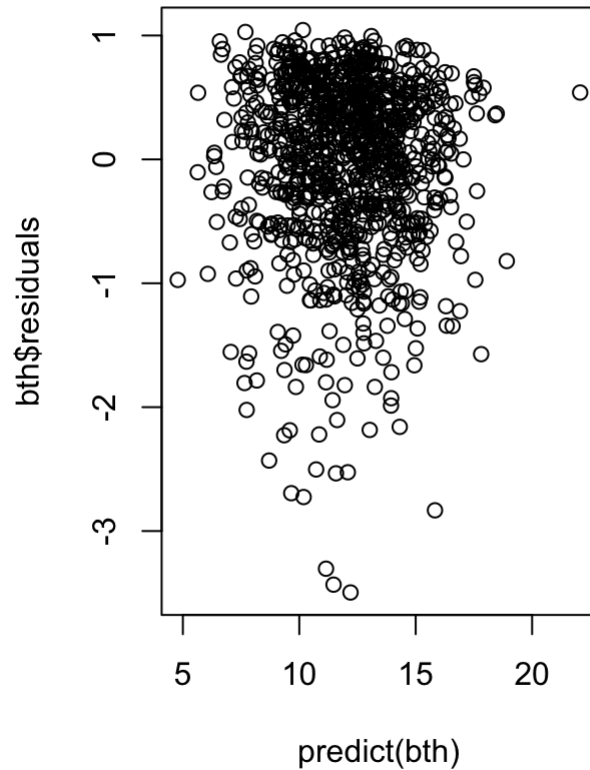
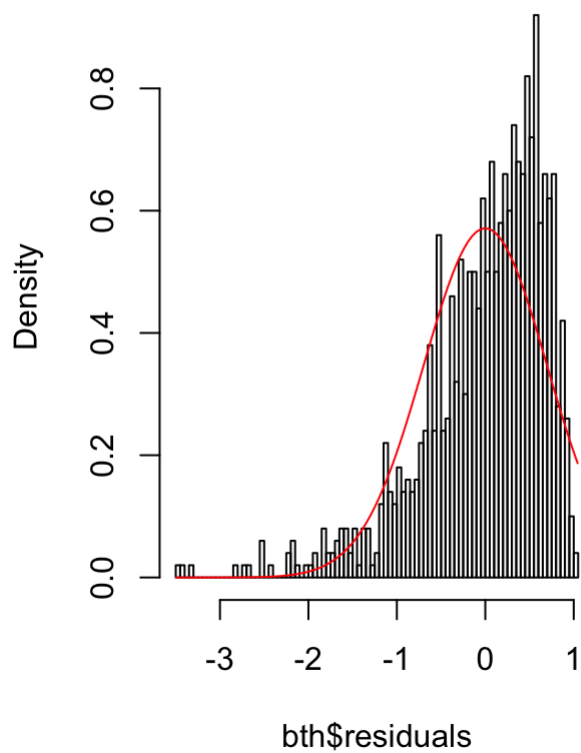
```
## trur beta= 1 2.3 1.5 0.05 sigma= 2
```

```
cat("beta_hat=",coefficients(bth), "sigma_hat=",summary(bth)$sigma,'\n') # model coef
ficients
```

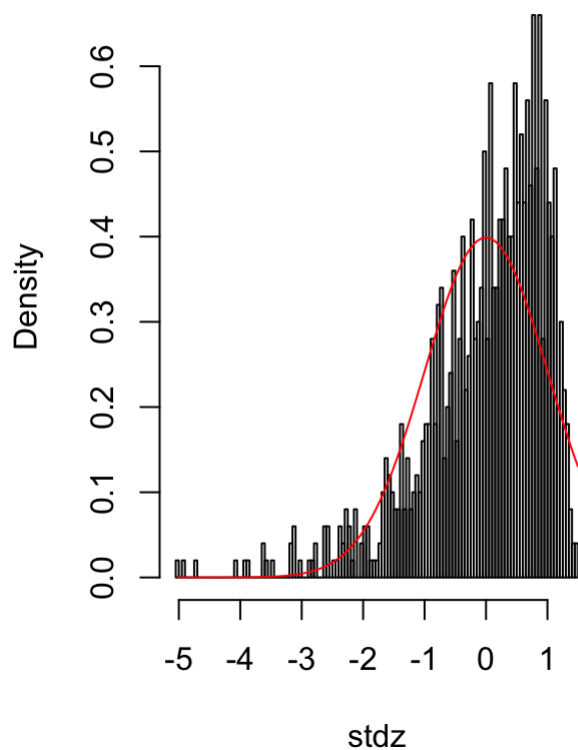
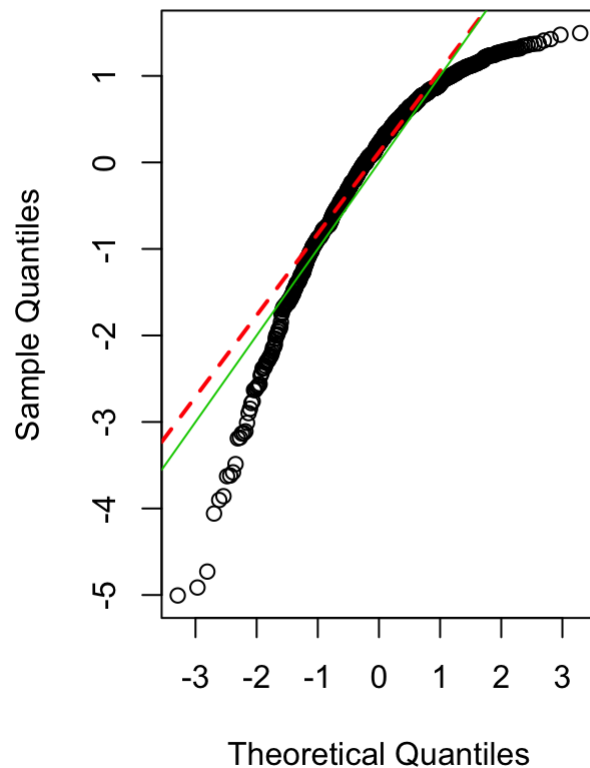
```
## beta_hat= -0.1056956 2.35867 1.519239 -0.04961164 sigma_hat= 0.6994423
```

```
par(mfrow=c(1,2))
hist(bth$residuals, breaks = 100, probability = T )
s<-seq(min(bth$residuals), max(bth$residuals), length=100)
lines(dnorm(s, mean(bth$residuals),sd(bth$residuals))~s, col=2)
plot(predict(bth),bth$residuals)
```

Histogram of bth\$residuals



```
#qqnorm(y = bth$residuals, plot.it = T )
#qqline(y=bth$residuals, col=2, lwd=2,lty=2)
stdz<-(stdres(bth))
hist(stdz, breaks = 100, probability = T )
s<-seq(min(stdz), max(stdz), length=100)
lines(dnorm(s, 0,1)~s, col=2)
qqnorm(y = stdz, plot.it = T )
qqline(y=stdz, col=2, lwd=2,lty=2)
abline(a = 0,b = 1, col=3)
```

Histogram of stdz**Normal Q-Q Plot**

```
print(ks.test(x=bth$residuals, y="pnorm",alternative = c("two.sided")))
```

```
##
## One-sample Kolmogorov-Smirnov test
##
## data:  bth$residuals
## D = 0.16872, p-value < 2.2e-16
## alternative hypothesis: two-sided
```

```
print(ks.test(x=stdz, y="pnorm",alternative = c("two.sided")))
```

```
##
## One-sample Kolmogorov-Smirnov test
##
## data:  stdz
## D = 0.092255, p-value = 8.101e-08
## alternative hypothesis: two-sided
```

```
#####      MODEL 7  # dependent normal #####
k<-3 # independent variables
n<- 1000 # number of observations
X<-array(0,dim=c(n,(k+1)))
bt<-c(1,2.3, 1.5,0.05)

x1<-rgamma(n,2,3)
x2<-rbinom(n,10,0.7)
x3<-rbeta(n,0.5,0.5)
X[,1]<-1
X[,2]<-x1
X[,3]<-x2
X[,4]<-x3
sigma<-2

eps<-BM(x = 0.1,t0 =0,T = 1,N = (n-1) )  # dependent normal Brownian motion
y<-X%*%bt+eps
d<- data.frame(y,X[,2],X[,3],X[,4])

bth<-lm(y~X[,2]+X[,3]+X[,4],data=d)

cat("trur beta=",bt, "sigma=",sigma,'\n')
```

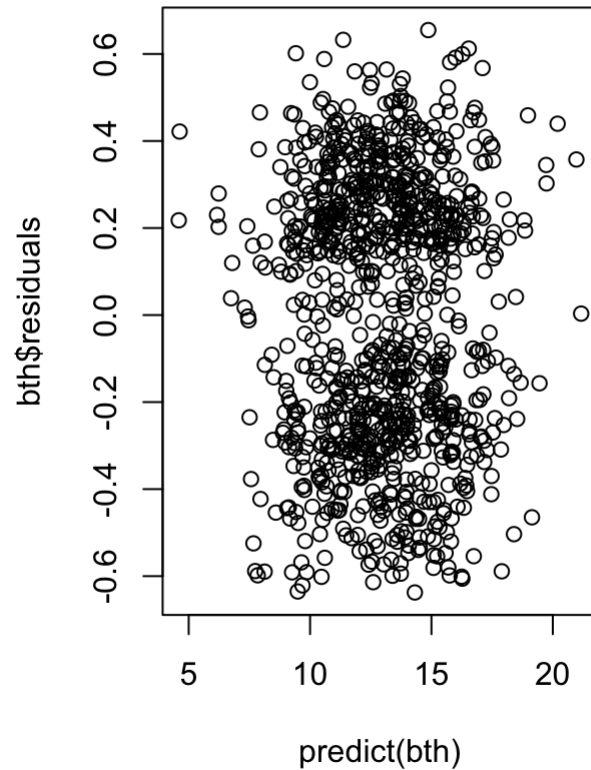
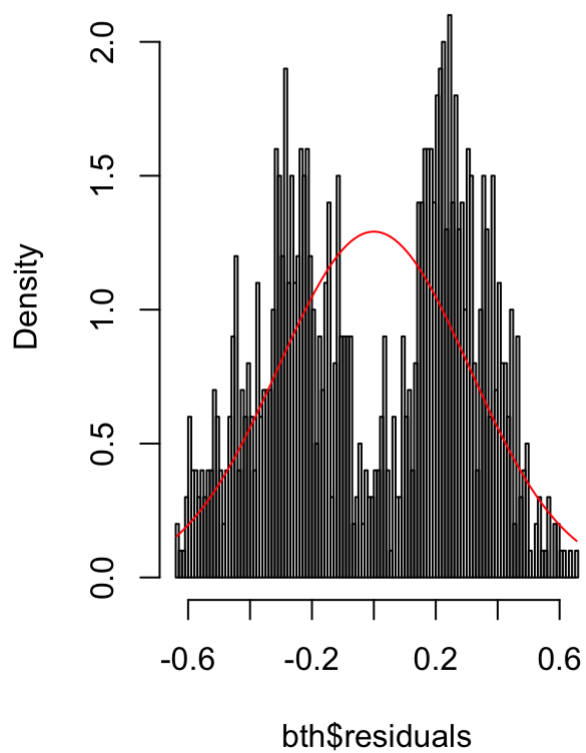
```
## trur beta= 1 2.3 1.5 0.05 sigma= 2
```

```
cat("beta_hat=",coefficients(bth), "sigma_hat=",summary(bth)$sigma,'\n') # model coef
ficients
```

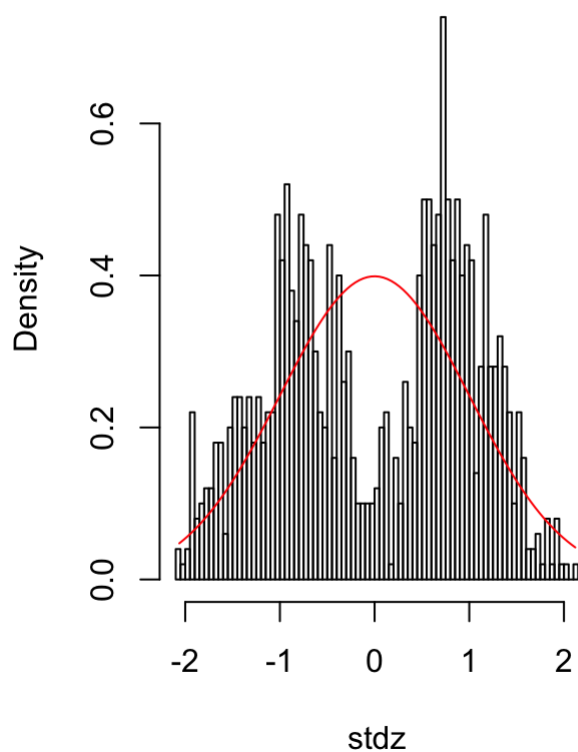
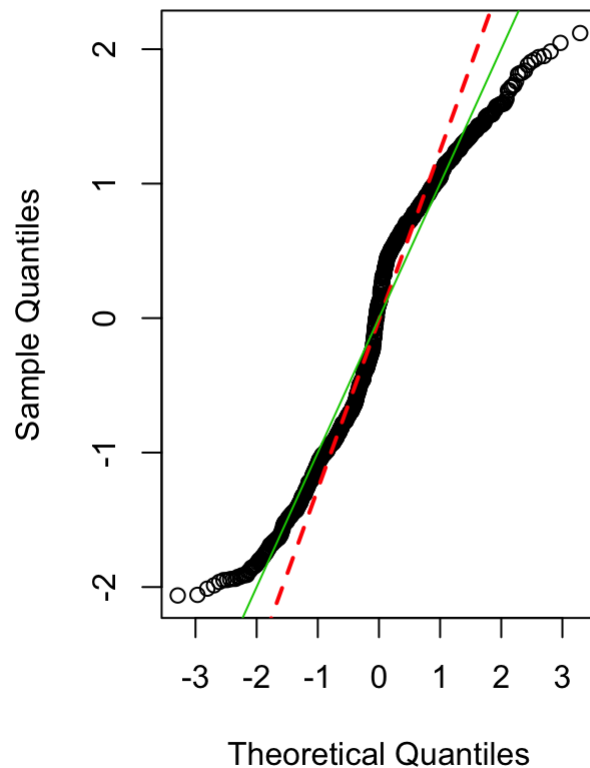
```
## beta_hat= 1.17556 2.281161 1.498571 0.09746791 sigma_hat= 0.3093547
```

```
par(mfrow=c(1,2))
hist(bth$residuals, breaks = 100, probability = T )
s<-seq(min(bth$residuals), max(bth$residuals), length=100)
lines(dnorm(s, mean(bth$residuals),sd(bth$residuals))~s, col=2)
plot(predict(bth),bth$residuals)
```

Histogram of bth\$residuals



```
#qqnorm(y = bth$residuals, plot.it = T )
#qqline(y=bth$residuals, col=2, lwd=2,lty=2)
stdz<-(stdres(bth))
hist(stdz, breaks = 100, probability = T )
s<-seq(min(stdz), max(stdz), length=100)
lines(dnorm(s, 0,1)~s, col=2)
qqnorm(y = stdz, plot.it = T )
qqline(y=stdz, col=2, lwd=2,lty=2)
abline(a = 0,b = 1, col=3)
```

Histogram of stdz**Normal Q-Q Plot**

```
print(ks.test(x=bth$residuals, y="pnorm",alternative = c("two.sided")))
```

```
##
## One-sample Kolmogorov-Smirnov test
##
## data:  bth$residuals
## D = 0.29114, p-value < 2.2e-16
## alternative hypothesis: two-sided
```

```
print(ks.test(x=stdz, y="pnorm",alternative = c("two.sided")))
```

```
##
## One-sample Kolmogorov-Smirnov test
##
## data:  stdz
## D = 0.12014, p-value = 5.805e-13
## alternative hypothesis: two-sided
```

```
#####      MODEL 8  # wrong model 1  #####
k<-3 # independent variables
n<- 1000 # number of observations
X<-array(0,dim=c(n,(k+1)))
bt<-c(1,2.3, 1.5,0.05)

x1<-rgamma(n,2,3)
x2<-rbinom(n,10,0.7)
x3<-rbeta(n,0.5,0.5)
X[,1]<-1
X[,2]<-x1
X[,3]<-x2
X[,4]<-100*x3*x1^2
sigma<-2

eps<-rnorm(n,0,sigma)
y<-X%*%bt+eps
X[,4]<-x3
d<- data.frame(y,X[,2],X[,3],X[,4])

bth<-lm(y~X[,2]+X[,3]+X[,4],data=d)

cat("trur beta=",bt, "sigma=",sigma,'\n')
```

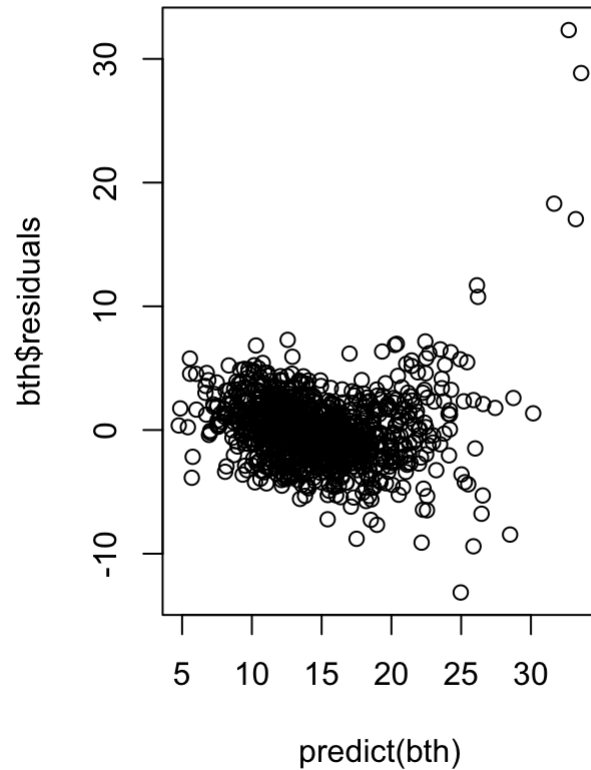
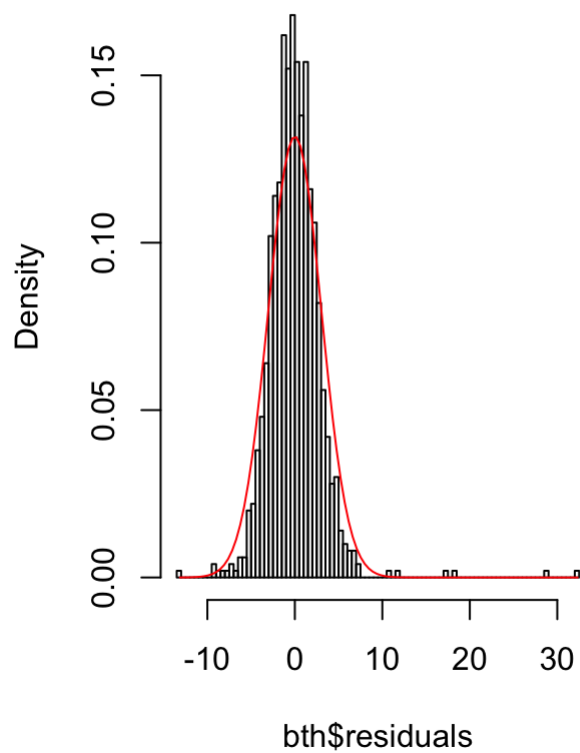
```
## trur beta= 1 2.3 1.5 0.05 sigma= 2
```

```
cat("beta_hat=",coefficients(bth), "sigma_hat=",summary(bth)$sigma,'\n') # model coef
ficients
```

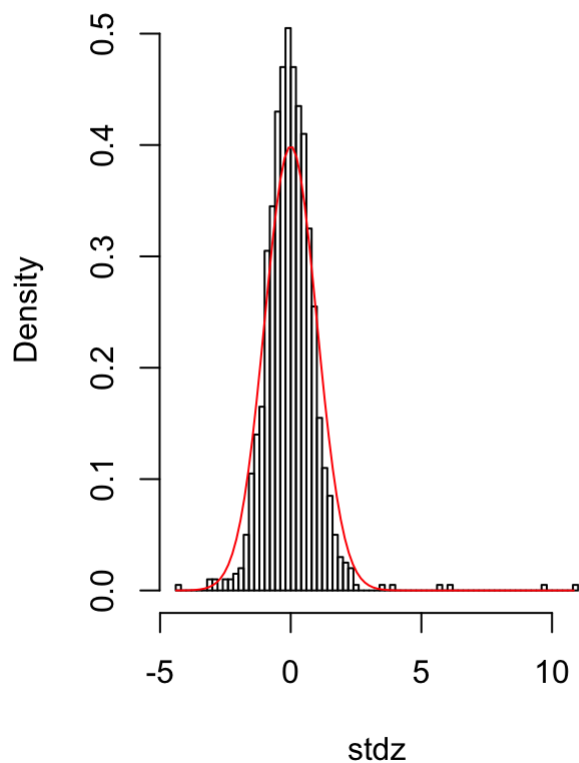
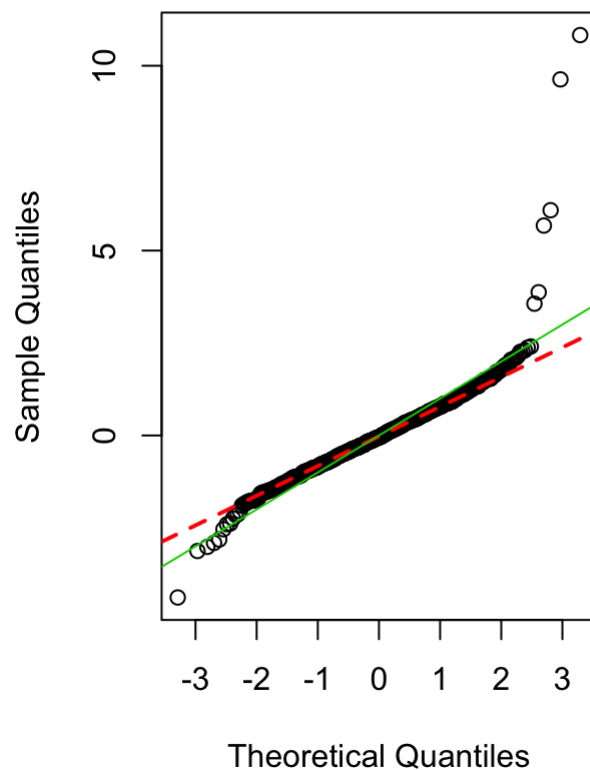
```
## beta_hat= -3.014627 7.26379 1.588446 3.406742 sigma_hat= 3.032979
```

```
par(mfrow=c(1,2))
hist(bth$residuals, breaks = 100, probability = T )
s<-seq(min(bth$residuals), max(bth$residuals), length=100)
lines(dnorm(s, mean(bth$residuals),sd(bth$residuals))~s, col=2)
plot(predict(bth),bth$residuals)
```

Histogram of bth\$residuals



```
#qqnorm(y = bth$residuals, plot.it = T )
#qqline(y=bth$residuals, col=2, lwd=2,lty=2)
stdz<-(stdres(bth))
hist(stdz, breaks = 100, probability = T )
s<-seq(min(stdz), max(stdz), length=100)
lines(dnorm(s, 0,1)~s, col=2)
qqnorm(y = stdz, plot.it = T )
qqline(y=stdz, col=2, lwd=2,lty=2)
abline(a = 0,b = 1, col=3)
```


Histogram of stdz**Normal Q-Q Plot**

```
print(ks.test(x=bth$residuals, y="pnorm",alternative = c("two.sided")))
```

```
##
## One-sample Kolmogorov-Smirnov test
##
## data: bth$residuals
## D = 0.2173, p-value < 2.2e-16
## alternative hypothesis: two-sided
```

```
print(ks.test(x=stdz, y="pnorm",alternative = c("two.sided")))
```

```
##
## One-sample Kolmogorov-Smirnov test
##
## data: stdz
## D = 0.06397, p-value = 0.000558
## alternative hypothesis: two-sided
```

```
#####      MODEL 9  # wrong model 2  #####
k<-3 # independent variables
n<- 1000 # number of observations
X<-array(0,dim=c(n,(k+1)))
bt<-c(1,2.3, 1.5,0.05)

x1<-rgamma(n,2,3)
x2<-rbinom(n,10,0.7)
x3<-rbeta(n,0.5,0.5)
X[,1]<-1
X[,2]<-x1
X[,3]<-x2
X[,4]<-x3
sigma<-2

eps<-rnorm(n,0,sigma)
y<-X%%bt+eps*x3      # error depends on x values
d<- data.frame(y,X[,2],X[,3],X[,4])

bth<-lm(y~X[,2]+X[,3]+X[,4],data=d)

cat("trur beta=",bt, "sigma=",sigma,'\n')
```

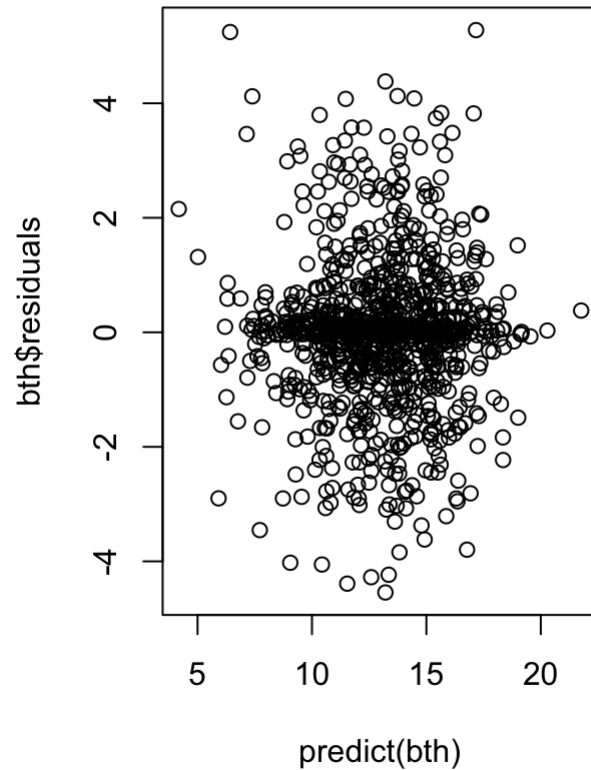
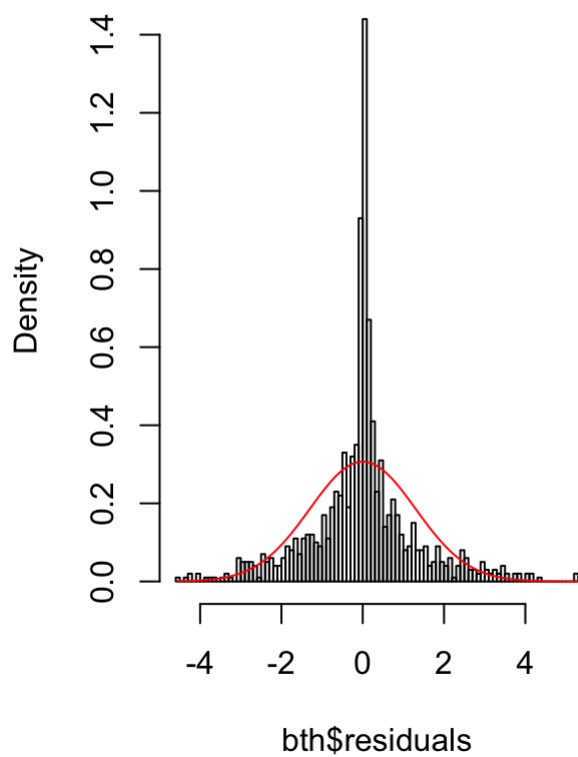
```
## trur beta= 1 2.3 1.5 0.05 sigma= 2
```

```
cat("beta_hat=",coefficients(bth), "sigma_hat=",summary(bth)$sigma,'\n') # model coef
ficients
```

```
## beta_hat= 0.8565554 2.244991 1.521265 0.1050314 sigma_hat= 1.301697
```

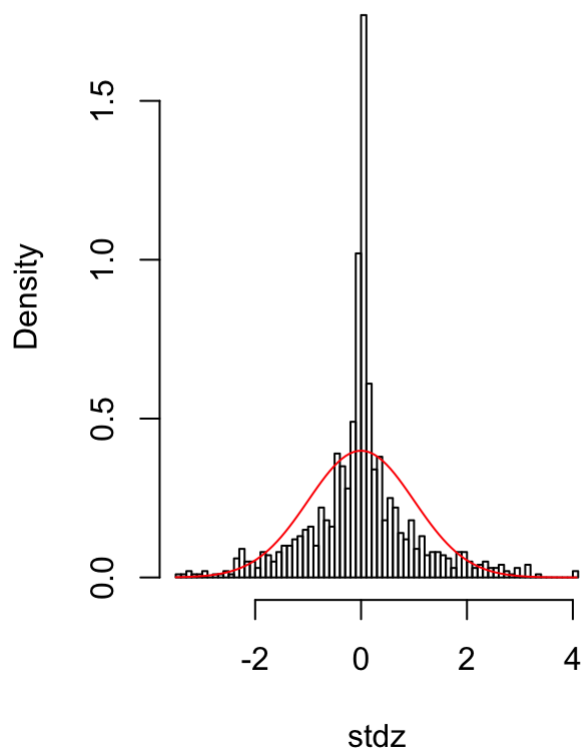
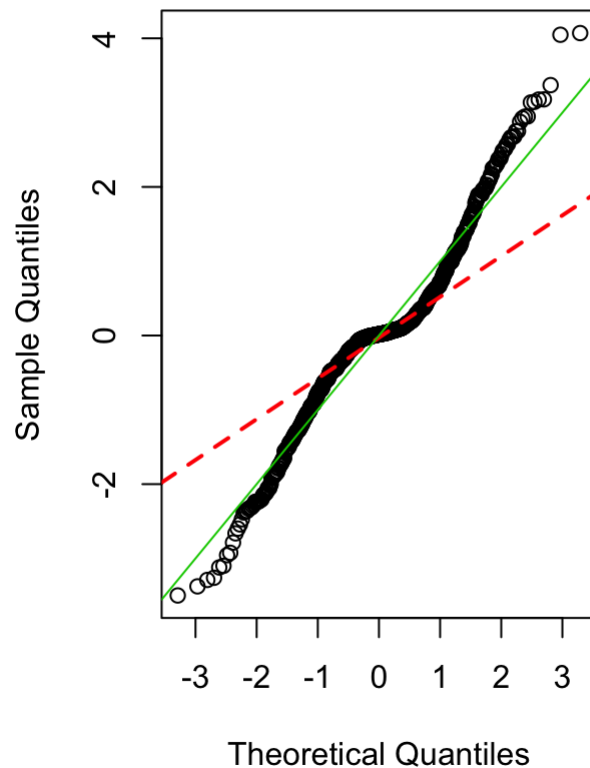
```
par(mfrow=c(1,2))
hist(bth$residuals, breaks = 100, probability = T )
s<-seq(min(bth$residuals), max(bth$residuals), length=100)
lines(dnorm(s, mean(bth$residuals),sd(bth$residuals))~s, col=2)
plot(predict(bth),bth$residuals)
```

Histogram of bth\$residuals



```
#qqnorm(y = bth$residuals, plot.it = T )
#qqline(y=bth$residuals, col=2, lwd=2,lty=2)

stdz<-(stdres(bth))
hist(stdz, breaks = 100, probability = T )
s<-seq(min(stdz), max(stdz), length=100)
lines(dnorm(s, 0,1)~s, col=2)
qqnorm(y = stdz, plot.it = T )
qqline(y=stdz, col=2, lwd=2,lty=2)
abline(a = 0,b = 1, col=3)
```

Histogram of stdz**Normal Q-Q Plot**

```
print(ks.test(x=bth$residuals, y="pnorm",alternative = c("two.sided")))
```

```
##
## One-sample Kolmogorov-Smirnov test
##
## data:  bth$residuals
## D = 0.10221, p-value = 1.688e-09
## alternative hypothesis: two-sided
```

```
print(ks.test(x=stdz, y="pnorm",alternative = c("two.sided")))
```

```
##
## One-sample Kolmogorov-Smirnov test
##
## data:  stdz
## D = 0.12544, p-value = 4.297e-14
## alternative hypothesis: two-sided
```

```

# Motor Trend Car Road Tests
#
# Description
#
# The data was extracted from the 1974 Motor Trend US magazine,
# and comprises fuel consumption and 10 aspects of automobile design
# and performance for 32 automobiles (1973–74 models).
# A data frame with 32 observations on 11 variables.
#
# [, 1] mpg      Miles/(US) gallon
# [, 2] cyl      Number of cylinders
# [, 3] disp     Displacement (cu.in.)
# [, 4] hp       Gross horsepower
# [, 5] drat     Rear axle ratio
# [, 6] wt       Weight (1000 lbs)
# [, 7] qsec     1/4 mile time
# [, 8] vs       V/S
# [, 9] am       Transmission (0 = automatic, 1 = manual)
# [,10] gear     Number of forward gears
# [,11] carb     Number of carburetors
# Source
#
# Henderson and Velleman (1981), Building multiple regression models interactively. B
# iometrics, 37, 391–411.

rsqurd<-array(0,dim = c(10))
adjrsqurd<-array(0,dim = c(10))
fit<-lm(mpg~wt, data = mtcars)
rsqurd[1]<-summary(fit)$r.squared
adjrsqurd[1]<-summary(fit)$adj.r.squared

fit<-lm(mpg~wt+am, data = mtcars)
rsqurd[2]<-summary(fit)$r.squared
adjrsqurd[2]<-summary(fit)$adj.r.squared

fit<-lm(mpg~wt+am+qsec, data = mtcars)
rsqurd[3]<-summary(fit)$r.squared
adjrsqurd[3]<-summary(fit)$adj.r.squared

fit<-lm(mpg~wt+am+qsec+hp, data = mtcars)
rsqurd[4]<-summary(fit)$r.squared
adjrsqurd[4]<-summary(fit)$adj.r.squared

fit<-lm(mpg~wt+am+qsec+hp+disp, data = mtcars)
rsqurd[5]<-summary(fit)$r.squared
adjrsqurd[5]<-summary(fit)$adj.r.squared

fit<-lm(mpg~wt+am+qsec+hp+disp+drat, data = mtcars)
rsqurd[6]<-summary(fit)$r.squared
adjrsqurd[6]<-summary(fit)$adj.r.squared

fit<-lm(mpg~wt+am+qsec+hp+disp+drat+gear, data = mtcars)
rsqurd[7]<-summary(fit)$r.squared
adjrsqurd[7]<-summary(fit)$adj.r.squared

```

```
fit<-lm(mpg~wt+am+qsec+hp+disp+drat+gear+carb, data = mtcars)
rsqurd[8]<-summary(fit)$r.squared
adjrsqurd[8]<-summary(fit)$adj.r.squared

fit<-lm(mpg~wt+am+qsec+hp+disp+drat+gear+carb+vs, data = mtcars)
rsqurd[9]<-summary(fit)$r.squared
adjrsqurd[9]<-summary(fit)$adj.r.squared

fit<-lm(mpg~wt+am+qsec+hp+disp+drat+gear+carb+vs+cyl, data = mtcars)
rsqurd[10]<-summary(fit)$r.squared
adjrsqurd[10]<-summary(fit)$adj.r.squared

par(mfrow=c(1,1))
plot(rsqurd, type='b', ylim=c(0.7,0.88), main="R^2 (black) & adj R^2 (red)")
lines(adjrsqurd,col=2,type = 'b')
```

R² (black) & adj R² (red)

