Quantum and Oscillator Strategy and other Strategies

Summary and Implement

2018-12-08

Moving Average Convergence/Divergence

Here I used yahoo_Finance as my data source. When a user want to use this program, he can just change the date. Here, I use XOM for example. Load data:

```
library("quantmod")
#reset the date and ticker
start <-as.Date("2017-12-11")
end <-as.Date("2018-12-07")
ticker <- "XOM"
#
getSymbols(ticker,src = "yahoo", from = start,to = end)
```

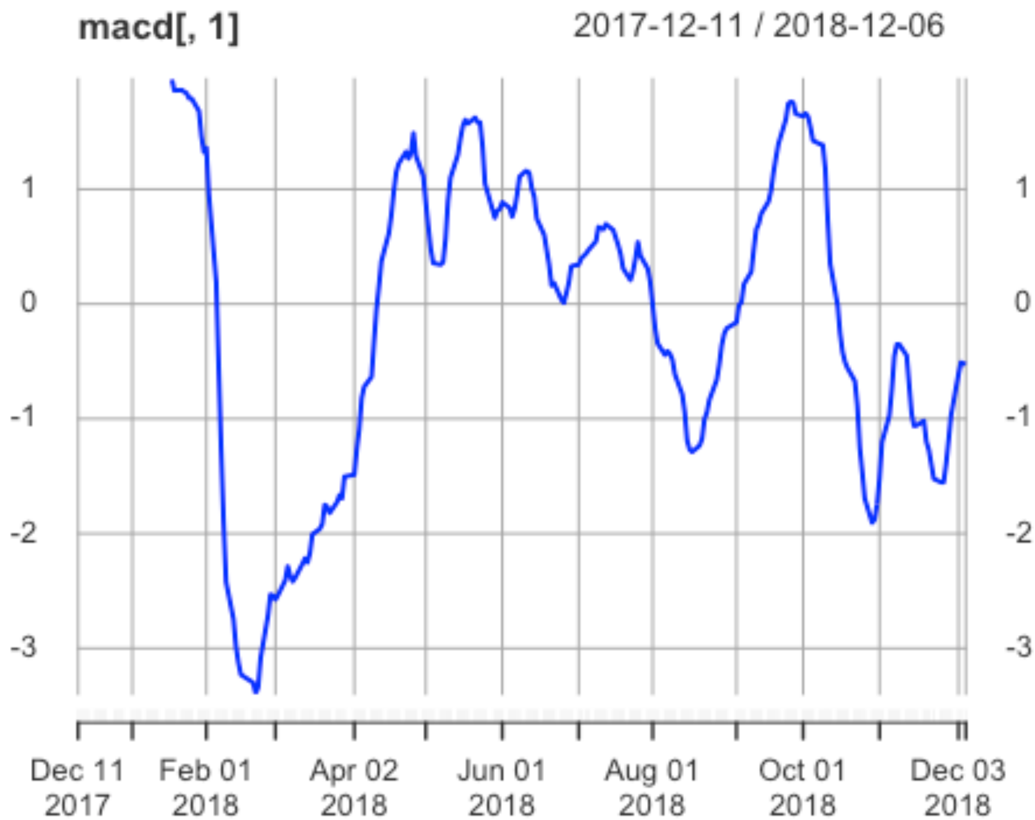
```
## [1] "XOM"
```

```
head(XOM)
```

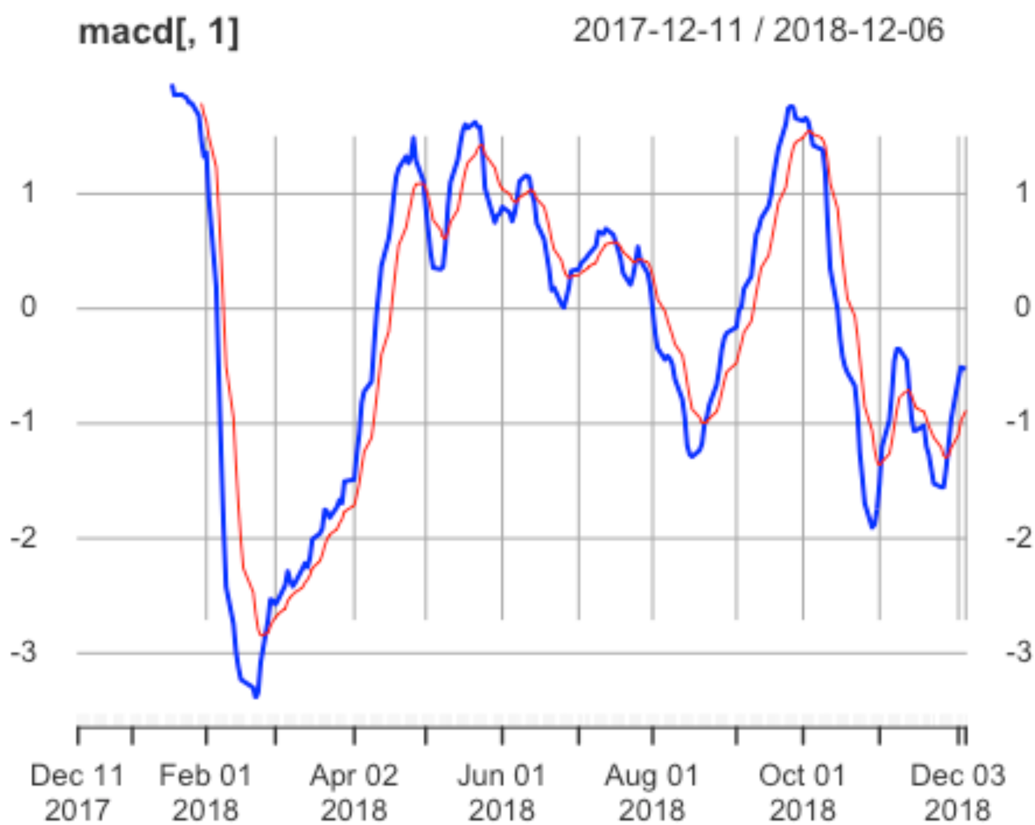
```
##            XOM.Open XOM.High XOM.Low XOM.Close XOM.Volume XOM.Adjusted
## 2017-12-11    83.04    83.25   82.74     83.03    8760700     78.85057
## 2017-12-12    82.89    83.38   82.70     82.76   11307000     78.59415
## 2017-12-13    82.61    83.30   82.48     83.12   10172700     78.93604
## 2017-12-14    83.03    83.33   82.89     82.90    9492400     78.72712
## 2017-12-15    83.16    83.28   82.87     83.03   26582300     78.85057
## 2017-12-18    83.18    83.67   82.91     82.94    9363500     78.76509
```

Reset the parameter of MACD. In my example, the fast EMA is 12, slow EMA is 26, signal line is 9.

```
#reset the parameter
macd <- MACD(XOM[, "XOM.Close"], 12, 26, 9, maType = "EMA")
# draw the graph
plot(macd[, 1], type = "l", col = "blue")
```




```r
lines(macd[, 2], type = "l", col = "red")
```




```
#legend(201, 1.5, c("MACD", "Singal_line"), lty = c(1,1), col = c("blue",
"red"), bty = "n")
```

Begin to build the strategy. Here, I use some trick to spot the cross point, where the trader should implement his trading.

```
n <- sum(is.na(macd[,2]))
Cp <- c()
Cp <- rep(0, n)
for(i in (n+1) : nrow(macd)){
  if(macd[i, 1] > macd[i, 2]){
    Cp[i] <- 1}
  else{
      Cp[i] <- -1}
}
# xomsignal is the trasaction signal
xomsignal <- rep(0,nrow(macd))
for(i in (n+1) : nrow(macd)){
  if((Cp[i] - Cp[i - 1]) == 2) {
    xomsignal[i] <- 'buy'}
  else if((Cp[i] - Cp[i - 1]) == -2){
    xomsignal[i] <- 'sell'}
}
```

```r
XOM2<- cbind(as.data.frame(XOM), xomsignal)
signals <- subset(XOM2,xomsignal!=0)
signals

##            XOM.Open XOM.High XOM.Low XOM.Close XOM.Volume XOM.Adjusted
## 2018-02-26    77.74    78.93   77.56     78.84   16940400     75.63708
## 2018-05-01    77.26    77.26   75.98     76.95   16231000     73.82388
## 2018-05-10    80.64    81.79   80.50     81.72   17710300     78.40009
## 2018-05-24    81.35    81.36   79.95     80.27   13360500     77.78955
## 2018-06-07    82.73    83.29   82.56     82.88   13502500     80.31891
## 2018-06-13    82.44    82.60   81.47     81.51   12049300     78.99125
## 2018-06-29    82.45    83.54   82.29     82.73   17323200     80.17355
## 2018-07-18    81.80    82.32   81.49     82.22    8711900     79.67930
## 2018-07-26    83.83    84.40   83.37     84.24   13210100     81.63688
## 2018-07-27    80.97    82.38   80.81     81.92   18220800     79.38857
## 2018-08-23    79.56    79.63   78.90     79.08    7203900     77.42679
## 2018-10-04    85.50    86.08   85.25     85.58   10204600     83.79091
## 2018-11-02    81.76    82.45   80.23     81.95   19350400     80.23679
## 2018-11-14    78.86    79.09   76.75     77.39   18552100     76.54024
## 2018-11-29    78.22    79.53   78.19     79.06   10255200     78.19190
##            xomsignal
## 2018-02-26       buy
## 2018-05-01      sell
## 2018-05-10       buy
## 2018-05-24      sell
## 2018-06-07       buy
## 2018-06-13      sell
## 2018-06-29       buy
## 2018-07-18      sell
## 2018-07-26       buy
## 2018-07-27      sell
## 2018-08-23       buy
## 2018-10-04      sell
## 2018-11-02       buy
## 2018-11-14      sell
## 2018-11-29       buy
```

Set a the initial capital and transaction fee. For example: initial capital = 10000 transaction fee = 5 (including sell and buy)

```r
# set the initial capital and transaction fee
cap<-10000
fee <- 5
# calculate the odd or even
transaction.times <- nrow(signals) %/% 2 * 2
if(nrow(signals)%%2 == 0){
  parity <- "even"
}else if(nrow(signals)%%2 == 1){
  parity <- "odd"
}
```

```r
# calculate the number of shares
shares<-rep(0,transaction.times)
for(i in 1:(transaction.times/2)) {
  shares[2*i-1]=cap/(signals$XOM.Close[2*i-1])
  }
shares<-floor(shares)
# calculate the profits
if (parity == "odd"){
  PL<-cbind(signals[-nrow(signals),],shares)
}else{
  PL<-cbind(signals,shares)
}

profit<-rep(0,transaction.times)
for(i in 1:(transaction.times/2)){
  if(PL$xomsignal[1] == "buy"){
  profit[2*i] <- PL$shares[2*i-1]*(PL$XOM.Close[2*i]-PL$XOM.Close[2*i-1])-fee
}
  if(PL$xomsignal[1] == "sell"){
  profit[2*i] <- PL$shares[2*i-1]*(PL$XOM.Close[2*i]-PL$XOM.Close[2*i-1])-fee
}
  }
final<-cbind(PL,profit)
final[,5:9]
```

```
##            XOM.Volume XOM.Adjusted xomsignal shares     profit
## 2018-02-26   16940400     75.63708       buy    126    0.00000
## 2018-05-01   16231000     73.82388      sell      0 -243.13987
## 2018-05-10   17710300     78.40009       buy    122    0.00000
## 2018-05-24   13360500     77.78955      sell      0 -181.90049
## 2018-06-07   13502500     80.31891       buy    120    0.00000
## 2018-06-13   12049300     78.99125      sell      0 -169.39940
## 2018-06-29   17323200     80.17355       buy    120    0.00000
## 2018-07-18    8711900     79.67930      sell      0  -66.20024
## 2018-07-26   13210100     81.63688       buy    118    0.00000
## 2018-07-27   18220800     79.38857      sell      0 -278.76000
## 2018-08-23    7203900     77.42679       buy    126    0.00000
## 2018-10-04   10204600     83.79091      sell      0  814.00000
## 2018-11-02   19350400     80.23679       buy    122    0.00000
## 2018-11-14   18552100     76.54024      sell      0 -561.31976
```

Use the data to calculate return rate, sharpe ratio and so on. For example: risk-free rate is 0.511.

```r
# set risk-free rate
rf <- 0.511
#
mean(final$profit)
```

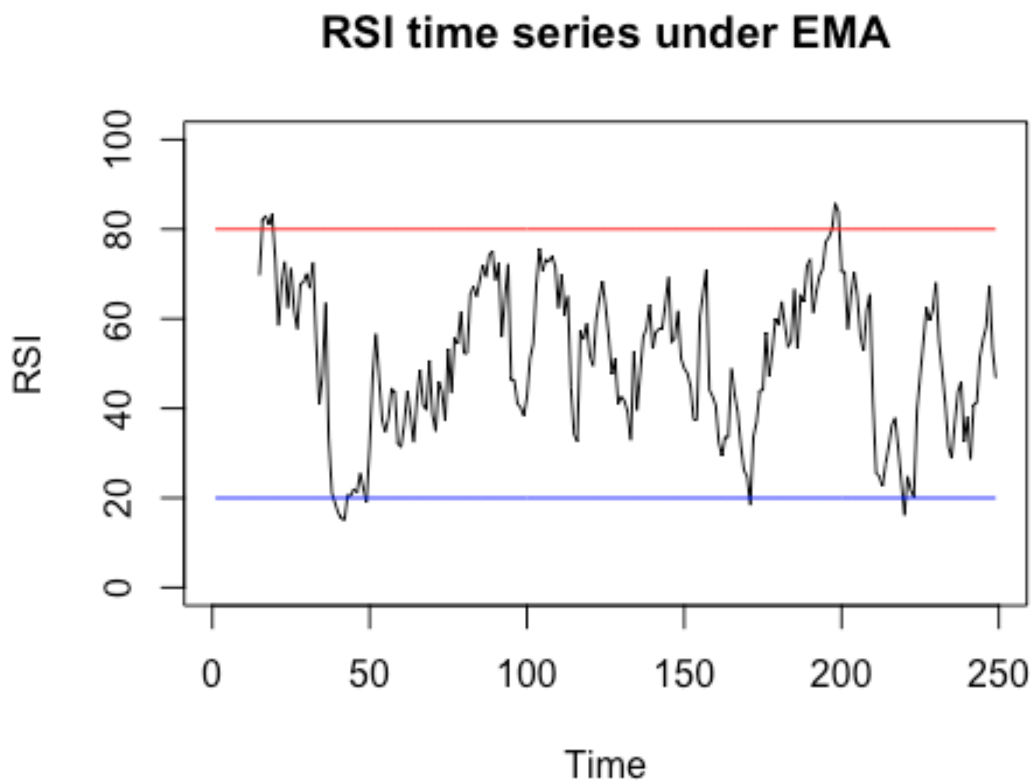
```
## [1] -49.05141
```

```r
var(final$profit)

## [1] 88229.37

sd(final$profit)

## [1] 297.0343

rf<-5.11/100
ri<-rep(0,transaction.times)
for(i in 1:(transaction.times/2)){
  ri[2*i]<-log(final$XOM.Close[2*i]/final$XOM.Close[2*i-1]) }
ri<-ri[ri!=0]
sharpe<-(mean(ri)-rf)/sd(ri-rf)
sharpe

## [1] -1.444312
```

RSI- Relative Strength Index

We still use the data of XOM. 1.set the time period, N =14 2.set overbought and oversold market parameter, up = 80, down=20

```r
# set parameter
N <- 14
up <- 80
down <- 20
# EMA
rsi<-RSI(XOM$XOM.Close,N,maType = EMA)
ts.plot(rsi,ylim=c(0,100),main="RSI time series under EMA",ylab="RSI")
overbought<-c(rep(up,length(rsi)))
oversold<-c(rep(down,length(rsi)))
lines(overbought,col="red")
lines(oversold,col="blue")
```



Simulate the trading process. The trick to find the point is similar to MACD.

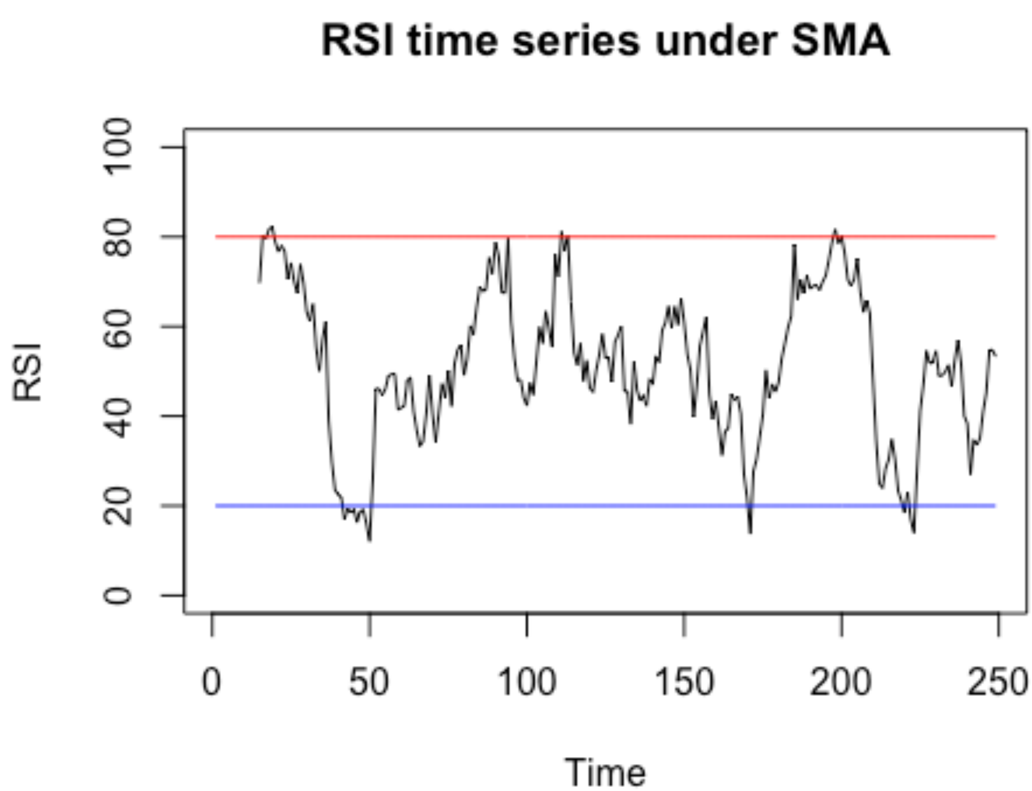
```
state1<-c(rep(0,length(rsi)))
n <- sum(is.na(rsi))
for(i in (n+1):length(rsi)){
  if(rsi[i] < 20){state1[i]<-1}
  if(rsi[i] > 80){state1[i]<--1}
}
trade1<-c(rep(0,length(rsi)))
for(i in 15:length(rsi)){
  if(((state1[i]-state1[i-1])==1)&(state1[i-1]==0)) {
    trade1[i]<-'buy'}
  if(((state1[i]-state1[i-1])==-1)&(state1[i-1]==0)){
    trade1[i]<-'sell' }
  }
trade_set1<-cbind(as.data.frame(XOM),trade1)
trade_signal1<-subset(trade_set1,trade1!=0)
trade_signal1
```

```
##            XOM.Open XOM.High XOM.Low XOM.Close XOM.Volume XOM.Adjusted
## 2018-01-03    85.16    86.97   84.82     86.70   13957700     82.33583
## 2018-02-06    78.51    80.35   76.90     78.35   36262800     74.40614
## 2018-02-21    75.82    76.44   74.87     74.89   11715000     71.84756
```

```
## 2018-08-15     77.78     77.90    76.51      76.94    16307800      75.33153
## 2018-09-21     85.01     85.43    84.52      85.17    26639400      83.38948
## 2018-10-24     80.13     80.26    77.55      77.62    16085700      75.99732
##              trade1
## 2018-01-03     sell
## 2018-02-06      buy
## 2018-02-21      buy
## 2018-08-15      buy
## 2018-09-21     sell
## 2018-10-24      buy
```

SMA is similar.

```
rsi<-RSI(XOM$XOM.Close,N,maType = SMA)
ts.plot(rsi,ylim=c(0,100),main="RSI time series under SMA",ylab="RSI")
overbought<-c(rep(up,length(rsi)))
oversold<-c(rep(down,length(rsi)))
lines(overbought,col="red")
lines(oversold,col="blue")
```




```
state1<-c(rep(0,length(rsi)))
n <- sum(is.na(rsi))
for(i in (n+1):length(rsi)){
  if(rsi[i] < 20){state1[i]<-1}
```

```
  if(rsi[i] > 80){state1[i]<--1}
}
trade1<-c(rep(0,length(rsi)))
for(i in 15:length(rsi)){
  if(((state1[i]-state1[i-1])==1)&(state1[i-1]==0)) {
    trade1[i]<-'buy'}
  if(((state1[i]-state1[i-1])==-1)&(state1[i-1]==0)){
    trade1[i]<-'sell' }
  }
trade_set1<-cbind(as.data.frame(XOM),trade1)
trade_signal1<-subset(trade_set1,trade1!=0)
trade_signal1
```

```
##            XOM.Open XOM.High XOM.Low XOM.Close XOM.Volume XOM.Adjusted
## 2018-01-03    85.16    86.97   84.82     86.70   13957700     82.33583
## 2018-01-05    86.75    86.88   85.71     86.75   11047600     82.38332
## 2018-02-09    76.25    76.48   73.90     75.78   29491600     72.70140
## 2018-05-21    81.73    82.35   81.52     82.28    8822400     79.73744
## 2018-05-23    80.95    82.23   80.57     82.15   15140900     79.61146
## 2018-08-15    77.78    77.90   76.51     76.94   16307800     75.33153
## 2018-09-24    85.79    87.09   85.72     86.60   13549500     84.78958
## 2018-09-26    86.02    86.50   85.69     85.78   10275500     83.98673
## 2018-10-24    80.13    80.26   77.55     77.62   16085700     75.99732
## 2018-10-26    77.87    78.41   76.96     77.53   18160100     75.90919
##            trade1
## 2018-01-03   sell
## 2018-01-05   sell
## 2018-02-09    buy
## 2018-05-21   sell
## 2018-05-23   sell
## 2018-08-15    buy
## 2018-09-24   sell
## 2018-09-26   sell
## 2018-10-24    buy
## 2018-10-26    buy
```

Pair trading strategy

Here we use XOM and CVS to implement pair trading strategy. ticker1 = XOM ticker2 = CVS

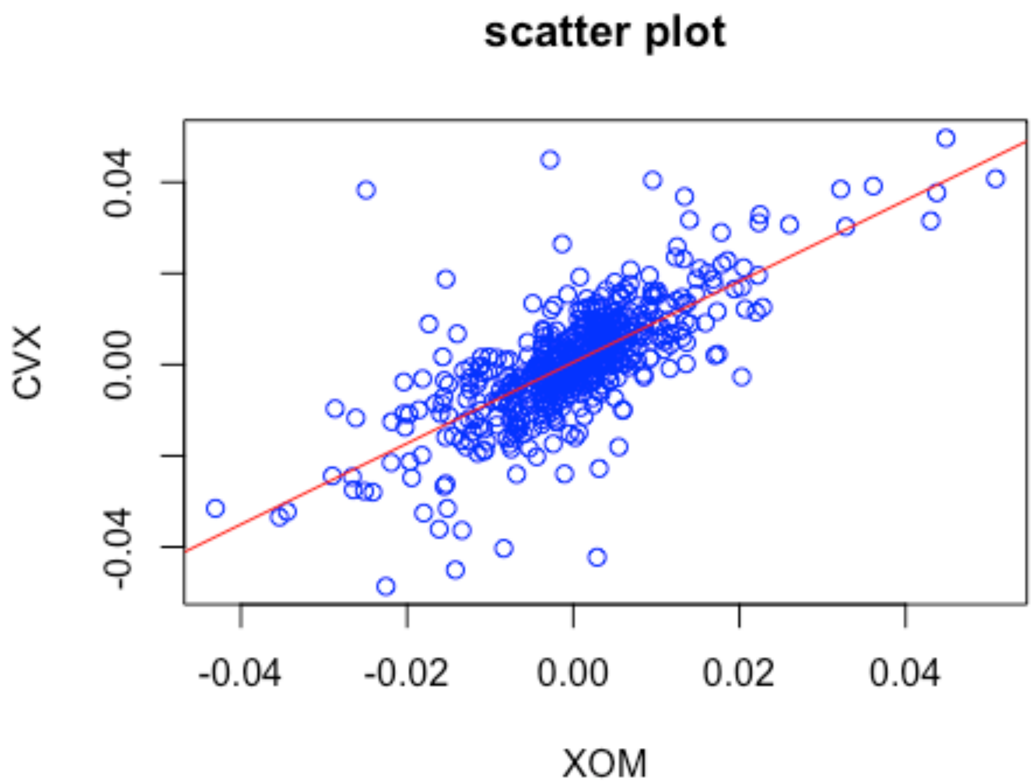
```
library(tseries)
if(FALSE){
# set the tickers and time period.
 start <- as.Date("2015-11-30")
 end <- as.Date("2017-11-30")
 ticker1 = "XOM"
ticker2 = "CVS"
getSymbols(ticker1,src = "yahoo", from = start,to = end)
getSymbols(ticker2,src = "yahoo", from = start,to = end)
```

```r
# get the graphs
close1 <- as.matrix(XOM$XOM.Close)
close2 <- as.matrix(CVS$CVS.Close)
logr1 <- diff(log(close1))
logr2 <- diff(log(close2))
}

setwd("/Users/yifuhe/Desktop")
CVS <-read.csv("CVX.csv")
XOM <-read.csv("XOM.csv")
x <-diff(log(XOM$Close))
y <-diff(log(CVS$Close))
fit2<-lm(y~x)
summary(fit2)

##
## Call:
## lm(formula = y ~ x)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.045283 -0.004507  0.000057  0.004919  0.059951
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) 0.0004814  0.0003980    1.21    0.227
## x           0.8882734  0.0374877   23.70   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.008918 on 500 degrees of freedom
## Multiple R-squared:  0.5289, Adjusted R-squared:  0.528
## F-statistic: 561.5 on 1 and 500 DF,  p-value: < 2.2e-16

z<-c(NA)
```

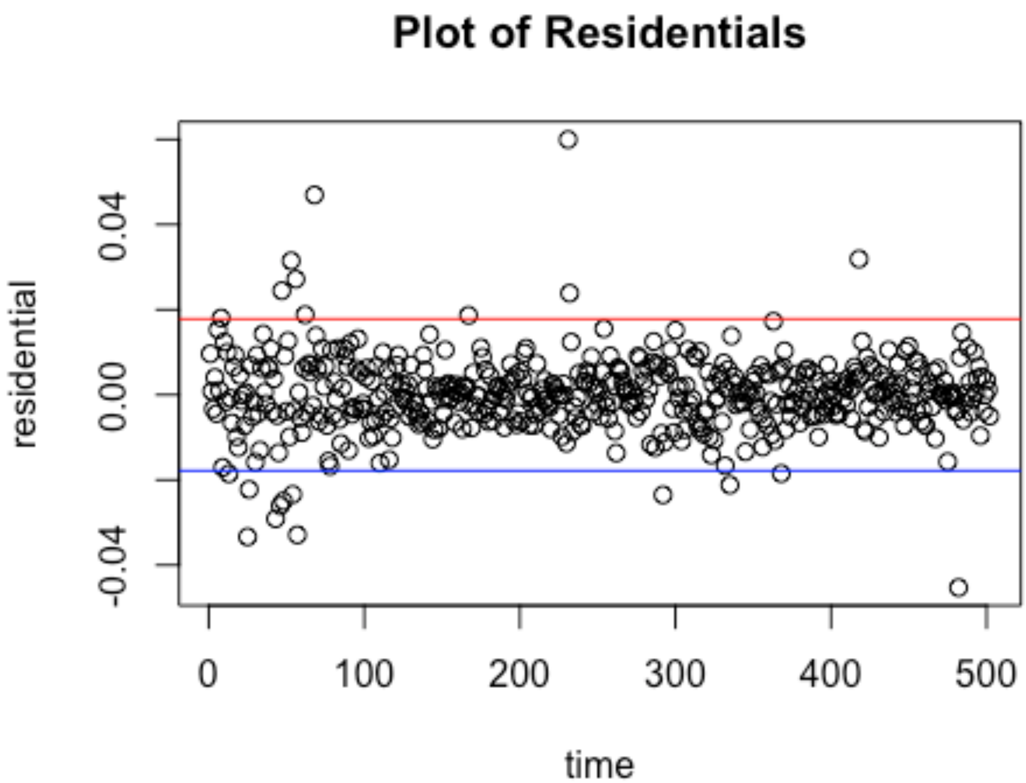
build the strategy

```r
# Estimate the co-integrating relation
if(FALSE){
plot(x,y,main = "scatter plot of the log returns")
fit <- lm(logr2~logr1)
summary(fit)
intercept <- coef(fit)[1]
slope <- coef(fit)[2]
abline(fit,cex = 1.3,pch = 16, col = "red" )
res<-fit$residuals
plot(fit,which=1)
# adf test
adf.test(res)
}
```

```r
#png(file = "linearregression of XOM and CVX.png")
plot(x,y,col = "blue",main = "scatter plot",xlab="XOM",ylab="CVX")
abline(fit2,cex = 1.3,pch = 16,col = "red")
```




```r
z <- fit2$residuals
stdz<-sd(z)
delta <-2*stdz
plot(z,ylab="residential",xlab="time",main="Plot of Residentials")
abline(h=-delta,col="blue")
abline(h=delta,col="red")
```




```
# adf test
adf.test(z)

##
##  Augmented Dickey-Fuller Test
##
## data:  z
## Dickey-Fuller = -8.5793, Lag order = 7, p-value = 0.01
## alternative hypothesis: stationary
```

if P-value is less than 0.01, we can rejected the null Hypothesis. For example: use delta = 2 * std(z_t) accuracy = 0.001 Portfolio: long — logr2 short — logr1

```
if(FALSE){
# set delta
delta<-2*sd(res)
accuracy = 0.001
##
date<-as.Date(row.names(as.data.frame(XOM))[-1])
error <- logr2-slope*logr1 - intercept
data <- data.frame(date,logr1,logr2,error)
data$signal=c(rep("none",nrow(data)))
data[abs((data$error+delta))<=accuracy,]$signal<-"buy"
data[abs((data$error-delta))<=accuracy,]$signal<-"sell"
```

```
data$order <- seq(nrow(data))
trade_signal <- subset(data, data$signal != "none")
trade_signal}
##


slope <- coef(fit2)[2]
intercept <- coef(fit2)[1]
date<-as.Date(XOM$Date[-1])
yt_axt<-y-slope*x
data<-data.frame(date,x,y,yt_axt)
data$signal = rep("none",nrow(data))
data[abs((data$yt_axt+delta-intercept))<=0.001,]$signal<-"buy"
data[abs((data$yt_axt-delta-intercept))<=0.001,]$signal<-"sell"
data$order = seq(nrow(data))
trade<-subset(data,data$signal!="none")
trade
```

```
##           date             x           y      yt_axt signal order
## 8   2015-12-10  0.0007930875  0.01922055  0.01851607   sell     8
## 9   2015-12-11 -0.0179969667 -0.03255097 -0.01656474    buy     9
## 13  2015-12-17 -0.0151489498 -0.03152779 -0.01807138    buy    13
## 62  2016-03-01  0.0140000675  0.03172991  0.01929403   sell    62
## 167 2016-07-29 -0.0139550134  0.00675581  0.01915168   sell   167
## 363 2017-05-10 -0.0048714503  0.01342300  0.01775018   sell   363
## 368 2017-05-17 -0.0068069425 -0.02406347 -0.01801704    buy   368
```

Calculate P/L Suppose that the transaction size is 1 contract.

```
if(FALSE){
close1 <- XOM$Close[(trade_signal$order)+1]
close2 <- CVS$Close[(trade_signal$order)+1]
signal <- trade_signal$signal
signal[signal == "sell"] = 1
signal[signal == "buy"] = -1
signal <- as.numeric(signal)
signal1 <- signal*slope
signal1[length(signal1)] = -2*slope
signal2 <- signal*(-1)
signal2[length(signal2)] = 2
pnl1 <- signal1 %*% close1
pnl2 <- signal2 %*% close2
pnl <- pnl1 +pnl2
pnl}

# need to figure out why get different outcome when use same data from
different source
close1 <- XOM$Close[(trade$order)+1]
close2 <- CVS$Close[(trade$order)+1]
signal <- trade$signal
```

```r
signal[signal == "sell"] = 1
signal[signal == "buy"] = -1
signal <- as.numeric(signal)
signal1 <- signal*slope
signal1[length(signal1)] = -2*slope
signal2 <- signal*(-1)
signal2[length(signal2)] = 2
pnl1 <- signal1 %*% close1
pnl2 <- signal2 %*% close2
pnl <- pnl1 +pnl2
pnl

##          [,1]
## [1,] 12.22956
```

The profit is 12.23 for 1 unit of portfolio.