Capital Gain of Two Investment Strategies over 30 years

From: RStudio Markdown
Purpose: assignment for *R for Data Science*
Author: yours truly =]
Lesson learned: best strategy is no strategy at all.

Import libraries

```
library(quantmod)
```

```
## Loading required package: xts
```

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

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

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

```
## Loading required package: TTR
```

```
## Registered S3 method overwritten by 'quantmod':
##   method            from
##   as.zoo.data.frame zoo
```

```
## Version 0.4-0 included new data defaults. See ?getSymbols.
```

```
library(ggplot2)
library(dplyr)
```

```
##
## Attaching package: 'dplyr'
```

```
## The following objects are masked from 'package:xts':
##
##     first, last
```

```
## The following objects are masked from 'package:stats':
##
##     filter, lag
```

```
## The following objects are masked from 'package:base':
##
##     intersect, setdiff, setequal, union
```

```
library(TTR)
```

Turn off Timezone message

```
options(xts_check_TZ=FALSE)
```

Get last 30 years of S&P 500 index fund data Note: only data from 1993 on is available

```
getSymbols("SPY", from="1990-01-01")
```

```
## 'getSymbols' currently uses auto.assign=TRUE by default, but will
## use auto.assign=FALSE in 0.5-0. You will still be able to use
## 'loadSymbols' to automatically load data. getOption("getSymbols.env")
## and getOption("getSymbols.auto.assign") will still be checked for
## alternate defaults.
##
## This message is shown once per session and may be disabled by setting
## options("getSymbols.warning4.0"=FALSE). See ?getSymbols for details.
```

```
## [1] "SPY"
```

Get Simple Moving Average of Adjusted price with n=5

```
sma.5 <- SMA(SPY[,6],n=5)
head(sma.5,n=10)
```

```
##                 SMA
## 1993-01-29       NA
## 1993-02-01       NA
## 1993-02-02       NA
## 1993-02-03       NA
## 1993-02-04 26.61726
## 1993-02-05 26.74071
## 1993-02-08 26.82675
## 1993-02-09 26.86416
## 1993-02-10 26.85294
## 1993-02-11 26.84546
```

Get SMA change per day

```
sma.diff <- sma.5 - lag(sma.5,k=1)
head(sma.diff,n=20)
```

```
##                   SMA
## 1993-01-29         NA
## 1993-02-01         NA
## 1993-02-02         NA
## 1993-02-03         NA
## 1993-02-04         NA
## 1993-02-05  0.1234500
## 1993-02-08  0.0860428
## 1993-02-09  0.0374084
## 1993-02-10 -0.0112198
## 1993-02-11 -0.0074810
## 1993-02-12 -0.0448932
## 1993-02-16 -0.1795676
```

```
## 1993-02-17 -0.1458996
## 1993-02-18 -0.1571246
## 1993-02-19 -0.1646046
## 1993-02-22 -0.1047452
## 1993-02-23  0.0261874
## 1993-02-24  0.0972664
## 1993-02-25  0.1122344
## 1993-02-26  0.1010106
```

Get Momentum based on Adjusted price with n=5

```
mmt.5 <- momentum(SPY[,6],n=5)
head(mmt.5,n=20)
```

```
##            SPY.Adjusted
## 1993-01-29           NA
## 1993-02-01           NA
## 1993-02-02           NA
## 1993-02-03           NA
## 1993-02-04           NA
## 1993-02-05     0.617250
## 1993-02-08     0.430214
## 1993-02-09     0.187042
## 1993-02-10    -0.056099
## 1993-02-11    -0.037405
## 1993-02-12    -0.224466
## 1993-02-16    -0.897838
## 1993-02-17    -0.729498
## 1993-02-18    -0.785623
## 1993-02-19    -0.823023
## 1993-02-22    -0.523726
## 1993-02-23     0.130937
## 1993-02-24     0.486332
## 1993-02-25     0.561172
## 1993-02-26     0.505053
```

We saw that SMA and Momentum have similar indicators so we can confidently choose one for strategy 2.

Merge SMA change into source data

```
SPY1 <- merge(SPY[,6],sma.diff,join="left")
head(SPY1)
```

```
##            SPY.Adjusted     SMA
## 1993-01-29     26.29929      NA
## 1993-02-01     26.48632      NA
## 1993-02-02     26.54245      NA
## 1993-02-03     26.82300      NA
## 1993-02-04     26.93524      NA
## 1993-02-05     26.91654 0.12345
```

Set last trading date of the month as pay day with 1000 deposit

```
SPY2 <- SPY1[endpoints(SPY1,on="months",k=1)]
SPY2$PayDay <- 1000
SPY2$Baseline <- 0
SPY2$S1Total <- 0
SPY2$S1Share <- 0
SPY2$S2Saving <- 0
SPY2$S2Share <- 0
SPY2$S2Total <- 0
#head(SPY2)

SPY.Setup <- merge(SPY1,SPY2[,3:9],join="left",fill=0)
#head(SPY.Setup,n=10)
```

Simulate two strategies over our source data to get result at the end

```
t5 <- SPY.Setup

# set up first observation
t5[1,4] <- t5[1,3]
if (t5[1,3] > 0) {
  t5[1,5] <- t5[1,3]
  t5[1,6] <- t5[1,3]/t5[1,1]
  t5[1,7] <- t5[1,3]    # for S2, all money is saved
  t5[1,9] <- t5[1,3]
}

# for each following observation
for (i in 2:nrow(t5)){

  # update per previous observation
  t5[i,4] <- t5[i-1,4]
  t5[i,6] <- t5[i-1,6]
  t5[i,5] <- t5[i,6]*t5[i,1]
  t5[i,7] <- t5[i-1,7]
  t5[i,8] <- t5[i-1,8]
  t5[i,9] <- t5[i,8]*t5[i,1] + t5[i,7]

  # new money
  if (t5[i,3]>0){
    # add to baseline
    t5[i,4] <- t5[i,4]+t5[i,3]

    # S1 always buy
    t5[i,6] <- t5[i,6] + t5[i,3] / t5[i,1]
    t5[i,5] <- t5[i,6]*t5[i,1]

    # S2 goes to saving first
    t5[i,7] <- t5[i,7] + t5[i,3]
```

```
    t5[i,9] <- t5[i,7] + t5[i,8] * t5[i,1]
  }

  # S2 strategy
  if (!is.na(t5[i,2])){

    # buy
    if (t5[i,2]>=0){
      if (t5[i,7]>0){
        t5[i,8] <- t5[i,8] + t5[i,7] / t5[i,1]
        t5[i,9] <- t5[i,8] * t5[i,1]
        t5[i,7] <- 0
      }
    }

    # sell
    else {
      if (t5[i,8]>0){
        t5[i,7] <- t5[i,7] + t5[i,8] * t5[i,1]
        t5[i,9] <- t5[i,7]
        t5[i,8] <- 0
      }
    }
  }
}
SPY.Result <- t5
#head(SPY.Result,n=10)
```

Get investment result at end of each month

```
result_by_month <- SPY.Result[endpoints(SPY.Result,on="months",k=1)]
head(result_by_month[,c(4,5,9)])
```

```
##            Baseline  S1Total  S2Total
## 1993-01-29     1000 1000.000 1000.000
## 1993-02-26     2000 2010.669 2010.802
## 1993-03-31     3000 3055.704 3046.110
## 1993-04-30     4000 3977.516 4029.315
## 1993-05-28     5000 5084.788 5094.912
## 1993-06-30     6000 6103.130 6090.946
```

```
tail(result_by_month[,c(4,5,9)])
```

```
##            Baseline S1Total  S2Total
## 2019-11-29   323000 1291255 451733.0
## 2019-12-31   324000 1329773 458004.1
## 2020-01-31   325000 1330236 467058.9
## 2020-02-28   326000 1225927 486547.0
## 2020-03-31   327000 1073844 446411.0
## 2020-04-24   328000 1179916 440455.4
```

Show this table with S1Total as the networth for strategy 1 and S2Total as networth for strategy 2.

Get investment result at end of each year

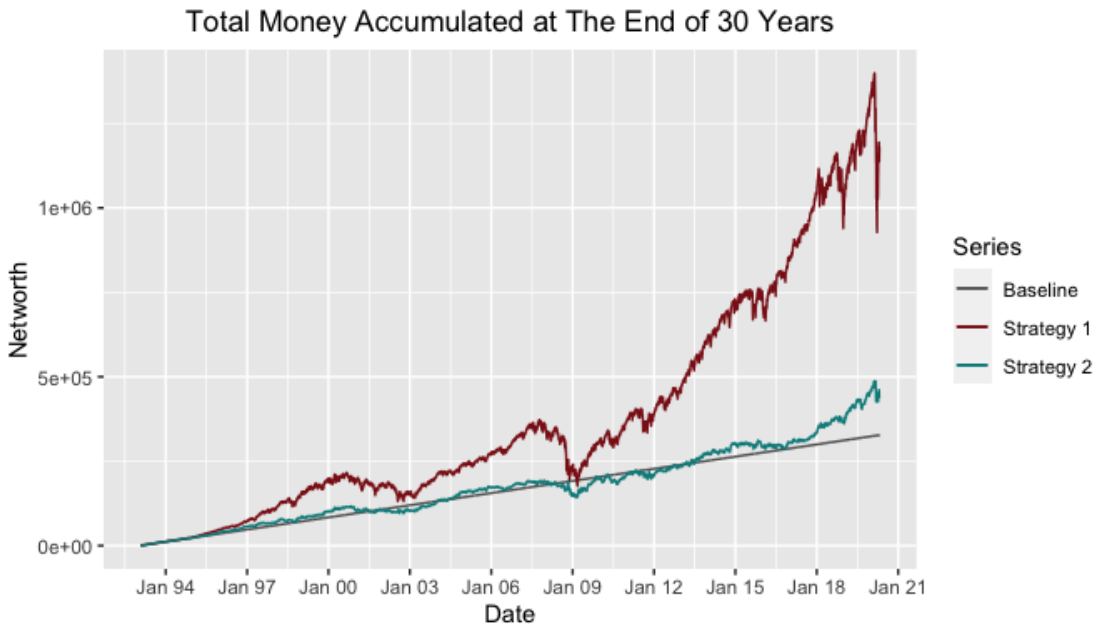
```
result_by_year <- SPY.Result[endpoints(SPY.Result,on="year",k=1)]
print(result_by_year[,c(4,5,9)])
```

```
##            Baseline    S1Total   S2Total
## 1993-12-31    12000   12494.73  11947.03
## 1994-12-30    24000   24587.68  23490.10
## 1995-12-29    36000   47676.91  39428.54
## 1996-12-31    48000   71714.08  56181.60
## 1997-12-31    60000  109230.42  68589.46
## 1998-12-31    72000  154329.90  84497.42
## 1999-12-31    84000  199147.00 103081.50
## 2000-12-29    96000  190906.14 107564.47
## 2001-12-31   108000  180138.77 104424.82
## 2002-12-31   120000  152173.68 102374.67
## 2003-12-31   132000  209037.49 130200.20
## 2004-12-31   144000  244304.13 160546.91
## 2005-12-30   156000  268592.56 171275.35
## 2006-12-29   168000  324184.33 184351.05
## 2007-12-31   180000  352870.60 187854.59
## 2008-12-31   192000  232292.73 149631.32
## 2009-12-31   204000  307991.23 198205.28
## 2010-12-31   216000  367880.16 210104.24
## 2011-12-30   228000  386767.82 206504.96
## 2012-12-31   240000  461099.69 234460.58
## 2013-12-31   252000  623688.87 276920.59
## 2014-12-31   264000  720510.46 301079.71
## 2015-12-31   276000  741475.96 291432.52
## 2016-12-30   288000  843361.28 305089.10
## 2017-12-29   300000 1039590.15 333641.17
## 2018-12-31   312000 1003194.95 369826.90
## 2019-12-31   324000 1329773.32 458004.06
## 2020-04-24   328000 1179916.21 440455.40
```

plot reuslts

```
ggplot(SPY.Result, aes(x = index(SPY.Result))) +
  geom_line(aes(y = SPY.Result$Baseline, color = "Baseline")) +
  geom_line(aes(y = SPY.Result$S1Total, color = "Strategy 1")) +
  geom_line(aes(y = SPY.Result$S2Total, color = "Strategy 2")) +
  xlab("Date") + ylab("Networth") +
  ggtitle("Total Money Accumulated at The End of 30 Years") +
  theme(plot.title = element_text(hjust = 0.5), panel.border =
element_blank()) +
  scale_x_date(date_labels = "%b %y", date_breaks = "3 years") +
  scale_y_continuous() +
```

```
  scale_colour_manual("Series", values=c("Baseline"="gray40",
      "Strategy 1"="firebrick4", "Strategy 2"="darkcyan"))
```



Show this table with S1Total as the networth for strategy 1 and S2Total as networth for strategy 2.

Show last observation of result, which is the total money accumulated

```
tail(SPY.Result[,c(4,5,9)],n=1)
```

```
##            Baseline S1Total  S2Total
## 2020-04-24   328000 1179916 440455.4
```

Analysis

Our result showed that both strategies will perform better than keeping money in a cookie jar. However, it was surprising to see that strategy 1 performed significantly better than strategy 1. Even though strategy 2 took a more conservative approach to sell when market went down compared to strategy 1. From our graph, we observed that strategy 2 did not increase nor decrease value as quickly as strategy 1. By assuming the market generally goes up over time, we believed strategy 2 lost out more by missing market increase than saving on market decrease. Thus, we conclude that strategy 1 is better over time.