

On portfolios

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Problem #1

Your initial wealth is exactly \$100. You are allowed to invest in shares of a particular stock. You are also allowed to both lend and borrow at the continuously compounded, risk-free interest rate of 0.05. Keeping your money uninvested is **not allowed**.

You can rebalance your portfolio every morning, once you have observed the opening stock price. This means that you can change the number of shares you own (if you decide to do so) and accordingly adapt your risk-free investment.

You proceed to create a “rule” according to which you will be rebalancing your portfolio. Here is a possible rule you can use:

Start by purchasing half a share of stock. Thereafter, if the stock had gone up overnight, you invest an extra \$10 in the stock (you might need to borrow money); if the stock had gone down, you take out \$10 worth of investment from the stock and put that in the savings account (you might need to short the stock); if the stock price remains the same, change nothing.

Over the following 10 days, you observe the following stock prices for a non-dividend-paying stock:

Day	0	1	2	3	4	5	6	7	8	9	10
Stock price	100	80	64	80	64	80	100	80	64	80	100

As the time passes you follow investment rules above to rebalance your portfolio. Complete the following table describing your portfolio **just before** and **just after** the rebalancing is done. Even more precisely, for the 10 days, both for “before” and “after” the rebalancing, print out:

- the number of shares of stock in the portfolio,
- the balance of the risk-free investment,
- the wealth in the stock,
- the total wealth.

Solution: First, I will make a vector containing the evolution of the stock price:

```
s=c(100, 80, 64, 80, 64, 80, 100, 80, 64, 80, 100)
```

Define the continuously compounded, risk-free interest rate:

```
r=0.05
```

The rule implemented.

```
pi.v=numeric(11)
cash=numeric(11)
wealth=numeric(11)
```

```

pi.v[1]=1/2
cash[1]=50
wealth[1]=cash[1]+pi.v[1]*s[1]

rebalance<-function(s.beg, s.end, shares, wealth){
  if (s.beg==s.end){
    return(shares)
  } else {
    if (s.beg<s.end){
      return(shares+10/s.end)
    } else {
      if (s.beg>s.end) {
        return(shares-10/s.end)
      }
    }
  }
}

for (i in 1:10){
  cash[i+1]=cash[i]*exp(r/365)
  wealth[i+1]=s[i+1]*pi.v[i]+cash[i+1]

  print(sprintf("Day = %d, %s", i, "before"))
  print(sprintf("shares = %6.2f, cash = %6.2f, wealth in stock = %6.2f, total wealth = %6.2f",
    pi.v[i], cash[i+1], pi.v[i]*s[i+1], wealth[i+1]))

  pi.v[i+1]=rebalance(s[i], s[i+1], pi.v[i], wealth[i])
  cash[i+1]=wealth[i+1]-s[i+1]*pi.v[i+1]

  print(sprintf("Day = %d, %s", i, "after"))
  print(sprintf("shares = %6.2f, cash = %6.2f, wealth in stock = %6.2f, total wealth = %6.2f",
    pi.v[i+1], cash[i+1], pi.v[i+1]*s[i+1], wealth[i+1]))
}

## [1] "Day = 1, before"
## [1] "shares = 0.50, cash = 50.01, wealth in stock = 40.00, total wealth = 90.01"
## [1] "Day = 1, after"
## [1] "shares = 0.38, cash = 60.01, wealth in stock = 30.00, total wealth = 90.01"
## [1] "Day = 2, before"
## [1] "shares = 0.38, cash = 60.02, wealth in stock = 24.00, total wealth = 84.02"
## [1] "Day = 2, after"
## [1] "shares = 0.22, cash = 70.02, wealth in stock = 14.00, total wealth = 84.02"
## [1] "Day = 3, before"
## [1] "shares = 0.22, cash = 70.02, wealth in stock = 17.50, total wealth = 87.52"
## [1] "Day = 3, after"
## [1] "shares = 0.34, cash = 60.02, wealth in stock = 27.50, total wealth = 87.52"
## [1] "Day = 4, before"
## [1] "shares = 0.34, cash = 60.03, wealth in stock = 22.00, total wealth = 82.03"
## [1] "Day = 4, after"
## [1] "shares = 0.19, cash = 70.03, wealth in stock = 12.00, total wealth = 82.03"
## [1] "Day = 5, before"
## [1] "shares = 0.19, cash = 70.04, wealth in stock = 15.00, total wealth = 85.04"
## [1] "Day = 5, after"
## [1] "shares = 0.31, cash = 60.04, wealth in stock = 25.00, total wealth = 85.04"

```

```

## [1] "Day = 6, before"
## [1] "shares = 0.31, cash = 60.05, wealth in stock = 31.25, total wealth = 91.30"
## [1] "Day = 6, after"
## [1] "shares = 0.41, cash = 50.05, wealth in stock = 41.25, total wealth = 91.30"
## [1] "Day = 7, before"
## [1] "shares = 0.41, cash = 50.06, wealth in stock = 33.00, total wealth = 83.06"
## [1] "Day = 7, after"
## [1] "shares = 0.29, cash = 60.06, wealth in stock = 23.00, total wealth = 83.06"
## [1] "Day = 8, before"
## [1] "shares = 0.29, cash = 60.07, wealth in stock = 18.40, total wealth = 78.47"
## [1] "Day = 8, after"
## [1] "shares = 0.13, cash = 70.07, wealth in stock = 8.40, total wealth = 78.47"
## [1] "Day = 9, before"
## [1] "shares = 0.13, cash = 70.08, wealth in stock = 10.50, total wealth = 80.58"
## [1] "Day = 9, after"
## [1] "shares = 0.26, cash = 60.08, wealth in stock = 20.50, total wealth = 80.58"
## [1] "Day = 10, before"
## [1] "shares = 0.26, cash = 60.08, wealth in stock = 25.62, total wealth = 85.71"
## [1] "Day = 10, after"
## [1] "shares = 0.36, cash = 50.08, wealth in stock = 35.62, total wealth = 85.71"

```