VaR

Introduction

My recent article focused on using R to perform some basic exploratory data analysis.[1]

The focus of this article will be to highlight some packages that focus on financial analytics (TTR, quantmod and PerformanceAnalytics) and a package that will allow us to build an interactive UI with a package called Shiny.

For this article we will focus on Value at Risk[2], a common market risk measure developed by JP Morgan and most recently criticized by Nassim Taleb [3].

Simple Historical Simulation Methodology

For the first part of this article I will walk through the methodology of calculating VaR for a single-stock using the historical simulation method (as opposed to the Monte Carlo or parametric method) [4].

VaR allows a risk manager to make a statement about a maximum loss over a specified horizon at a certain confidence level.

V will be the Value at Risk; N will be the horizon, and X the confidence level.

Briefly, this method is: retrieve and sort a returns timeseries from a specified period (usually 500 days) and take a specific quantile and you will have the Value at Risk for that position.

Note however this will only apply to a single stock – adding stocks to a portfolio will require correlation effects to be accounted for, and this will substantially increase compute requirements, a topic for later. Normally a portfolio will not only include multiple stocks, but forwards, futures and other derivative positions.

In R, we would proceed as follows.

```
##pre-requisite packages

library(quantmod)
library(PerformanceAnalytics)
```

With the packages loaded we can now run through the algorithm:

```
X <- c(0.05)
stock <- c("AA") ##American Airlines


## define the historical timeseries
begin <- Sys.Date() - 501
end <- Sys.Date()

## first use of quantmod to get the ticker and populate our dataset with the timeseries of Adjusted cl
tickers <- getSymbols(stock, from = begin, to = end, auto.assign = TRUE)
dataset <- Ad(get(tickers[1]))

## now we need to convert the closing prices into a daily returns timeseries - we will use the Perfor
returns_AA <- Return.calculate(dataset, method=c("simple"))
```

[1] http://www.broadgateconsultants.com/blog/2014/08/31/big-data-analysis-an-example-of-using-r/

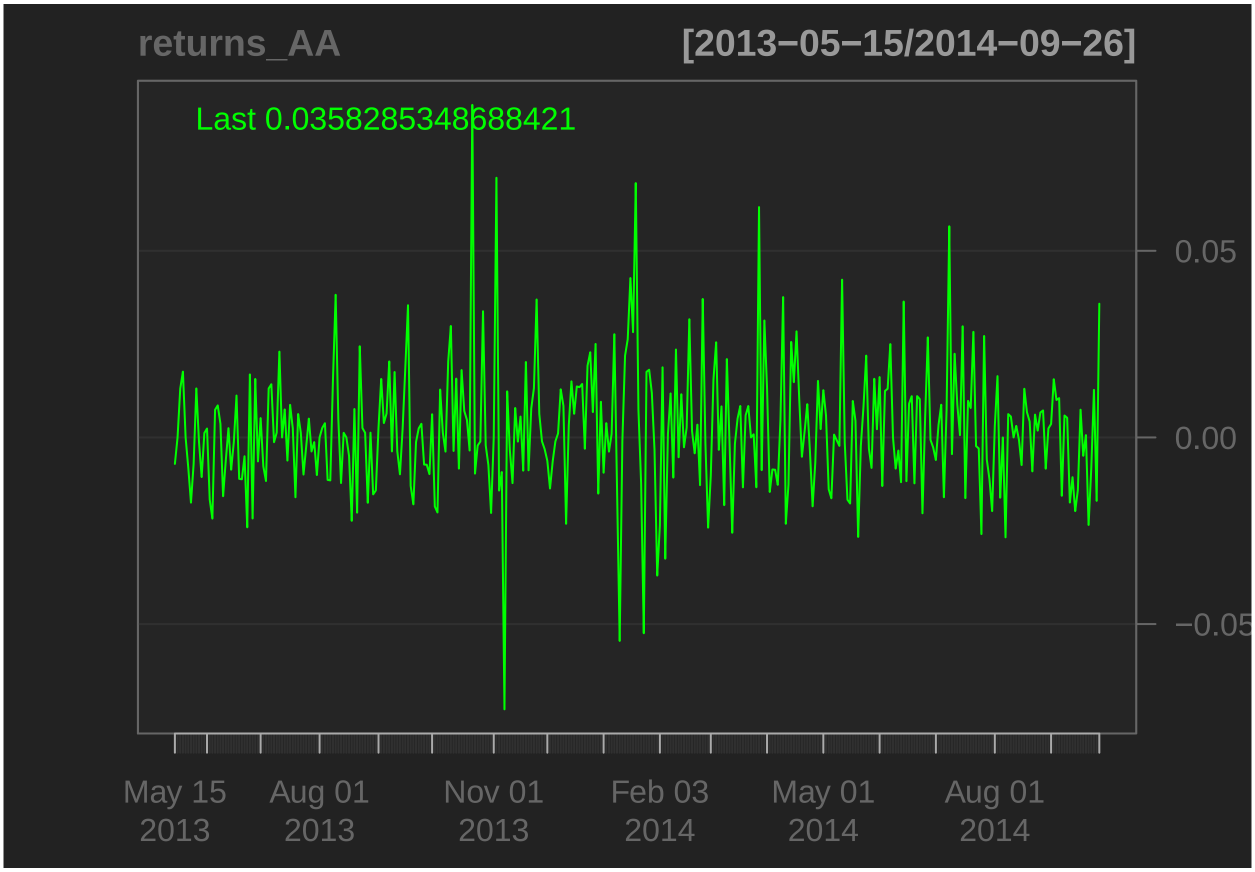
[2] http://en.wikipedia.org/wiki/Value_at_risk

[3] http://www.futuresmag.com/2010/12/01/var-the-number-that-killed-us

[4] Main sources are Hull's "Options, Futures and other derivatives" (http://www.amazon.co.uk/Options-Futures-Other-Derivatives-John/dp/0273759078) and Bionic Turtles excellent video (https://www.youtube.com/watch?v=yiyqIEWieEQ)

We now have the dataset and can start to do some elementary plotting, firstly the returns timeseries to have a quick look:

```
chartSeries(returns_AA)
```



Now, we'll convert the timeseries into a sorted list and apply the quantile function

```
##convert to matrix datatype as zoo datatypes can't be sorted, then sort ascending
returns_AA.m <- as.matrix(returns_AA); sorted <- returns_AA.m[order(returns_AA.m[,1])]

##calculate the 5th percentile, na.rm=TRUE tells the function to ignore NA values (not available valu
100*round(quantile(returns_AA.m[order(returns_AA.m[,1])], c(.05), na.rm=TRUE), 4)
```

```
##    5%
## -2.14
```

This shows us that the 5% one day value at risk for a position in American Airlines is -2.14%, that is, for $100 of position, once every 20 days you would lose *more than* $2.14.

Building a UI

A worthwhile read to using Shiny is available on the Shiny Website. (http://shiny.rstudio.com/tutorial/)

In essence, we will need to define two files in one directory, *server.R* and *UI.R*.

We'll start with the UI code, not that I have used the "Telephones by Region" as a template (http://shiny.rstudio.com/gallery/telephones-by-region.html).

The basic requirements are:

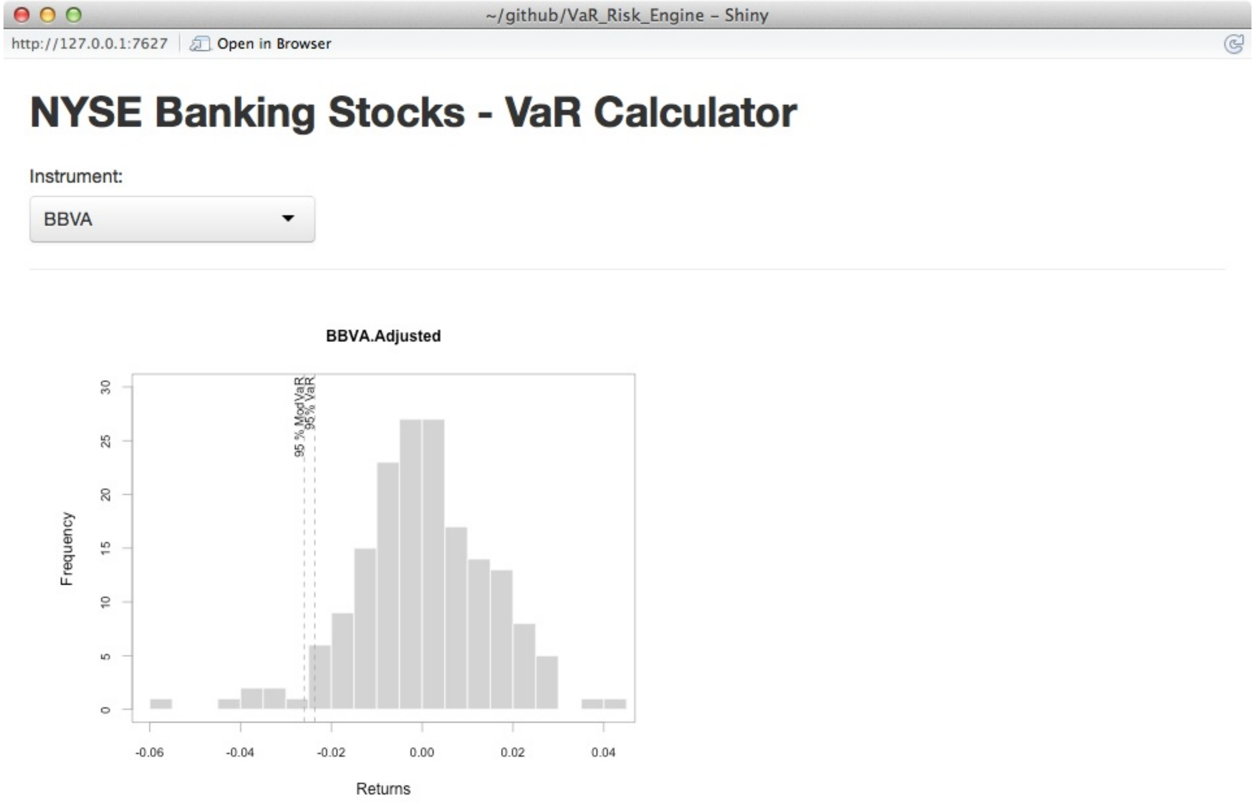
1. A drop-down box to choose the stock.
2. A function that plots a histogram of the returns time-series and shows the VaR as a quantile on the histogram.

```r
##get the dataset for the drop-down box, we'll use the TTR package for downloading a vector of stocks, a
library(TTR)
library(sqldf)
library(shiny)

suppressWarnings(SYMs <- TTR::stockSymbols())

##use the handy sqldf package to query dataframes using SQL syntax - we'll focus on Banking stocks on th
SYMs <- sqldf("select Symbol from SYMs where Exchange='NYSE' and Industry like '%Banks%'")

# Define the overall UI, shamelessly stolen from the shiny gallery

shinyUI(

  # Use a fluid Bootstrap layout

  fluidPage(
    # Give the page a title

    titlePanel("NYSE Banking Stocks - VaR Calculator"),

    # Generate a row with a sidebar, calling the sidebar "Instrument" and populating the choices with th

    sidebarLayout(

      selectInput("Instrument", "Instrument:", choices=SYMs),
      hr(),
    ),

    # Create a spot for the histogram

    mainPanel(plotOutput("VaRPlot"))

    )
  )
```

With the UI layout defined, we can now define the functions in the Server.R code:

```r
shinyServer(function(input, output){

  # Fill in the spot we created in UI.R using the code under "renderPlot"

  output$VaRPlot<-renderPlot({

    ##use the code shown above to get the data for the chosen instrument captured in input$Instrument

    begin <- Sys.Date() - 501
    end <- Sys.Date()

    tickers <- getSymbols(input$Instrument, from = begin, to = end, auto.assign = TRUE)
    dataset <- Ad(get(tickers[1]))
    dataset <- dataset[,1]
    returns <- Return.calculate(dataset, method=c("simple"))

    ##use the quantmod package that creates the histogram and adds 95% VaR using the add.risk method

    chart.Histogram(returns, methods = c("add.risk"))

  })

})
```

In RStudio, you will then see the button “Run App”, which after clicking will run your new and Shiny app.



NYSE Banking Stocks - VaR Calculator

Instrument:

BBVA