
University of Washington

CFRM 462 - Introduction to Computational Finance and Financial Econometrics

# Equity Portfolio Optimization

## A Mutual Fund Asset Allocation Project

August 19, 2016

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## Executive Summary

# Contents

# Chapter 1

# Introduction

## Dataset Description

### VFINX - S&P 500 Index

The Vanguard 500 Index Fund[1] is an ETF that invests in 500 of the largest U.S. companies. These companies span many different industries, and thus provides investors with full exposure to the domestic stock market. The fund focuses on large-capitalization companies that encompass nearly 75% of the U.S. equity market. The fund treats the Standard & Poor's 500[2] as its benchmark, and thus acts as a measurement of overall stock market performance.

### VEURX - European Stock Index

The Vanguard European Stock Index Fund[3] is an ETF that provides investors with exposure to the major stock markets of Europe. The fund holds positions in approximately 1,200 stocks across European markets, which represents nearly half of global (non U.S.) equity. In addition to systematic risk, this fund is also exposed to currency risk, and may have significant regional risk as all markets in which the fund invests in are located in Europe. This fund treated the MSCI Europe Index[4] as its benchmark through March 26, 2013, but has used the FTSE Developed Europe Index[5] as its benchmark thereafter.

### VEIEX - Emerging Markets Fund

The Vanguard Emerging Markets Stock Index Fund[6] is an ETF that provides investors with exposure to emerging markets around the world including but not limited to: Brazil, Russia, India and China. As emerging markets tend to be more volatile, this fund has the potential for higher returns, but with considerably higher risk. Similar to the European Stock Index Fund, the returns of this fund too are exposed to significant currency risk. This fund treated the FTSE Emerging Index[7] as its benchmark through November 2, 2015, but has since switched to the FTSE Emerging Markets All Cap China A Transition Index.[8]

[1] The Vanguard Group Inc. (2016a)
[2] S&P Dow Jones Indices LLC (2016)
[3] The Vanguard Group Inc. (2016c)
[4] MSCI Inc. (2016)
[5] FTSE Russell (2016a)
[6] The Vanguard Group Inc. (2016b)
[7] FTSE Russell (2016c)
[8] FTSE Russell (2016b)

**VBLTX - Long-Term Bond Fund**

**VBISX - Short-Term Bond Fund**

**VPACX - Pacific Stock Index**

# Appendix A

# Project Source Code

## Initialization and Constants

```
library(boot)
library(IntroCompFinR)
library(knitr)
library(PerformanceAnalytics)
library(tseries)
library(xlsx)

# Constants
asset.names <- c("VFINX", "VEURX", "VEIEX", "VBLTX", "VBISX", "VPACX")
export.pricedata.name <- "price_data.xlsx"
```

## Helper Functions

```
# Function to get adjusted close prices from online services See
# ??get.hist.quote for more info/options
get.adjclose <- function(instrument, interval, start = "1800-01-01", end = Sys.date()) {
    prices <- get.hist.quote(instrument = instrument, quote = c("AdjClose"),
        start = start, end = end, compression = interval, retclass = "zoo")
    prices
}
```

## Downloading and Exporting Price Data

```
# Defining date range
start.date <- "2011-06-01"
end.date <- "2016-06-30"

# Getting adjusted close prices for each of the securities
vfinx.adjclose <- get.adjclose("VFINX", "m", start.date, end.date)
veurx.adjclose <- get.adjclose("VEURX", "m", start.date, end.date)
```

```r
veiex.adjclose <- get.adjclose("VEIEX", "m", start.date, end.date)
vbltx.adjclose <- get.adjclose("VBLTX", "m", start.date, end.date)
vbisx.adjclose <- get.adjclose("VBISX", "m", start.date, end.date)
vpacx.adjclose <- get.adjclose("VPACX", "m", start.date, end.date)

# Changing class of index to yearmon, which is ideal for monthly data
index(vfinx.adjclose) <- as.yearmon(index(vfinx.adjclose))
index(veurx.adjclose) <- as.yearmon(index(veurx.adjclose))
index(veiex.adjclose) <- as.yearmon(index(veiex.adjclose))
index(vbltx.adjclose) <- as.yearmon(index(vbltx.adjclose))
index(vbisx.adjclose) <- as.yearmon(index(vbisx.adjclose))
index(vpacx.adjclose) <- as.yearmon(index(vpacx.adjclose))

# Merging price data
prices <- merge(vfinx.adjclose, veurx.adjclose, veiex.adjclose, vbltx.adjclose,
    vbisx.adjclose, vpacx.adjclose)
colnames(prices) <- asset.names

# Computing continuously compounded returns, and casting to different
# types for function compatibility
ret.z <- diff(log(prices))  # Type 'zoo'
ret.mat <- coredata(ret.z)  # Type 'matrix'
ret.df <- as.data.frame(coredata(ret.z))  # Type 'dataframe'

# Computing simple returns
ret.simple.z <- exp(ret.z) - 1

# Check if output Excel file exists, if so delete
if (file.exists(export.pricedata.name)) {
    file.remove(export.pricedata.name)
}

# Loop through each asset, and export price, simple and geometric
# return to separate sheets in an Excel file
for (i in seq_along(asset.names)) {
    simple.ret = exp(ret.df[, i]) - 1
    export.data.names <- c("Adjusted Close", "Simple Return", "Continuously Compounded Return")
    export.data = data.frame(prices[, i][-(1:1)], simple.ret, ret.df[,
        i])
    rownames(export.data) <- index(prices)[-(1:1)]
    colnames(export.data) <- export.data.names
    write.xlsx(export.data, file = export.pricedata.name, sheetName = asset.names[i],
        append = TRUE)
}
```

# References


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