

Analyzing NBIM returns

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These notes illustrate the usage of R to analyze the historical returns of the Norwegian “Oil Fund” (GPF). It is based on the report Dahlquist and Ødegaard (2018), and illustrate the implementation of some of these calculations using R. Many of the calculations have been updated with data through 2020.

Data

The prime data source is the most recent spreadsheet of historical returns provided by NBIM adjoint to their annual report.

Reading data

```
library(xts) # time series library
library(readxl) # reading excel files library
datadir <- "/home/bernt/data/2021/nbim/" # set datadir to where the file lives
filename <- paste0(datadir,"monthly-returns_2020.xlsx")
DataEquityReturnsUSD <- read_xlsx(filename, sheet="Equity - USD",skip=2)
dates <- as.yearmon(as.Date(as.character(na.omit(DataEquityReturnsUSD$Month)))
n <- length(dates)
dates <- dates[2:n] # cut the first date, as this is empty
Equity_Rets_USD <- xts(na.omit(DataEquityReturnsUSD$`Actual portfolio`), order.by=dates)
names(Equity_Rets_USD) <- "Equity_Rets_USD" # 10
Equity_Benchmark_Rets_USD <- xts(na.omit(DataEquityReturnsUSD$`Benchmark portfolio`), order.by=dates)
names(Equity_Benchmark_Rets_USD) <- "Equity_Benchmark_Rets_USD" # 20
```

```
DataFixedIncomeReturnsUSD <- read_xlsx(filename, sheet="Fixed income - USD",skip=2)
dates <- as.yearmon(as.Date(as.character(na.omit(DataFixedIncomeReturnsUSD$Month)))
Fixed_Income_Rets_USD <- xts(na.omit(DataFixedIncomeReturnsUSD$`Actual portfolio`), order.by=dates)
names(Fixed_Income_Rets_USD) <- "Fixed_Income_Rets_USD" # 10
Fixed_Income_Benchmark_Rets_USD <- xts(na.omit(DataFixedIncomeReturnsUSD$`Benchmark portfolio`), order.by=dates)
names(Fixed_Income_Benchmark_Rets_USD) <- "Fixed_Income_Benchmark_Rets_USD" # 20
```

```
DataTotalReturnsUSD <- read_xlsx(filename, sheet="Fund combined - USD",skip=2)
dates <- as.yearmon(as.Date(as.character(na.omit(DataTotalReturnsUSD$Month)))
```

Aggregate wealth

Purpose: Illustrate the increase in wealth from asset returns (not accounting for inflows/outflows).

Wealth (in NOK) implied in the equity part of the portfolio, where wealth is calculated as

$$W_T = \prod_{t=1}^T (1 + r_t)$$

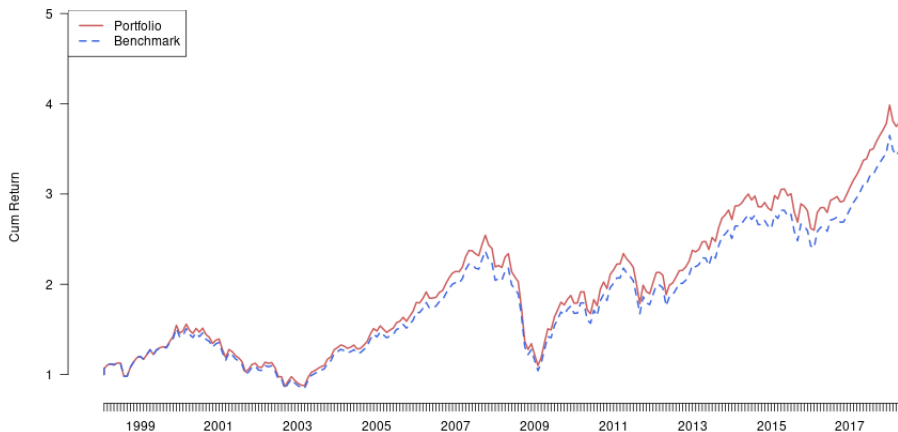


```
source (" ../2021_06_read_current/read_nbim_NOK_returns_from_excel.R")
outdir <- " ../results/2021_06_cumulative_wealth_plots/"

Rp <- as.matrix(Equity_Rets_NOK)
wp <- 1.0
Wealth <- c(wp)
for ( i in 1:length(Rp)) {
  wp <- wp*(1+Rp[i])
  Wealth <- c(Wealth,wp)
}
dates <- c(as.yearmon("1998-02"),index(Equity_Rets_NOK))
Wealth <- xts(Wealth,order.by=dates)
filename <- paste0(outdir,"wealth_evolution_equity_portfolio_NOK.png")
png(filename,width=1000,heigh=500)
plot.zoo(Wealth,
  main="", ylab="Cum Return", xlab="", las=1,lwd=2, bty="n", col="in
dev.off()
```

Aggregate wealth, Equity, USD

Evolution of portfolio and benchmark



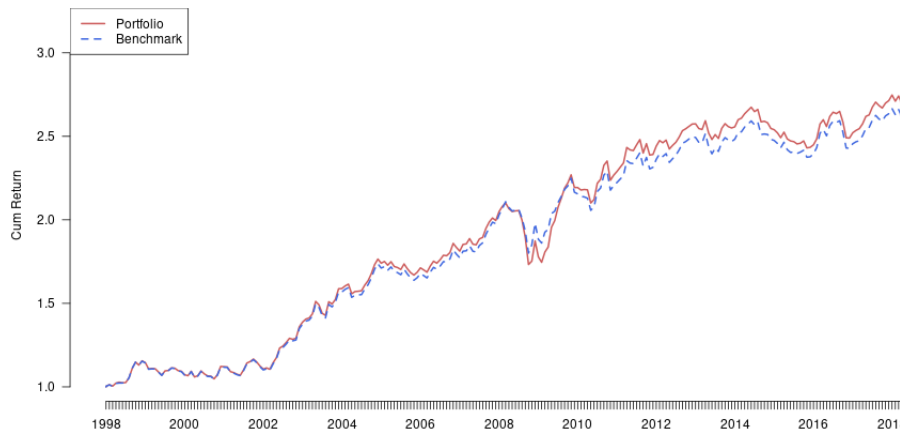
Aggregate wealth, Equity, USD

Evolution of difference portfolio



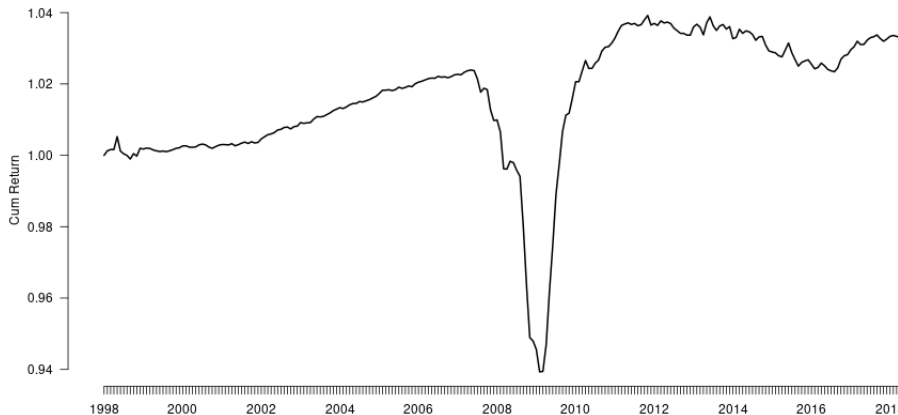
Aggregate wealth, Fixed Income, USD

Evolution of portfolio and benchmark



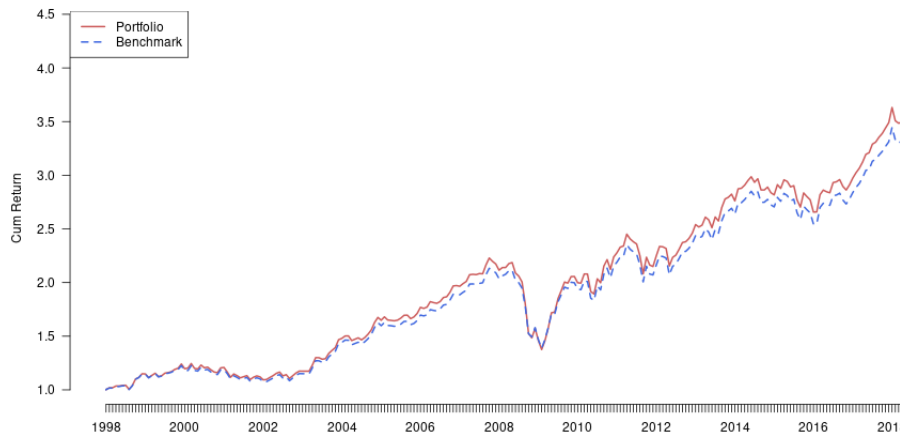
Aggregate wealth, Fixed Income, USD

Evolution of difference portfolio



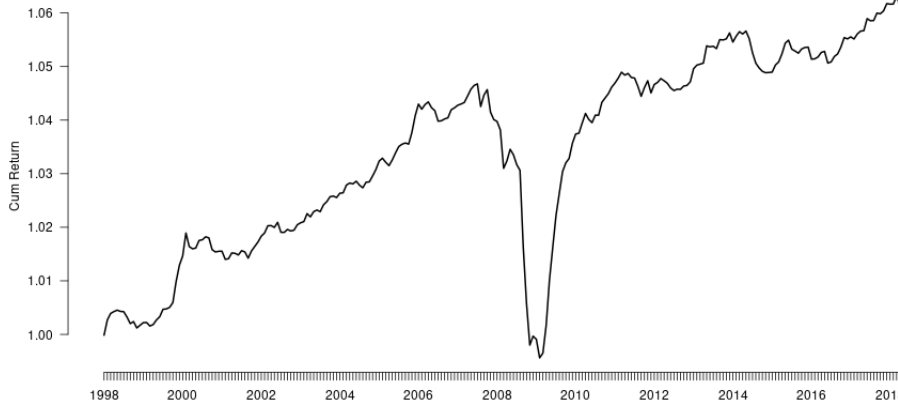
Aggregate wealth, Total, USD

Evolution of portfolio and benchmark



Aggregate wealth, Total, USD

Evolution of difference portfolio



Alpha estimation

Estimate the “alpha” of the equity portfolio.

$$r_{pt} - r_{ft} = \alpha + \beta(r_{mt} - r_{ft}) + b^{SMB}SMB_t + b^{HML}HML_t + \varepsilon_t$$

	<i>Dependent variable:</i>
	eRp
Constant	-0.0005 (0.0004)
RMRF	1.059*** (0.008)
SMB	-0.045** (0.018)
HML	0.067*** (0.013)
Observations	275
Adjusted R ²	0.986

Note: *p<0.1; **p<0.05; ***p<0.01

Here r_{pt} is the portfolio return, r_{ft} the risk free rate, r_{mt} the return on a market portfolio, and SMB_t and HML_t are the two Fama French factors on market size and

```
library(xts)
library(stargazer)
source ("~/data/2021/french_global_data/read_global_3_pricing_factors.R"
source (" ../2021_06_read_current/read_nbim_USD_returns_from_excel.R")
outdir <- " ../ ./results/2021_06_alpha_estimation/"
```

```
data <- merge(Equity_Rets_USD,RF,RMRF,SMB,HML,all=FALSE)
Rp <- data$Equity_Rets_USD
eRp <- data$Equity_Rets_USD-data$RF
RMRF <- data$RMRF
SMB <- data$SMB
HML <- data$HML
```

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```
regr <- lm(eRp~RMRF+SMB+HML)
```

```
filename <- paste0(outdir,"alpha_estimation_equity_USD_whole_period_three_
stargazer(regr,
  no.space=TRUE,
  model.numbers=FALSE,
  float=FALSE,
  align=TRUE,
  digits=3,
  intercept.top=TRUE,
  intercept.bottom=FALSE.
```

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Magnus Dahlquist and Bernt Arne Ødegaard. A review of Norges Bank's active management of the government pension fund global. Technical report, January 2018. URL <https://www.regjeringen.no/no/aktuelt/ekspertrapporter-om-spu/id2585465/>. Report to Norwegian Ministry of Finance.