# Socially Responsible Investing

Panko A.S, Yakimchyk N.S, Kurennoi I.I, Agafonov N.S

Vienna University of Economics and Business

June 26, 2019

# Overview

# SRI and SIN definitions

**Socially Responsible Investing (SRI)** - investing strategy that avoids investment in companies involved in socially disadvantageous activities (e.g. production or selling alcohol and tobacco).
**SIN industries** - companies involved in socially disadvantageous activities (e.g. drug, selling weapons).

# Objective

Analyze the profitability and riskiness of SRI in comparison with SIN industries and the market

# Data

## Data

- Annual returns of US 49 industry indexes in period 1970 - 2014
  - Source: Ken Frenchs website
  - Link: `http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html`
- Treasury Bills interest rates
  - Source: Federal Reserve Economic Data
  - Link: `https://fred.stlouisfed.org/series/TB3MS`

# Download data in R and Methodology

### R code: Download data

To download data from .csv file into a data frame object next function is used:

```
data_frame <- read.csv('File_Name.csv', header=TRUE)
```

### Methodology

- Equally-weighted portfolio
- Mean-variance optimized portfolio

# Define SIN and SRI industries

SIN industries

1. Candy and Soda
2. Beer and Liquor
3. Tobacco Products
4. Chemicals
5. Rubber and Plastic Products
6. Defense
7. Coal
8. Oil
9. Utilities

SRI industries

Other 40 industries

Total: 49 industries (MKT - Market)

# Portfolio characteristics

Let P be a portfolio of n indices.

- $w = (w_1, \cdots, w_n)^T$ - vector of weights
- r - Treasury Bill interest rate
- $\sum$ - covariance matrix of indices returns

Then portfolio return $\mu(P)$ is:

$$\mu(P) = \mu^T w \tag{1}$$

Portfolio risk $\sigma(P)$ is:

$$\sigma(P) = \sqrt{var(P)} = \sqrt{w^T \sum w} \tag{2}$$

Sharpe Ratio SR(P) is:

$$SR(P) = \frac{\mu(P) - r}{\sigma(P)} \tag{3}$$

# Equally-weighted portfolio

## Description

Equally-weighted portfolio is a portfolio of n assets with all equal weights:

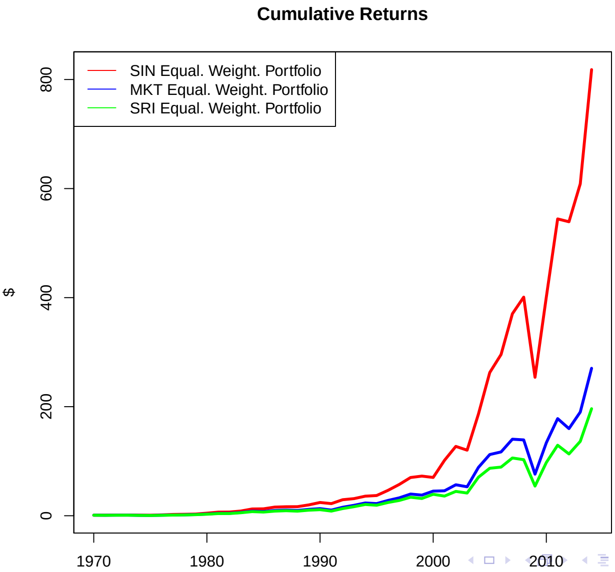
$w_1 = w_2 = \cdots = w_n = \frac{1}{n}$

## Portfolios' statistics

| | Return | Standard.Deviation | Sharpe.Ratio |
|---|---|---|---|
| SIN Portfolio | 18.05 | 21.31 | 0.61 |
| MKT Portfolio | 16.28 | 25.68 | 0.44 |
| SRI Portfolio | 15.88 | 27.24 | 0.40 |

# Cumulative returns

1 USD invested in 1970:



Let's find the best place for the money!

| | Sharpe.Ratio |
|---|---|
| Soda | 0.44 |
| Beer | 0.47 |
| Smoke | 0.64 |
| Chems | 0.46 |
| Rubbr | 0.40 |
| Guns | 0.53 |
| Coal | 0.19 |
| Oil | 0.31 |
| Util | 0.60 |

# Mean-Variance optimized portfolio

## Description

Changing weights it is possible to make returns higher and risk lower. To find appropriate weights, next optimization problem is solved

$$var(P) - q\mu(P) \underset{\mu}{\rightarrow} min \tag{4}$$

- $q \geq 0$ - risk tolerance. If $q = 0$, the aim is to minimize portfolio variance(risk)
- if $q = \inf$, the aim is to maximize portfolio return
- for the research q $= 1$ is chosen

# Our case

With q = 1 formula (4) is:

$$w^T \sum w - \mu^T w \underset{w}{\rightarrow} min \tag{5}$$

## Constraints

1. $\sum_{i=1}^{n} w_i = 1$
2. $w_i \geq 0$ for i = 1,...,n
3. $w_i \leq 0.1$ (SRI and MKT)
   $w_i \leq 0.2$ (SIN)

In R exists a function, which solves general quadratic problem:

```r
library(quadprog)
result <- solve.QP(Dmat, dvec, Amat, bvec, meq)
```

### Quadratic programming problem

$$\frac{1}{2}w^T Dw - d^T w \underset{w}{\rightarrow} min \tag{6}$$

$$A^T w \geq b \tag{7}$$

# Function Parameters

- $D = 2\sum$
- $d = \mu$
- $meq = 1$

The matrix of constraints A:

$$A = \begin{bmatrix} 1 & 1 & & \dots & -1 & & \dots & 0 \\ 1 & & 1 & \dots & & -1 & \dots & 0 \\ \hdotsfor{6} & & \\ \hdotsfor{6} & & \\ \hdotsfor{6} & & \\ 1 & & & \dots & 1 & & \dots & -1 \end{bmatrix}$$

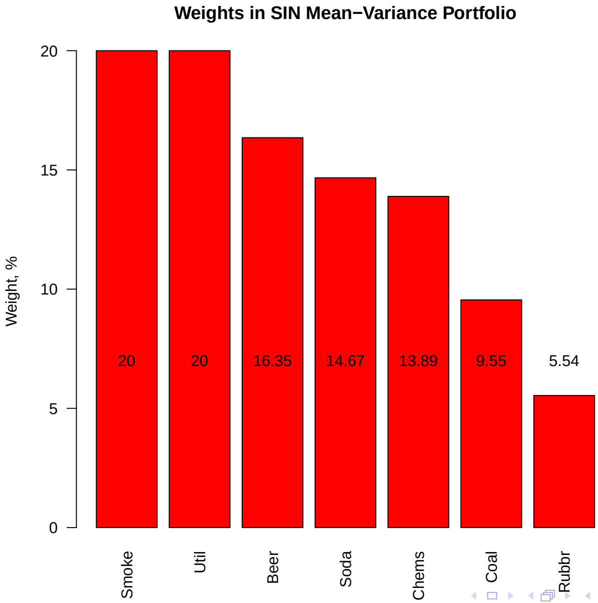
$$b = \begin{bmatrix} 1 \\ 0 \\ \vdots \\ -0.2 \\ \vdots \end{bmatrix}$$

# Results

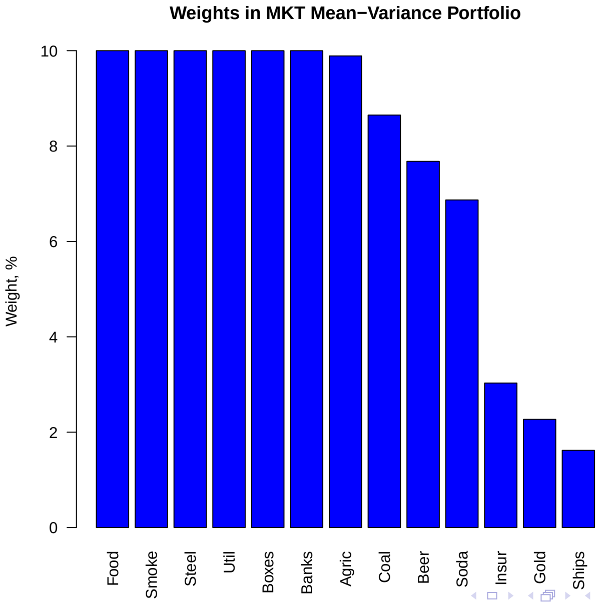
## Mean-Variance Portfolios' Statistics

| | Return | Standard.Deviation | Sharpe.Ratio |
|---|---|---|---|
| SIN MV Portfolio | 17.65 | 19.18 | 0.66 |
| MKT MV Portfolio | 15.78 | 17.98 | 0.60 |
| SRI MV Portfolio | 14.64 | 20.82 | 0.46 |

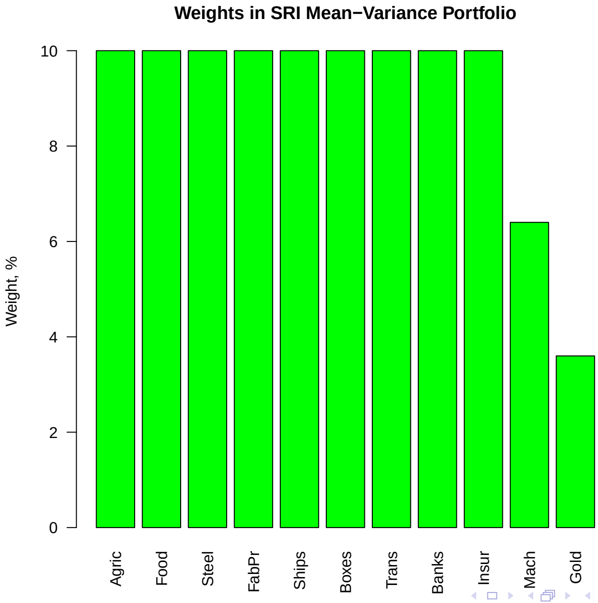
# Results: weights SIN



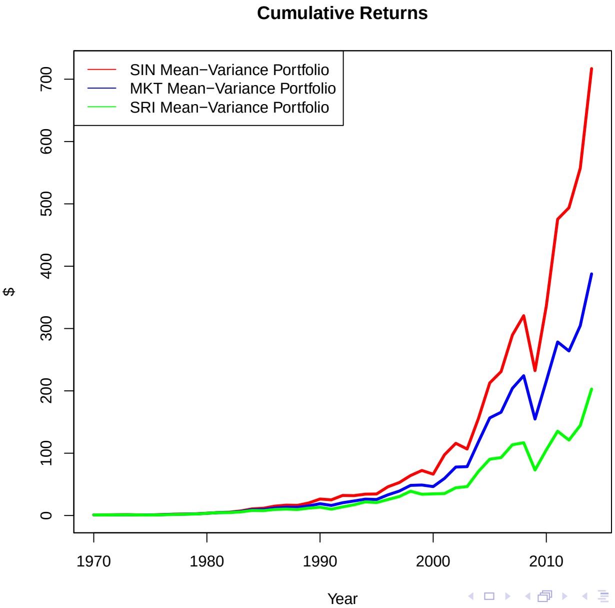
# Results: weights MKT



# Results: weights SRI



# Results: Cumulative returns



# Conclusion

1. The SRI mean-variance and equally weighted portfolios show the worst performance comparing to other portfolios
2. The SIN mean-variance and equally weighted portfolios show the best performance comparing to other portfolios