

Design of Risk Parity Portfolios

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This vignette illustrates the design of risk-parity portfolios, widely used by practitioners in the financial industry, with the package `riskParityPortfolio` (with a comparison with other packages) and gives a description of the algorithms used.

1 Comparison with other packages

Existing packages that I quickly found (a more thorough search is due):

- Package `cccp` contains function `rp` (and the package itself may be useful for solving conic optimization problems)
- Package `FinCovRegularization` contains function `RiskParity` (the package may be useful for covariance matrix regularization, which is one of my upcoming projects...)
- Here you can find some simple code for risk parity portfolio: <http://nakisa.org/bankr-useful-financial-r-snippets/risk-parity-portfolios-r/>

Websites to check:

- Many links to docs related to risk parity here: <https://www.r-bloggers.com/risk-parity/>
- Nice intro articles that I can use in my slides for the course:
 - <https://www.ipe.com/risk-parity-nice-idea-awkward-reality/40026.article>
 - <http://news.morningstar.com/pdfs/gmohiddenrisks.pdf>
 - https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1707478
- More links:
 - <https://pdfs.semanticscholar.org/094d/24b924caa659442065401999d7a77e06953e.pdf>
 - https://cdn2.hubspot.net/hubfs/2529352/Blog/2010_03_nepc_risk_parity.pdf?t=1501681499185
 - https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1271972

2 Usage of the package

```
library(riskParityPortfolio)
library(xts)
library(quantmod)
library(PerformanceAnalytics)
```

```

N <- 10
stocks_index <- c(1:N)
Sigma <- diag(stocks_index ^ 2)
# add some correlation between stocks 1 and 2
Sigma[2, 1] <- 10
Sigma[1, 2] <- 10

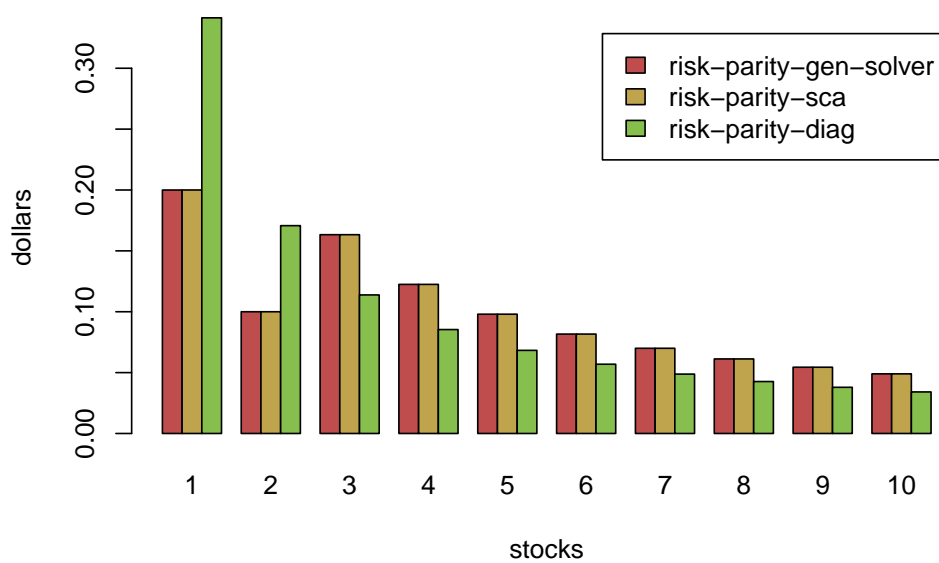
res_gen <- riskParityPortfolioGenSolver(Sigma)
res_qp <- riskParityPortfolioQP(Sigma)

w_diag <- 1/sqrt(diag(Sigma))
w_diag <- w_diag/sum(w_diag)

w_all <- cbind(res_gen$portfolio_weights, res_qp$portfolio_weights, w_diag)
colnames(w_all) <- c("risk-parity-gen-solver", "risk-parity-sca", "risk-parity-diag")
rownames(w_all) <- stocks_index
round(w_all, digits = 2)
#>      risk-parity-gen-solver risk-parity-sca risk-parity-diag
#> 1                0.20                0.20                0.34
#> 2                0.10                0.10                0.17
#> 3                0.16                0.16                0.11
#> 4                0.12                0.12                0.09
#> 5                0.10                0.10                0.07
#> 6                0.08                0.08                0.06
#> 7                0.07                0.07                0.05
#> 8                0.06                0.06                0.04
#> 9                0.05                0.05                0.04
#> 10               0.05                0.05                0.03
barplot(t(w_all),
        main = "Portfolio allocation", xlab = "stocks", ylab = "dollars", beside = TRUE,
        legend = colnames(w_all), col = rainbow8equal[1:3])

```

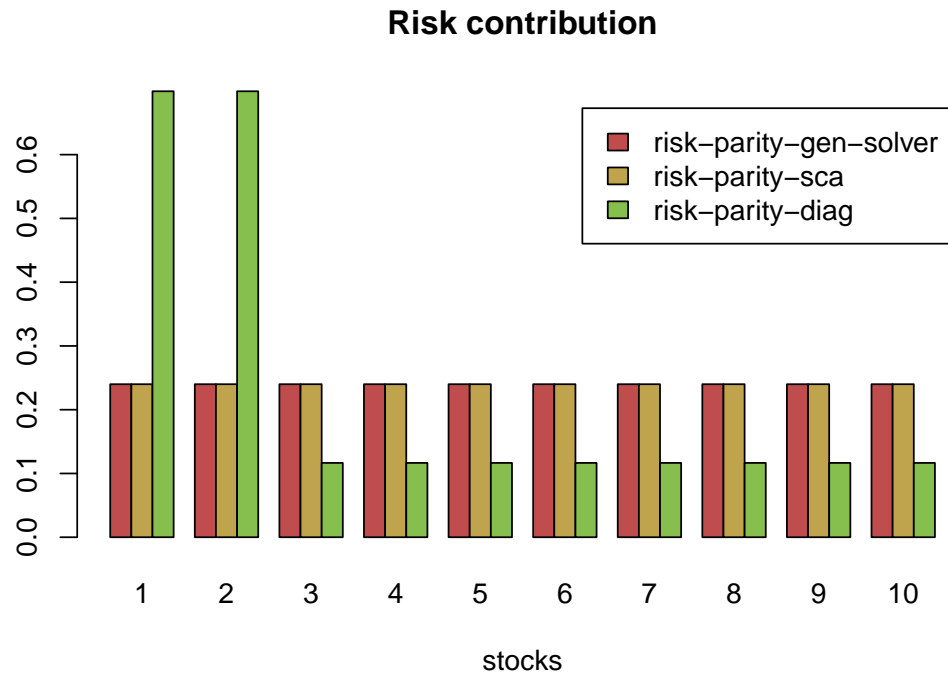
Portfolio allocation



```

risk_contrib_all <- cbind(res_gen$risk_contribution, res_qp$risk_contribution,
                        w_diag * (Sigma %*% w_diag))
colnames(risk_contrib_all) <- c("rc-gen-solver", "rc-sca", "rc-diag")
rownames(risk_contrib_all) <- stocks_index
barplot(t(risk_contrib_all),
        main = "Risk contribution", xlab = "stocks", beside = TRUE,
        legend = colnames(w_all), col = rainbow8equal[1:3])

```



3 Explanation of the algorithms

References