Package ‘DOSPortfolio’

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Title Dynamic Optimal Shrinkage Portfolio

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Description Constructs dynamic optimal shrinkage estimators for the weights of the global minimum variance portfolio which are reconstructed at given reallocation points as derived in Bodnar, Parolya, and Thorsén (2021) (<arXiv:2106.02131>). Two dynamic shrinkage estimators are available in this package. One using overlapping samples while the other use nonoverlapping samples.

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URL https://github.com/Statistics-In-Portfolio-Theory/DOSportfolio

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RdMacros Rdpack

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Depends R (>= 3.5.0)

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The DOSPortfolio package consists of two shrinkage estimators for the Global Minimum Variance (GMV) portfolio. These are implemented in the package's main interface: `DOSPortfolio`. The shrinkage is performed at fixed reallocation points in a dynamic manner where the sample estimator of the GMV weights is shrunk towards the holding portfolio. The reallocation points are specified by a deterministic sequence given a priori. The estimation is performed such that the shrinkage coefficients are optimal for large portfolios, e.g. there are many assets in comparison to observations. The main interface validates the main assumptions of the theory used to derive these methods.

### Methods

DOSPortfolio: (Bodnar et al. 2021)

### References


This is the main function to compute the weights of the global minimum variance portfolio by using the dynamic optimal shrinkage estimators presented in Eq. (2.11) and Eq. (2.23) of Bodnar et al. (2021). It implements two different estimators for the shrinkage coefficients, one using overlapping samples (see, Eq. (2.23) of Bodnar et al. (2021)) and one using non-overlapping samples (see, Eq. (2.11) of Bodnar et al. (2021)).
DOSPortfolio

Usage

DOSPortfolio(
  data,
  reallocation_points,
  relative_loss = NULL,
  target_portfolio = rep(1, ncol(data))/ncol(data),
  shrinkage_type = "non-overlapping"
)

Arguments

data       an n by p matrix of asset returns. Columns represent different assets rows are
           observations, where n>p, containing, for instance, log-returns.
reallocation_points
           a vector of reallocation points. The reallocation points determine when the hold-
           ing portfolio should be reconstructed and its weights should be recomputed.
relative_loss
           possibly a numeric or NULL. The initial value of the relative loss in the variance
           of the target portfolio. If its NULL, then it will be initialized with the first
           subsample and the function r0Strategy.
target_portfolio
           a vector which determines the weights of the target portfolio used when the
           shrinkage estimator of the global minimum variance portfolio is constructed for
           the first time.
shrinkage_type
           the type of shrinkage estimator to use. The two implemented approaches are
           "non-overlapping" and "overlapping".

Value

An S3 class which contains the matrix of the constructed weights of the dynamic shrinkage estima-

tor of the global minimum variance portfolio and the type of the shrinkage estimator (i.e., "over-
lapping" or "non-overlapping") that was used in its construction. Each row of the weight matrix

 corresponds to the reallocation point and the column corresponds to the asset.

References


02131.

See Also

Section 2.1 and 2.2 of (Bodnar et al. 2021)

Examples

n <- 250*2
p <- 80
c <- p/n
new_DOSPortfolio <- c(120, 240)
data <- sqrt(5/3) * matrix(rt(n*p, df=5), ncol=p, nrow=n)
weights <- DOSPortfolio(data, reallocation_points, 1)

new_DOSPortfolio  
Constructor for the DOSPortfolio class

Description

Constructor for the DOSPortfolio class

Usage

new_DOSPortfolio(
data,  
reallocation_points,  
target_portfolio,  
relative_loss,  
shrinkage_type
)

Arguments

data an n by p matrix of asset returns. Columns represent different assets rows are observations, where n>p, containing, for instance, log-returns.
reallocation_points a vector of reallocation points. The reallocation points determine when the holding portfolio should be reconstructed and its weights should be recomputed.
target_portfolio a vector which determines the weights of the target portfolio used when the shrinkage estimator of the global minimum variance portfolio is constructed for the first time.
relative_loss possibly a numeric or NULL. The initial value of the relative loss in the variance of the target portfolio. If its NULL, then it will be initialized with the first subsample and the function r0Strategy.
shrinkage_type the type of shrinkage estimator to use. The two implemented approaches are “non-overlapping” and "overlapping".

Value

a DOSPortfolio class.
r0Strategy

Computes the relative loss of the target portfolio used

**Description**

The function computes the initial value of the relative loss in the variance of the target portfolio as given in Eq. (2.10) of Bodnar et al. (2021).

**Usage**

```r
r0Strategy(data, target_portfolio, c)
```

**Arguments**

- `data` an n by p matrix of asset returns. Columns represent different assets rows are observations, where n>p, containing, for instance, log-returns.
- `target_portfolio` a vector which determines the weights of the target portfolio used when the shrinkage estimator of the global minimum variance portfolio is constructed for the first time.
- `c` a numeric which is the concentration ratio.

**Value**

vector

**References**


**Examples**

```r
n <- 200*2
p <- 80
data <- 5/3 * matrix(rt(n*p, df=5), ncol=p, nrow=n)
# set a target portfolio, such as equally weighted
b <- rep(1,p)/p
r0Strategy(data, b, p/n)
```
validate_input

Validates input to the DOSPortfolio function.

Description

This function validates the assumptions made to derive the analytic formulas implemented in the different functions of the package. It is called for its side-effects.

Usage

validate_input(
  data,
  reallocation_points,
  target_portfolio,
  relative_loss,
  shrinkage_type
)

Arguments

data an n by p matrix of asset returns. Columns represent different assets rows are observations, where n>p, containing, for instance, log-returns.

reallocation_points a vector of reallocation points. The reallocation points determine when the holding portfolio should be reconstructed and its weights should be recomputed.

target_portfolio a vector which determines the weights of the target portfolio used when the shrinkage estimator of the global minimum variance portfolio is constructed for the first time.

relative_loss possibly a numeric or NULL. The initial value of the relative loss in the variance of the target portfolio. If its NULL, then it will be initialized with the first subsample and the function r0Strategy.

shrinkage_type the type of shrinkage estimator to use. The two implemented approaches are "non-overlapping" and "overlapping".

Value

NULL, only called for its side effects
Sample estimator of the weights of the global minimum variance portfolio

Description
The function computes the sample estimate of the weights of the global minimum variance portfolio (see, e.g., Eq. (1.4) of Bodnar et al. (2021)).

Usage
wGMV(data)

Arguments
data
an n by p matrix of asset returns. Columns represent different assets, rows are observations, where n>p, containing, for instance, log-returns.

Value
a vector, which is the Global Minimum Variance Portfolio.

Examples
n <- 200
p <- 80
data <- 3/5 * matrix(rt(n*p, df=5), ncol=p, nrow=n)
weights <- wGMV(data)
# since the covariance matrix is the identity-matrix the estimated weights
# should be close to the equally weighted portfolio.
mean(abs(wGMV(data) - 1/p))

Dynamic optimal shrinkage estimator of the weights of the global minimum variance portfolio when non-overlapping samples are used.

Description
The function implements the dynamic shrinkage estimator of the weights of the global minimum-variance portfolio when the non-overlapping samples are used as given in Eq. (2.11) of Bodnar et al. (2021).

Usage
wGMVNonOverlapping(data, reallocation_points, target_portfolio, relative_loss)
Arguments

data  an n by p matrix of asset returns. Columns represent different assets rows are observations, where n>p, containing, for instance, log-returns.
reallocation_points  a vector of reallocation points. The reallocation points determine when the holding portfolio should be reconstructed and it is weights should be recomputed.
target_portfolio  a vector which determines the weights of the target portfolio used when the shrinkage estimator of the global minimum variance portfolio is constructed for the first time.
relative_loss  possibly a numeric or NULL. The initial value of the relative loss in the variance of the target portfolio. If it is NULL, then it will be initialized with the first subsample and the function r0Strategy.

Value

a matrix of the constructed weights at each reallocation point of the dynamic shrinkage estimator of the global minimum variance portfolio when non-overlapping samples are used.

References


See Also

section 2.1 (Bodnar et al. 2021)

Examples

n <- 200*2
p <- 80
reallocation_point <- c(199)
data <- 3/5 * matrix(rt(n*p, df=5), ncol=p, nrow=n)
target_portfolio <- as.vector(rep(1,p))/p
wGMVNonOverlapping(data, reallocation_point, target_portfolio, 1)

wGMVOlapping  Dynamic optimal shrinkage estimator of the weights of the global minimum variance portfolio when overlapping samples are used.

Description

The function implements the dynamic shrinkage estimator of the weights of the global minimum-variance portfolio when the overlapping samples are used as given in Eq. (2.23) of Bodnar et al. (2021).
Usage

\texttt{wGMVOverlapping(data, reallocation_points, target_portfolio, relative_loss)}

Arguments

data an \( n \) by \( p \) matrix of asset returns. Columns represent different assets, rows are observations, where \( n > p \), containing, for instance, log-returns.

reallocation_points a vector of reallocation points. The reallocation points determine when the holding portfolio should be reconstructed and its weights should be recomputed.

target_portfolio a vector which determines the weights of the target portfolio used when the shrinkage estimator of the global minimum variance portfolio is constructed for the first time.

relative_loss possibly a numeric or NULL. The initial value of the relative loss in the variance of the target portfolio. If it is NULL, then it will be initialized with the first subsample and the function \texttt{r0Strategy}.

Value

a matrix of the constructed weights at each reallocation point of the dynamic shrinkage estimator of the global minimum variance portfolio when overlapping samples are used.

References


See Also

\texttt{wGMVNonOverlapping}

Examples

\begin{verbatim}
n <- 200*2
p <- 80
reallocation_points <- c(199)
data <- matrix(rt(n*p, df=5), ncol=p, nrow=n)
target_portfolio <- as.vector(rep(1,p))/p
wGMVOverlapping(data, reallocation_points, target_portfolio, 1)
\end{verbatim}
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