

Package ‘etrm’

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Type Package

Title Energy Trading and Risk Management

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Author Anders D. Sleire

Maintainer Anders D. Sleire <sleire@gmail.com>

Description Provides a collection of functions to perform core tasks within Energy Trading and Risk Management (ETRM). Calculation of maximum smoothness forward price curves for electricity and natural gas contracts with flow delivery, as presented in F. E. Benth, S. Koekebakker, and F. Ollmar (2007) <[doi:10.3905/jod.2007.694791](https://doi.org/10.3905/jod.2007.694791)> and F. E. Benth, J. S. Benth, and S. Koekebakker (2008) <[doi:10.1142/6811](https://doi.org/10.1142/6811)>. Portfolio insurance trading strategies for price risk management in the forward market, see F. Black (1976) <[doi:10.1016/0304-405X\(76\)90024-6](https://doi.org/10.1016/0304-405X(76)90024-6)>, T. Bjork (2009) <<https://EconPapers.repec.org/RePEc:oxp:obooks:9780199574742>>, F. Black and R. W. Jones (1987) <[doi:10.3905/jpm.1987.409131](https://doi.org/10.3905/jpm.1987.409131)> and H. E. Leland (1980) <<http://www.jstor.org/stable/2327419>>.

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 etrm-package

etrm: Energy Trading and Risk Management

Description

Tools for energy market risk management (forward curves and trading strategies)

Author(s)

Anders D. Sleire <sleire@gmail.com>

References

- F. E. Benth, S. Koekkebakker, and F. Ollmar. Extracting and applying smooth forward curves from average-based commodity contracts with seasonal variation. *The Journal of Derivatives*, 15(1):52–66, 2007b. <https://doi.org/10.3905/jod.2007.694791>
- F. E. Benth, J. S. Benth, and S. Koekebakker. Stochastic modelling of electricity and related markets, volume 11. World Scientific, 2008. <https://doi.org/10.1142/6811>
- F. Black. The pricing of commodity contracts. *Journal of financial economics*, 3(1):167–179, 1976. [https://doi.org/10.1016/0304-405X\(76\)90024-6](https://doi.org/10.1016/0304-405X(76)90024-6)

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- F. Black and R. W. Jones. Simplifying portfolio insurance. The Journal of Portfolio Management, 14(1):48–51, 1987. <https://doi.org/10.3905/jpm.1987.409131>
- H. E. Leland. Who should buy portfolio insurance? The Journal of Finance, 35(2):581–594, 1980. <http://www.jstor.org/stable/2327419>

 cppi

Constant Proportion Portfolio Insurance (CPPI)

Description

Implements CPPI strategy for commodity price risk management

Usage

```
cppi(q, tdate, f, tper, rper, tcost = 0, int = TRUE)
```

Arguments

q	numeric value for quantity to be hedged, either positive (net buyer) or negative (net seller)
tdate	date vector with trading days
f	numeric futures price vector
tper	numeric target price markup/down to the price on the first trading day
rper	numeric risk factor as a percentage of the price on the first trading day
tcost	numeric transaction costs pr unit
int	TRUE/FALSE integer restriction on tradable volume

Value

instance of the CPPI class

Examples

```
# CPPI for a buyer (seller), where stop loss is set 10% above (below) initial market price.

set.seed(5)
# GBM price process parameters
mu <- 0.2
sigma <- 0.1
S0 <- 100

# time
Y <- 2
N <- 500
delta <- Y/N
```

```

t <- seq(0, 1, length = N + 1)

# price process and date vector
W <- c(0, cumsum(sqrt(delta) * rnorm(N)))
f_gbm <- S0 * exp(mu * t + sigma * W)
tr_dates <- seq(Sys.Date(), Sys.Date()+500, by = "day")

# implement cpqi strategy for buyer
cpqi_b <- cpqi(q = 10,
  tdate = tr_dates,
  f = f_gbm,
  tper = 0.1,
  rper = 0.1,
  tcost = 0,
  int = TRUE)

# implement cpqi strategy for seller
cpqi_s <- cpqi(q = - 10,
  tdate = tr_dates,
  f = f_gbm,
  tper = - 0.1,
  rper = 0.1,
  tcost = 0,
  int = TRUE)

```

CPPI-class

An S4 class for the CPPI hedging strategy

Description

An S4 class for the CPPI hedging strategy

Slots

RiskFactor The risk factor (cushion) used in the CPPI model

dppi

Dynamic Proportion Portfolio Insurance (DPPI)

Description

Implements DPPI strategy for commodity price risk management

Usage

```
dppi(q, tdate, f, tper, rper, tcost = 0, int = TRUE)
```

Arguments

q	numeric value for quantity to be hedged, either positive (net buyer) or negative (net seller)
tdate	date vector with trading days
f	numeric futures price vector
tper	numeric target price factor, markup/down to the price on the first trading day
rper	numeric risk factor as a percentage of the price on the first trading day
tcost	numeric transaction costs pr unit
int	TRUE/FALSE integer restriction on tradable volume

Value

instance of the DPPI class

Examples

DPPI for a buyer (seller), where stop loss is set 10% above (below) initial market price.

```

set.seed(5)
# GBM price process parameters
mu <- 0.2
sigma <- 0.1
S0 <- 100

# time
Y <- 2
N <- 500
delta <- Y/N
t <- seq(0, 1, length = N + 1)

# price process and date vector
W <- c(0, cumsum( sqrt(delta) * rnorm(N)))
f_gbm <- S0 * exp(mu * t + sigma * W)
tr_dates <- seq(Sys.Date(), Sys.Date()+500, by = "day")

# implement dppi strategy for buyer
dppi_b <- dppi(q = 10,
  tdate = tr_dates,
  f = f_gbm,
  tper = 0.1,
  rper = 0.1,
  tcost = 0,
  int = TRUE)

# implement dppi strategy for seller
dppi_s <- dppi(q = - 10,
  tdate = tr_dates,
  f = f_gbm,
  tper = - 0.1,

```

```
rper = 0.1,
tcost = 0,
int = TRUE)
```

DPPI-class *An S4 class for the DPPI hedging strategy*

Description

An S4 class for the DPPI hedging strategy

Slots

TargetPercent A percentage of first trading day's market price used to set target price (cap or floor)

RiskFactor The risk factor (cushion) used in the DPPI model

GenericStrat-class *An S4 VIRTUAL parent class for the hedging strategy classes in etrm*

Description

An S4 VIRTUAL parent class for the hedging strategy classes in etrm

Slots

Name A string with the portfolio insurance strategy name

Volume The quantity to be hedged

TargetPrice The target price(s) for the portfolio (cap or floor)

TransCost Transaction costs pr unit traded

TradeisInt TUE/FALSE integer restriction on tradable volume, TRUE sets smallest transacted unit to 1

Results Data frame with strategy results, daily values for market price, transactions, exposure, position, hedge and portfolio price

msfc

*Maximum Smoothness Forward Curve (MSFC)***Description**

Creates a smooth forward curve from futures prices for a flow delivery

Usage

```
msfc(tdate, include, contract, sdate, edate, f, prior = 0)
```

Arguments

tdate	trading date
include	logical vector to determine if contracts should be included in calculation
contract	vector with contract names
sdate	date vector with contract delivery start dates
edate	date vector with contract delivery end dates
f	numeric vector with futures contract prices
prior	numeric vector with prior forward price curve

Value

instance of the MSFC class

Examples

```
# calculate forward curve for synthetic futures contracts, without prior

# date for curve calculation and contract information
tdate <- as.Date("2021-06-17")
include <- rep(TRUE, 10)
contract <- c("JUL-21", "AUG-21", "SEP-21", "OCT-21", "NOV-21", "DEC-21",
"Q1-22", "Q2-22", "Q3-22", "Q4-22")

sdate <- as.Date(c("2021-07-01", "2021-08-01", "2021-09-01", "2021-10-01",
"2021-11-01", "2021-12-01", "2022-01-01", "2022-04-01", "2022-07-01", "2022-10-01"))

edate <- as.Date(c("2021-07-30", "2021-08-31", "2021-09-30", "2021-10-31",
"2021-11-30", "2021-12-31", "2022-03-31", "2022-06-30", "2022-09-30", "2022-12-31"))

f <- c(32.55, 32.50, 32.50, 32.08, 36.88, 39.80, 39.40, 25.20, 21.15, 29.50)

fwd_curve <- msfc(tdate = tdate,
include = include,
contract = contract,
sdate = sdate,
edate = edate,
f = f)
```

MSFC-class	<i>An S4 class for the Maximum Smoothness Forward Curve (MSFC) in etrm</i>
------------	--

Description

An S4 class for the Maximum Smoothness Forward Curve (MSFC) in etrm

Slots

Name A string with the acronym for Maximum Smoothness Forward Curve, "MSFC"

TradeDate The trading date

BenchSheet A data frame with futures contracts selected for calculation with MSFC computed prices

Polynomials The number of polynomials in the MSFC spline

PriorFunc A numeric vector with the prior function values

Results A data frame with daily values for the calculated MSFC and contracts in "BenchSheet"

SplineCoef List with coefficients for the polynomials in the MSFC spline

KnotPoints Vector with spline knot points

CalcDat Data frame extending "Results" with daily values for time vectors and polynomial coefficients used in calculation

obpi	<i>Option Based Portfolio Insurance (OBPI)</i>
------	--

Description

Implements OBPI strategy for commodity price risk management

Usage

```
obpi(
  q,
  tdate,
  f,
  k = f[1],
  vol,
  r = 0,
  tdays = 250,
  daysleft,
  tcost = 0,
  int = TRUE
)
```

Arguments

q	numeric value for quantity to be hedged, either positive (net buyer) or negative (net seller)
tdate	date vector with trading days
f	numeric futures price vector
k	numeric value for option strike price
vol	value for volatility
r	value for interest rate
tdays	integer assumed number of trading days per year
daysleft	integer with days left to option expiry
tcost	numeric transaction costs pr unit
int	TRUE/ FALSE integer restriction on tradable volume

Value

instance of the OBPI class

Examples

OBPI for a buyer (seller), where stop loss is set 10% above (below) initial market price.

```

set.seed(5)
# GBM price process parameters
mu <- 0.2
sigma <- 0.1
S0 <- 100

# time
Y <- 2
N <- 500
delta <- Y/N
t <- seq(0, 1, length = N + 1)

# price process and date vector
W <- c(0, cumsum( sqrt(delta) * rnorm(N)))
f_gbm <- S0 * exp(mu * t + sigma * W)
tr_dates <- seq(Sys.Date(), Sys.Date()+500, by = "day")

#implement obpi strategy for buyer
obpi_b <- obpi(q = 10,
  tdate = tr_dates,
  f = f_gbm,
  k = f_gbm[1],
  vol = 0.2,
  r = 0,
  tdays = 250,
  daysleft = length(f_gbm),
  tcost = 0,

```

```

int = TRUE)

# implement obpi strategy for seller
obpi_s <- obpi(q = - 10,
  tdate = tr_dates,
  f = f_gbm,
  k = f_gbm[1],
  vol = 0.2,
  r = 0,
  tdays = 250,
  daysleft = length(f_gbm),
  tcost = 0,
  int = TRUE)

```

OBPI-class

An S4 class for the OBPI hedging strategy

Description

An S4 class for the OBPI hedging strategy

Slots

StrikePrice Strike price for the synthetic option hedging

AnnVol Annualized volatility for the contract to be traded

InterestRate Risk-free rate of interest

TradingDays The number of trading days per year

plot,GenericStrat-method

S4 method for the plot generic for portfolio insurance strategy classes

Description

S4 method for the plot generic for portfolio insurance strategy classes

Usage

```

## S4 method for signature 'GenericStrat'
plot(
  x,
  y = NULL,
  title = "Strategy plot",
  xlab = "",

```

```

    ylab.1 = "Price",
    ylab.2 = "Hedge %",
    pcols = c("#F8766D", "steelblue3", "gray60", "gray80"),
    legend = "bottom"
  )

```

Arguments

x	instance of the strategy class created by the corresponding strategy function
y	NULL
title	plot title
xlab	label for x-axis
ylab.1	label for y-axis on price plot in top panel
ylab.2	label for y-axis on hedge plot in bottom panel
pcols	vector with four color codes for plot
legend	legend position in c("top", "bottom")

Value

a two-panel chart with daily values for (top panel) target price, market price and portfolio price and (bottom) portfolio hedge rate

plot,MSFC-method	<i>S4 method for the plot generic for class "MSFC"</i>
------------------	--

Description

S4 method for the plot generic for class "MSFC"

Usage

```

## S4 method for signature 'MSFC'
plot(
  x,
  y = NULL,
  plot.prior = FALSE,
  title = "",
  xlab = "",
  ylab = "Price",
  legend = "right"
)

```

Arguments

<code>x</code>	instance of the MSFC class created by the <code>msfc</code> function
<code>y</code>	NULL
<code>plot.prior</code>	TRUE/FALSE for including prior function in plot
<code>title</code>	plot title
<code>xlab</code>	x-axis title
<code>ylab</code>	y-axis title
<code>legend</code>	position of legend, as implemented in <code>ggplot2</code>

Value

a chart with daily values for the forward curve and contracts used in calculation

<code>powcal</code>	<i>Historical daily closing prices for 11 calendar year power futures contracts</i>
---------------------	---

Description

A synthetic dataset containing the closing prices and other attributes of 11 power futures contracts for calendar year delivery for 2006 - 2016.

Usage

```
powcal
```

Format

A data frame with 3253 rows and 12 columns:

Date the trading date
CAL-06 the closing price for the 2006 futures contract
CAL-07 the closing price for the 2007 futures contract
CAL-08 the closing price for the 2008 futures contract
CAL-09 the closing price for the 2009 futures contract
CAL-10 the closing price for the 2010 futures contract
CAL-11 the closing price for the 2011 futures contract
CAL-12 the closing price for the 2012 futures contract
CAL-13 the closing price for the 2013 futures contract
CAL-14 the closing price for the 2014 futures contract
CAL-15 the closing price for the 2015 futures contract
CAL-16 the closing price for the 2016 futures contract

powfutures130513 *Closing prices for power futures contracts at trading date 2013-05-13*

Description

A synthetic dataset containing the closing prices and other attributes of 38 power futures contracts.

Usage

powfutures130513

Format

A data frame with 38 rows and 5 columns:

Include boolean variable to determine if contract should be included in forward curve calculation

Contract the name of the futures contract

Start delivery start date for the futures contract

End delivery start date for the futures contract

Closing the futures contract closing price

powpriors130513 *Example priors at trading date 2015-05-13*

Description

An example of two simple priors for forward market price to be used with powfutures130513

Usage

powpriors130513

Format

A data frame with 3885 rows and 3 columns:

Date vector of dates ranging from 2013-05-13 to final end date of contracts in powfutures130513

trig.prior a simple smooth trigonometric prior describing power price seasonality

mod.prior a trigonometric prior adjusted for typical calendar effects

show,GenericStrat-method

S4 method for the show generic for portfolio insurance strategy classes

Description

S4 method for the show generic for portfolio insurance strategy classes

Usage

```
## S4 method for signature 'GenericStrat'  
show(object)
```

Arguments

object instance of a strategy class

Value

a data frame with daily observations for market price, transactions, exposed volume, forward positions, hedge rate, target price and portfolio price

show,MSFC-method

S4 method for the show generic for class "MSFC"

Description

S4 method for the show generic for class "MSFC"

Usage

```
## S4 method for signature 'MSFC'  
show(object)
```

Arguments

object instance of the MSFC class

Value

data frame with daily values for forward curve and forward contracts used in calculation

shpi	<i>Step Hedge Portfolio Insurance (SHPI)</i>
------	--

Description

Implements SHPI strategy for commodity price risk management

Usage

```
shpi(q, tdate, f, daysleft, tper, tcost = 0, int = TRUE)
```

Arguments

q	numeric value for quantity to be hedged, either positive (net buyer) or negative (net seller)
tdate	date vector with trading days
f	numeric futures price vector
daysleft	integer with days left to contract expiry
tper	numeric target price markup/down to the price on the first trading day
tcost	numeric transaction costs pr unit
int	TRUE/FALSE integer restriction on tradable volume

Value

instance of the SHPI class

Examples

```
# SHPI for a buyer (seller), where stop loss is set 10% above (below) initial market price.

set.seed(5)
# GBM price process parameters
mu <- 0.2
sigma <- 0.1
S0 <- 100

# time
Y <- 2
N <- 500
delta <- Y/N
t <- seq(0, 1, length = N + 1)

# price process and date vector
W <- c(0, cumsum(sqrt(delta) * rnorm(N)))
f_gbm <- S0 * exp(mu * t + sigma * W)
tr_dates <- seq(Sys.Date(), Sys.Date()+500, by = "day")
```

```

# implement step-hedge strategy for buyer
shpi_b <- shpi(q = 10,
  tdate = tr_dates,
  f = f_gbm,
  daysleft = length(tr_dates),
  tper = 0.1,
  tcost = 0,
  int = TRUE)

# implement step-hedge strategy for seller
shpi_s <- shpi(q = - 10,
  tdate = tr_dates,
  f = f_gbm,
  daysleft = length(tr_dates),
  tper = - 0.1,
  tcost = 0,
  int = TRUE)

```

SHPI-class	<i>An S4 class for the SHPI hedging strategy</i>
------------	--

Description

An S4 class for the SHPI hedging strategy

slpi	<i>Stop Loss Portfolio Insurance (SLPI)</i>
------	---

Description

Implements SLPI strategy for commodity price risk management

Usage

```
slpi(q, tdate, f, tper, tcost = 0, int = TRUE)
```

Arguments

q	numeric value for quantity to be hedged, either positive (net buyer) or negative (net seller)
tdate	date vector with trading days
f	numeric futures price vector
tper	numeric target price markup/down to the price on the first trading day
tcost	numeric transaction costs pr unit
int	TRUE/FALSE integer restriction on tradable volume

Value

instance of the SLPI class

Examples

SLPI for a buyer (seller), where stop loss is set 10% above (below) initial market price.

```

set.seed(5)
# GBM price process parameters
mu <- 0.2
sigma <- 0.1
S0 <- 100

# time
Y <- 2
N <- 500
delta <- Y/N
t <- seq(0, 1, length = N + 1)

# price process and date vector
W <- c(0, cumsum( sqrt(delta) * rnorm(N)))
f_gbm <- S0 * exp(mu * t + sigma * W)
tr_dates <- seq(Sys.Date(), Sys.Date()+500, by = "day")

# implement stop-loss strategy for buyer
slpi_b <- slpi(q = 10,
  tdate = tr_dates,
  f = f_gbm,
  tper = 0.1,
  tcost = 0,
  int = TRUE)

# implement stop-loss strategy for seller
slpi_s <- slpi(q = - 10,
  tdate = tr_dates,
  f = f_gbm,
  tper = - 0.1,
  tcost = 0,
  int = TRUE)

```

 SLPI-class

An S4 class for the SLPI hedging strategy

Description

An S4 class for the SLPI hedging strategy

```
summary,GenericStrat-method
    S4 method for the summary generic for portfolio insurance strategy
    classes
```

Description

S4 method for the summary generic for portfolio insurance strategy classes

Usage

```
## S4 method for signature 'GenericStrat'
summary(object)
```

Arguments

object instance of a strategy class

Value

a list with five elements. 1) A string describing the type of portfolio insurance trading strategy and number of observations, 2) volume to be hedged, calculated churn rate (numer of times volume to be hedged has been traded) and 5) a data frame with summary statistics for achieved results

```
summary,MSFC-method      S4 method for the summary generic for class "MSFC"
```

Description

S4 method for the summary generic for class "MSFC"

Usage

```
## S4 method for signature 'MSFC'
summary(object)
```

Arguments

object instance of the MSFC class

Value

a list with three elements. 1) A string describing length of forward curve, number of polynomials used in spline and trading date, 2) a vector with a sample of the prior used via head(prior) and 3) a data frame with all forward contracts used in the calculation along with computed forward curve prices

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