Package 'yrnd'

November 1, 2026

Title Extracts Risk Neutral Densities of Prices, Money Market Rates and Government Bond Yields from Interest Rates Futures Options Prices

Version 0.1.8

Description Provides with parametric Risk Neutral Densities (RNDs) and cumulative densities of futures prices on fixed-income products, relying on options on Short Term Interest Rate futures or options on government bond futures. It models the futures price at options' maturity as a mixture of lognormal densities. Leveraging on this, the package provides with the RNDs and cumulative densities of the money market rate or the government bond yield inferred from the futures price, using the RND of the futures price. The package also extracts from options prices on bond futures in one go the RND of the cheapest-to-deliver (ctd) bond repo rate from options' to futures' maturity and the RND of the ctd bond yield at options' maturity. The package also provides with the probability attached to each bond in the delivery basket of a government bond futures to be the cheapest at options' maturity from an examination of either the implied repo rate or the net basis of bonds in the delivery basket, as well as the value of the quality option embedded in the futures contract. At last, the package provides with the non parametric distribution of the spread between either two bond yields or two bond repo rates, using two RNDs based on options on bond futures of the same maturity. The package leverages on the works of Melick, W. R. and Thomas, C. P. (1997) <doi:10.2307/2331318> and B. Bahra (1998) <doi:10.2139/ssr

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Imports DEoptim, dplyr, ggplot2, lubridate, MASS, Rblpapi, scales, stats, tibble, tvm, utils, zoo

Suggests knitr, rmarkdown

VignetteBuilder knitr

NeedsCompilation no

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`bond_future_charac_bbg` *bond_future_charac_bbg*

Description

bond_future_charac_bbg

Usage

```
bond_future_charac_bbg(bbg_tickers)
```

Arguments

`bbg_tickers`	a vector of Bloomberg tickers of bond futures contracts, in character format

Value

for each bond futures contract, its currency, its listing place and its underlying asset all in character format, its first delivery date and its maturity date, all in Date format

Examples

```
## Not run:
bond_future_charac_bbg(c("TYU24", "CNM6", "KAAH6", "IKM6", "OATU6"))

## End(Not run)
```

bond_future_price *bond_future_price*

Description

bond_future_price

Usage

```
bond_future_price(
  call_prices,
  call_strikes,
  put_prices,
  put_strikes,
  nb_log,
  r,
  day_count_conv,
  cot,
  ctd_matu,
  fut_price,
  fut_matu,
  option_matu,
  start_date,
  nationality = NA,
  currency = NA
)
```

Arguments

call_prices	a vector of call prices on a bond futures, in numeric format
call_strikes	a vector of call strikes attached to the call prices, in numeric format
put_prices	a vector of put prices on the same bond futures, in numeric format
put_strikes	a vector of put strikes attached to the put prices, in numeric format
nb_log	a number for the number of component densities in the lognormal mixture to model the bond futures' price, either 2 or 3, in numeric format
r	a number for the riskfree spot rate whose maturity is equal to the options' maturity, in numeric format
day_count_conv	a number for the day count convention, 1 for ACT/ACT, 2 for ACT/360, 3 for ACT/365 and 4 for 30/360, in numeric format
cot	a number for the options' style, 1 for European options, 2 for American options and 3 for American options with futures-style margin, in numeric format
ctd_matu	a date for the maturity date of the current Cheapest-to-Deliver Bond of the bond futures, in Date format
fut_price	a number for the bond futures' price on calibration date, in numeric format

fut_matu	a date for the bond futures' maturity date, in Date format
option_matu	a date for the maturity date of the options, in Date format
start_date	a date for the observation date, in Date format
nationality	a character for the nationality of the issuer of the bond underlying the futures contract, in character format (NA by default)
currency	a character for the currency in which the futures contract and the options are traded, in character format (NA by default)

Value

the mean and standard deviation of each component lognormal density and the weight on the first density (for a mixture of 2) or on the first 2 densities (for a mixture of 3) in numeric format, a discretized domain of the futures price at option's maturity by increments of 0.001 units of the currency of the futures contract, in numeric format, the probability density for each value in the discretized domain in numeric format, the cumulative density for each value in the discretized domain in numeric format, the type of convergence in the optimization in numeric format (0 indicating successful convergence), the mean, standard deviation, skewness and kurtosis of the distribution of the futures price in numeric format, quantiles of order 0.1%, 0.5%, 1%, 5%, 10%, 25%, 50%, 75%, 90%, 95%, 99%, 99.5% and 99.9% of the distribution in numeric format, the mode of the distribution in numeric format, the options' prices predicted by the model in numeric format, a plot of the RND and a plot of the CDF of the futures price

Examples

```
bond_future_price(c(10.39,9.92,9.46,9.00,8.55,8.10,7.66,7.23,
6.81,6.39,5.98,5.58,5.20,4.82,4.46,4.10,3.76,3.44,3.13,2.83,2.56,
2.29,2.05,1.82,1.61,1.42,1.25,1.09,0.95,0.82,0.71,0.61,0.53,0.45,
0.38,0.33,0.28,0.23,0.20,0.17,0.14,0.12,0.10,0.08),
seq(106, 127.5, 0.5),
c(0.22,0.25,0.29,0.33,0.38,0.43,0.49,0.56,0.64,0.72,0.81,0.91,
1.03,1.15,1.29, 1.43,1.59,1.77,1.96,2.16,2.39,2.62,2.88,3.15,
3.44,3.75,4.08, 4.42,4.78,5.15,5.54,5.94,6.36,6.78,7.21,7.66,
8.11,8.56,9.03, 9.50,9.97,10.45,10.93,11.41),
seq(106, 127.5, 0.5),
2,
0.0344,
1,
3,
as.Date("2033-11-01"),
116.17,
as.Date("2024-12-10"),
as.Date("2024-11-22"),
as.Date("2024-06-14"),
"Italian",
"EUR")
```

bond_fut_irr_ytm *bond_fut_irr_ytm*

Description

bond_fut_irr_ytm

Usage

```
bond_fut_irr_ytm(
  bond_call_prices,
  bond_call_strikes,
  bond_put_prices,
  bond_put_strikes,
  stir_call_prices,
  stir_call_strikes,
  stir_put_prices,
  stir_put_strikes,
  r,
  r_2,
  r_3,
  day_count_conv,
  cot_bond,
  bond_fut_price,
  bond_cp,
  bond_cp_f,
  bond_conv_factor,
  sett,
  bond_N = 100,
  bond_matu,
  bond_fut_matu,
  bond_option_matu,
  cot_stir,
  stir_fut_price,
  stir_fut_matu,
  stir_option_matu,
  start_date,
  country = NA,
  currency = NA,
  term_stir
)
```

Arguments

bond_call_prices
: a vector of call prices on a bond futures, in numeric format

bond_call_strikes
: a vector of call strikes attached to the call prices, in numeric format

bond_put_prices
: a vector of put prices on the same bond futures, in numeric format

bond_put_strikes
: a vector of put strikes attached to the put prices, in numeric format

stir_call_prices
: a vector of call prices on a STIR futures whose maturity date is near the maturity date of the bond futures (maturity distance below 30 days), in numeric format

stir_call_strikes
: a vector of call strikes attached to the call prices, in numeric format

stir_put_prices
: a vector of put prices on the same STIR futures, in numeric format

stir_put_strikes
: a vector of put strikes attached to the put prices, in numeric format

r
: a number for the riskfree spot rate whose maturity is equal to the options' maturity, in numeric format

r_2
: a number for the spot repo funding rate of the underlying bond, with maturity equal to the options' maturity (by default, the General Collateral repo rate of the jurisdiction), in numeric format

r_3
: a number for the spot repo funding rate of the underlying bond, with maturity equal to the futures' maturity (by default, the General Collateral repo rate of the jurisdiction), in numeric format

day_count_conv
: a number for the day count convention, 1 for ACT/ACT, 2 for ACT/360, 3 for ACT/365 and 4 for 30/360, in numeric format

cot_bond
: a number for the bond options' style, 1 for European options, 2 for American options and 3 for American options with futures-style margin, in numeric format

bond_fut_price
: a number for the bond futures' price on calibration date, in numeric format

bond_cp
: a number for the coupon rate of the current Cheapest-to-Deliver Bond, in numeric format

bond_cp_f
: a number for the frequency of coupon payment of the current Cheapest-to-Deliver Bond, either 1 if the frequency is annual or 2 if semi-annual

bond_conv_factor
: a number for the conversion factor assigned by the futures exchange to the current Cheapest-to-Deliver Bond of the bond futures, in numeric format

sett
: a number for the number of days between the ex-coupon date and the coupon payment date of the current Cheapest-to-Deliver Bond, in numeric format

bond_N
: a number for the value of the principal of the current Cheapest-to-Deliver Bond, in numeric format (100 by default)

bond_matu
: a date for the maturity date of the current Cheapest-to-Deliver Bond, in Date format

bond_fut_matu
: a date for the maturity date of the bond futures contract, in Date format

bond_option_matu
: a date for the maturity date of the bond options, in Date format

cot_stir	a number for the STIR options' style, 1 for European options, 2 for American options and 3 for American options with futures-style margin, in numeric format
stir_fut_price	a number for the STIR futures' price on calibration date, in numeric format
stir_fut_matu	a date for the maturity date of the STIR futures contract, in Date format
stir_option_matu	a date for the maturity date of the STIR options, in Date format
start_date	a date for the observation date, in Date format
country	a character for the country of the issuer of the bond underlying the futures contract, in character format (NA by default)
currency	a character for the currency in which the futures contract and the options are traded, in character format (NA by default)
term_stir	a number for the term to maturity, in months, of the STIR at observation date, in numeric format

Value

for the cheapest to deliver bond of the futures contract, the parameters (means, standard deviations and weight in the first component lognormal law) of respectively the RND of the bond price and the RND of the bond repo asset price at options' maturity, the mean, standard deviation, skewness, kurtosis, mode, quantiles of order 0.1%, 0.5%, 1%, 5%, 10%, 25%, 50%, 75%, 90%, 95%, 99%, 99.5% and 99.9% of respectively the bond yield and the bond repo rate distributions in numeric format, the discretized domain and associated RND values of respectively the bond yield to maturity and of the bond repo rate at options' maturity, in numeric format, the RND and CDF plots of respectively the bond yield to maturity and the bond repo rate at options' maturity, the correlation coefficient between the bond price and the bond repo asset price at options' maturity, the convergence, with 0 indicating successful convergence, in numeric format, the options' prices predicted by the model, in numeric format

Examples

```
bond_fut_irr_ytm(c(12.64, 12.14, 11.65, 11.15, 10.65, 10.15, 9.65,
9.16, 8.66, 8.16, 7.67,  7.17, 6.68, 6.19, 5.70, 5.21, 4.73, 4.25,
3.78, 3.32, 2.87, 2.45, 2.05, 1.67, 1.33, 1.03, 0.77, 0.57, 0.41,
0.29, 0.21, 0.15, 0.10, 0.07, 0.06, 0.04, 0.04, 0.03, 0.02, 0.02,
0.02, 0.02, 0.01, 0.01, 0.01, 0.01, 0.01),
c(seq(114, 136.5, 0.5), 137.5),
c(0.01, 0.01, 0.02, 0.02, 0.02, 0.02, 0.02, 0.03, 0.03, 0.03, 0.04,
0.04, 0.05, 0.06, 0.07, 0.08, 0.10, 0.12, 0.15, 0.19, 0.24, 0.32,
0.42, 0.54, 0.70, 0.90, 1.14, 1.44, 1.78, 2.16, 2.58, 3.02, 3.47,
3.94, 4.43, 4.91, 5.41, 5.90, 6.39, 6.89, 7.39, 7.89, 8.38, 8.88,
9.38, 9.88, 10.88),
c(seq(114, 136.5, 0.5), 137.5),
c(1.704999924, 1.579999924, 1.454999924, 1.329999924, 1.204999924,
1.079999924, 0.954999983, 0.892499983, 0.829999983, 0.767499983,
0.704999983, 0.642499983, 0.582499981, 0.519999981, 0.457499981,
0.397499979, 0.334999979, 0.275000006, 0.217500001, 0.162499994,
0.112499997, 0.072499998, 0.039999999, 0.02, 0.0075, 0.0025, 0.0025,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0),
```

```
c(seq(95.75, 96.5, 0.125), seq(96.5625, 98.75, 0.0625),
seq(98.875, 99.5, 0.125)),
c(0, 0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0.0025,  0.0025,
0.0025,  0.005, 0.005,  0.0075,  0.012499999,  0.02, 0.029999999,
0.055, 0.085000001, 0.127499998, 0.177499995, 0.234999999,
0.297499985, 0.357499987, 0.419999987, 0.482499987, 0.544999957,
0.607499957, 0.669999957, 0.732499957, 0.794999957, 0.857499957,
0.919999957, 0.982499957, 1.044999957, 1.107499957, 1.169999957,
1.232499957, 1.294999957, 1.419999957, 1.544999957, 1.669999957,
1.794999957, 1.919999957, 2.044999838),
c(seq(95.75, 96.5, 0.125), seq(96.5625, 98.75, 0.0625),
seq(98.875, 99.5, 0.125)),
0.0224,
0.0224,
0.02232,
1,
3,
126.66,
0.026,
1,
0.770088,
2,
bond_N = 100,
as.Date("2035-08-15"),
as.Date("2026-09-08"),
as.Date("2026-08-21"),
3,
97.45,
as.Date("2026-09-14"),
as.Date("2026-08-14"),
as.Date("2026-06-17"),
"Germany",
"EUR",
3)
```

`bond_yield_spread` *bond_yield_spread*

Description

bond_yield_spread

Usage

```
bond_yield_spread(
  call_prices_1,
  call_strikes_1,
  put_prices_1,
  put_strikes_1,
```

```
  call_prices_2,
  call_strikes_2,
  put_prices_2,
  put_strikes_2,
  r,
  r_2,
  day_count_conv_1,
  day_count_conv_2,
  cot_1,
  cot_2,
  ctd_matu_1,
  ctd_matu_2,
  fut_price_1,
  fut_price_2,
  fut_matu,
  option_matu,
  start_date,
  bond_ISIN_1,
  bond_coupon_1,
  bond_cp_f_1,
  bond_matu_1,
  bond_conv_factor_1,
  bond_ytm_1,
  sett_1,
  bond_ISIN_2,
  bond_coupon_2,
  bond_cp_f_2,
  bond_matu_2,
  bond_conv_factor_2,
  bond_ytm_2,
  sett_2,
  bond_nomi = 100,
  corr,
  ctry_1 = NA,
  ctry_2 = NA
)
```

Arguments

call_prices_1	a vector of call prices on the first bond futures, in numeric format
call_strikes_1	a vector of call strikes attached to the call prices, in numeric format
put_prices_1	a vector of put prices on the first bond futures, in numeric format
put_strikes_1	a vector of put strikes attached to the put prices, in numeric format
call_prices_2	a vector of call prices on the second bond futures, in numeric format
call_strikes_2	a vector of call strikes attached to the call prices, in numeric format
put_prices_2	a vector of put prices on the second bond futures, in numeric format
put_strikes_2	a vector of put strikes attached to the put prices, in numeric format

`r` a number for the riskfree spot rate whose maturity is equal to the options' maturity, in numeric format

`r_2` a number for the riskfree spot rate whose maturity is equal to the futures contracts' maturity, in numeric format

`day_count_conv_1` a number for the day count convention of the first bond futures, 1 for ACT/ACT, 2 for ACT/360, 3 for ACT/365 and 4 for 30/360, in numeric format

`day_count_conv_2` a number for the day count convention of the second bond futures, 1 for ACT/ACT, 2 for ACT/360, 3 for ACT/365 and 4 for 30/360, in numeric format

`cot_1` a number for style of the options on the first bond futures, 1 for European options, 2 for American options and 3 for American options with futures-style margin, in numeric format

`cot_2` a number for style of the options on the second bond futures, 1 for European options, 2 for American options and 3 for American options with futures-style margin, in numeric format

`ctd_matu_1` a date for the maturity date of the current Cheapest-to-Deliver Bond of the first bond futures, in Date format

`ctd_matu_2` a date for the maturity date of the current Cheapest-to-Deliver Bond of the second bond futures, in Date format

`fut_price_1` a number for the first bond futures' price on calibration date, in numeric format

`fut_price_2` a number for the second bond futures' price on calibration date, in numeric format

`fut_matu` a date for the bond futures' maturity date, in Date format

`option_matu` a date for the maturity date of the options, in Date format

`start_date` a date for the observation date, in Date format

`bond_ISIN_1` a vector of ISIN codes for the bonds in the delivery basket of the first bond futures, in character format

`bond_coupon_1` a vector of the corresponding coupon rates for the bonds in the delivery basket, in numeric format

`bond_cp_f_1` a vector of the corresponding frequencies of coupon payment, either 1 for annual payment or 2 for semiannual payment, in numeric format

`bond_matu_1` a vector of the corresponding maturity dates for the bonds in the basket of deliverable bonds, in Date format

`bond_conv_factor_1` a vector of the corresponding conversion factors for the bonds in the delivery basket, in numeric format

`bond_ytm_1` a vector of the corresponding yield to maturities at observation date for the bonds in the delivery basket, in numeric format

`sett_1` a number for the number of days between the ex-coupon date and the coupon payment date of the bonds in the delivery basket, in numeric format

`bond_ISIN_2` a vector of ISIN codes for the bonds in the delivery basket of the second bond futures, in character format

bond_coupon_2 a vector of the corresponding coupon rates for the bonds in the delivery basket, in numeric format

bond_cp_f_2 a vector of the corresponding frequencies of coupon payment, either 1 for annual payment or 2 for semiannual payment, in numeric format

bond_matu_2 a vector of the corresponding maturity dates for the bonds in the basket of deliverable bonds, in Date format

bond_conv_factor_2 a vector of the corresponding conversion factors for the bonds in the delivery basket, in numeric format

bond_ytm_2 a vector of the corresponding yield to maturities at observation date for the bonds in the delivery basket, in numeric format

sett_2 a number for the number of days between the ex-coupon date and the coupon payment date of the bonds in the delivery basket, in numeric format

bond_nomi a single number for the nominal of the bonds (100 by default) in numeric format

corr a number for the correlation coefficient between the returns on the two bond futures prices with identical maturity, in numeric format

ctry_1 a character for the nationality of the issuer of the bond in the first bond futures, in character format (NA by default)

ctry_2 a character for the nationality of the issuer of the bond in the second bond futures, in character format (NA by default)

Value

based on the user's correlation coefficient, 10,000 realizations of the bond yield spread between either two different issuers or two bonds of the same issuer, using options on two bond futures of identical maturity, and a density plot of the spread, in bps

Examples

```
bond_yield_spread(
c(12.64, 12.14, 11.65, 11.15, 10.65, 10.15,  9.65,  9.16, 8.66,
8.16, 7.67,  7.17, 6.68, 6.19, 5.70, 5.21, 4.73, 4.25, 3.78, 3.32,
2.87,  2.45, 2.05, 1.67, 1.33, 1.03, 0.77, 0.57, 0.41, 0.29,
0.21,  0.15, 0.10, 0.07, 0.06, 0.04, 0.04, 0.03, 0.02, 0.02, 0.02,
0.02,  0.01, 0.01, 0.01, 0.01, 0.01),
c(seq(114, 136.5, 0.5), 137.5),
c(0.01, 0.01, 0.02, 0.02, 0.02, 0.02, 0.02, 0.03, 0.03, 0.03, 0.04, 0.04,
0.05, 0.06, 0.07, 0.08, 0.10, 0.12, 0.15, 0.19, 0.24, 0.32, 0.42, 0.54,
0.70, 0.90, 1.14, 1.44, 1.78, 2.16, 2.58, 3.02, 3.47, 3.94, 4.43, 4.91,
5.41, 5.90, 6.39, 6.89, 7.39, 7.89, 8.38, 8.88, 9.38, 9.88, 10.88),
c(seq(114, 136.5, 0.5), 137.5),
c(13.46, 12.96, 12.46, 11.96, 11.47, 10.97, 10.47, 9.98, 9.48, 8.99, 8.49,
8.00,  7.51, 7.02, 6.53, 6.04, 5.56, 5.08, 4.61, 4.15, 3.69, 3.25, 2.82,
2.41,  2.02, 1.67, 1.34, 1.05, 0.80, 0.59, 0.43, 0.30, 0.21, 0.14, 0.09,
0.06, 0.04,  0.02, 0.01, 0.01, 0.01, 0.01, 0.01, 0.01, 0.01, 0.01, 0.01, 0.01),
seq(105.5, 129, 0.5),
c(0.02, 0.02, 0.02, 0.02, 0.03, 0.03, 0.03, 0.04, 0.04, 0.05, 0.05, 0.06,
0.07, 0.08, 0.09, 0.10, 0.12, 0.14, 0.17, 0.21, 0.25, 0.31, 0.38, 0.47,
```

```
0.58, 0.73, 0.90, 1.11, 1.36, 1.65, 1.99, 2.36, 2.77, 3.20, 3.65, 4.12,
4.60, 5.08, 5.57, 6.07, 6.57, 7.06, 7.56, 8.06, 8.56, 9.06, 9.56, 10.06),
seq(105.5, 129, 0.5),
0.0187,
0.019,
1,
1,
3,
3,
as.Date("2035-08-15"),
as.Date("2035-08-01"),
126.66,
119.04,
as.Date("2026-09-08"),
as.Date("2026-08-21"),
as.Date("2026-06-17"),
c("DE000BU2Z056", "DE000BU2Z064"),
c(0.026, 0.029),
rep(1, 2),
as.Date(c("2035-08-15", "2036-02-15")),
c(0.770088, 0.781249),
c(0.02898, 0.02926),
2,
c("IT0005631590", "IT0005648149", "IT0005676504", "IT0005402117",
"IT0005706285", "IT0005433195"),
c(0.0365, 0.0360, 0.0345, 0.0145, 0.0380, 0.0095),
rep(2, 6),
as.Date(c("2035-08-01", "2035-10-01", "2036-02-01", "2036-03-01",
"2036-07-01", "2037-03-01")),
c(0.845212, 0.839556, 0.824415, 0.679587, 0.844354, 0.616457),
c(0.03567, 0.03587, 0.03620, 0.03614, 0.03665, 0.03712),
2,
100,
0.4,
"Germany",
"Italy")
```

`ctd_bond_yield` *ctd_bond_yield*

Description

ctd_bond_yield

Usage

```
ctd_bond_yield(
  call_prices,
```

```
  call_strikes,
  put_prices,
  put_strikes,
  nb_log,
  r,
  r_2,
  day_count_conv,
  cot,
  conv_factor,
  ctd_cp,
  ctd_matu,
  cp_f,
  ctd_N,
  sett,
  fut_price,
  fut_matu,
  option_matu,
  start_date,
  nationality = NA,
  currency = NA
)
```

Arguments

call_prices	a vector of call prices on a bond futures, in numeric format
call_strikes	a vector of call strikes attached to the call prices, in numeric format
put_prices	a vector of put prices on the same bond futures, in numeric format
put_strikes	a vector of put strikes attached to the put prices, in numeric format
nb_log	a number for the number of component densities in the lognormal mixture to model the bond futures' price, either 2 or 3, in numeric format
r	a number for the riskfree spot rate whose maturity is equal to the options' maturity, in numeric format
r_2	a number for the riskfree spot rate whose maturity is equal to the futures contract's maturity, in numeric format
day_count_conv	a number for the day count convention, 1 for ACT/ACT, 2 for ACT/360, 3 for ACT/365 and 4 for 30/360, in numeric format
cot	a number for the options' style, 1 for European options, 2 for American options and 3 for American options with futures-style margin, in numeric format
conv_factor	a number for the conversion factor assigned by the futures exchange to the current Cheapest-to-Deliver Bond of the bond futures, in numeric format
ctd_cp	a number for the coupon rate of the current Cheapest-to-Deliver Bond, in numeric format
ctd_matu	a date for the maturity date of the current Cheapest-to-Deliver Bond, in Date format
cp_f	a number for the frequency of coupon payment of the current Cheapest-to-Deliver Bond, either 1 if the frequency is annual or 2 if semi-annual

ctd_N	a number for the value of the principal of the current Cheapest-to-Deliver Bond, in numeric format
sett	a number for the number of days between the ex-coupon date and the coupon payment date of the current Cheapest-to-Deliver Bond, in numeric format
fut_price	a number for the bond futures' price on calibration date, in numeric format
fut_matu	a date for the maturity date of the bond futures contract, in Date format
option_matu	a date for the maturity date of the options, in Date format
start_date	a date for the observation date, in Date format
nationality	a character for the nationality of the issuer of the bond underlying the futures contract, in character format (NA by default)
currency	a character for the currency in which the futures contract and the options are traded, in character format (NA by default)

Value

A discretized domain of the current Cheapest-to-Deliver bond yield at option's maturity in numeric format, the probability density for each value in the discretized domain in numeric format, the cumulative density for each value in the discretized domain in numeric format, the type of convergence in the optimization in numeric format (0 indicating successful convergence), the mean, standard deviation, skewness and kurtosis of the distribution of the current Cheapest-to-Deliver bond yield in numeric format, quantiles of order 0.1%, 0.5%, 1%, 5%, 10%, 25%, 50%, 75%, 90%, 95%, 99%, 99.5% and 99.9% of the distribution in numeric format, the mode of the distribution in numeric format, a plot of the RND and a plot of the CDF of the current Cheapest-to-Deliver bond yield

Examples

```
ctd_bond_yield(c(10.39,9.92,9.46,9.00,8.55,8.10,7.66,7.23,
6.81,6.39,5.98,5.58,5.20,4.82,4.46,4.10,3.76,3.44,3.13,2.83,2.56,
2.29,2.05,1.82,1.61,1.42,1.25,1.09,0.95,0.82,0.71,0.61,0.53,0.45,
0.38,0.33,0.28,0.23,0.20,0.17,0.14,0.12,0.10,0.08),
seq(106, 127.5, 0.5),
c(0.22,0.25,0.29,0.33,0.38,0.43,0.49,0.56,0.64,0.72,0.81,0.91,
1.03,1.15,1.29, 1.43,1.59,1.77,1.96,2.16,2.39,2.62,2.88,3.15,
3.44,3.75,4.08, 4.42,4.78,5.15,5.54,5.94,6.36,6.78,7.21,7.66,
8.11,8.56,9.03, 9.50,9.97,10.45,10.93,11.41),
seq(106, 127.5, 0.5),
2,
0.0344,
0.035,
1,
3,
0.893,
0.0435,
as.Date("2033-11-01"),
2,
100,
2,
116.17,
as.Date("2024-12-10"),
```

```
as.Date("2024-11-22"),
as.Date("2024-06-14"),
"Italian",
"EUR")
```

---

deliv_bonds_charac_bbg *deliv_bonds_charac_bbg*

Description

deliv_bonds_charac_bbg

Usage

```
deliv_bonds_charac_bbg(bbg_ticker, date)
```

Arguments

bbg_ticker	a Bloomberg ticker of a bond futures contract, in character format
date	a date for the recovery of the characteristics of the deliverable bonds in the futures contract, in Date format

Value

For the bonds in the delivery basket, their ISIN code in character format, their coupon rate and frequency of coupon payment in numeric format (1 for annual and 2 for semi-annual), their maturity date in Date format, their conversion factor, yield to maturity and day count convention in numeric format (1 for ACT/ACT, 2 for ACT/360, 3 for ACT/365 and 4 for 30/360). Provided physical delivery of the contract, the same information is also displayed for the current Cheapest-to-Deliver Bond in a second table, with in addition its net basis in currency units of the futures contract and its implied repo rate in percentage, as calculated by Bloomberg, in numeric format

Examples

```
## Not run:
deliv_bonds_charac_bbg("UBU6", as.Date("2026-05-19"))

## End(Not run)
```

option_prices_bbg *option_prices_bbg*

Description

option_prices_bbg

Usage

```
option_prices_bbg(fut_bbg_ticker, date)
```

Arguments

fut_bbg_ticker	a single Bloomberg ticker of a STIR or bond futures contract, in character format
date	a date for the recovery of options' closing prices, in Date format

Value

provided there are listed options on the futures, call and put options strike prices and attached call and put options closing market prices in numeric format, the maturity date of the options in Date format, the option's style in character format, the option's currency in character format, the listing place of the options in character format, the closing price of the futures contract in numeric format. When options of different maturities are listed on the same futures contract, this information concerns options whose maturity date is closest to the maturity date of the futures contract.

Examples

```
## Not run:
option_prices_bbg("ERM6", as.Date("2026-03-20"))

## End(Not run)
```

proba_ctd *proba_ctd*

Description

proba_ctd

Usage

```
proba_ctd(
  call_prices,
  call_strikes,
  put_prices,
  put_strikes,
  nb_log,
  r,
  day_count_conv,
  cot,
  ctd_matu,
  fut_price,
  fut_matu,
  option_matu,
  start_date,
  bond_ISIN,
  bond_coupon,
  bond_cp_f,
  bond_matu,
  bond_nomi = 100,
  bond_conv_factor,
  bond_ytm,
  sett
)
```

Arguments

call_prices	a vector of call prices on a bond futures, in numeric format
call_strikes	a vector of call strikes attached to the call prices, in numeric format
put_prices	a vector of put prices on the same bond futures, in numeric format
put_strikes	a vector of put strikes attached to the put prices, in numeric format
nb_log	a number for the number of lognormal densities in the lognormal mixture to model the futures contracts, either 2 or 3, in numeric format
r	a number for the riskfree spot rate whose maturity is equal to the option's maturity, in numeric format
day_count_conv	a number for the day count convention, 1 for ACT/ACT, 2 for ACT/360, 3 for ACT/365 and 4 for 30/360, in numeric format
cot	a number for the options' style, 1 for European options, 2 for American options and 3 for American options with futures-style margin, in numeric format
ctd_matu	a date for the maturity date of the current Cheapest-to-Deliver Bond in the basket of deliverable bonds of the futures contract, in Date format
fut_price	a number for the bond futures' price on calibration date, in numeric format
fut_matu	a date for the maturity date of the futures contract, in Date format
option_matu	a date for the maturity date of the options, in Date format
start_date	a date for the observation date, in Date format

bond_ISIN	a vector of ISIN codes for the bonds in the delivery basket, in character format
bond_coupon	a vector of the corresponding coupon rates for the bonds in the delivery basket, in numeric format
bond_cp_f	a vector of the corresponding frequencies of coupon payment, either 1 for annual payment or 2 for semiannual payment, in numeric format
bond_matu	a vector of the corresponding maturity dates for the bonds in the basket of deliverable bonds, in Date format
bond_nomi	a single number for the nominal of the bonds (100 by default) in numeric format
bond_conv_factor	a vector of the corresponding conversion factors for the bonds in the delivery basket, in numeric format
bond_ytm	a vector of the corresponding yields to maturity at observation date for the bonds in the delivery basket, in numeric format
sett	a number for the number of days between the ex-coupon date and the coupon payment date of the current Cheapest-to-Deliver Bond, in numeric format

Value

for the bonds in the delivery basket, their ISIN in character format and their probability of being the CtD bond at futures' maturity based on their net basis at futures' maturity, in numeric format

Examples

```
proba_ctd( c(24.10, 23.10, 22.12, 21.12, 20.12, 19.14, 18.14, 17.16, 16.18, 15.20,
14.22, 13.24, 12.28, 11.32, 10.36, 9.44, 8.50, 7.60, 6.72, 5.86, 5.04, 4.28,
3.56, 2.88, 2.30, 1.78,  1.36, 1.02, 0.76, 0.56, 0.42, 0.30, 0.22, 0.18, 0.14,
0.10,  0.08, 0.06, 0.06, 0.04, 0.04, 0.02, 0.02, 0.02, 0.02, 0.02, 0.02),
seq(85, 131),
c(0.02,  0.02, 0.02, 0.02, 0.02, 0.04, 0.04, 0.06, 0.08, 0.10, 0.12, 0.14, 0.18, 0.22,
0.26, 0.34,  0.40, 0.50, 0.62, 0.76, 0.94, 1.18, 1.46, 1.78, 2.20, 2.68, 3.26, 3.92,
4.66,  5.46, 6.32, 7.20, 8.12, 9.08, 10.04, 11.00, 11.98, 12.96, 13.96, 14.94, 15.94,
16.92, 17.92, 18.92, 19.92, 20.92, 21.92),
seq(85, 131),
2,
0.0187,
1,
3,
as.Date("2054-08-15"),
109.1,
as.Date("2026-09-08"),
as.Date("2026-08-21"),
as.Date("2026-05-28"),
c("DE0001102572", "DE0001102614", "DE0001030757", "DE000BU2D004", "DE000BU2D012"),
c(0.000, 0.018, 0.018, 0.025, 0.029),
rep(1, 5),
as.Date(c("2052-08-15", "2053-08-15", "2053-08-15", "2054-08-15", "2056-08-15")),
100,
c(0.361698, 0.641260, 0.641260, 0.750372, 0.809987),
c(0.03500, 0.03507, 0.03492, 0.03510, 0.03514),
```

```
2)
```

---

proba_ctd_irr *proba_ctd_irr*

Description

proba_ctd_irr

Usage

```
proba_ctd_irr(
  bond_call_prices,
  bond_call_strikes,
  bond_put_prices,
  bond_put_strikes,
  stir_call_prices,
  stir_call_strikes,
  stir_put_prices,
  stir_put_strikes,
  r,
  r_2,
  r_3,
  day_count_conv,
  cot_bond,
  bond_fut_price,
  bond_cp,
  bond_cp_f,
  bond_conv_factor,
  bond_ytm,
  sett,
  Nomi = 100,
  bond_matu,
  bond_ISIN,
  bond_fut_matu,
  bond_option_matu,
  cot_stir,
  stir_fut_price,
  stir_fut_matu,
  stir_option_matu,
  start_date,
  term_stir
)
```

Arguments

bond_call_prices	a vector of call prices on a bond futures, in numeric format
bond_call_strikes	a vector of call strikes attached to the call prices, in numeric format
bond_put_prices	a vector of put prices on the same bond futures, in numeric format
bond_put_strikes	a vector of put strikes attached to the put prices, in numeric format
stir_call_prices	a vector of call prices on a STIR futures whose maturity date is near the maturity date of the bond futures (maturity distance below 30 days), in numeric format
stir_call_strikes	a vector of call strikes attached to the call prices, in numeric format
stir_put_prices	a vector of put prices on the same STIR futures, in numeric format
stir_put_strikes	a vector of put strikes attached to the put prices, in numeric format
r	a number for the riskfree spot rate whose maturity is equal to the options' maturity, in numeric format
r_2	a number for the spot repo funding rate of the underlying bond, with maturity equal to the options' maturity (by default, the General Collateral repo rate of the jurisdiction), in numeric format
r_3	a number for the spot repo funding rate of the underlying bond, with maturity equal to the futures' maturity (by default, the General Collateral repo rate of the jurisdiction), in numeric format
day_count_conv	a number for the day count convention, 1 for ACT/ACT, 2 for ACT/360, 3 for ACT/365 and 4 for 30/360, in numeric format
cot_bond	a number for the bond options' style, 1 for European options, 2 for American options and 3 for American options with futures-style margin, in numeric format
bond_fut_price	a number for the bond futures' price on calibration date, in numeric format
bond_cp	a vector of the coupon rates for the bonds in the delivery basket, in numeric format
bond_cp_f	a vector of the corresponding frequencies of coupon payment, either 1 for annual payment or 2 for semiannual payment, in numeric format
bond_conv_factor	a vector of the corresponding conversion factors for the bonds in the delivery basket, in numeric format
bond_ytm	a vector of the corresponding yields to maturity at observation date for the bonds in the delivery basket, in numeric format
sett	a number for the number of days between the ex-coupon date and the coupon payment date of the current Cheapest-to-Deliver Bond, in numeric format
Nomi	a single number for the value of the principal of the bonds in the delivery basket, in numeric format (100 by default)

bond_matu	a vector of the corresponding maturity dates for the bonds in the basket of deliverable bonds, in Date format
bond_ISIN	a vector of the corresponding ISIN codes for the bonds in the delivery basket of the bond futures, in character format
bond_fut_matu	a date for the maturity date of the bond futures contract, in Date format
bond_option_matu	a date for the maturity date of the bond options, in Date format
cot_stir	a number for the STIR options' style, 1 for European options, 2 for American options and 3 for American options with futures-style margin, in numeric format
stir_fut_price	a number for the STIR futures' price on calibration date, in numeric format
stir_fut_matu	a date for the maturity date of the STIR futures contract, in Date format
stir_option_matu	a date for the maturity date of the STIR options, in Date format
start_date	a date for the observation date, in Date format
term_stir	a number for the term to maturity, in months, of the STIR at observation date, in numeric format

Value

for the bonds in the delivery basket, their ISIN in character format and their probability of being the CtD bond at options' maturity based on each deliverable bond's joint distribution of bond yield and repo rate, in numeric format. If a timing option is embedded in the futures contract it is here ignored.

Examples

```
proba_ctd_irr(
c(19.12, 18.12, 17.12, 16.14, 15.14, 14.16, 13.18, 12.20, 11.22, 10.24, 9.30, 8.34,
7.42, 6.52, 5.66, 4.84, 4.06, 3.32, 2.66, 2.08, 1.64, 1.28, 1.00, 0.78, 0.60, 0.46,
0.34, 0.26, 0.20, 0.14, 0.10, 0.08, 0.06, 0.04, 0.04, 0.02, 0.02, 0.02, 0.02, 0.02,
0.02, 0.02, 0.02, 0.02, 0.02, 0.02, 0.02, 0.02),
seq(84, 131),
c(0.04, 0.04, 0.04, 0.06, 0.06, 0.08, 0.10, 0.12, 0.14, 0.16, 0.22, 0.26, 0.34, 0.44,
0.58, 0.76, 0.98, 1.24, 1.58, 2.00, 2.56, 3.20, 3.92, 4.70, 5.52, 6.38, 7.26, 8.18,
9.12, 10.06, 11.02, 12.00, 12.98, 13.96, 14.96, 15.94, 16.94, 17.94, 18.92, 19.92,
20.92, 21.92, 22.92, 23.92, 24.92, 25.92, 26.92, 27.92),
seq(84, 131),
c(3.1850, 3.0600, 2.9350, 2.8100, 2.6850, 2.5600, 2.4350, 2.3100, 2.1850, 2.0625,
1.9375, 1.8125, 1.6875, 1.5625, 1.4375, 1.3150, 1.1900, 1.1275, 1.0650, 0.9400,
0.8800, 0.8175, 0.7550, 0.6950, 0.6325, 0.5725, 0.5125, 0.4525, 0.3925, 0.3350,
0.2775, 0.2225, 0.1700, 0.1250, 0.0875, 0.0575, 0.0325, 0.0150, 0.0075, 0.0050,
0.0025, 0.0025, 0.0025, 0.0025, 0.0025, 0.0025, 0.0025, 0.0025, 0.0025, 0.0025,
0.0025, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000,
0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000,
0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000),
c(seq(94, 96, 0.125), 96.0625, 96.125, seq(96.25, 99.25, 0.0625), 99.3750,
99.5000, 99.6250,  99.6875, 99.7500,  99.8750, 100.0000, 101.0000),
c(0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0025,
```

```
0.0025, 0.0025, 0.0025, 0.0025, 0.0025, 0.0050, 0.0050, 0.0050, 0.0050, 0.0050,
0.0075, 0.0075, 0.0075, 0.0100, 0.0100, 0.0125, 0.0150, 0.0175, 0.0200, 0.0250,
0.0300, 0.0375, 0.0475, 0.0650, 0.0900, 0.1225, 0.1600, 0.2050, 0.2600, 0.3200,
0.3800, 0.4425, 0.5050, 0.5675, 0.6300, 0.6925, 0.7550, 0.8175, 0.8800, 0.9425,
1.0050, 1.0650, 1.1275, 1.1900, 1.2525, 1.3150, 1.3775, 1.4400, 1.5025, 1.5650,
1.6275, 1.6900, 1.7525, 1.8150, 1.8775, 1.9400, 2.0025, 2.0650, 2.1900, 2.3150,
2.4400, 2.5025, 2.5650, 2.6900, 2.8150, 3.8150),
c(seq(94, 96, 0.125), 96.0625, 96.125, seq(96.25, 99.25, 0.0625), 99.3750,
99.5000, 99.6250,  99.6875, 99.7500,  99.8750, 100.0000, 101.0000),
0.02303,
0.02303,
0.02388,
1,
3,
103.08,
c(0.000, 0.018, 0.018, 0.025, 0.029),
rep(1, 5),
c(0.365252, 0.643086, 0.643086, 0.751530, 0.810737),
c(0.03811, 0.03816, 0.03806, 0.03813, 0.03812),
2,
Nomi = 100,
as.Date(c("2052-08-15", "2053-08-15", "2053-08-15", "2054-08-15", "2056-08-15")),
c("DE0001102572", "DE0001102614", "DE0001030757", "DE000BU2D004", "DE000BU2D012"),
as.Date("2026-12-08"),
as.Date("2026-11-20"),
3,
97.185,
as.Date("2026-12-14"),
as.Date("2026-12-14"),
as.Date("2026-08-31"),
3)
```

---

proba_ctd_opt *proba_ctd_opt*

Description

proba_ctd_opt

Usage

```
proba_ctd_opt(
  call_prices,
  call_strikes,
  put_prices,
  put_strikes,
  nb_log,
  r,
```

```
  r_2,
  day_count_conv,
  cot,
  ctd_matu,
  fut_price,
  fut_matu,
  option_matu,
  start_date,
  bond_ISIN,
  bond_coupon,
  bond_cp_f,
  bond_matu,
  bond_nomi = 100,
  bond_conv_factor,
  bond_ytm,
  sett,
  deliv_date
)
```

Arguments

call_prices	a vector of call prices on a bond futures, in numeric format
call_strikes	a vector of call strikes attached to the call prices, in numeric format
put_prices	a vector of put prices on the same bond futures, in numeric format
put_strikes	a vector of put strikes attached to the put prices, in numeric format
nb_log	a number for the number of component densities in the lognormal mixture to model the bond futures' price, either 2 or 3, in numeric format
r	a number for the riskfree spot rate whose maturity is equal to the options' maturity date, in numeric format
r_2	a number for the riskfree spot rate whose maturity is equal to the futures' maturity date, or to the delivery date if delivery takes place at another date, in numeric format
day_count_conv	a number for the day count convention, 1 for ACT/ACT, 2 for ACT/360, 3 for ACT/365 and 4 for 30/360, in numeric format
cot	a number for the options' style, 1 for European options, 2 for American options and 3 for American options with futures-style margin, in numeric format
ctd_matu	a date for the maturity date of the current Cheapest-to-Deliver Bond of the bond futures, in Date format
fut_price	a number for the bond futures' price on calibration date, in numeric format
fut_matu	a date for the bond futures' maturity date, in Date format
option_matu	a date for the maturity date of the options, in Date format
start_date	a date for the observation date, in Date format
bond_ISIN	a vector of ISIN codes for the bonds in the delivery basket of the bond futures, in character format

bond_coupon	a vector of the corresponding coupon rates for the bonds in the delivery basket, in numeric format
bond_cp_f	a vector of the corresponding frequencies of coupon payment, either 1 for annual payment or 2 for semiannual payment, in numeric format
bond_matu	a vector of the corresponding maturity dates for the bonds in the basket of deliverable bonds, in Date format
bond_nomi	a single number for the nominal of the bonds (100 by default) in numeric format
bond_conv_factor	a vector of the corresponding conversion factors for the bonds in the delivery basket, in numeric format
bond_ytm	a vector of the corresponding yields to maturity at observation date for the bonds in the delivery basket, in numeric format
sett	a number for the number of days between the ex-coupon date and the coupon payment date of the bonds in the delivery basket, in numeric format
deliv_date	a date for the delivery date of the bond, in Date format

Value

for the bonds in the delivery basket, their ISIN in character format and their probability of being the CtD bond at options' maturity relying successively on their net compared bases at options' maturity and on their compared implied repo rates at option's maturity, in numeric format. Also returns the value of the quality option embedded in the futures contract with the two methods

Examples

```
proba_ctd_opt( c(24.10, 23.10, 22.12, 21.12, 20.12, 19.14, 18.14, 17.16, 16.18, 15.20,
14.22, 13.24, 12.28, 11.32, 10.36, 9.44, 8.50, 7.60, 6.72, 5.86, 5.04, 4.28,
3.56, 2.88, 2.30, 1.78,  1.36, 1.02, 0.76, 0.56, 0.42, 0.30, 0.22, 0.18, 0.14,
0.10,  0.08, 0.06, 0.06, 0.04, 0.04, 0.02, 0.02, 0.02, 0.02, 0.02, 0.02),
seq(85, 131),
c(0.02,  0.02, 0.02, 0.02, 0.02, 0.04, 0.04, 0.06, 0.08, 0.10, 0.12, 0.14, 0.18, 0.22,
0.26, 0.34,  0.40, 0.50, 0.62, 0.76, 0.94, 1.18, 1.46, 1.78, 2.20, 2.68, 3.26, 3.92,
4.66,  5.46, 6.32, 7.20, 8.12, 9.08, 10.04, 11.00, 11.98, 12.96, 13.96, 14.94, 15.94,
16.92, 17.92, 18.92, 19.92, 20.92, 21.92),
seq(85, 131),
2,
0.0187,
0.019,
1,
3,
as.Date("2054-08-15"),
109.1,
as.Date("2026-09-08"),
as.Date("2026-08-21"),
as.Date("2026-05-28"),
c("DE0001102572", "DE0001102614", "DE0001030757", "DE000BU2D004", "DE000BU2D012"),
c(0.000, 0.018, 0.018, 0.025, 0.029),
rep(1, 5),
as.Date(c("2052-08-15", "2053-08-15", "2053-08-15", "2054-08-15", "2056-08-15")),
```

```
100,
c(0.361698, 0.641260, 0.641260, 0.750372, 0.809987),
c(0.03500, 0.03507, 0.03492, 0.03510, 0.03514),
2,
as.Date("2026-09-08"))
```

---

sc_repo_spread *sc_repo_spread*

Description

sc_repo_spread

Usage

```
sc_repo_spread(
  bond_call_prices_1,
  bond_call_strikes_1,
  bond_put_prices_1,
  bond_put_strikes_1,
  bond_call_prices_2,
  bond_call_strikes_2,
  bond_put_prices_2,
  bond_put_strikes_2,
  stir_call_prices,
  stir_call_strikes,
  stir_put_prices,
  stir_put_strikes,
  r,
  r_2,
  r_3,
  day_count_conv,
  cot_bond_1,
  cot_bond_2,
  bond_fut_price_1,
  bond_fut_price_2,
  bond_cp_1,
  bond_cp_f_1,
  bond_conv_factor_1,
  bond_matu_1,
  bond_cp_2,
  bond_cp_f_2,
  bond_conv_factor_2,
  bond_matu_2,
  sett,
```

```
  bond_N = 100,
  bond_fut_matu,
  bond_option_matu,
  cot_stir,
  stir_fut_price,
  stir_fut_matu,
  stir_option_matu,
  start_date,
  country_1,
  country_2,
  term_stir,
  corr_rp
)
```

Arguments

`bond_call_prices_1`
: a vector of call prices on the first bond futures, in numeric format

`bond_call_strikes_1`
: a vector of call strikes attached to the call prices, in numeric format

`bond_put_prices_1`
: a vector of put prices on the first bond futures, in numeric format

`bond_put_strikes_1`
: a vector of put strikes attached to the put prices, in numeric format

`bond_call_prices_2`
: a vector of call prices on the second bond futures, in numeric format

`bond_call_strikes_2`
: a vector of call strikes attached to the call prices, in numeric format

`bond_put_prices_2`
: a vector of put prices on the second bond futures, in numeric format

`bond_put_strikes_2`
: put_strikes_2 a vector of put strikes attached to the put prices, in numeric format

`stir_call_prices`
: a vector of call prices on a STIR futures whose maturity date is near the maturity date of the bond futures (maturity distance below 30 days), in numeric format

`stir_call_strikes`
: a vector of call strikes attached to the call prices, in numeric format

`stir_put_prices`
: a vector of put prices on the same STIR futures, in numeric format

`stir_put_strikes`
: a vector of put strikes attached to the put prices, in numeric format

`r`
: a number for the riskfree spot rate whose maturity is equal to the options' maturity, in numeric format

`r_2`
: a number for the spot repo funding rate of the underlying bond, with maturity equal to the options' maturity (by default, the General Collateral repo rate of the jurisdiction), in numeric format

`r_3` a number for the spot repo funding rate of the underlying bond, with maturity equal to the futures' maturity (by default, the General Collateral repo rate of the jurisdiction), in numeric format

`day_count_conv` a number for the day count convention of the bond futures, 1 for ACT/ACT, 2 for ACT/360, 3 for ACT/365 and 4 for 30/360, in numeric format

`cot_bond_1` a number for style of the options on the first bond futures, 1 for European options, 2 for American options and 3 for American options with futures-style margin, in numeric format

`cot_bond_2` a number for style of the options on the second bond futures, 1 for European options, 2 for American options and 3 for American options with futures-style margin, in numeric format

`bond_fut_price_1` a number for the first bond futures' price on calibration date, in numeric format

`bond_fut_price_2` a number for the second bond futures' price on calibration date, in numeric format

`bond_cp_1` a number for the coupon rate of the current Cheapest-to-Deliver bond of the first futures contract, in numeric format

`bond_cp_f_1` a number for the frequency of coupon payment of the current Cheapest-to-Deliver bond in the first futures contract, either 1 for annual payment or 2 for semiannual payment, in numeric format

`bond_conv_factor_1` a number for the conversion factor of the current Cheapest-to-Deliver bond of the first futures contract, in numeric format

`bond_matu_1` a date for the maturity date of the current Cheapest-to-Deliver Bond of the first bond futures, in Date format

`bond_cp_2` a number for the coupon rate of the current Cheapest-to-Deliver bond of the second futures contract, in numeric format

`bond_cp_f_2` a number for the frequency of coupon payment of the current Cheapest-to-Deliver bond in the second futures contract, either 1 for annual payment or 2 for semiannual payment, in numeric format

`bond_conv_factor_2` a number for the conversion factor of the current Cheapest-to-Deliver bond of the second futures contract, in numeric format

`bond_matu_2` a date for the maturity date of the current Cheapest-to-Deliver Bond of the second bond futures, in Date format

`sett` a number for the number of days between the ex-coupon date and the coupon payment date of the bonds, in numeric format

`bond_N` a single number for the nominal of the bonds (100 by default) in numeric format

`bond_fut_matu` a date for the bond futures' maturity date, in Date format

`bond_option_matu` a date for the maturity date of the options, in Date format

`cot_stir` a number for the STIR options' style, 1 for European options, 2 for American options and 3 for American options with futures-style margin, in numeric format

stir_fut_price	a number for the STIR futures' price on calibration date, in numeric format
stir_fut_matu	a date for the maturity date of the STIR futures contract, in Date format
stir_option_matu	a date for the maturity date of the STIR options, in Date format
start_date	a date for the observation date, in Date format
country_1	a character for the nationality of the issuer of the bond in the first bond futures, in character format
country_2	a character for the nationality of the issuer of the bond in the second bond futures, in character format
term_stir	a number for the term to maturity, in months, of the STIR at observation date, in numeric format
corr_rp	a number for the correlation coefficient between the two bond repo rates, in numeric format

Value

based on the user's correlation coefficient, a density plot of the spread, in bps, of 10,000 realizations of the repo rate spread between two cheapest-to-deliver bonds of either different issuers or of the same issuer with different maturities, using options on two bond futures of identical maturity and options of a STIR contract with a maturity close to the maturity of the bond futures options

Examples

```
sc_repo_spread(
c(20.71, 20.21, 19.71, 19.21, 18.71, 18.21, 17.71,
17.21, 16.71, 16.22, 15.72, 15.22, 14.72, 14.22, 13.72,
13.22, 12.73, 12.23, 11.73, 11.24, 10.74, 10.24, 9.75,
9.25, 8.76, 8.27, 7.78, 7.29, 6.80, 6.32, 5.84, 5.36,
4.89, 4.42, 3.97, 3.53, 3.10, 2.69, 2.30, 1.93, 1.59,
1.28, 1.01, 0.77, 0.58, 0.43, 0.31, 0.23, 0.17, 0.13,
0.10, 0.08, 0.06, 0.05, 0.04, 0.03, 0.03, 0.02, 0.02,
0.02, 0.02, 0.01, 0.01, 0.01, 0.01, 0.01, 0.01, 0.01),
seq(105, 138.5, 0.5),
c(0.01,  0.01,  0.01, 0.01, 0.01, 0.01, 0.01, 0.01, 0.01,
0.02, 0.02, 0.02, 0.02, 0.02, 0.02, 0.02, 0.03, 0.03, 0.03,
0.04, 0.04, 0.04, 0.05, 0.05, 0.06, 0.07, 0.08, 0.09, 0.10,
0.12, 0.14, 0.16, 0.19, 0.22, 0.27, 0.33, 0.40, 0.49,
0.60, 0.73, 0.89, 1.08, 1.31, 1.57, 1.88, 2.23, 2.61, 3.03,
3.47, 3.93, 4.40, 4.88, 5.36, 5.85, 6.34, 6.83, 7.33, 7.82,
8.32, 8.82, 9.32, 9.81, 10.31, 10.81, 11.31, 11.81, 12.31, 12.81),
seq(105, 138.5, 0.5),
c(2.205, 2.105, 2.010, 1.910, 1.810, 1.715, 1.615, 1.520,
1.425, 1.330, 1.235, 1.140, 1.045, 0.955, 0.865, 0.780,
0.695, 0.615, 0.540, 0.470, 0.400, 0.335, 0.280, 0.225,
0.180, 0.140, 0.110, 0.085, 0.065, 0.050, 0.040, 0.030, 0.025,
0.020, 0.015, 0.015, 0.015, 0.010, 0.010, 0.010, 0.010,
0.010, 0.010, 0.005, 0.005, 0.005, 0.005, 0.005),
c(seq(103.6, 107.9, 0.1), 108.3, 108.5, 108.6, 108.7),
c(0.010, 0.010, 0.015, 0.015, 0.015, 0.020, 0.020, 0.025,
```

```
0.030, 0.035, 0.040, 0.045, 0.050, 0.060, 0.070, 0.085,
0.100, 0.120, 0.145, 0.175, 0.205, 0.240, 0.285, 0.330,
0.385, 0.445, 0.515, 0.590, 0.670, 0.755, 0.845, 0.935,
1.030, 1.125, 1.220, 1.320, 1.420, 1.515, 1.615, 1.715,
1.815, 1.915, 2.015, 2.110, 2.510, 2.710, 2.810, 2.910),
c(seq(103.6, 107.9, 0.1), 108.3, 108.5, 108.6, 108.7),
c(2.5300, 2.4050, 2.2800, 2.1550, 2.0300, 1.9050, 1.7800,
1.6550, 1.5300, 1.4700, 1.4075, 1.3450, 1.2825, 1.1575,
1.0350, 0.9125, 0.8525, 0.7900, 0.7300, 0.6700,
0.6125, 0.5525, 0.4950, 0.4400, 0.3850, 0.3325, 0.2800,
0.2325, 0.1875, 0.1475, 0.1100, 0.0775, 0.0550, 0.0375,
0.0250, 0.0150, 0.0125, 0.0100, 0.0075, 0.0075, 0.0050,
0.0050, 0.0050, 0.0050, 0.0050, 0.0050, 0.0025, 0.0025,
0.0025, 0.0025, 0.0025, 0.0025, 0.0025, 0.0025, 0.0025,
0.0025, 0.0025, 0.0025, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000),
c(seq(95.0000, 96.000, 0.125), 96.0625, 96.1250, 96.1875 ,
96.2500, 96.3750, 96.5000,
seq(96.6250, 99.2500, 0.0625),
100.3750, 100.6250, 100.7500, 100.8750, 101.0000),
c(0.000, 0.0000, 0.0000, 0.0000, 0.000, 0.0000, 0.0000,
0.0000, 0.000, 0.0025, 0.0025, 0.0025, 0.0025, 0.0025,
0.0050, 0.0075, 0.0100, 0.0100, 0.0125, 0.0150, 0.0200,
0.0225, 0.0275, 0.0350, 0.0425, 0.0525, 0.0625, 0.0775,
0.0950, 0.1175, 0.1425, 0.1725, 0.2125, 0.2575, 0.3075,
0.3600, 0.4200, 0.4800, 0.5400, 0.6025, 0.6625, 0.7250,
0.7875, 0.8500, 0.9125, 0.9750, 1.0350, 1.0975, 1.1600,
1.2225, 1.2850, 1.3475, 1.4100, 1.4725, 1.5350, 1.5975,
1.6600, 1.7225, 2.8450, 3.0950, 3.2200, 3.3450, 3.4700),
c(seq(95.0000, 96.000, 0.125), 96.0625, 96.1250,
96.1875, 96.2500, 96.3750, 96.5000,
seq(96.6250, 99.2500, 0.0625), 100.3750,
100.6250, 100.7500, 100.8750, 101.0000),
0.02052,
0.02052,
0.02059,
1,
3,
3,
125.7,
105.795,
0.025,
1,
0.768181,
as.Date("2035-02-15"),
0.021,
1,
0.936365,
as.Date("2028-03-15"),
2,
bond_N = 100,
as.Date("2026-06-08"),
as.Date("2026-05-22"),
3,
```

```
97.53,
as.Date("2026-06-15"),
as.Date("2026-06-15"),
as.Date("2026-04-01"),
"Germany",
"Germany",
3,
0.9)
```

`stir_future_charac_bbg` *stir_future_charac_bbg*

Description

stir_future_charac_bbg

Usage

```
stir_future_charac_bbg(bbg_tickers)
```

Arguments

`bbg_tickers`	a vector of Bloomberg tickers of STIR futures contracts, in character format

Value

for each STIR futures contract, its maturity date in Date format, its currency, its listing place and its underlying asset all in character format

Examples

```
## Not run:
stir_future_charac_bbg(c("FFU24", "ERM6"))

## End(Not run)
```

stir_future_price *stir_future_price*

Description

stir_future_price

Usage

```
stir_future_price(
  call_prices,
  call_strikes,
  put_prices,
  put_strikes,
  nb_log,
  r,
  day_count_conv,
  cot,
  fut_price,
  fut_matu,
  option_matu,
  start_date,
  ref_rate = NA,
  currency = NA
)
```

Arguments

call_prices	a vector of call prices on a STIR futures, in numeric format
call_strikes	a vector of call strikes attached to the call prices, in numeric format
put_prices	a vector of put prices on the same STIR futures, in numeric format
put_strikes	a vector of put strikes attached to the put prices, in numeric format
nb_log	a number for the number of component densities in the lognormal mixture to model the STIR futures' price, either 2 or 3, in numeric format
r	a number for the riskfree spot rate whose maturity is equal to the options' maturity, in numeric format
day_count_conv	a number for the day count convention, 1 for ACT/ACT, 2 for ACT/360, 3 for ACT/365 and 4 for 30/360, in numeric format
cot	a number for the options' style, 1 for European options, 2 for American options and 3 for American options with futures-style margin, in numeric format
fut_price	a number for the STIR futures' price on calibration date, in numeric format
fut_matu	a date for the STIR futures' maturity date, in Date format
option_matu	a date for the maturity date of the options, in Date format
start_date	a date for the observation date, in Date format

ref_rate	a character for the name of the STIR, in character format (NA by default)
currency	a character for the currency in which the STIR futures contract and the options are traded, in character format (NA by default)

Value

the mean and standard deviation of each component lognormal density and the weight on the first density (for a mixture of 2) or on the first 2 densities (for a mixture of 3) in numeric format, a discretized domain of the futures price at option's maturity by increments of 0.001 units of the currency of the futures contract, in numeric format, the probability density for each value in the discretized domain in numeric format, the cumulative density for each value in the discretized domain in numeric format, the type of convergence in the optimization in numeric format (0 indicating successful convergence), the mean, standard deviation, skewness and kurtosis of the distribution of the futures price in numeric format, quantiles of order 0.1%, 0.5%, 1%, 5%, 10%, 25%, 50%, 75%, 90%, 95%, 99%, 99.5% and 99.9% of the distribution in numeric format, the mode of the distribution in numeric format, the options' prices predicted by the model in numeric format, a plot of the RND and a plot of the CDF of the futures price

Examples

```
stir_future_price( c(1.44500, 1.32000, 1.19750, 1.07500, 0.95750,
0.84250, 0.78750, 0.73250, 0.68000, 0.62750, 0.57750, 0.53000, 0.48500,
0.44000, 0.39750, 0.35750, 0.32000, 0.28500, 0.25250, 0.22250, 0.19500,
0.17000, 0.14750, 0.12750, 0.10750, 0.09250, 0.07750, 0.06500, 0.05500,
0.04500, 0.03750, 0.03000, 0.02500, 0.02000, 0.01500, 0.01250, 0.01000,
0.00750, 0.00500, 0.00500, 0.00250, 0.00250, 0.00250, 0.00250,
rep(0.00024, 47)),
c(seq(93.25, 93.875, 0.125),  seq(93.9375, 98.8125, 0.0625),
seq(98.875, 99.5, 0.125)),
c(0.0025, 0.0050, 0.0075, 0.0125, 0.0175, 0.0300, 0.0350, 0.0425, 0.0525,
0.0625, 0.0750, 0.0900, 0.1050, 0.1225, 0.1425, 0.1650, 0.1900, 0.2175,
0.2450, 0.2775, 0.3125, 0.3500, 0.3875, 0.4300, 0.4725, 0.5175, 0.5675,
0.6150, 0.6675, 0.7200, 0.7750, 0.8300, 0.8850, 0.9425, 1.0025, 1.0625,
1.1225, 1.1825, 1.2425, 1.3050, 1.3675, 1.4300, 1.4925, 1.5550, 1.6175,
1.6800, 1.7425, 1.8050, 1.8675, 1.9300, 1.9925, 2.0550, 2.1175, 2.1800,
2.2425, 2.3050, 2.3675, 2.4300, 2.4925, 2.5550, 2.6175, 2.6800, 2.7425,
2.8050, 2.8675, 2.9300, 2.9925, 3.0550, 3.1175, 3.1800, 3.2425, 3.3050,
3.3675, 3.4300, 3.4925, 3.5550, 3.6175, 3.6800, 3.7425, 3.8050, 3.8675,
3.9300, 3.9925, 4.0550, 4.1175, 4.1800, 4.3050, 4.4300, 4.5550, 4.6800,
4.8050),
c(seq(93.25, 93.875, 0.125),  seq(93.9375, 98.8125, 0.0625),
seq(98.875, 99.5, 0.125)),
2,
0.0537,
1,
2,
94.7,
as.Date("2024-02-29"),
as.Date("2024-02-25"),
as.Date("2023-12-18"),
"fed_fund_rate",
```

```
  "USD")
```

`stir_rate` *stir_rate*

Description

stir_rate

Usage

```
stir_rate(
  call_prices,
  call_strikes,
  put_prices,
  put_strikes,
  nb_log,
  r,
  day_count_conv,
  cot,
  fut_price,
  fut_matu,
  option_matu,
  start_date,
  ref_rate = NA,
  currency = NA
)
```

Arguments

`call_prices`	a vector of call prices on a STIR futures, in numeric format
`call_strikes`	a vector of call strikes attached to the call prices, in numeric format
`put_prices`	a vector of put prices on the same STIR futures, in numeric format
`put_strikes`	a vector of put strikes attached to the put prices, in numeric format
`nb_log`	a number for the number of component densities in the lognormal mixture to model the futures' price, either 2 or 3, in numeric format
`r`	a number for the riskfree spot rate whose maturity is equal to the options' maturity, in numeric format
`day_count_conv`	a number for the day count convention, 1 for ACT/ACT, 2 for ACT/360, 3 for ACT/365 and 4 for 30/360, in numeric format
`cot`	a number for the options' style, 1 for European options, 2 for American options and 3 for American options with futures-style margin, in numeric format

fut_price	a number for the STIR futures contract price on calibration date, in numeric format
fut_matu	a date for the maturity date of the STIR futures contract, in Date format
option_matu	a date for the maturity date of the options, in Date format
start_date	a date for the observation date, in Date format
ref_rate	a character for the name of the STIR, in character format (NA by default)
currency	a character for the currency in which the STIR futures and the options are traded, in character format (NA by default)

Value

a discretized domain of the future rate at option's maturity by increments of 0.001% in numeric format, the probability density for each value in the discretized domain in numeric format, the cumulative density for each value in the discretized domain in numeric format, the type of convergence in the optimization in numeric format (0 indicating successful convergence), the mean, standard deviation, skewness and kurtosis of the distribution of future rates in numeric format, quantiles of order 0.1%, 0.5%, 1%, 5%, 10%, 25%, 50%, 75%, 90%, 95%, 99%, 99.5% and 99.9% of the distribution in numeric format, the mode of the distribution in numeric format, a plot of the RND and a plot of the CDF of the rate futures

Examples

```
stir_rate( c(1.44500, 1.32000, 1.19750, 1.07500, 0.95750,
0.84250, 0.78750, 0.73250, 0.68000, 0.62750, 0.57750, 0.53000, 0.48500,
0.44000, 0.39750, 0.35750, 0.32000, 0.28500, 0.25250, 0.22250, 0.19500,
0.17000, 0.14750, 0.12750, 0.10750, 0.09250, 0.07750, 0.06500, 0.05500,
0.04500, 0.03750, 0.03000, 0.02500, 0.02000, 0.01500, 0.01250, 0.01000,
0.00750, 0.00500, 0.00500, 0.00250, 0.00250, 0.00250, 0.00250,
rep(0.00024, 47)),
c(seq(93.25, 93.875, 0.125),  seq(93.9375, 98.8125, 0.0625),
seq(98.875, 99.5, 0.125)),
c(0.0025, 0.0050, 0.0075, 0.0125, 0.0175, 0.0300, 0.0350, 0.0425,
0.0525, 0.0625, 0.0750, 0.0900, 0.1050, 0.1225, 0.1425, 0.1650, 0.1900,
0.2175, 0.2450, 0.2775, 0.3125, 0.3500, 0.3875, 0.4300, 0.4725, 0.5175,
0.5675, 0.6150, 0.6675, 0.7200, 0.7750, 0.8300, 0.8850, 0.9425, 1.0025,
1.0625, 1.1225, 1.1825, 1.2425, 1.3050, 1.3675, 1.4300, 1.4925, 1.5550,
1.6175, 1.6800, 1.7425, 1.8050, 1.8675, 1.9300, 1.9925, 2.0550, 2.1175,
2.1800, 2.2425, 2.3050, 2.3675, 2.4300, 2.4925, 2.5550, 2.6175, 2.6800,
2.7425, 2.8050, 2.8675, 2.9300, 2.9925, 3.0550, 3.1175, 3.1800, 3.2425,
3.3050, 3.3675, 3.4300, 3.4925, 3.5550, 3.6175, 3.6800, 3.7425, 3.8050,
3.8675, 3.9300, 3.9925, 4.0550, 4.1175, 4.1800, 4.3050, 4.4300, 4.5550,
4.6800, 4.8050),
c(seq(93.25, 93.875, 0.125),  seq(93.9375, 98.8125, 0.0625),
seq(98.875, 99.5, 0.125)),
2,
0.0537,
1,
2,
94.7,
as.Date("2024-02-29"),
```

```
    as.Date("2024-02-25"),
    as.Date("2023-12-18"),
    "fed_fund_rate",
    "USD")
```

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