Package 'yrnd'

February 18, 2026

Title Computes Risk Neutral Densities of Futures Prices and Yields on Fixed Income Products

Version 0.1.0

Description Provides with parametric risk neutral densities and cumulative densities for futures prices on fixed-income products. It relies on options on Short Term Interest Rate futures contracts prices or options on bond futures contracts prices. It models the price of the underlying asset as a mixture of either two or three lognormal densities. It also brings new functions which provide with risk neutral densities and cumulative densities of the rate or the yield underlying the futures contract, using the density of the futures price. The package is based on the works of Melick, W. R. and Thomas, C. P. (1997) <doi:10.2307/2331318> and B. Bahra (1998) <doi:10.2

License GPL-3

Encoding UTF-8

RoxygenNote 7.3.3

Imports dplyr, ggplot2, lubridate, scales, stats, tvm, utils, zoo

Suggests knitr, rmarkdown

VignetteBuilder knitr

NeedsCompilation no

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Repository CRAN

Date/Publication 2026-02-18 19:20:02 UTC

Contents

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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 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 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 to model the futures contracts, either 2 or 3, in numeric format
r	a number for the riskfree discount rate whose maturity is equal to the option's maturity, in numeric format
day_count_conv	a number for the day count convention, either 1 (ACT/ACT), 2 (ACT/360), 3 (ACT/365) or 4 (30/360), in numeric format
cot	a number for the type of quotation of the options, either 1 (European options), 2 (American options quoted as futures) or 3 (American options), in numeric format
ctd_matu	a date for the maturity date of the Cheapest-to-Deliver Bond in the basket of deliverable bonds of the futures contract, in Date format

`fut_price`	a number for the futures contract 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 calibration date, in Date format
`nationality`	a character for the nationality of the issuer of the bond in the futures contract underlying the option, in character format
`currency`	a character for the currency in which the futures contract and the options are traded, in character format

Value

the mean and standard deviation of each lognormal density in the mixture 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 series of values for the futures contract's price at options maturity in numeric format, the probability density attached to each value of the futures contract's price in numeric format, the cumulative density attached to each value of the futures contract's price in numeric format, the type of convergence in numeric format with 0 indicating successful convergence, the mean, the standard deviation, the skewness and the kurtosis of the futures contract's prices distribution at option's maturity in numeric format, a plot of the RND of the futures prices, a plot of the CDF of the futures prices, quantiles of order 0.1%, 0.5%, 1%, 5%, 10%, 25%, 50%, 75%, 90%, 95%, 99%, 99.5% and 99.9% of the distribution of futures prices at options' maturity, in numeric format

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")
```

`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 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 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 to model the futures contracts, either 2 or 3, in numeric format
r	a number for the riskfree discount rate whose maturity is equal to the option's maturity, in numeric format
r_2	a number for the riskfree discount rate whose maturity is equal to the futures contract's maturity, in numeric format
day_count_conv	a number for the day count convention, either 1 (ACT/ACT), 2 (ACT/360), 3 (ACT/365) or 4 (30/360), in numeric format
cot	a number for the type of quotation of the options, either 1 (European options), 2 (American options quoted as futures) or 3 (American options), in numeric format
conv_factor	a number for the conversion factor assigned by the futures exchange to the Cheapest-to-Deliver Bond, in numeric format
ctd_cp	a number for the coupon rate of the Cheapest-to-Deliver Bond, in numeric format

ctd_matu	a date for the maturity date of the Cheapest-to-Deliver Bond in the basket of deliverable bonds of the futures contract, in Date format
cp_f	a number for the frequency of coupon payment of the Cheapest-to-Deliver Bond, in numeric format. Worth 1 if the frequency is annual and 0.5 if frequency is semi-annual
ctd_N	a number for the value of the principal of the 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 Cheapest-to-Deliver Bond, in numeric format
fut_price	a number for the futures contract 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 calibration date, in Date format
nationality	a character for the nationality of the issuer of the bond in the futures contract underlying the option, in character format
currency	a character for the currency in which the futures contract and the options are traded, in character format

Value

a series of values for the CtD Bond yield in numeric format, the probability density attached to each value of the CtD Bond yield in numeric format, the cumulative density attached to each value of the CtD Bond yield in numeric format, the type of convergence in numeric format with 0 indicating successful convergence, the mean, the standard deviation, the skewness and the kurtosis of the CtD Bond yields' distribution at options' maturity in numeric format, a plot of the RND of the CtD Bond yields, a plot of the CDF of the CtD Bond yiels, quantiles of order 0.1%, 0.5%, 1%, 5%, 10%, 25%, 50%, 75%, 90%, 95%, 99%, 99.5% and 99.9% of the distribution of futures prices at options' maturity, in numeric format

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"), 0.5, 100,
2, 116.17, as.Date("2024-12-10"), as.Date("2024-11-22"), as.Date("2024-06-14"),
"Italian", "EUR")
```

---

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 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 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 to model the futures contracts, either 2 or 3, in numeric format
r	a number for the riskfree discount rate whose maturity is equal to the option's maturity, in numeric format
day_count_conv	a number for the day count convention, either 1 (ACT/ACT), 2 (ACT/360), 3 (ACT/365) or 4 (30/360), in numeric format
cot	a number for the type of quotation of the options, either 1 (European options), 2 (American options quoted as futures) or 3 (American options), in numeric format
fut_price	a number for the futures contract 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 calibration date, in Date format

ref_rate   a character for the name of the STIR, in character format

currency   a character for the currency in which the futures contract and the options are
                  traded, in character format

Value

the mean and standard deviation of each lognormal density in the mixture 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 series
of values for the futures contract's price at options maturity in numeric format, the probability den-
sity attached to each value of the futures contract's price in numeric format, the cumulative density
attached to each value of the futures contract's price in numeric format, the type of convergence
in numeric format with 0 indicating successful convergence, the mean, the standard deviation, the
skewness and the kurtosis of the futures contract's prices distribution at option's maturity in numeric
format, a plot of the RND of the futures prices, a plot of the CDF of the futures prices, quantiles
of order 0.1%, 0.5%, 1%, 5%, 10%, 25%, 50%, 75%, 90%, 95%, 99%, 99.5% and 99.9% of the
distribution of futures prices at options' maturity, in numeric format

Examples

```
stir_future_price( c(11.44500, 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, 0.00024,
0.00024, 0.00024, 0.00024, 0.00024, 0.00024, 0.00024, 0.00024, 0.00024,
0.00024, 0.00024, 0.00024, 0.00024, 0.00024, 0.00024, 0.00024, 0.00024,
0.00024, 0.00024, 0.00024, 0.00024, 0.00024, 0.00024, 0.00024, 0.00024,
0.00024, 0.00024, 0.00024, 0.00024, 0.00024, 0.00024, 0.00024, 0.00024,
0.00024, 0.00024, 0.00024, 0.00024, 0.00024, 0.00024, 0.00024, 0.00024,
0.00024, 0.00024, 0.00024, 0.00024, 0.00024, 0.00024),
c(93.2500, 93.3750, 93.5000, 93.6250, 93.7500, 93.8750, 93.9375, 94.0000,
94.0625, 94.1250, 94.1875, 94.2500, 94.3125, 94.3750, 94.4375, 94.5000,
94.5625, 94.6250, 94.6875, 94.7500, 94.8125, 94.8750, 94.9375, 95.0000,
95.0625, 95.1250, 95.1875, 95.2500,95.3125, 95.3750, 95.4375, 95.5000,
95.5625, 95.6250, 95.6875, 95.7500, 95.8125, 95.8750, 95.9375, 96.0000,
96.0625, 96.1250, 96.1875, 96.2500, 96.3125, 96.3750, 96.4375, 96.5000,
96.5625, 96.6250, 96.6875, 96.7500, 96.8125, 96.8750, 96.9375, 97.0000,
97.0625, 97.1250, 97.1875, 97.2500, 97.3125, 97.3750, 97.4375, 97.5000,
97.5625, 97.6250, 97.6875, 97.7500, 97.8125, 97.8750, 97.9375, 98.0000,
98.0625, 98.1250, 98.1875, 98.2500, 98.3125, 98.3750, 98.4375, 98.5000,
98.5625, 98.6250, 98.6875, 98.7500, 98.8125, 98.8750, 99.0000, 99.1250,
99.2500, 99.3750, 99.5000), 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(11.44500, 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, 0.00024, 0.00024, 0.00024, 0.00024, 0.00024, 0.00024, 0.00024,
0.00024, 0.00024, 0.00024, 0.00024, 0.00024, 0.00024, 0.00024, 0.00024,
0.00024, 0.00024, 0.00024, 0.00024, 0.00024, 0.00024, 0.00024, 0.00024,
0.00024, 0.00024, 0.00024, 0.00024, 0.00024, 0.00024, 0.00024, 0.00024,
0.00024, 0.00024, 0.00024, 0.00024, 0.00024, 0.00024, 0.00024, 0.00024,
0.00024, 0.00024, 0.00024, 0.00024, 0.00024, 0.00024, 0.00024, 0.00024),
2, 0.0537, 1, 3, 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,
  r_2,
  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 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 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 to model the futures contracts, either 2 or 3, in numeric format
`r`	a number for the riskfree discount rate whose maturity is equal to the option's maturity, in numeric format
`r_2`	a number for the riskfree discount rate whose maturity is equal to the futures contract's maturity, in numeric format
`day_count_conv`	a number for the day count convention, either 1 (ACT/ACT), 2 (ACT/360), 3 (ACT/365) or 4 (30/360), in numeric format
`cot`	a number for the type of quotation of the options, either 1 (European options), 2 (American options quoted as futures) or 3 (American options), in numeric format
`fut_price`	a number for the futures contract 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 calibration date, in Date format
`ref_rate`	a character for the name of the STIR, in character format
`currency`	a character for the currency in which the futures contract and the options are traded, in character format

Value

a series of values for STIR rate in numeric format, the probability density attached to each value of the STIR rate in numeric format, the cumulative density attached to each value of the STIR rate in numeric format, the type of convergence in numeric format with 0 indicating successful convergence, the mean, the standard deviation, the skewness and the kurtosis of the STIR rates' distribution at options maturity in numeric format, a plot of the RND of the STIR rates, a plot of the CDF of the STIR rates, quantiles of order 0.1%, 0.5%, 1%, 5%, 10%, 25%, 50%, 75%, 90%, 95%, 99%, 99.5% and 99.9% of the distribution of futures prices at options' maturity, in numeric format

Examples

```
stir_rate( c(11.44500, 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, 0.00024,
0.00024, 0.00024, 0.00024, 0.00024, 0.00024, 0.00024, 0.00024, 0.00024,
0.00024, 0.00024, 0.00024, 0.00024, 0.00024, 0.00024, 0.00024, 0.00024,
0.00024, 0.00024, 0.00024, 0.00024, 0.00024, 0.00024, 0.00024, 0.00024,
```

```
0.00024, 0.00024, 0.00024, 0.00024, 0.00024, 0.00024, 0.00024, 0.00024,
0.00024, 0.00024, 0.00024, 0.00024, 0.00024, 0.00024, 0.00024, 0.00024,
0.00024, 0.00024, 0.00024, 0.00024, 0.00024, 0.00024),
c(93.2500, 93.3750, 93.5000, 93.6250, 93.7500, 93.8750, 93.9375, 94.0000,
94.0625, 94.1250, 94.1875, 94.2500, 94.3125, 94.3750, 94.4375, 94.5000,
94.5625, 94.6250, 94.6875, 94.7500, 94.8125, 94.8750, 94.9375, 95.0000,
95.0625, 95.1250, 95.1875, 95.2500,95.3125, 95.3750, 95.4375, 95.5000,
95.5625, 95.6250, 95.6875, 95.7500, 95.8125, 95.8750, 95.9375, 96.0000,
96.0625, 96.1250, 96.1875, 96.2500, 96.3125, 96.3750, 96.4375, 96.5000,
96.5625, 96.6250, 96.6875, 96.7500, 96.8125, 96.8750, 96.9375, 97.0000,
97.0625, 97.1250, 97.1875, 97.2500, 97.3125, 97.3750, 97.4375, 97.5000,
97.5625, 97.6250, 97.6875, 97.7500, 97.8125, 97.8750, 97.9375, 98.0000,
98.0625, 98.1250, 98.1875, 98.2500, 98.3125, 98.3750, 98.4375, 98.5000,
98.5625, 98.6250, 98.6875, 98.7500, 98.8125, 98.8750, 99.0000, 99.1250,
99.2500, 99.3750, 99.5000), 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(11.44500, 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, 0.00024, 0.00024, 0.00024, 0.00024, 0.00024, 0.00024, 0.00024,
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2, 0.0537, 0.0539, 1, 3, 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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