Package: volrisk (via r-universe)

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Type Package

Title Simulation of Life Reinsurance with Profit Commission

Version 0.1.0

Description Simulates and evaluates stochastic scenarios of death and lapse events in life reinsurance contracts with profit commissions. The methodology builds on materials published by the Institute of Actuaries of Japan <https://www.actuaries.jp/examin/textbook/pdf/modeling.pdf>. A paper describing the detailed algorithms will be published by the author within a few months after the initial release of this package.

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`calc_pc` *Calculate Profit Commission for Reinsurance*

Description

Calculates profit commission payouts for a single set of reinsurance cash flows.

This function supports standard profit commission rules using input cash flows and applies key parameters such as the profit commission rate, administrative expense rate, and loss carryforward logic.

Usage

```
calc_pc(PREM, CLAIM, pc_rate, me, loss_carry, duration)
```

Arguments

`PREM`	Numeric vector of premiums.
`CLAIM`	Numeric vector of claims.
`pc_rate`	Profit commission rate (typically between 0 and 1).
`me`	Administrative expense rate deducted from premium (typically between 0 and 1).
`loss_carry`	Whether to apply loss carryforward across periods. Must be "Y" (yes) or "N" (no).
`duration`	Numeric vector of durations. Must match length of PREM and CLAIM and be consecutive integers.

Value

A numeric vector of calculated profit commissions (same length as duration).

Examples

```
# Simple numeric vectors
PREM <- c(1000, 1000, 1000, 1000, 1000, 1000)
CLAIM <- c(600, 1800, 600, 600, 600, 600)
duration <- 1:6
calc_pc(PREM, CLAIM, pc_rate = 0.9, me = 0.05, loss_carry = "Y", duration = duration)

# Using example_simulation dataset
example_simulation_with_PC <- example_simulation %>%
  dplyr::group_by(split, sim_n) %>%
  dplyr::mutate(
  PC = calc_pc(PREM,
               CLAIM,
               pc_rate = 0.9,
               me = 0.05,
               loss_carry = "N",
               duration = DURATION)) %>%
  dplyr::ungroup()
```

---

example_portfolio *Example Portfolio*

Description

A synthetic insurance portfolio provided for testing and demonstration of package functionality. This dataset illustrates the structure and variables commonly used in life insurance modeling.

Usage

```
example_portfolio
```

Format

A data frame with 50 rows and 12 variables:

POL_ID Policy ID number

CLIENT_ID Client ID number

ISSUE_AGE Age of the insured at policy issue

GENDER Gender of the insured

DURATION Policy year of coverage

ATT_AGE Attained age in each duration

qx Mortality rate based on Japanese standard valuation table

FACE Face amount of the policy

RATE Premium rate applied

MORTALITY Actual assumed mortality rate

LAPSE Policy lapse rate

NAR Net amount at risk

example_simulation *Example Simulation Results*

Description

A synthetic dataset representing simulated insurance cash flows over time. This dataset is provided for demonstration and validation of key package functions, including risk evaluation (`risk()`) and profit commission calculation (`calc_pc()`). It includes premium and claim flows per simulation trial and policy duration, enabling users to test volatility risk metrics and profit commission calculations.

Usage

```
data(example_simulation)
```

Format

A tibble with 10 rows and 5 variables:

split Repetition number of the simulation

sim_n Simulation trial number

DURATION Duration year of the policy

PREM Premium

CLAIM Claim

make_portfolio *Create Insurance Portfolio for Simulation*

Description

This function standardizes and validates raw insurance portfolio data to prepare it for simulation. It ensures all necessary fields are correctly mapped and conform to required formats. If no column mapping is provided, the user will be prompted interactively.

Usage

```
make_portfolio(data, cols = NULL)
```

Arguments

`data`	A data.frame containing raw insurance portfolio data.
`cols`	A named list with column mappings. The list should include: `unique_id`, `client_id`, `duration`, `mortality`, `lapse`, `nar`, `rate`.

Value

A cleaned data.frame with standardized column names: `unique_id`, `client_id`, `duration`, `mortality`, `lapse`, `nar`, `rate`.

Examples

```
make_portfolio(example_portfolio, cols = list(
  unique_id = "POL_ID",
  client_id = "CLIENT_ID",
  duration = "DURATION",
  mortality = "MORTALITY",
  lapse = "LAPSE",
  nar = "NAR",
  rate = "RATE"
))
```

---

risk *Compute Risk Measures*

Description

Computes Value-at-Risk (VaR) and Tail Value-at-Risk (TVaR) based on simulated insurance cash flows. The function supports discounting for multi-year horizons and can evaluate loss ratio (LR) or balance (BAL).

Usage

```
risk(
  cf,
  time_horizon = c(1),
  level = c(0.005, 0.01, 0.1, 0.2, 0.5, 0.8, 0.9, 0.99, 0.995),
  discount = 0,
  output = "LR"
)
```

Arguments

`cf`	A data.frame containing simulated cash flow results. Must include columns: `split`, `sim_n`, `PREM`, `CLAIM`, `DURATION`.
`time_horizon`	A numeric vector specifying time horizons (e.g., c(1, 5, 10)).
`level`	A numeric vector of confidence levels for risk quantification (e.g., c(0.01, 0.1, 0.99)).
`discount`	Annual discount rate to convert future cash flows to present value. Default is 0 (no discount).
`output`	The metric to be analyzed: `"LR"` for loss ratio or `"BAL"` for balance. Default is `"LR"`.

Value

A data.frame summarizing VaR and TVaR values across the specified horizons and confidence levels.

Examples

```
# Using example_simulation dataset (assumes data is loaded)
result <- risk(example_simulation,
               time_horizon = c(1, 10),
               level = c(0.01, 0.99),
               discount = 0.02,
               output = "BAL")
print(result)
```

---

simulation *Run Simulation of Death and Lapse Scenarios*

Description

This function simulates death and lapse events over the insurance period using the portfolio created by `make_portfolio()`. The total number of simulations is `n_sim * split`, and results are saved in CSV or Parquet format in the specified path.

Usage

```
simulation(
  df,
  n_sim = NULL,
  split = NULL,
  seed = NULL,
  sync_seed = TRUE,
  output_format = "csv",
  output_path = NULL
)
```

Arguments

`df`	A data.frame returned by `make_portfolio()`
`n_sim`	Number of simulations per split
`split`	Number of splits (simulation repetitions)
`seed`	Random seed (optional)
`sync_seed`	Logical flag (default = TRUE). If TRUE, ensures that all policies belonging to the same insured person use synchronized random seeds for death simulation, thereby ensuring consistent timing of death events across policies. This is critical for accurately capturing volatility risk arising from common mortality shocks.
`output_format`	Output file format: "csv" or "parquet"
`output_path`	Path to save the simulation results and logs

Value

No return value. Files are saved to `output_path`.

Examples

```
# Prepare portfolio
port <- make_portfolio(example_portfolio, cols = list(
  unique_id = "POL_ID",
  client_id = "CLIENT_ID",
  duration = "DURATION",
  mortality = "MORTALITY",
  lapse = "LAPSE",
  nar = "NAR",
  rate = "RATE"
))

# Run simulation (output_path = tempdir() for demonstration)
simulation(port,
           n_sim = 10,
           split = 100,
           seed = 12345,
           output_format = "csv",
           output_path = tempdir()
           )
```

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