

Package ‘dynamicpv’

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Title Evaluates Present Values and Health Economic Models with Dynamic Pricing and Uptake

Version 0.4.2

Description The goal of 'dynamicpv' is to provide a simple way to calculate (net) present values and outputs from health economic models (especially cost-effectiveness and budget impact) in discrete time that reflect dynamic pricing and dynamic uptake. Dynamic pricing is also known as life cycle pricing; dynamic uptake is also known as multiple or stacked cohorts, or dynamic disease prevalence. Shafrin (2024) <[doi:10.1515/fhep-2024-0014](https://doi.org/10.1515/fhep-2024-0014)> provides an explanation of dynamic value elements, in the context of Generalized Cost Effectiveness Analysis, and Puls (2024) <[doi:10.1016/j.jval.2024.03.006](https://doi.org/10.1016/j.jval.2024.03.006)> reviews challenges of incorporating such dynamic value elements. This package aims to reduce those challenges.

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URL <https://MSDLLCpapers.github.io/dynamicpv/>,
<https://github.com/MSDLLCpapers/dynamicpv>

BugReports <https://github.com/MSDLLCpapers/dynamicpv/issues>

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+.dynpv	<i>Method to add two dynpv objects together</i>
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Description

Add together two objects each of class "dynpv"

Usage

```
## S3 method for class 'dynpv'
e1 + e2
```

Arguments

e1	First "dynpv" object
e2	Second "dynpv" object

Value

S3 object of class "dynpv"

-.dynpv	<i>Method to subtract one dynpv object from another</i>
---------	---------------------------------------------------------

Description

Subtract one object of S7 class "dynpv" from another

Usage

```
## S3 method for class 'dynpv'
e1 - e2
```

Arguments

e1	First "dynpv" object
e2	Second "dynpv" object

Details

Present value of e1-e2 is the present values from e1 less that from e2. Total uptake of e1-e2 is the uptake from e1 less that from e2. Take care of this when using \$mean of the summed object.

Value

S3 object of class "dynpv"

addprod	<i>Method to add two dynpv objects together</i>
---------	-------------------------------------------------

Description

Add together two objects each of S3 class "dynpv": e1 + mult * e2

Usage

```
addprod(e1, e2, mult)
```

Arguments

e1	First "dynpv" object
e2	Second "dynpv" object
mult	Numeric

Present value is present value from e1 plus mult times the present value from e2. Total uptake is the uptake from e1 plus mult times the uptake from e2. Take care of this when using \$mean of the summed object.

Value

S3 object of class "dynpv"

See Also

[dynpv\(\)](#), [futurepv\(\)](#)

dynpv

Present values with dynamic pricing and dynamic uptake

Description

Calculate present value for a payoff with dynamic (lifecycle) pricing and dynamic uptake (stacked cohorts).

Usage

```
dynpv(
  uptakes = 1,
  payoffs,
  horizon = length(payoffs),
  tzero = 0,
  prices = rep(1, length(payoffs) + tzero),
  discrate = 0
)
```

Arguments

uptakes	Vector of patient uptake over time
payoffs	Vector of payoffs of interest (numeric vector)
horizon	Time horizon for the calculation (length must be less than or equal to the length of payoffs)
tzero	Time at the date of calculation, to be used in lookup in prices vector
prices	Vector of price indices through the time horizon of interest
discrate	Discount rate per timestep, corresponding to price index

Details

Suppose payoffs in relation to patients receiving treatment (such as costs or health outcomes) occur over timesteps $t = 1, \dots, T$. Let us partition time as follows.

- Suppose $j = 1, \dots, T$ indexes the time at which the patient begins treatment.
- Suppose $k = 1, \dots, T$ indexes time since initiating treatment.

In general, $t = j + k - 1$, and we are interested in the set of (j, k) such that $1 \leq t \leq T$.

For example, $t = 3$ comprises:

- patients who are in the third timestep of treatment that began in timestep 1: (j,k)=(1,3);
- patients who are in the second timestep of treatment that began in timestep 2, (j,k)=(2,2); and
- patients who are in the first timestep of treatment that began in timestep 3, (j,k)=(3,1)

The **Present Value** of a cashflow p_k for the u_j patients who began treatment at time j and who are in their k th timestep of treatment is as follows

$$PV(j, k, l) = u_j \cdot p_k \cdot R_{j+k+l-1} \cdot (1+i)^{2-j-k}$$

where i is the risk-free discount rate per timestep, p_k is the cashflow amount in today's money, and $p_k \cdot R_{j+k+l-1}$ is the nominal amount of the cashflow at the time it is incurred, allowing for an offset of $l = tzero$.

The total present value, $TPV(l)$, is therefore the sum over all j and k within the time horizon T , namely:

$$TPV(l) = \sum_{j=1}^T \sum_{k=1}^{T-j+1} PV(j, k, l) = \sum_{j=1}^T \sum_{k=1}^{T-j+1} u_j \cdot p_k \cdot R_{l+j+k-1} \cdot (1+i)^{2-j-k}$$

This function calculates $PV(j, k, l)$ for all values of j , k and l , and returns this in a tibble.

Value

A tibble of class "dynpv" with the following columns:

- j: Time at which patients began treatment
- k: Time since patients began treatment
- l: Time offset for the price index (from tzero)
- t: Equals $j + k - 1$
- uj: Uptake of patients beginning treatment at time j (from uptakes)
- pk: Cashflow amount in today's money in respect of patients at time k since starting treatment (from payoffs)
- R: Index of prices over time $l + t$ (from prices)
- v: Discounting factors, $(1+i)^{1-t}$, where i is the discount rate per timestep
- pv: Present value, $PV(j, k, l)$

Examples

```
# Simple example
pv1 <- dynpv(
  uptakes = (1:10), # 1 patient uptakes in timestep 1, 2 patients in timestep 2, etc
  tzero = c(0,5), # Calculations are performed with prices at times 0 and 5
  payoffs = 90 + 10*(1:10), # Payoff vector of length 10 = (100, 110, ..., 190)
  prices = 1.02^((1:15)-1), # Prices increase at 2% per timestep in future
  discrate = 0.05 # The nominal discount rate is 5% per timestep;
                # the real discount rate per timestep is 3% (=5% - 3%)
)
```

```

summary(pv1)

# More complex example, using cashflow output from a heemod model

# Obtain dataset
democe <- get_dynfields(
  heemodel = oncpms,
  payoffs = c("cost_daq_new", "cost_total", "qaly"),
  discount = "disc"
)

# Obtain short payoff vector of interest
payoffs <- democe |>
  dplyr::filter(int=="new", model_time<11) |>
  dplyr::mutate(cost_oth = cost_total - cost_daq_new)

# Example calculation
pv2 <- dynpv(
  uptakes = rep(1, nrow(payoffs)),
  payoffs = payoffs$cost_oth,
  prices = 1.05^(0:(nrow(payoffs)-1)),
  discrate = 0.08
)
summary(pv2)

```

futurepv

Calculate present value for a payoff in a single cohort with dynamic pricing across multiple timepoints

Description

Present value of a series of payoffs for a single given cohort, entering at given future time, allowing for dynamic pricing. This function is a wrapper for `dynpv()` restricted to evaluation of a single cohort.

Usage

```
futurepv(tzero = 0, payoffs, prices, discrate)
```

Arguments

tzero	Time at the date of calculation, to be used in lookup in prices vector
payoffs	Vector of payoffs of interest (numeric vector)
prices	Vector of price indices through the time horizon of interest
discrate	Discount rate per timestep, corresponding to price index

Value

A tibble of class "dynpv" with the following columns:

- *j*: Time at which patients began treatment
- *k*: Time since patients began treatment
- *l*: Time offset for the price index (from *tzero*)
- *t*: Equals $j + k - 1$
- *uj*: Uptake of patients beginning treatment at time *j* (from *uptakes*)
- *pk*: Cashflow amount in today's money in respect of patients at time *k* since starting treatment (from *payoffs*)
- *R*: Index of prices over time $l + t$ (from *prices*)
- *v*: Discounting factors, $(1 + i)^{1-t}$, where *i* is the discount rate per timestep
- *pv*: Present value, $PV(j, k, l)$

See Also

[dynpv\(\)](#)

Examples

```
library(dplyr)

# Obtain dataset
democe <- get_dynfields(
  heemodel = oncpsm,
  payoffs = c("cost_daq_new", "cost_total", "qaly"),
  discount = "disc"
)

# Obtain discount rate
discrate <- get_param_value(oncpsm, "disc")

# Obtain payoff vector of interest
payoffs <- democe |>
  filter(int=="new") |>
  mutate(cost_oth_rup = cost_total_rup - cost_daq_new_rup)
Nt <- nrow(payoffs)

# Run calculation for times 0-9
fpv <- futurepv(
  tzero = (0:9)*52,
  payoffs = payoffs$cost_oth_rup,
  prices = 1.001^(1:(2*Nt)-1), # Approx 5.3% every 52 steps
  discrate = 0.001 + discrate
)
fpv
summary(fpv)
```

get_dynfields	<i>Helper function to get a tibble of the relevant fields from heemod output</i>
---------------	----------------------------------------------------------------------------------

Description

Helper function to get a tibble of the relevant fields from heemod output

Usage

```
get_dynfields(heemodel, payoffs, discount, fname = NA)
```

Arguments

heemodel	A health economic model object from the <i>heemod</i> package (see heemod::heemod-package).
payoffs	Field names of payoffs of interest (string vector)
discount	Name of parameter providing discount rate per cycle (string)
fname	Export data to a .CSV file of this name, if given (character)

Value

Tibble of payoffs taken from the heemod model, by intervention and model timestep (`model_time`).

The field `vt` is calculated as $(1+i)^{(1-\text{model_time})}$, where i is the discount rate per model timestep set in the *heemod* model through the parameter `disc_cycle`. This can be useful in 'rolling-up' payoff values to the timestep in which they were incurred.

An additional set of payoffs (identified with a `"_rup"` suffix) provides calculations of the payoffs as at the start of the timestep in which they were incurred, i.e. original payoff / `vt`.

See Also

[heemod::heemod-package](#)

Examples

```
democe <- get_dynfields(
  heemodel = oncpm,
  payoffs = c("cost_daq_new", "cost_total", "qaly"),
  discount = "disc"
)
head(democe)
```

get_param_value	<i>Obtain parameter value(s) from a heemod output</i>
-----------------	-------------------------------------------------------

Description

Obtain parameter value(s) from a heemod output

Usage

```
get_param_value(heemodel, param)
```

Arguments

heemodel	A health economic model object from the <i>heemod</i> package (see heemod::heemod-package).
param	Name of parameter to extract from the heemod model

Value

Value of the parameter from the heemod model

See Also

[heemod::heemod-package](#)

Examples

```
get_param_value(
  heemodel = oncpvm,
  param = "disc"
)
```

mean.dynpv	<i>Mean present value per uptaking patient</i>
------------	------------------------------------------------

Description

Mean of the Present Value per uptaking patient, by time at which the calculation is performed (tzero input to [dynpv\(\)](#)).

Usage

```
## S3 method for class 'dynpv'
mean(x, ...)
```

Arguments

x Tibble of class "dynpv" created by [dynpv\(\)](#) or [futurepv\(\)](#)
... Currently unused

Details

This is equal to [total\(\)](#) divided by [uptake\(\)](#).

Value

A number or tibble

See Also

[dynpv\(\)](#), [futurepv\(\)](#)

ncoh

Number of cohorts of uptaking patients

Description

Number of cohorts of uptaking patients, calculated as the length of the uptakes input to [dynpv\(\)](#)

Usage

ncoh(df)

Arguments

df Tibble of class "dynpv" created by [dynpv\(\)](#) or [futurepv\(\)](#)

Value

A number

See Also

[dynpv\(\)](#), [futurepv\(\)](#)

ntimes	<i>Number of times at which present value calculations are performed</i>
--------	--------------------------------------------------------------------------

Description

Number of times at which present value calculations are performed, calculated as the length of the tzero input to [dynpv\(\)](#)

Usage

```
ntimes(df)
```

Arguments

df Tibble of class "dynpv" created by [dynpv\(\)](#) or [futurepv\(\)](#)

Value

A number

See Also

[dynpv\(\)](#), [futurepv\(\)](#)

oncpsm	<i>Heemod cost-effectiveness model example</i>
--------	------------------------------------------------

Description

An example three state cost-effectiveness model in oncology built using [heemod : heemod-package\(\)](#) according to the assumptions and specification in the accompanying paper.

Usage

```
oncpsm
```

Format

```
oncpsm:  
A heemod object
```

Source

Created based on assumptions.

summary.dynpv	<i>Summarize a dynpv object</i>
---------------	---------------------------------

Description

Summarize a dynpv object

Usage

```
## S3 method for class 'dynpv'
summary(object, ...)
```

Arguments

object	Tibble of class "dynpv" created by dynpv() or futurepv()
...	Currently unused

Value

A list of class "dynpv_summary" with the following elements:

- ncoh: Number of cohorts of uptaking patients, from [ncoh\(\)](#)
- ntimes: Number of times at which present value calculations are performed, from [ntimes\(\)](#)
- uptake: Total number of uptaking patients, from [uptake\(\)](#)
- sum_by_coh: Present value for each uptake cohort and calculation time, from [sum_by_coh\(\)](#)
- total: Total present value, from [total\(\)](#)
- mean: Mean present value per uptaking patient, from [mean\(\)](#), equal to total/uptake.

See Also

[dynpv\(\)](#), [futurepv\(\)](#)

sum_by_coh	<i>Present value for each uptake cohort and calculation time</i>
------------	------------------------------------------------------------------

Description

Calculates the sum of the Present Value by uptake cohort (j) and time at which the calculation is performed (tzero input to [dynpv\(\)](#))

Usage

```
sum_by_coh(df)
```

Arguments

df Tibble of class "dynpv" created by [dynpv\(\)](#) or [futurepv\(\)](#)

Details

The **Present Value** of a cashflow p_k for the u_j patients who began treatment at time j and who are in their k th timestep of treatment is as follows

$$PV(j, k, l) = u_j \cdot p_k \cdot R_{j+k+l-1} \cdot (1 + i)^{2-j-k}$$

where i is the risk-free discount rate per timestep, p_k is the cashflow amount in today's money, and $p_k \cdot R_{j+k+l-1}$ is the nominal amount of the cashflow at the time it is incurred, allowing for an offset of $l = tzero$.

This method returns $\sum_{k=1}^{T-j+1} PV(j, k, l)$ for each value of j and l , where T is the time horizon of the calculation.

Value

A number or tibble

See Also

[dynpv\(\)](#), [futurepv\(\)](#)

total	<i>Total present value</i>
-------	----------------------------

Description

Sum of the Present Value, by time at which the calculation is performed (tzero input to [dynpv\(\)](#))

Usage

total(df)

Arguments

df Tibble of class "dynpv" created by [dynpv\(\)](#) or [futurepv\(\)](#)

Details

The **Present Value** of a cashflow p_k for the u_j patients who began treatment at time j and who are in their k th timestep of treatment is as follows

$$PV(j, k, l) = u_j \cdot p_k \cdot R_{j+k+l-1} \cdot (1 + i)^{2-j-k}$$

where i is the risk-free discount rate per timestep, p_k is the cashflow amount in today's money, and $p_k \cdot R_{j+k+l-1}$ is the nominal amount of the cashflow at the time it is incurred, allowing for an offset of $l = tzero$.

The total present value by time at which the calculation is performed, $TPV(l)$, is therefore the sum of $PV(j, k, l)$ over all j and k within the time horizon T , namely:

$$TPV(l) = \sum_{j=1}^T \sum_{k=1}^{T-j+1} PV(j, k, l) = \sum_{j=1}^T \sum_{k=1}^{T-j+1} u_j \cdot p_k \cdot R_{l+j+k-1} \cdot (1+i)^{2-j-k}$$

Value

A number or tibble

See Also

[dynpv\(\)](#), [futurepv\(\)](#)

trim_vec

Trim the trailing zeroes from a long vector

Description

Trim the trailing zeroes from a long vector

Usage

```
trim_vec(vec)
```

Arguments

vec Vector. Final elements may be zero.

Value

A vector whose length is shorter than the original, if there were trailing zero elements

Examples

```
trim_vec(c(1:10, rep(0,3)))
```

uptake	<i>Total number of uptaking patients</i>
--------	------------------------------------------

Description

Total number of uptaking patients, calculated as the sum of the uptake input to [dynpv\(\)](#), or $\sum_{j=1}^T u_j$

Usage

```
uptake(df)
```

Arguments

df Tibble of class "dynpv" created by [dynpv\(\)](#) or [futurepv\(\)](#)

Value

A number or tibble

See Also

[dynpv\(\)](#), [futurepv\(\)](#)

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