

# Package ‘rpsftm’

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**Type** Package

**Title** Rank Preserving Structural Failure Time Models

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**Description** Implements methods described by the paper Robins and Tsiatis (1991) <[DOI:10.1080/03610929108830654](https://doi.org/10.1080/03610929108830654)>. These use g-estimation to estimate the causal effect of a treatment in a two-armed randomised control trial where non-compliance exists and is measured, under an assumption of an accelerated failure time model and no unmeasured confounders.

**Depends** R (>= 2.10)

**License** GPL-2

**Imports** ggplot2, stats, survival

**LazyData** true

**RoxygenNote** 7.3.1

**Suggests** knitr, rmarkdown, tableone, testthat

**VignetteBuilder** knitr

**Language** en-GB

**Encoding** UTF-8

**NeedsCompilation** no

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rpsftm-package	<i>rpsftm: a package to fit Rank Preserving Structural Failure Time Model</i>
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### Description

This implements the method of Robins JM, Tsiatis AA. The key function is [rpsftm](#), which provides estimates of the causal parameter of interest.

### Details

rpsftm: a package to fit Rank Preserving Structural Failure Time Model

### Author(s)

**Maintainer:** Simon Bond <simon.bond7@nhs.net> (primary author of code, secondary author of vignette)

Authors:

- Annabel Allison (primary author of vignette, secondary author of code)

### References

Robins JM, Tsiatis AA. Correcting for non-compliance in randomized trials using rank preserving structural failure time models. *Communications in Statistics–Theory and Methods* 1991; 20: 2609–2631

### See Also

[survdiff](#)  
[coxph](#)  
[survreg](#)

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cox.zph	<i>Test the proportional hazards assumption of an RPSFTM/Cox Regression</i>
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### Description

If the `fit` inherits *both* `rpsftm` and `coxph` then this pulls out the genuine `survival::coxph` object that is deeply nested in the object, and then runs `survival::cox.zph` on it. Or it avoids overwriting the function from `survival` by calling `survival::cox.zph` directly if the object does not inherit `rpsftm`. Or it fails.

### Usage

```
cox.zph(fit, ...)
```

### Arguments

<code>fit</code>	the result of fitting a <code>rpsftm</code> model using <code>coxph</code> as the inner estimation tool.
<code>...</code>	any other arguments to pass to <code>cox.zph</code> .

### Note

This does rely on the order of loading packages. The `rpsftm` package must be loaded after `survival`, if both are required, to avoid the masking of synonymous functions causing errors.

### See Also

[cox.zph](#)

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immdef	<i>immdef</i>
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### Description

Simulated data to use with the `rpsftm` function.

### Usage

```
immdef
```

**Format**

A simulated data frame with 9 variables and 1000 observations representing a study where participants were randomly assigned to receive treatment immediately or deferred. Participants in the deferred arm could crossover and receive treatment. The primary endpoint was time to disease progression.

The data are based on a randomized controlled trial Concorde [doi:10.1016/S01406736\(94\)90006X](https://doi.org/10.1016/S01406736(94)90006X)

**id** participant ID number

**def** indicator that the participant was assigned to the Deferred treatment arm

**imm** indicator that the participant was assigned to the Immediate treatment arm

**censyrs** censoring time, in years, corresponding to the close of study minus the time of entry for each participant

**xo** an indicator that crossover occurred

**xoyrs** the time, in years, from entry to switching, or 0 for participants in the Immediate arm

**prog** an indicator of disease progression (1), or censoring (0)

**progyrs** time, in years, from entry to disease progression or censoring

**entry** the time of entry into the study, measured in years from the date of randomisation

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plot.rpsftm

*Plot Method*

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**Description**

Function used to plot the KM curves of the treatment-free transformed times

**Usage**

```
## S3 method for class 'rpsftm'
plot(x, ...)
```

**Arguments**

**x** an object returned from the `rpsftm` function.  
**...** further arguments passed to or from other methods.

**Value**

a ggplot plot of the fitted KM curves. The underlying data.frame has variables

- time: failure time
- survival: estimated treatment-free survival probability
- upper: upper confidence interval at level defined by alpha in the call to rpsftm
- lower: lower confidence interval at level defined by alpha in the call to rpsftm
- group: randomised treatment arm

**Author(s)**

Simon Bond

**Examples**

```
fit <- rpsftm(Surv(progyrs, prog)~rand(imm,1-xoyrs/progyrs),immdef, censyrs)
plot(fit)
library(ggplot2)
plot(fit)+
  scale_linetype_discrete(labels=c("Control","Experimental"))+
  ylim(0.5,1)+
  geom_ribbon(aes(ymin=lower, ymax=upper, fill=group), alpha=0.3)+
  labs(x="Time (years)", title=NULL, lty="Arm", fill="Arm")
```

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print.rand

*Print method*

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**Description**

print method for rand() objects - to display the summary of rx, by arm

**Usage**

```
## S3 method for class 'rand'
print(x, ...)
```

**Arguments**

x                    a rand() object  
...                   further arguments passed to or from other methods.

**Value**

a summary of rx values broken down by arm for a rand() object

**Author(s)**

Simon Bond

**See Also**

[rand](#), [rpsftm](#)

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print.rpsftm	<i>Print Method</i>
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**Description**

Function used to print of the underlying test object at the point estimate of a rpsftm object

**Usage**

```
## S3 method for class 'rpsftm'
print(x, ...)
```

**Arguments**

x	an object returned from the <a href="#">rpsftm</a> function.
...	further arguments passed to or from other methods.

**Value**

a print of the underlying test object at the point estimate.

**Author(s)**

Simon Bond

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rand	<i>rand functions to use in the rpsftm() formula</i>
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**Description**

A function that is defined to be used in the formula argument, and identified as specials in the terms() object

**Usage**

```
rand(arm, rx)
```

**Arguments**

arm	the randomised treatment arm. a factor with 2 levels, or numeric variable with values 0/1.
rx	the proportion of time on active treatment (arm=1 or the non-reference level of the factor)

**Value**

matrix with two columns named arm and rx. These can be used in the formula argument to rpsftm()

**Author(s)**

Simon Bond

**See Also**

[print.rand](#), [rpsftm](#)

**Examples**

```
x <- with(immdef, rand(imm , 1 - xoyrs / progyrs ) )
x
class(x)
y <- as.data.frame(x)
head(y)
```

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residuals.rpsftm	<i>residual() method for rpsftm objects</i>
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**Description**

Function to apply residual method to rpsftm objects

**Usage**

```
## S3 method for class 'rpsftm'
residuals(object, ...)
```

**Arguments**

object	an object returned from the rpsftm() function.
...	further arguments passed to or from other methods.

**Value**

a residuals object.

**Author(s)**

Simon Bond

**See Also**

[residuals](#) [residuals.coxph](#) [residuals.survreg](#)

rpsftm

*Rank Preserving Structural Failure Time Model***Description**

Main Function used for estimating causal parameters under the Rank Preserving Structural Failure Time Model

**Usage**

```
rpsftm(
  formula,
  data,
  censor_time,
  subset,
  na.action,
  test = survdiff,
  low_psi = -1,
  hi_psi = 1,
  alpha = 0.05,
  treat_modifier = 1,
  autoswitch = TRUE,
  n_eval_z = 100,
  ...
)
```

**Arguments**

formula	a formula with a minimal structure of <code>Surv(time, status)~rand(arm,rx)</code> . Further terms can be added to the right hand side to adjust for covariates and use strata or cluster arguments.
data	an optional data frame that contains variables
censor_time	variable or constant giving the time at which censoring would, or has occurred. This should be provided for all observations unlike standard Kaplan-Meier or Cox regression where it is only given for censored observations. If no value is given then re-censoring is not applied.
subset	expression indicating which subset of the rows of data should be used in the fit. This can be a logical vector (which is replicated to have length equal to the number of observations), a numeric vector indicating which observation numbers are to be included (or excluded if negative), or a character vector of row names to be included. All observations are included by default.
na.action	a missing-data filter function. This is applied to the model.frame after any subset argument has been used. Default is <code>options()\$na.action</code> .
test	the survival regression function to calculate the z-statistic: <code>survdiff</code> , <code>coxph</code> , <code>survreg</code>



low_psi	the lower limit of the range to search for the causal parameter
hi_psi	the upper limit of the range to search for the causal parameter
alpha	the significance level used to calculate confidence intervals
treat_modifier	an optional variable that psi is multiplied by on an individual observation level to give differing impact to treatment.
autoswitch	a logical to autodetect cases of no switching. If TRUE, then if all observations in an arm have perfect compliance then recensoring is not applied in that arm. If FALSE the recensoring is applied regardless of perfect compliance.
n_eval_z	The number of points between hi_psi and low_psi at which to evaluate the Z-statistics in the estimating equation. Default is 100.
...	arguments to supply to the test function.

### Details

the formula object `Surv(time, status)~rand(arm,rx)`. `rand()` stands for randomisation, both the randomly assigned and actual observed treatment.

- `arm`: the randomised treatment arm. a factor with 2 levels, or numeric variable with values 0/1.
- `rx`: the proportion of time on active treatment (`arm=1` or the non-reference level of the factor)

Further adjustment terms can be added on the right hand side of the formula if desired, included `strata()` or `cluster()` terms.

### Value

a `rpsftm` method object that is a list of the following:

- `psi`: the estimated parameter
- `fit`: a `survdiff` object to produce Kaplan-Meier curves of the estimated counterfactual untreated failure times for each treatment arm
- `CI`: a vector of the confidence interval around `psi`
- `Sstar`: the recensored `Surv()` data using the estimate value of `psi` to give counterfactual untreated failure times.
- `rand`: the `rand()` object used to specify the allocated and observed amount of treatment.
- `ans`: the values from `uniroot_all` used to solve the estimating equation, but embedded within a list as per `uniroot`, with an extra element `root_all`, a vector of all roots found in the case of multiple solutions. The first element of `root_all` is subsequently used.
- `eval_z`: a data frame with the Z-statistics from the estimating equation evaluated at a sequence of values of `psi`. Used to plot and check if the range of values to search for solution and limits of confidence intervals need to be modified.
- Further elements corresponding to either a `survdiff`, `coxph`, or `survreg` object. This will always include:
  - `call`: the R call object
  - `formula`: a formula representing any adjustments, strata or clusters- used for the `update()` function
  - `terms`: a more detailed representation of the model formula

**Author(s)**

Simon Bond

**See Also**[survdif](#), [coxph.object](#), [survreg.object](#)**Examples**

```
?immdef
fit <- rpsftm(Surv(progyrs, prog)~rand(imm,1-xoyrs/progyrs),immdef, censyrs)
print(fit)
summary(fit)
plot(fit)
```

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`summary.rpsftm`*summary Method*

---

**Description**

Function used to summarise the fitted model to an rpsftm object

**Usage**

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

**Arguments**

<code>object</code>	an object returned from the <code>rpsftm()</code> function.
<code>...</code>	further arguments passed to or from other methods.

**Value**

a summary of the fitted regression model.

**Author(s)**

Simon Bond

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survfit.rpsftm	<i>survfit() method for rpsftm objects</i>
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**Description**

Function to apply survfit method to rpsftm objects

**Usage**

```
## S3 method for class 'rpsftm'  
survfit(formula, ...)
```

**Arguments**

formula	an object returned from the rpsftm() function. (with the name "formula" to agree with generic argument names)
...	further arguments passed to or from other methods.

**Value**

a survfit object.

**Author(s)**

Simon Bond

**See Also**

[survfit](#)

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