

# Package ‘tpn’

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**Type** Package

**Title** Truncated Positive Normal Model and Extensions

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**Description** Provide data generation and estimation tools for the truncated positive normal model discussed in Gomez, Olmos, Varela and Bolfarine (2018) <[doi:10.1007/s11766-018-3354-x](https://doi.org/10.1007/s11766-018-3354-x)>, the slash truncated positive normal distribution discussed in Gomez, Gallardo and Santoro (2021) <[doi:10.3390/sym13112164](https://doi.org/10.3390/sym13112164)>, the bimodal truncated positive normal distribution discussed in Gomez et al. (2022) <[doi:10.3390/sym14040665](https://doi.org/10.3390/sym14040665)> and the flexible truncated positive normal model.

**Depends** R (>= 4.0.0)

**Imports** pracma, skewMLRM, moments, VGAM

**License** GPL (>= 2)

**NeedsCompilation** no

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btpn	<i>Bimodal truncated positive normal</i>
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### Description

Density, distribution function and random generation for the bimodal truncated positive normal (btpn) discussed in Gomez et al. (2022).

### Usage

```
dbtpn(x, sigma, lambda, eta, log = FALSE)
pbtpn(x, sigma, lambda, eta, lower.tail=TRUE, log=FALSE)
rbtpn(n, sigma, lambda, eta)
```

### Arguments

x	vector of quantiles
n	number of observations
sigma	scale parameter for the distribution
lambda	shape parameter for the distribution
eta	shape parameter for the distribution
log	logical; if TRUE, probabilities p are given as log(p).
lower.tail	logical; if TRUE (default), probabilities are P[X <= x] otherwise, P[X > x].

### Details

Random generation is based on the stochastic representation of the model, i.e., the product between a tpn (see Gomez et al. 2018) and a dichotomous variable assuming values  $-(1 + \epsilon)$  and  $1 - \epsilon$  with probabilities  $(1 + \epsilon)/2$  and  $(1 - \epsilon)/2$ , respectively.

### Value

dbtpn gives the density, pbtpn gives the distribution function and rbtpn generates random deviates.

The length of the result is determined by n for rbtpn, and is the maximum of the lengths of the numerical arguments for the other functions.

The numerical arguments other than n are recycled to the length of the result. Only the first elements of the logical arguments are used.

A variable have btpn distribution with parameters  $\sigma > 0$ ,  $\lambda \in \mathbb{R}$  and  $\eta \in \mathbb{R}$  if its probability density function can be written as

$$f(y; \sigma, \lambda, q) = \frac{\phi\left(\frac{x}{\sigma(1+\epsilon)} + \lambda\right)}{2\sigma\Phi(\lambda)}, y < 0,$$

and

$$f(y; \sigma, \lambda, q) = \frac{\phi\left(\frac{x}{\sigma(1-\epsilon)} - \lambda\right)}{2\sigma\Phi(\lambda)}, y \geq 0,$$

where  $\epsilon = \eta/\sqrt{1+\eta^2}$  and  $\phi(\cdot)$  and  $\Phi(\cdot)$  denote the probability density function and the cumulative distribution function for the standard normal distribution, respectively.

### Author(s)

Gallardo, D.I., Gomez, H.J. and Gomez, Y.M.

### References

Gomez, H.J., Caimanque, W., Gomez, Y.M., Magalhaes, T.M., Concha, M., Gallardo, D.I. (2022) Bimodal Truncation Positive Normal Distribution. *Symmetry*, 14, 665.

Gomez, H.J., Olmos, N.M., Varela, H., Bolfarine, H. (2018). Inference for a truncated positive normal distribution. *Applied Mathematical Journal of Chinese Universities*, 33, 163-176.

### Examples

```
dbtpn(c(1,2), sigma=1, lambda=-1, eta=2)
pbtpn(c(1,2), sigma=1, lambda=-1, eta=2)
rbtpn(n=10, sigma=1, lambda=-1, eta=2)
```

---

choose.ftp

*Choose a distribution in the flexible truncated positive class of models*

---

### Description

Provide model selection for a given data set in the flexible truncated positive class of models

### Usage

```
choose.ftp(y, criteria = "AIC")
```

### Arguments

y                      positive vector of responses  
 criteria                model criteria for the selection: AIC (default) or BIC.

### Details

The function fits the truncated positive normal, truncated positive laplace, truncated positive Cauchy and truncated positive logistic models and select the model which provides the lower criteria (AIC or BIC).

**Value**

A list with the following components

AIC	a vector with the AIC for the different truncated positive fitted models: normal, laplace, cauchy and logistic.
selected	the selected model
estimate	the estimated for sigma and lambda and the respective standard errors (s.e.)
conv	the code related to the convergence for the optim function. 0 if the convergence was attached.
logLik	log-likelihood function evaluated in the estimated parameters.
AIC	Akaike's criterion.
BIC	Schwartz's criterion.

**Author(s)**

Gallardo, D.I., Gomez, H.J. and Gomez, Y.M.

**References**

Gomez, H.J., Gomez, H.W., Santoro, K.I., Venegas, O., Gallardo, D.I. (2022). A Family of Truncation Positive Distributions. Submitted.

Gomez, H.J., Olmos, N.M., Varela, H., Bolfarine, H. (2018). Inference for a truncated positive normal distribution. Applied Mathematical Journal of Chinese Universities, 33, 163-176.

**Examples**

```
set.seed(2021)
y=rftp(n=100,sigma=10,lambda=1,dist="logis")
choose.fntp(y)
```

---

 est.btpn

---

*Parameter estimation for the btpn*


---

**Description**

Perform the parameter estimation for the bimodal truncated positive normal (btpn) discussed in Gomez et al. (2022). Estimated errors are computed based on the hessian matrix.

**Usage**

```
est.btpn(y)
```

**Arguments**

y the response vector. All the values must be positive.

**Details**

A variable have btpn distribution with parameters  $\sigma > 0$ ,  $\lambda \in \mathbb{R}$  and  $\eta \in \mathbb{R}$  if its probability density function can be written as

$$f(y; \sigma, \lambda, q) = \frac{\phi\left(\frac{x}{\sigma(1+\epsilon)} + \lambda\right)}{2\sigma\Phi(\lambda)}, y < 0,$$

and

$$f(y; \sigma, \lambda, q) = \frac{\phi\left(\frac{x}{\sigma(1-\epsilon)} - \lambda\right)}{2\sigma\Phi(\lambda)}, y \geq 0,$$

where  $\epsilon = \eta/\sqrt{1+\eta^2}$  and  $\phi(\cdot)$  and  $\Phi(\cdot)$  denote the probability density function and the cumulative distribution function for the standard normal distribution, respectively.

**Value**

A list with the following components

estimate	A matrix with the estimates and standard errors
iter	Iterations in which the convergence were attached.
logLik	log-likelihood function evaluated in the estimated parameters.
AIC	Akaike's criterion.
BIC	Schwartz's criterion.

**Note**

A warning is presented if the estimated hessian matrix is not invertible.

**Author(s)**

Gallardo, D.I., Gomez, H.J. and Gomez, Y.M.

**References**

Gomez, H.J., Caimanque, W., Gomez, Y.M., Magalhaes, T.M., Concha, M., Gallardo, D.I. (2022) Bimodal Truncation Positive Normal Distribution. *Symmetry*, 14, 665.

**Examples**

```
set.seed(2021)
y=rbtnp(n=100,sigma=10,lambda=1,eta=1.5)
est.btpn(y)
```

est.ftp

*Parameter estimation for the ftp class of distributions***Description**

Perform the parameter estimation for the Flexible truncated positive (ftp) class discussed in Gomez et al. (2022) based on maximum likelihood estimation. Estimated errors are computed based on the hessian matrix.

**Usage**

```
est.ftp(y, dist="norm")
```

**Arguments**

y	the response vector. All the values must be positive.
dist	standard symmetrical distribution. Available options: norm (default), logis, cauchy and laplace.

**Details**

A variable has ftp distribution with parameters  $\sigma > 0$  and  $\lambda \in \mathbb{R}$  if its probability density function can be written as

$$f(y; \sigma, \lambda, q) = \frac{g_0\left(\frac{y}{\sigma} - \lambda\right)}{\sigma G_0(\lambda)}, y > 0,$$

where  $g_0(\cdot)$  and  $G_0(\cdot)$  denote the pdf and cdf for the specified distribution. The case where  $g_0(\cdot)$  and  $G_0(\cdot)$  are from the standard normal model is known as the truncated positive normal model discussed in Gomez et al. (2018).

**Value**

A list with the following components

estimate	A matrix with the estimates and standard errors
dist	distribution specified
conv	the code related to the convergence for the optim function. 0 if the convergence was attached.
logLik	log-likelihood function evaluated in the estimated parameters.
AIC	Akaike's criterion.
BIC	Schwartz's criterion.

**Note**

A warning is presented if the estimated hessian matrix is not invertible.

**Author(s)**

Gallardo, D.I. and Gomez, H.J.

**References**

Gomez, H.J., Gomez, H.W., Santoro, K.I., Venegas, O., Gallardo, D.I. (2022). A Family of Truncation Positive Distributions. Submitted.

Gomez, H.J., Olmos, N.M., Varela, H., Bolfarine, H. (2018). Inference for a truncated positive normal distribution. Applied Mathematical Journal of Chinese Universities, 33, 163-176.

**Examples**

```
set.seed(2021)
y=rftp(n=100,sigma=10,lambda=1,dist="logis")
est.ftp(y,dist="logis")
```

---

 est.stpn

---

*Parameter estimation for the stpn*


---

**Description**

Perform the parameter estimation for the slash truncated positive normal (stpn) discussed in Gomez, Gallardo and Santoro (2021) based on the EM algorithm. Estimated errors are computed based on the Louis method to approximate the hessian matrix.

**Usage**

```
est.stpn(y, sigma0=NULL, lambda0=NULL, q0=NULL, prec = 0.001,
max.iter = 1000)
```

**Arguments**

y	the response vector. All the values must be positive.
sigma0, lambda0, q0	initial values for the EM algorithm for sigma, lambda and q. If they are omitted, by default sigma0 is defined as the root of the mean of the y^2, lambda as 0 and q as 3.
prec	the precision defined for each parameter. By default is 0.001.
max.iter	the maximum iterations for the EM algorithm. By default is 1000.

**Details**

A variable has stpn distribution with parameters  $\sigma > 0, \lambda \in \mathbb{R}$  and  $q > 0$  if its probability density function can be written as

$$f(y; \sigma, \lambda, q) = \int_0^1 t^{1/q} \sigma \phi(yt^{1/q} \sigma - \lambda) dt, y > 0,$$

where  $\phi(\cdot)$  denotes the density function for the standard normal distribution.

**Value**

A list with the following components

estimate	A matrix with the estimates and standard errors
iter	Iterations in which the convergence were attached.
logLik	log-likelihood function evaluated in the estimated parameters.
AIC	Akaike's criterion.
BIC	Schwartz's criterion.

**Note**

A warning is presented if the estimated hessian matrix is not invertible.

**Author(s)**

Gallardo, D.I. and Gomez, H.J.

**References**

Gomez, H., Gallardo, D.I., Santoro, K. (2021) Slash Truncation Positive Normal Distribution: with application using the EM algorithm. *Symmetry*, 13, 2164.

**Examples**

```
set.seed(2021)
y=rstpn(n=100,sigma=10,lambda=1,q=2)
est.stpn(y)
```

---

est.tpn

*Parameter estimation for the tpn*

---

**Description**

Perform the parameter estimation for the truncated positive normal (tpn) discussed in Gomez et al. (2018) based on maximum likelihood estimation. Estimated errors are computed based on the hessian matrix.

**Usage**

```
est.tpn(y)
```

**Arguments**

y the response vector. All the values must be positive.



**Details**

A variable have tpn distribution with parameters  $\sigma > 0$  and  $\lambda \in \mathbf{R}$  if its probability density function can be written as

$$f(y; \sigma, \lambda, q) = \frac{\phi\left(\frac{y}{\sigma} - \lambda\right)}{\sigma\Phi(\lambda)}, y > 0,$$

where  $\phi(\cdot)$  and  $\Phi(\cdot)$  denote the density and cumulative distribution functions for the standard normal distribution.

**Value**

A list with the following components

estimate	A matrix with the estimates and standard errors
logLik	log-likelihood function evaluated in the estimated parameters.
AIC	Akaike's criterion.
BIC	Schwartz's criterion.

**Note**

A warning is presented if the estimated hessian matrix is not invertible.

**Author(s)**

Gallardo, D.I. and Gomez, H.J.

**References**

Gomez, H.J., Olmos, N.M., Varela, H., Bolfarine, H. (2018). Inference for a truncated positive normal distribution. Applied Mathematical Journal of Chinese Universities, 33, 163-176.

**Examples**

```
set.seed(2021)
y=rtpn(n=100,sigma=10,lambda=1)
est.tpn(y)
```

---

ftp

---

*Flexible truncated positive normal*


---

**Description**

Density, distribution function and random generation for the flexible truncated positive (ftp) class discussed in Gomez et al. (2022).

**Usage**

```
dftp(x, sigma, lambda, dist="norm", log = FALSE)
pftp(x, sigma, lambda, dist="norm", lower.tail=TRUE, log.p=FALSE)
qftp(p, sigma, lambda, dist="norm")
rftp(n, sigma, lambda, dist="norm")
```

**Arguments**

x	vector of quantiles
p	vector of probabilities
n	number of observations
sigma	scale parameter for the distribution
lambda	shape parameter for the distribution
dist	standard symmetrical distribution. Available options: norm (default), logis, cauchy and laplace.
log, log.p	logical; if TRUE, probabilities p are given as log(p).
lower.tail	logical; if TRUE (default), probabilities are P[X <= x] otherwise, P[X > x].

**Details**

Random generation is based on the inverse transformation method.

**Value**

dftp gives the density, pftp gives the distribution function, qftp gives the quantile function and rftp generates random deviates.

The length of the result is determined by n for rftp, and is the maximum of the lengths of the numerical arguments for the other functions.

The numerical arguments other than n are recycled to the length of the result. Only the first elements of the logical arguments are used.

A variable have ftp distribution with parameters  $\sigma > 0$  and  $\lambda \in \mathbb{R}$  if its probability density function can be written as

$$f(y; \sigma, \lambda, q) = \frac{g_0\left(\frac{y}{\sigma} - \lambda\right)}{\sigma G_0(\lambda)}, y > 0,$$

where  $g_0(\cdot)$  and  $G_0(\cdot)$  denote the pdf and cdf for the specified distribution. The case where  $g_0(\cdot)$  and  $G_0(\cdot)$  are from the standard normal model is known as the truncated positive normal model discussed in Gomez et al. (2018).

**Author(s)**

Gallardo, D.I., Gomez, H.J. and Gomez, Y.M.

## References

Gomez, H.J., Gomez, H.W., Santoro, K.I., Venegas, O., Gallardo, D.I. (2022). A Family of Truncation Positive Distributions. Submitted.

Gomez, H.J., Olmos, N.M., Varela, H., Bolfarine, H. (2018). Inference for a truncated positive normal distribution. Applied Mathematical Journal of Chinese Universities, 33, 163-176.

## Examples

```
dftp(c(1,2), sigma=1, lambda=1, dist="logis")
pftp(c(1,2), sigma=1, lambda=1, dist="logis")
rftp(n=10, sigma=1, lambda=1, dist="logis")
```

---

stpn

*Slash truncated positive normal*

---

## Description

Density, distribution function and random generation for the slash truncated positive normal (stpn) discussed in Gomez, Gallardo and Santoro (2021).

## Usage

```
dstpn(x, sigma, lambda, q, log = FALSE)
pstpn(x, sigma, lambda, q, lower.tail=TRUE, log=FALSE)
rstpn(n, sigma, lambda, q)
```

## Arguments

x	vector of quantiles
n	number of observations
sigma	scale parameter for the distribution
lambda	shape parameter for the distribution
q	shape parameter for the distribution
log	logical; if TRUE, probabilities p are given as log(p).
lower.tail	logical; if TRUE (default), probabilities are $P[X \leq x]$ otherwise, $P[X > x]$ .

## Details

Random generation is based on the stochastic representation of the model, i.e., the quotient between a tpn (see Gomez et al. 2018) and a beta random variable.

**Value**

dstpn gives the density, pstpn gives the distribution function and rstpn generates random deviates.

The length of the result is determined by n for rstpn, and is the maximum of the lengths of the numerical arguments for the other functions.

The numerical arguments other than n are recycled to the length of the result. Only the first elements of the logical arguments are used.

A variable has stpn distribution with parameters  $\sigma > 0$ ,  $\lambda \in \mathbb{R}$  and  $q > 0$  if its probability density function can be written as

$$f(y; \sigma, \lambda, q) = \int_0^1 t^{1/q} \sigma \phi(yt^{1/q} \sigma - \lambda) dt, y > 0,$$

where  $\phi(\cdot)$  denotes the density function for the standard normal distribution.

**Author(s)**

Gallardo, D.I. and Gomez, H.J.

**References**

Gomez, H., Gallardo, D.I., Santoro, K. (2021) Slash Truncation Positive Normal Distribution: with application using the EM algorithm. *Symmetry*, 13, 2164.

Gomez, H.J., Olmos, N.M., Varela, H., Bolfarine, H. (2018). Inference for a truncated positive normal distribution. *Applied Mathematical Journal of Chinese Universities*, 33, 163-176.

**Examples**

```
dstpn(c(1,2), sigma=1, lambda=-1, q=2)
pstpn(c(1,2), sigma=1, lambda=-1, q=2)
rstpn(n=10, sigma=1, lambda=-1, q=2)
```

---

 tpn

---

*Truncated positive normal*


---

**Description**

Density, distribution function and random generation for the slash truncated positive normal (stpn) discussed in Gomez, Gallardo and Santoro (2021).

**Usage**

```
dtpn(x, sigma, lambda, log = FALSE)
ptpn(x, sigma, lambda, lower.tail=TRUE, log=FALSE)
rtpn(n, sigma, lambda)
```

**Arguments**

x	vector of quantiles
n	number of observations
sigma	scale parameter for the distribution
lambda	shape parameter for the distribution
log	logical; if TRUE, probabilities p are given as log(p).
lower.tail	logical; if TRUE (default), probabilities are P[X <= x] otherwise, P[X > x].

**Details**

Random generation is based on the inverse transformation method.

**Value**

dtpn gives the density, ptpn gives the distribution function and rtpn generates random deviates.

The length of the result is determined by n for rtpn, and is the maximum of the lengths of the numerical arguments for the other functions.

The numerical arguments other than n are recycled to the length of the result. Only the first elements of the logical arguments are used.

A variable have tpn distribution with parameters  $\sigma > 0$  and  $\lambda \in \mathbb{R}$  if its probability density function can be written as

$$f(y; \sigma, \lambda, q) = \frac{\phi\left(\frac{y}{\sigma} - \lambda\right)}{\sigma\Phi(\lambda)}, y > 0,$$

where  $\phi(\cdot)$  and  $\Phi(\cdot)$  denote the density and cumulative distribution functions for the standard normal distribution.

**Author(s)**

Gallardo, D.I. and Gomez, H.J.

**References**

Gomez, H.J., Olmos, N.M., Varela, H., Bolfarine, H. (2018). Inference for a truncated positive normal distribution. Applied Mathematical Journal of Chinese Universities, 33, 163-176.

**Examples**

```
dtpn(c(1,2), sigma=1, lambda=-1)
ptpn(c(1,2), sigma=1, lambda=-1)
rtpn(n=10, sigma=1, lambda=-1)
```

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