# Package 'TPXG'

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**Type** Package

**Title** Two Parameter Xgamma & Poisson Xgamma: Regression & Distribution Functions

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**Depends** R (>= 4.0)

**Imports** Rfast2, stats

**Suggests** Rfast

**Description**
The two-parameter Xgamma and Poisson Xgamma distributions are analyzed, covering standard distribution and regression functions, maximum likelihood estimation, quantile functions, probability density and mass functions, cumulative distribution functions, and random number generation. References include: ``Sen, S., Chandra, N. and Maiti, S. S. (2018). On properties and applications of a two-parameter XGamma distribution. Journal of Statistical Theory and Applications, 17(4): 674--685. <doi:10.2991/jsta.2018.17.4.9>." ``Wani, M. A., Ahmad, P. B., Para, B. A. and Elah, N. (2023). A new regression model for count data with applications to health care data. International Journal of Data Science and Analytics. <doi:10.1007/s41060-023-00453-1>."



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`Cumulative Density Function of the TPXG Distribution`

*Cumulative Density Function of the TPXG Distribution*

---

## Description

Computes the cumulative density function of the Two-Parameter Xgamma distribution for given values.

## Usage

```
ptpxg(x, alpha = 1, theta = 1)
```

## Arguments

| | |
|---|---|
| `x` | A numeric vector with strictly positive values. |
| `alpha` | A positive real number. |
| `theta` | A positive real number. |

## Details

Let $X \sim \text{TPXG}(\alpha, \theta)$. Then the cumulative distribution function of X is given by:

$$F(x) = 1 - \frac{(\alpha + \theta + \alpha\theta x + \frac{1}{2}\alpha\theta^2 x^2)}{(\alpha + \theta)} e^{-\theta x} \quad x, \theta, \alpha > 0$$

## Value

A numeric vector containing the cumulative density function values of the TPXG distribution for each of the given values of x.

### Author(s)

Nikolaos Kontemeniotis.

R implementation and documentation: Nikolaos Kontemeniotis <kontemeniotisn@gmail.com> and Michail Tsagris <mtsagris@uoc.gr>.

### References

"Sen, S., Chandra, N. and Maiti, S. S. (2018). On properties and applications of a two-parameter XGamma distribution. Journal of Statistical Theory and Applications, 17(4): 674–685."

### See Also

dtpxg, qtpxg, rtpxg

### Examples

```
x <- ptpxg(100)
ptpxg(x, 1, 1)
```

---

Cumulative Mass Function of the TPPXG Distribution
*Cumulative Mass Function of the TPPXG Distribution*

---

### Description

Computes the cumulative mass function of the Two Parameter Poisson Xgamma distribution for given values.

### Usage

```
ptppxg(x , alpha = 1, theta = 1)
```

### Arguments

| | |
|---|---|
| x | A numeric vector containg non-negative integer values. |
| alpha | A positive real number. |
| theta | A positive real number. |

### Details

The cumulative distribution function of the Two Parameter Poisson Xgamma is given by:

$$F(x) = 1 - \frac{1}{2(\alpha+\theta)(1+\theta)^{x+3}} \left((x^2+5x+6)\alpha\theta^2 + 2(x+3)\alpha\theta + 2(1+\theta)^2 + 2\alpha\right)$$

### Value

A numeric vector containing the cumulative mass function of the TPPXG distribution for each of the given values of x.

### Author(s)

Nikolaos Kontemeniotis.

R implementation and documentation: Nikolaos Kontemeniotis <kontemeniotisn@gmail.com> and Michail Tsagris <mtsagris@uoc.gr>.

### References

"Wani, M. A., Ahmad, P. B., Para, B. A. and Elah, N. (2023). A new regression model for count data with applications to health care data. International Journal of Data Science and Analytics."

### See Also

dtppxg,qtppxg,rtppxg

### Examples

```
x <- rtppxg(100)
ptppxg(x, 1, 1)
```

---

## Inverse Cumulative Density Function of the TPXG Distribution

*Inverse Cumulative Density Function of the TPXG Distribution*

---

### Description

Computes the inverse cumulative density function of the Two-Parameter Xgamma distribution for given probabilities.

### Usage

```
qtpxg(p, alpha = 1, theta = 1 , tol = 1e-5)
```

### Arguments

| | |
|---|---|
| p | A numeric vector containing values in [0,1]. |
| alpha | A positive real number. |
| theta | A positive real number |
| tol | A positive real number specifying the tolerance level for the convergence of the Newton-Raphson algorithm. |

### Details

This function uses the Newton-Raphson algorithm in order to estimate the inverse cumulative density function.

### Value

A numeric vector containing the inverse cumulative density function values of the TPXG distribution for each of the given values of x.

### Author(s)

Nikolaos Kontemeniotis.

R implementation and documentation: Nikolaos Kontemeniotis `<kontemeniotisn@gmail.com>` and Michail Tsagris `<mtsagris@uoc.gr>`.

### References

"Sen, S., Chandra, N. and Maiti, S. S. (2018). On properties and applications of a two-parameter XGamma distribution. Journal of Statistical Theory and Applications, 17(4): 674–685."

### See Also

`dtpxg`, `ptpxg`, `rtpxg`

### Examples

```
p <- runif(100)
qtpxg(p, 1, 1)
```

---

`Inverse Cumulative Mass Function of the TPPXG Distribution`
*Inverse Cumulative Mass Function of the TPPXG Distribution*

---

### Description

Computes the inverse cumulative mass function (quantile function) of the Two Parameter Poisson Xgamma distribution for given probability values.

### Usage

```
qtppxg(p, alpha = 1, theta = 1, tol = 1e-5)
```

### Arguments

| | |
|---|---|
| `p` | A numeric vector containg values in [0,1]. |
| `alpha` | A positive real number. |
| `theta` | A positive real number. |
| `tol` | A positive real number specifying the tolerance level for the convergence of the Newton-Raphson algorithm. |

### Details

This function uses the Newton-Raphson algorithm in order to estimate the inverse cumulative mass function.

### Value

A numeric vector containing the inverse cumulative mass function of the TPPXG distribution at the given values of p.

### Author(s)

Nikolaos Kontemeniotis.

R implementation and documentation: Nikolaos Kontemeniotis <kontemeniotisn@gmail.com> and Michail Tsagris <mtsagris@uoc.gr>.

### References

"Wani, M. A., Ahmad, P. B., Para, B. A. and Elah, N. (2023). A new regression model for count data with applications to health care data. International Journal of Data Science and Analytics."

### See Also

dtppxg, ptppxg, rtppxg

### Examples

```
p <- runif(100)
qtppxg(p, 1, 1)
```

---

## Maximum Likelihood Estimation of TPPXG Distribution

*Maximum likelihood estimation of the TPPXG distribution parameters.*

---

### Description

Estimation of $\alpha$ and $\theta$ parameters of Two Parameter Poisson Xgamma distribution using maximum likelihood.

### Usage

```
tppxg.mle(x)
```

### Arguments

| | |
|---|---|
| x | A numeric vector containg non-negative integer values. |

### Details

The log-likelihood function of the TPPXG distribution is given by:

$$\ln L(\alpha,\theta) = 2n\ln\theta - n\ln(\alpha+\theta) - \left(3n + \sum_{i=1}^{n} x_i\right)\ln(1+\theta) + \sum_{i=1}^{n}\ln\left((1+\theta)^2 + \frac{\alpha\theta}{2}(x_i+1)(x_i+2)\right)$$

### Value

A named numeric vector containing the estimated values for $\alpha$, $\theta$ and maximum likelihood.

### Author(s)

Nikolaos Kontemeniotis.

R implementation and documentation: Nikolaos Kontemeniotis `<kontemeniotisn@gmail.com>` and Michail Tsagris `<mtsagris@uoc.gr>`.

### References

"Wani, M. A., Ahmad, P. B., Para, B. A. and Elah, N. (2023). A new regression model for count data with applications to health care data. International Journal of Data Science and Analytics."

### See Also

`tppxg.reg`

### Examples

```
x <- rtppxg(1000)
tppxg.mle(x)
```

---

## `Maximum Likelihood Estimation of TPPXG Regression Coefficients`
*Estimation of the TPPXG regression coefficients.*

---

### Description

This function estimates the Two Parameter Poisson Xgamma regression coefficients as well as the $\alpha$ parameter of the Two Parameter Poisson Xgamma distribution using the maximum likelihood method.

### Usage

```
tppxg.reg(y, x)
```

### Arguments

| | |
|---|---|
| `y` | A numeric vector containg non-negative integer values. |
| `x` | A matrix or a data.frame with the predictor variables. |

### Details

The $\theta$ parameter has been transformed as a function of the expected value of the response variable Y in the following manner:

$$\theta = \frac{1 - \alpha\mu + \sqrt{(\alpha\mu - 1)^2 + 12\alpha\mu}}{2\mu}$$

Given that the response variable satisfies $Y_i \sim \text{TPPXG}(\alpha, \mu_i)$, then the $i^{\text{th}}$ mean of Y is related to the predictor variables using the log link function:

$$\mu_i = e^{x_i^T \beta} \quad i = 1, 2, 3, \ldots n$$

For more details, see the paper referenced below.

### Value

A named list containing $\alpha$ parameter, a vector containing the $\beta$ coefficients and the maximum likelihood value.

### Author(s)

Nikolaos Kontemeniotis.

R implementation and documentation: Nikolaos Kontemeniotis <kontemeniotisn@gmail.com> and Michail Tsagris <mtsagris@uoc.gr>.

### References

"Wani, M. A., Ahmad, P. B., Para, B. A. and Elah, N. (2023). A new regression model for count data with applications to health care data. International Journal of Data Science and Analytics."

### See Also

tppxg.mle

### Examples

```
x <- matrix( rnorm(100 * 2), ncol = 2 )
y <- rtppxg(100)
tppxg.reg(y, x)
```

`Maximum Likelihood Estimation of TPXG Distribution`
*Maximum likelihood estimation of the TPXG distribution parameters.*

### Description

Estimation of $\alpha$ and $\theta$ parameters of Two Parameter Xgamma distribution using maximum likelihood.

### Usage

```
tpxg.mle(x)
```

### Arguments

| | |
|---|---|
| `x` | A numeric vector containg strictly positive values. |

### Details

The log-likelihood functiono of the TPXG distribution is given by:

$$\ln L(\alpha, \theta|x) = 2n \ln \theta - n \ln(\alpha + \theta) - \theta \left( \sum_{i=1}^{n} x_i \right) + \sum_{i=1}^{n} \ln \left( 1 + \frac{\alpha\theta}{2} x_i^2 \right)$$

### Value

A named numeric vector containing the estimated values for $\alpha$, $\theta$ and maximum likelihood.

### Author(s)

Nikolaos Kontemeniotis.

R implementation and documentation: Nikolaos Kontemeniotis `<kontemeniotisn@gmail.com>` and Michail Tsagris `<mtsagris@uoc.gr>`.

### References

"Sen, S., Chandra, N. and Maiti, S. S. (2018). On properties and applications of a two-parameter XGamma distribution. Journal of Statistical Theory and Applications, 17(4): 674–685."

### See Also

`tpxg.reg`

### Examples

```
x <- rtpxg(1000)
tpxg.mle(x)
```

---

`Maximum Likelihood Estimation of TPXG Regression Coefficients`
*Estimation of log-link TPXG regression coefficients.*

---

## Description

This function estimates the Two Parameter Xgamma regression coefficients as well as the $\alpha$ parameter of the Two Parameter Xgamma distribution using the maximum likelihood method.

## Usage

```
tpxg.reg(y,x)
```

## Arguments

| | |
|---|---|
| `y` | A numeric vector containg strictly positive values. |
| `x` | A matrix or a data.frame with the predictor variables. |

## Details

This implementation employs a logarithmic link function to relate the $\theta$ parameter of the Two-Parameter Xgamma distribution to the predictor variables. Specifically, the relationship is defined as:

$$\theta = e^{X\beta}$$

where X is a matrix whose columns represent the predictor variables, and $\beta$ is a column vector of corresponding regression coefficients.

## Value

A named list containing $\alpha$ parameter, a vector containing the $\beta$ coefficients and the maximum likelihood value.

## Author(s)

Nikolaos Kontemeniotis.

R implementation and documentation: Nikolaos Kontemeniotis `<kontemeniotisn@gmail.com>` and Michail Tsagris `<mtsagris@uoc.gr>`.

## References

"Sen, S., Chandra, N. and Maiti, S. S. (2018). On properties and applications of a two-parameter XGamma distribution. Journal of Statistical Theory and Applications, 17(4): 674–685."

## See Also

`tpxg.mle`

### Examples

```
x <- matrix( rnorm(100 * 2), ncol = 2 )
y <- rtpxg(100)
tpxg.reg(y, x)
```

---

`Probability Density Function of TPXG Distribution`
*Probability Density Function of TPPXG Distribution*

---

### Description

Computes the probability density function of the Two Parameter Xgamma distribution for a given set positive real values.

### Usage

```
dtpxg(x, alpha = 1, theta = 1)
```

### Arguments

| | |
|---|---|
| `x` | A numeric vector containing strictly positive values. |
| `alpha` | A positive real number. |
| `theta` | A positive real number. |

### Details

Let $U \sim$ TPXG$(\alpha, \theta)$.Then the probability density function of U is given by:

$$f(u; \alpha, \theta) = \frac{\theta^2}{\alpha + \theta}(1 + \frac{\alpha\theta}{2}u^2)e^{-\theta u} \quad \theta, \alpha > 0, u > 0$$

### Value

A numeric vector containing the probability density function value of the TPXG distribution for each of the given values of x.

### Author(s)

Nikolaos Kontemeniotis.

R implementation and documentation: Nikolaos Kontemeniotis <`kontemeniotisn@gmail.com`> and Michail Tsagris <`mtsagris@uoc.gr`>.

### References

"Sen, S., Chandra, N. and Maiti, S. S. (2018). On properties and applications of a two-parameter XGamma distribution. Journal of Statistical Theory and Applications, 17(4): 674–685."

### See Also

rtpxg,qtpxg,ptpxg

### Examples

```
x <- rtpxg(100)
dtpxg(x, 1, 1)
```

---

## Probability Mass Function of the TPPXG Distribution

*Probability Mass Function of the TPPXG Distribution*

---

### Description

Computes the probability mass function of the Two Parameter Poisson Xgamma distribution for a given set of non-negative integer values.

### Usage

```
dtppxg(x, alpha = 1, theta = 1)
```

### Arguments

| | |
|---|---|
| x | A numeric vector containing non-negative integer values. |
| alpha | A positive real number. |
| theta | A positive real number. |

### Details

Assume a random variable X follows the two-parameter Poisson-Xgamma distribution, which has the following stochastic representation:

$$X|\lambda \sim \text{Poisson}(\lambda)$$

$$\lambda|\alpha, \theta \sim \text{TPXG}(\alpha, \theta)$$

Then the probability mass function of X is given by:

$$P(X = x) = \frac{\theta^2}{(\alpha + \theta)(1 + \theta)^{x+3}} \left\{ (1 + \theta)^2 + \frac{\alpha\theta}{2}(x + 1)(x + 2) \right\}; x = 0, 1, 2, 3, \ldots$$

### Value

A numeric vector containing the probability mass function value of the TPPXG distribution for each of the given values of x.

### Author(s)

Nikolaos Kontemeniotis.

R implementation and documentation: Nikolaos Kontemeniotis `<kontemeniotisn@gmail.com>` and Michail Tsagris `<mtsagris@uoc.gr>`.

### References

"Wani, M. A., Ahmad, P. B., Para, B. A. and Elah, N. (2023). A new regression model for count data with applications to health care data. International Journal of Data Science and Analytics."

### See Also

`ptppxg`, `qtppxg`, `rtppxg`

### Examples

```
x <- rtppxg(100)
dtppxg(x, 1, 1)
```

---

`Random Numbers from the TPGX Distribution`
*Random Numbers from the TPGX Distribution*

---

### Description

Generates random numbers form the Two Parameter Xgamma distribution.

### Usage

```
rtpxg(n, alpha = 1, theta = 1)
```

### Arguments

| | |
|---|---|
| `n` | An integer indicating the desired sample size. |
| `alpha` | A positive real number. |
| `theta` | A positive real number. |

### Details

The TPXG distribution is a mixture of $exponential(\theta)$ and $gamma(3, \theta)$ with mixing proportions $\frac{\theta}{\alpha+\theta}$ and $\frac{\alpha}{\alpha+\theta}$ respectively.

### Value

A numeric vector of size n containing random values from the TPXG distribution.

### Author(s)

Nikolaos Kontemeniotis.

R implementation and documentation: Nikolaos Kontemeniotis <kontemeniotisn@gmail.com> and Michail Tsagris <mtsagris@uoc.gr>.

### References

"Sen, S., Chandra, N. and Maiti, S. S. (2018). On properties and applications of a two-parameter XGamma distribution. Journal of Statistical Theory and Applications, 17(4): 674–685."

### See Also

dtpxg, qtpxg, ptpxg

### Examples

```
x <- rtpxg(100)
```

---

Random Numbers from the TPPGX Distribution

*Random Numbers from the TPPGX Distribution*

---

### Description

Generates random numbers form the Two Parameter Poisson Xgamma distribution.

### Usage

```
rtppxg(n, alpha = 1, theta = 1)
```

### Arguments

| | |
|---|---|
| n | An integer indicating the desired sample size. |
| alpha | A positive real number. |
| theta | A positive real number. |

### Details

In order to obtain random numbers from the TPPXG distribution this function works in two parts. First it generates n random $\lambda$ values where $\lambda|\alpha, \theta \sim$ TPXG$(\alpha, \theta)$. Given this, it generates n numbers X where $X|\lambda \sim$ Poisson$(\lambda)$.

### Value

A numeric vector of size n containing random values from the TPPXG distribution.

### Author(s)

Nikolaos Kontemeniotis.

R implementation and documentation: Nikolaos Kontemeniotis <kontemeniotisn@gmail.com> and Michail Tsagris <mtsagris@uoc.gr>.

### References

"Wani, M. A., Ahmad, P. B., Para, B. A. and Elah, N. (2023). A new regression model for count data with applications to health care data. International Journal of Data Science and Analytics."

### See Also

dtppxg,qtppxg,ptppxg

### Examples

```
x <- rtppxg(100)
```

---

TPXG *Two Parameter Xgamma & Poisson Xgamma: Regression & Distribution Functions.*

---

### Description

The two-parameter Xgamma and Poisson Xgamma distributions are analyzed, covering standard distribution and regression functions, maximum likelihood estimation, quantile functions, probability density and mass functions, cumulative distribution functions, and random number generation.

### Details

| | |
|---|---|
| Package: | tpxg |
| Type: | Package |
| Version: | 1.0 |
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| License: | GPL-2 |

### Maintainers

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### Author(s)

Nikolaos Kontemeniotis <kontemeniotisn@gmail.com> and Michail Tsagris <mtsagris@uoc.gr>.

**References**

"Wani, M. A., Ahmad, P. B., Para, B. A. and Elah, N. (2023). A new regression model for count data with applications to health care data. International Journal of Data Science and Analytics."

"Sen, S., Chandra, N. and Maiti, S. S. (2018). On properties and applications of a two-parameter XGamma distribution. Journal of Statistical Theory and Applications, 17(4): 674–685."

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