**ESTIMATION OF STRESS-STRENGTH RELIABILITY FOR TRANSMUTED POWER FUNCTION DISTRIBUTION**

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| **Abstract** This study provides an estimation of the stress-strength reliability for the transmuted power function distribution. We analyzed the transmuted power function distribution and its properties and obtained stress-strength reliability. The maximum likelihood method was used to estimate the transmuted power function distribution parameters. Furthermore, by using the invariance property of the maximum likelihood estimator, we obtained the maximum likelihood estimator of the stress-strength reliability. We designed a comprehensive Monte Carlo simulation study to check whether the maximum likelihood estimator satisfies the estimation procedures in terms of bias and mean square error. The simulation results show that the maximum likelihood estimator of the stress-strength reliability of the transmuted power function distribution satisfies the estimation procedures. |
| Keywords: Transmuted power function distribution, Maximum likelihood estimation, Stress-strength reliability, Monte Carlo simulation |

1. **Introduction**

Transmuted power function distribution is introduced by [1]. The cumulative distribution function (CDF) and probability density function (PDF) are

  , (1)

and

 (2)

respectively, where and  is a shape parameter and  [1]. In this study, we briefly show transmuted power function distribution by.  distribution is useful in many fields namely, engineering, agriculture, economics, biology, and chemistry. [1] examined some distributional properties such as moments, variance, quantile function, reliability function, hazard function, order statistics, and generalized TL-moments for the  distribution. Also, Tanış [2] focused on estimation methods and characterizations such as density shapes and risk measures for distribution.

Stress-strength model describes the lifetime of a component (or a system) with strength and exposed to stress , and is defined as the stress-strength reliability . The stress-strength models have comprehensive application ares including medicine, biology, engineering and agriculture. The R can be written as follows:

, (3)

where is the PDF of *Y,* and is the CDF of *X.* Recenlty, there are many papers about the stress-strength reliability in the literature. Some of these studies are [3-5].

This study discusses the estimation of the stress-strength reliability for the  distribution. The study is organized as follows: Section 2 presents the maximum likelihood estimation of the  distribution. In. Section 3, compherensive Monte Carlo simulation study is performed to assess the performance of the maximum likelihood estimates in terms of mean squares error (MSE) and biases.

1. **Materials and Methods**

In this section, we obtain the maximum likelihood estimator (MLE) of R for the  distribution.

Let *X* and *Y* independently distributed with  and . The R is obtained as follows:

  (4)

To obtain the MLE of R, firstly we derive the MLEs the parameters of the  distribution.

Let  be a random sample from the  distribution. The log-likelihood function is

 (5)

where  is a parameter vector. Then, MLE of  is given as follows:

 (6)

The MLE given in (6) can be derived by **optim ()** function in R with BFGS algorithm.

Using the invariance property of the MLE, by substituting the MLE of into Eq. (4), the MLE of R is calculated as follows:

. (7)

1. **Simulation Study**

In this section, we perform an extensive Monte Carlo simulation study to evaluate the performances of the MLE of R according to MSE and bias. In the simulation study, we consider the parameter settings as follows:

Case 1: ,

Case 2: ,

Case 3: .

We employ 5000 trials for sample sizes n=100,200,500,1000. The simulation results are given in Table 1.

**Table 1.** The bias and MSE values of the R

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Case | R | n |  | bias | MSE |
| 1 | 0.6176 | 100 | 0.6309 | 0.0133 | 0.7836 |
|  |  | 200 | 0.6190 | 0.0014 | 0.0007 |
|  |  | 500 | 0.6181 | 0.0004 | 0.0003 |
|  |  | 1000 | 0.6174 | -0.0001 | 0.0001 |
| 2 | 0.4210 | 100 | 0.4191 | -0.0018 | 0.1032 |
|  |  | 200 | 0.4222 | 0.0012 | 0.0017 |
|  |  | 500 | 0.4213 | 0.0003 | 0.0003 |
|  |  | 1000 | 0.4212 | 0.0001 | 0.0001 |
| 3 | 0.3865 | 100 | 0.2115 | -0.1749 | 37.9998 |
|  |  | 200 | 0.3864 | -0.00007 | 0.0065 |
|  |  | 500 | 0.3847 | -0.0017 | 0.0002 |
|  |  | 1000 | 0.3846 | -0.0019 | 0.0001 |

From the Table 1, it is clear that as the sample size increases decreases the bias and MSE as expected. Also, as n increases  approaches the R and MSE approaches the zero.

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