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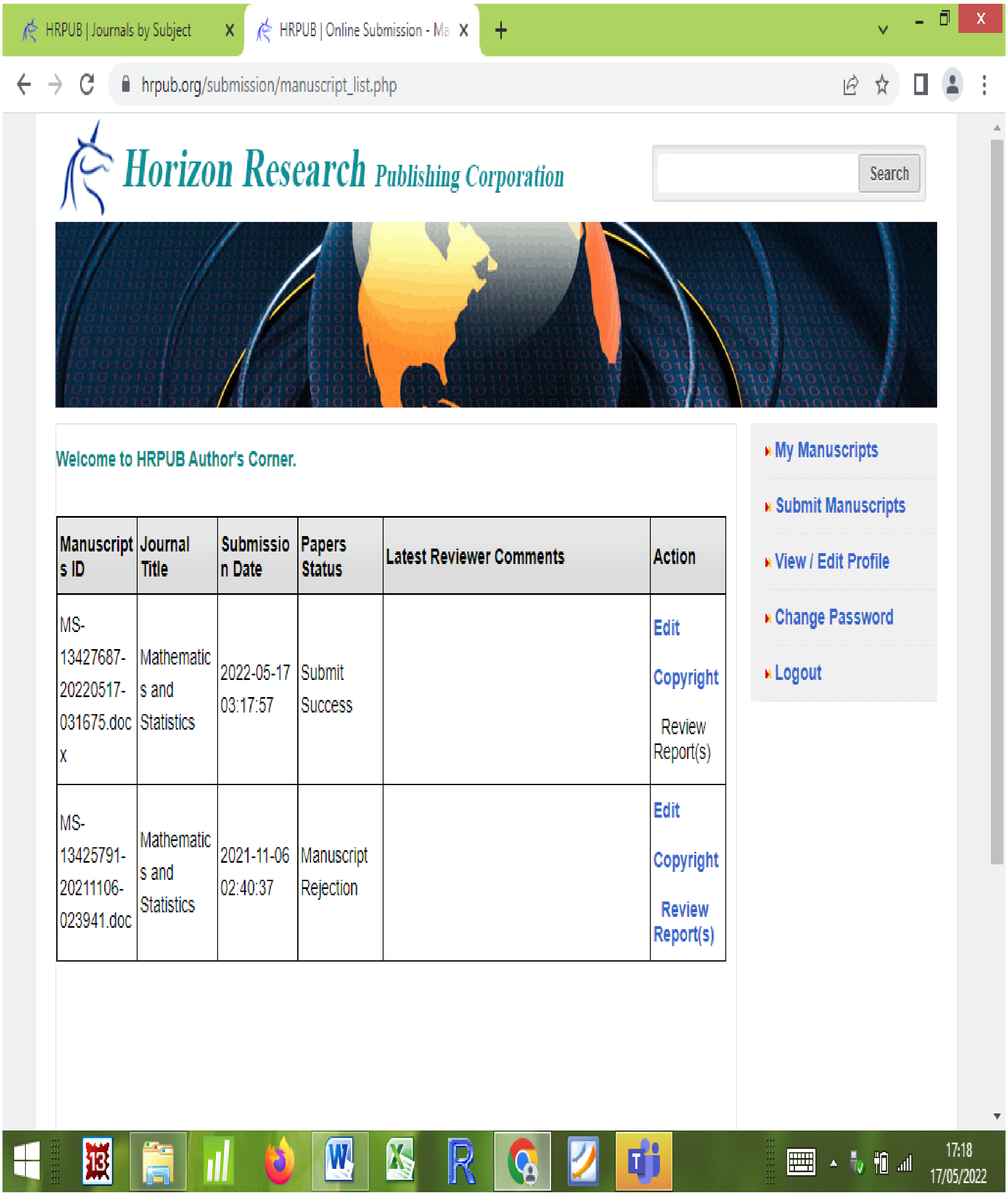

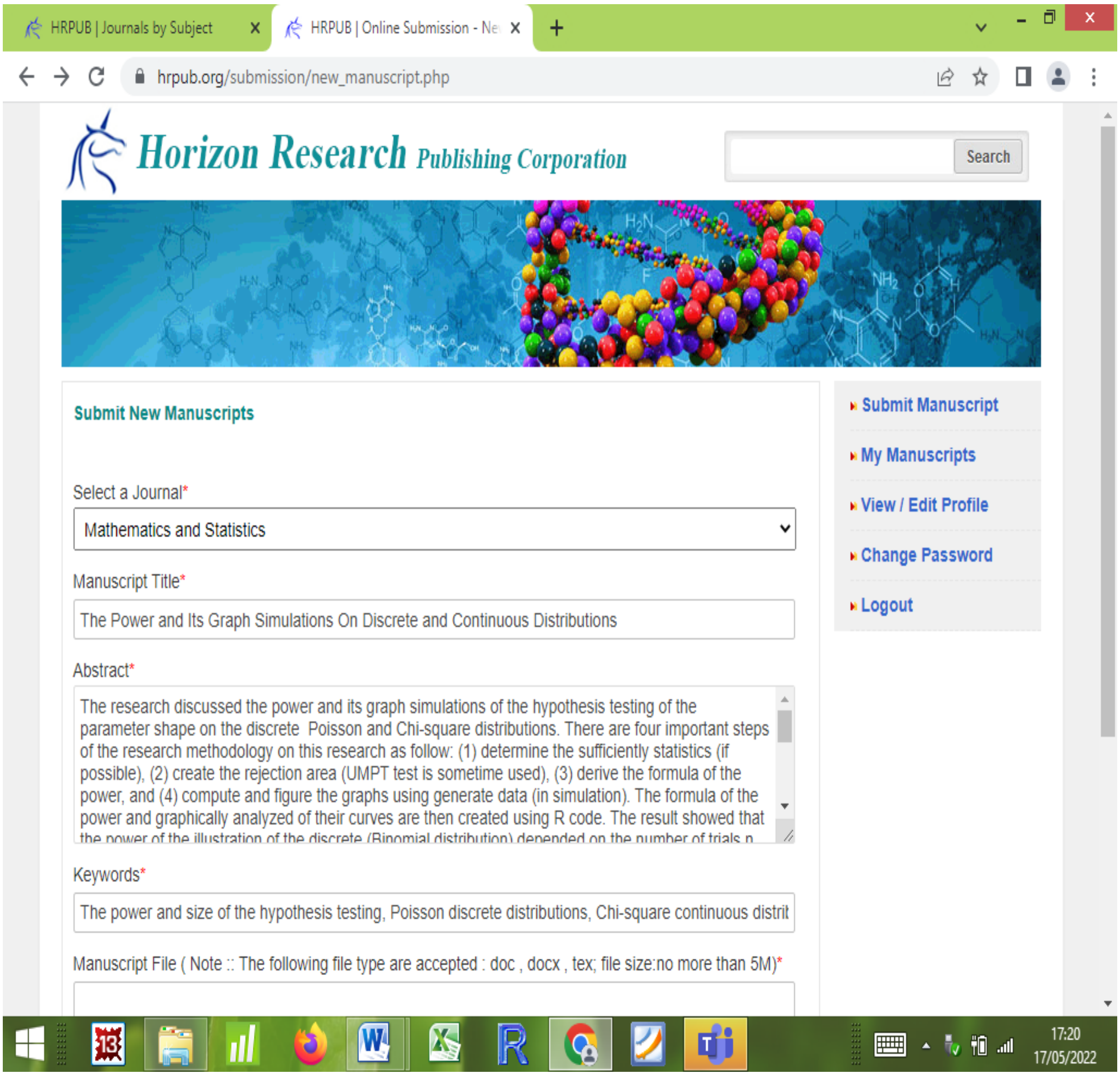
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The Power and Its Graph Simulations On Discrete and Continuous Distributions
Abstract*
The research discussed the power and its graph simulations of the hypothesis testing of the parameter shape on the discrete Poisson and Chi-square distributions. There are four important steps of the research methodology on this research as follow: (1) determine the sufficiently statistics (if possible), (2) create the rejection area (UMPT test is sometime used), (3) derive the formula of the power, and (4) compute and figure the graphs using generate data (in simulation). The formula of the power and graphically analyzed of their curves are then created using R code. The result showed that
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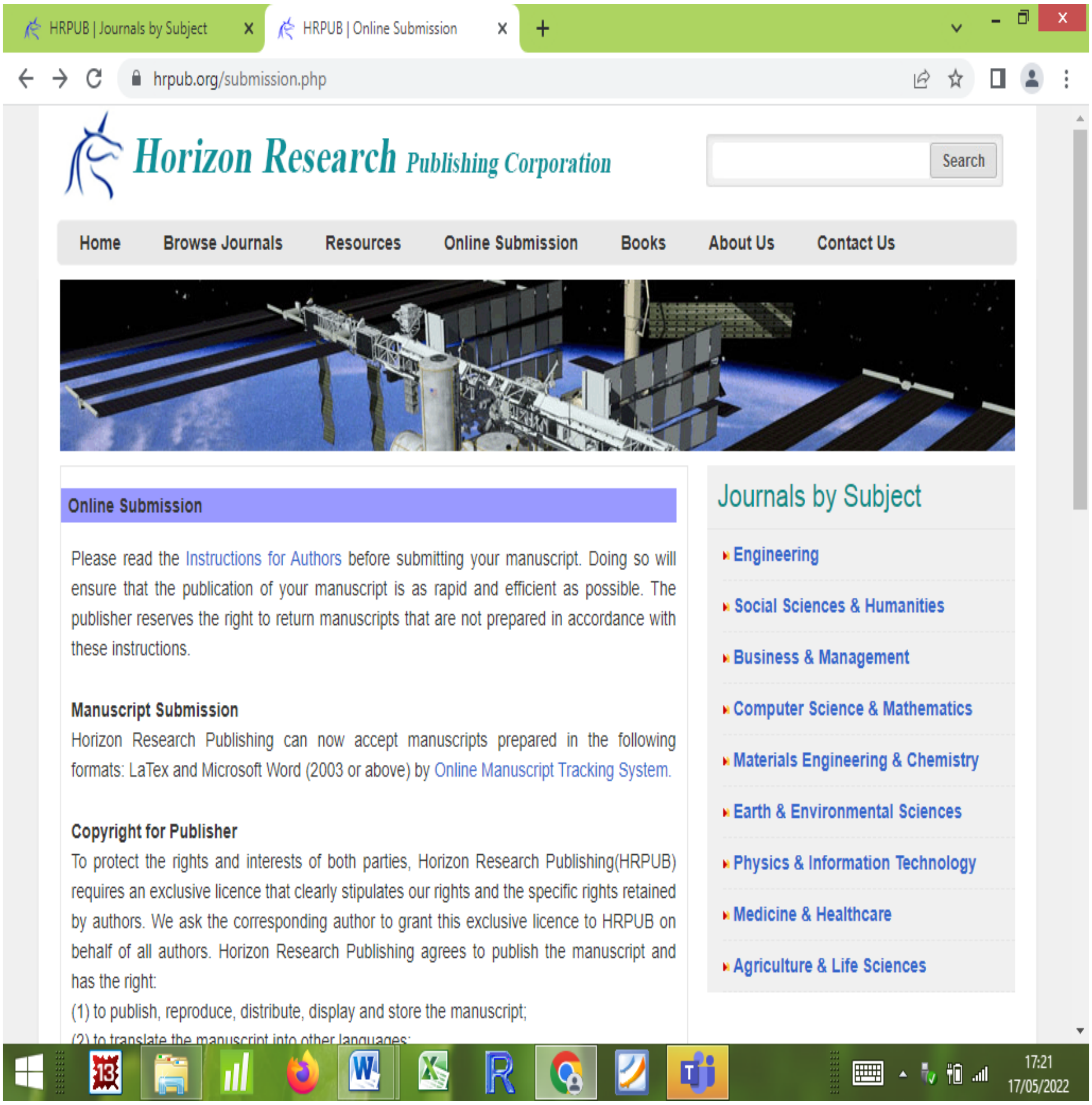

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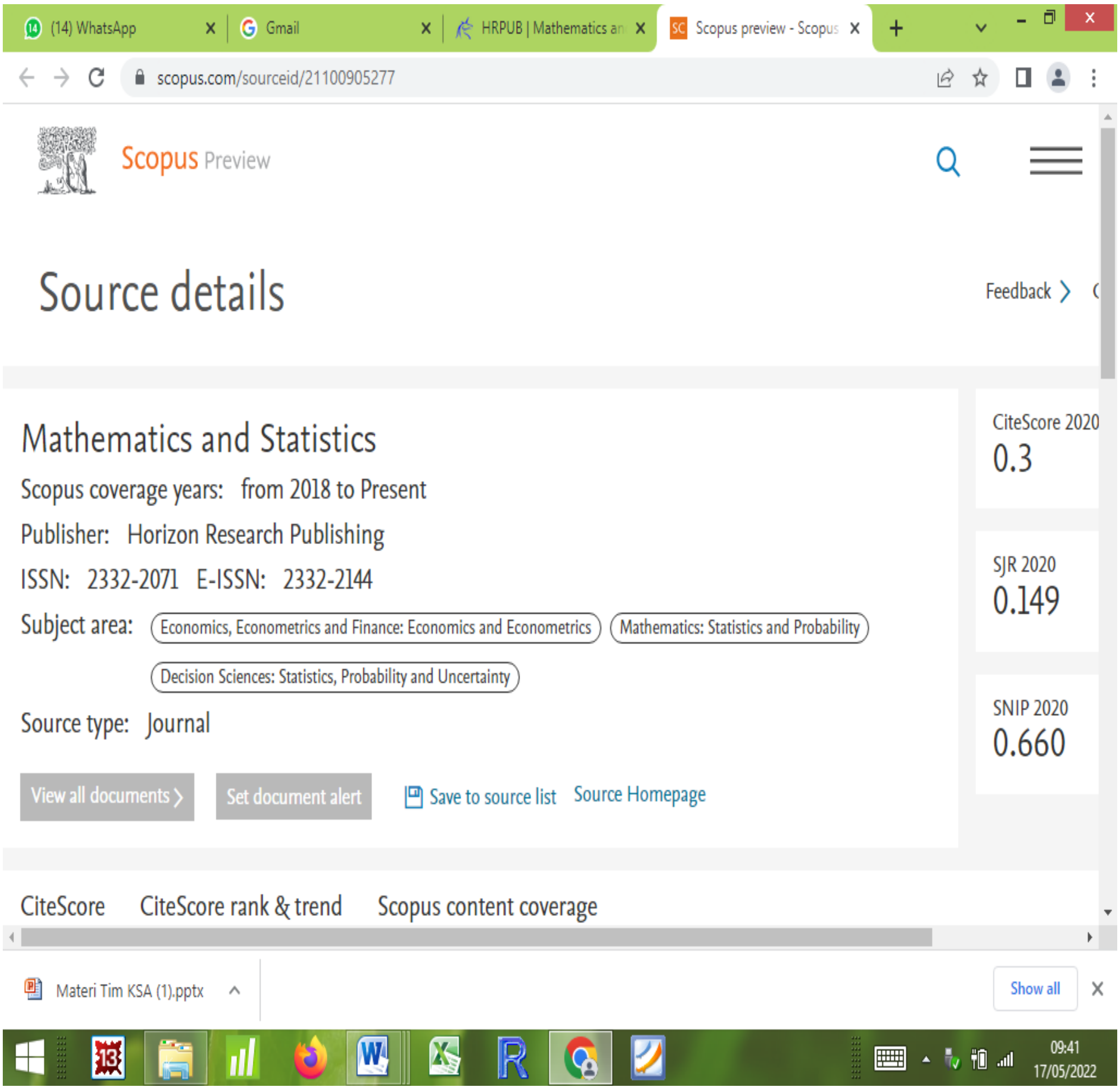
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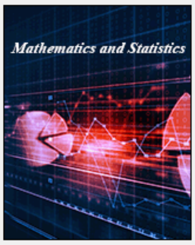

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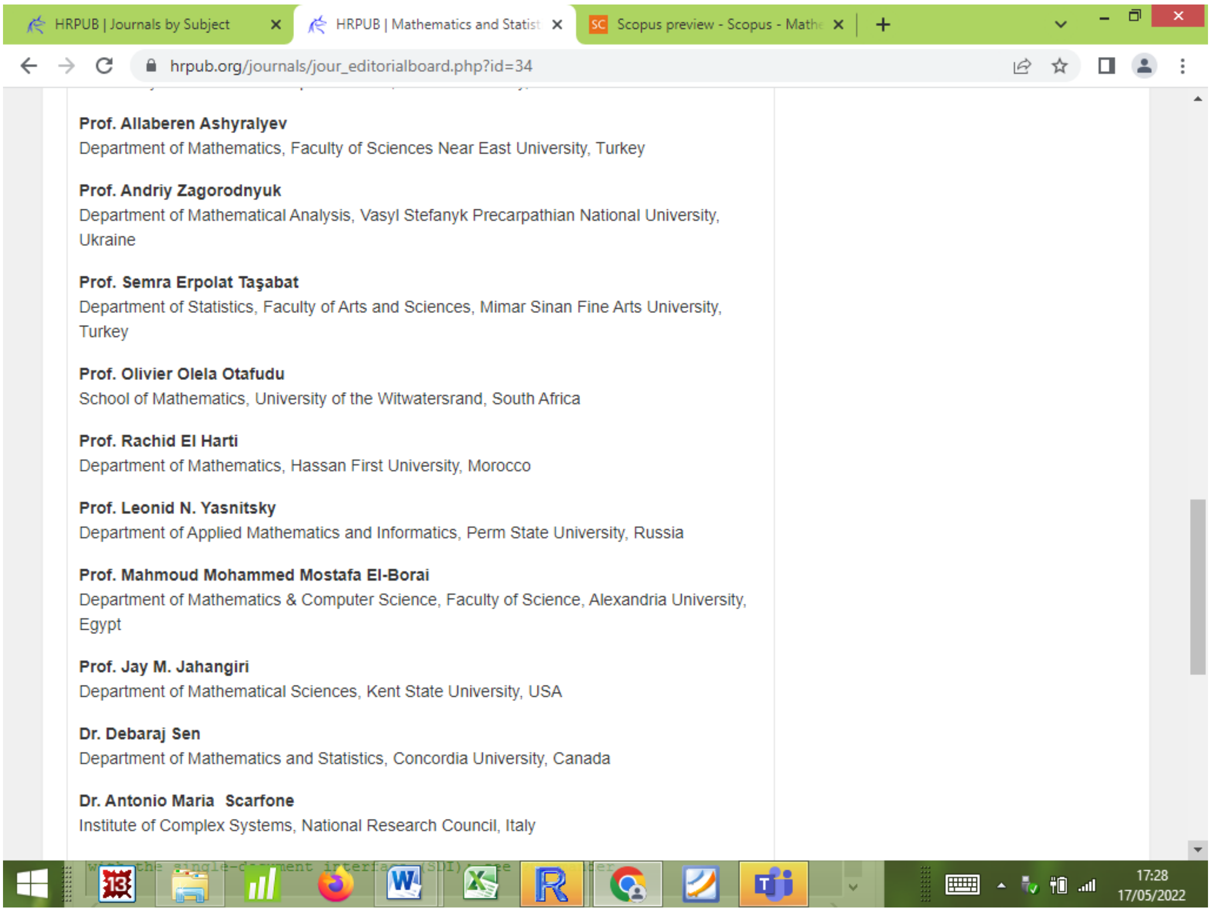
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Chloe Crawford <preview.hrpub@gmail.com> Kam, 19 Mei 14.20 (1 hari yang lalu)

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Thank you very much for submitting your manuscript to HRPUB.
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The R-code of the Graph (Sent 21 May 2022) to the editor for revision Graphs

R code of the Power

(1) for $k = 1,2,3,4,5$

```
op<-par(mfrow=c(1,1))
pi<-function(r)(1-((-(gamma(r/2)*pgamma(0.5,r/2,lower=FALSE)-
(gamma(r/2)*pgamma(0,r/2,lower=FALSE)))/gamma(r/2))))
pi2<-function(r)(1-((-(gamma(r/2)*pgamma(1,r/2,lower=FALSE)-
(gamma(r/2)*pgamma(0,r/2,lower=FALSE)))/gamma(r/2))))
pi3<-function(r)(1-((-(gamma(r/2)*pgamma(1.5,r/2,lower=FALSE)-
(gamma(r/2)*pgamma(0,r/2,lower=FALSE)))/gamma(r/2))))
pi4<-function(r)(1-((-(gamma(r/2)*pgamma(2,r/2,lower=FALSE)-
(gamma(r/2)*pgamma(0,r/2,lower=FALSE)))/gamma(r/2))))
pi5<-function(r)(1-((-(gamma(r/2)*pgamma(2.5,r/2,lower=FALSE)-
(gamma(r/2)*pgamma(0,r/2,lower=FALSE)))/gamma(r/2))))
curve(pi,0,100,n=2000,xname="r",col="black")
curve(pi2,0,100,n=2000,add=TRUE,col="red")
curve(pi3,0,100,n=2000,add=TRUE,col="dark blue")
curve(pi4,0,100,n=2000,add=TRUE,col="orange")
curve(pi5,0,100,n=2000,add=TRUE,col="dark green")
legend(60,0.8,title="k",c(expression(k=1),expression(k=2),expression(k=3),expression(k=4),
expression(k=5)),col=c('black','red','dark blue','orange','dark green'),lty=1,bg='white')
```

(2) for $k = 6,7,8,9,10$

```
op<-par(mfrow=c(1,1))
pi6<-function(r)(1-((-(gamma(r/2)*pgamma(3,r/2,lower=FALSE)-
(gamma(r/2)*pgamma(0,r/2,lower=FALSE)))/gamma(r/2))))
pi7<-function(r)(1-((-(gamma(r/2)*pgamma(3.5,r/2,lower=FALSE)-
(gamma(r/2)*pgamma(0,r/2,lower=FALSE)))/gamma(r/2))))
pi8<-function(r)(1-((-(gamma(r/2)*pgamma(4,r/2,lower=FALSE)-
(gamma(r/2)*pgamma(0,r/2,lower=FALSE)))/gamma(r/2))))
```

```
pi9<-function(r)(1-((-(gamma(r/2)*pgamma(4.5,r/2,lower=FALSE)-
(gamma(r/2)*pgamma(0,r/2,lower=FALSE)))/gamma(r/2))))
pi10<-function(r)(1-((-(gamma(r/2)*pgamma(5,r/2,lower=FALSE)-
(gamma(r/2)*pgamma(0,r/2,lower=FALSE)))/gamma(r/2))))
curve(pi6,0,100,n=2000, xname="r",col="black")
curve(pi7,0,100,n=2000,add=TRUE,col="red")
curve(pi8,0,100,n=2000,add=TRUE,col="dark blue")
curve(pi9,0,100,n=2000,add=TRUE,col="orange")
curve(pi10,0,100,n=2000,add=TRUE,col="dark green")
legend(60,0.8,title="k",c(expression(k=6),expression(k=7),expression(k=8),expression(k=9),
expression(k=10)),col=c('black','red','dark blue','orange','dark green'),lty=1,bg='white')
```

(3) for $k = 11,12,13,14,15$

```
op<-par(mfrow=c(1,1))
pi11<-function(r)(1-((-(gamma(r/2)*pgamma(5.5,r/2,lower=FALSE)-
(gamma(r/2)*pgamma(0,r/2,lower=FALSE)))/gamma(r/2))))
pi12<-function(r)(1-((-(gamma(r/2)*pgamma(6,r/2,lower=FALSE)-
(gamma(r/2)*pgamma(0,r/2,lower=FALSE)))/gamma(r/2))))
pi13<-function(r)(1-((-(gamma(r/2)*pgamma(6.5,r/2,lower=FALSE)-
(gamma(r/2)*pgamma(0,r/2,lower=FALSE)))/gamma(r/2))))
pi14<-function(r)(1-((-(gamma(r/2)*pgamma(7,r/2,lower=FALSE)-
(gamma(r/2)*pgamma(0,r/2,lower=FALSE)))/gamma(r/2))))
pi15<-function(r)(1-((-(gamma(r/2)*pgamma(7.5,r/2,lower=FALSE)-
(gamma(r/2)*pgamma(0,r/2,lower=FALSE)))/gamma(r/2))))
curve(pi11,0,100,n=2000,xname="r",col="black")
curve(pi12,0,100,n=2000,add=TRUE,col="red")
curve(pi13,0,100,n=2000,add=TRUE,col="dark blue")
curve(pi14,0,100,n=2000,add=TRUE,col="orange")
curve(pi15,0,100,n=2000,add=TRUE,col="dark green")
legend(60,0.8,title="k",c(expression(k=11),expression(k=12),expression(k=13),expression(k
=14),expression(k=15)),col=c('black','red','dark blue','orange','dark green'),lty=1,bg='white')
```

(4) for $k = 16,17,18,19,20$

```
op<-par(mfrow=c(1,1))
pi16<-function(r)(1-((-(gamma(r/2)*pgamma(8,r/2,lower=FALSE)-
(gamma(r/2)*pgamma(0,r/2,lower=FALSE)))/gamma(r/2))))
pi17<-function(r)(1-((-(gamma(r/2)*pgamma(8.5,r/2,lower=FALSE)-
(gamma(r/2)*pgamma(0,r/2,lower=FALSE)))/gamma(r/2))))
pi18<-function(r)(1-((-(gamma(r/2)*pgamma(9,r/2,lower=FALSE)-
(gamma(r/2)*pgamma(0,r/2,lower=FALSE)))/gamma(r/2))))
pi19<-function(r)(1-((-(gamma(r/2)*pgamma(9.5,r/2,lower=FALSE)-
(gamma(r/2)*pgamma(0,r/2,lower=FALSE)))/gamma(r/2))))
pi20<-function(r)(1-((-(gamma(r/2)*pgamma(10,r/2,lower=FALSE)-
(gamma(r/2)*pgamma(0,r/2,lower=FALSE)))/gamma(r/2))))
curve(pi16,0,100,n=2000, xname="r",col="black")
curve(pi17,0,100,n=2000,add=TRUE,col="red")
curve(pi18,0,100,n=2000,add=TRUE,col="dark blue")
curve(pi19,0,100,n=2000,add=TRUE,col="orange")
curve(pi20,0,100,n=2000,add=TRUE,col="dark green")
legend(60,0.8,title="k",c(expression(k=16),expression(k=17),expression(k=18),expression(k
=19),expression(k=20)),col=c('black','red','dark blue','orange','dark green'),lty=1,bg='white')
```

R code of the size

(1) for $k = 1,2,3,4,5$

```
op<-par(mfrow=c(1,1))
alpha<-function(r)(1-((-(gamma(r/2)*pgamma(8,r/2,lower=FALSE)-
(gamma(r/2)*pgamma(0,r/2,lower=FALSE)))/gamma(r/2))))
alpha1<-function(r)0.3+(0*r)
alpha2<-function(r)0.16+(0*r)
alpha3<-function(r)0.08+(0*r)
alpha4<-function(r)0.045+(0*r)
alpha5<-function(r)0.025+(0*r)
curve(alpha,0,100,n=2000,xname="r",col="white")
curve(alpha1,0,100,n=2000,add=TRUE,col="black")
curve(alpha2,0,100,n=2000,add=TRUE,col="red")
```

```
curve(alpha3,0,100,n=2000,add=TRUE,col="dark blue")
curve(alpha4,0,100,n=2000,add=TRUE,col="orange")
curve(alpha5,0,100,n=2000,add=TRUE,col="dark green")
legend(60,1.0,title="k",c(expression(k=1),expression(k=2),expression(k=3),expression(k=4),
expression(k=5)),col=c('black','red','dark blue','orange','dark green'),lty=1,bg='white')
```

(2) for $k = 6,7,8,9,10$

```
op<-par(mfrow=c(1,1))
alpha<-function(r)(1-((-(gamma(r/2)*pgamma(8,r/2,lower=FALSE)-
(gamma(r/2)*pgamma(0,r/2,lower=FALSE)))/gamma(r/2))))
alpha6<-function(r)0.014+(0*r)
alpha7<-function(r)0.008+(0*r)
alpha9<-function(r)0.0027+(0*r)
alpha10<-function(r)0.0016+(0*r)
alpha8<-function(r)0.0046+(0*r)
curve(alpha,0,100,n=2000,xname="r",col="white")
curve(alpha6,0,100,n=2000,add=TRUE,col="black")
curve(alpha7,0,100,n=2000,add=TRUE,col="red")
curve(alpha8,0,100,n=2000,add=TRUE,col="dark blue")
curve(alpha9,0,100,n=2000,add=TRUE,col="orange")
curve(alpha10,0,100,n=2000,add=TRUE,col="dark green")
legend(60,1.0,title="k",c(expression(k=6),expression(k=7),expression(k=8),expression(k=9),
expression(k=10)),col=c('black','red','dark blue','orange','dark green'),lty=1,bg='white')
```

(3) for $k = 11,12,13,14,15$

```
op<-par(mfrow=c(1,1))
alpha<-function(r)(1-((-(gamma(r/2)*pgamma(8,r/2,lower=FALSE)-
(gamma(r/2)*pgamma(0,r/2,lower=FALSE)))/gamma(r/2))))
alpha11<-function(r)0.000911+(0*r)
alpha12<-function(r)0.000532+(0*r)
alpha13<-function(r)0.00031+(0*r)
alpha14<-function(r)0.0001828+(0*r)
alpha15<-function(r)0.0001075+(0*r)
```

```
curve(alpha,0,100,n=2000,xname="r",col="white")
curve(alpha11,0,100,n=2000,add=TRUE,col="black")
curve(alpha12,0,100,n=2000,add=TRUE,col="red")
curve(alpha13,0,100,n=2000,add=TRUE,col="dark blue")
curve(alpha14,0,100,n=2000,add=TRUE,col="orange")
curve(alpha15,0,100,n=2000,add=TRUE,col="dark green")
legend(60,1.0,title="k",c(expression(k=11),expression(k=12),expression(k=13),expression(k
=14),expression(k=15)),col=c('black','red','dark blue','orange','dark green'),lty=1,bg='white')
```

(4) for $k = 16,17,18,19,20$

```
op<-par(mfrow=c(1,1))
alpha<-function(r)(1-((-(gamma(r/2)*pgamma(8,r/2,lower=FALSE)-
(gamma(r/2)*pgamma(0,r/2,lower=FALSE)))/gamma(r/2))))
alpha16<-function(r)0.0000633+(0*r)
alpha17<-function(r)0.0000373+(0*r)
alpha18<-function(r)0.0000221+(0*r)
alpha19<-function(r)0.0000131+(0*r)
alpha20<-function(r)0.00000774+(0*r)
curve(alpha,0,100,n=2000,xname="r",col="white")
curve(alpha16,0,100,n=2000,add=TRUE,col="black")
curve(alpha17,0,100,n=2000,add=TRUE,col="red")
curve(alpha18,0,100,n=2000,add=TRUE,col="dark blue")
curve(alpha19,0,100,n=2000,add=TRUE,col="yellow")
curve(alpha20,0,100,n=2000,add=TRUE,col="dark green")
legend(60,1.0,title="k",c(expression(k=16),expression(k=17),expression(k=18),expression(k
=19),expression(k=20)),col=c('black','red','dark blue','orange','dark green'),lty=1,bg='white')
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dari: **Chloe Crawford** <preview.hrpub@gmail.com>

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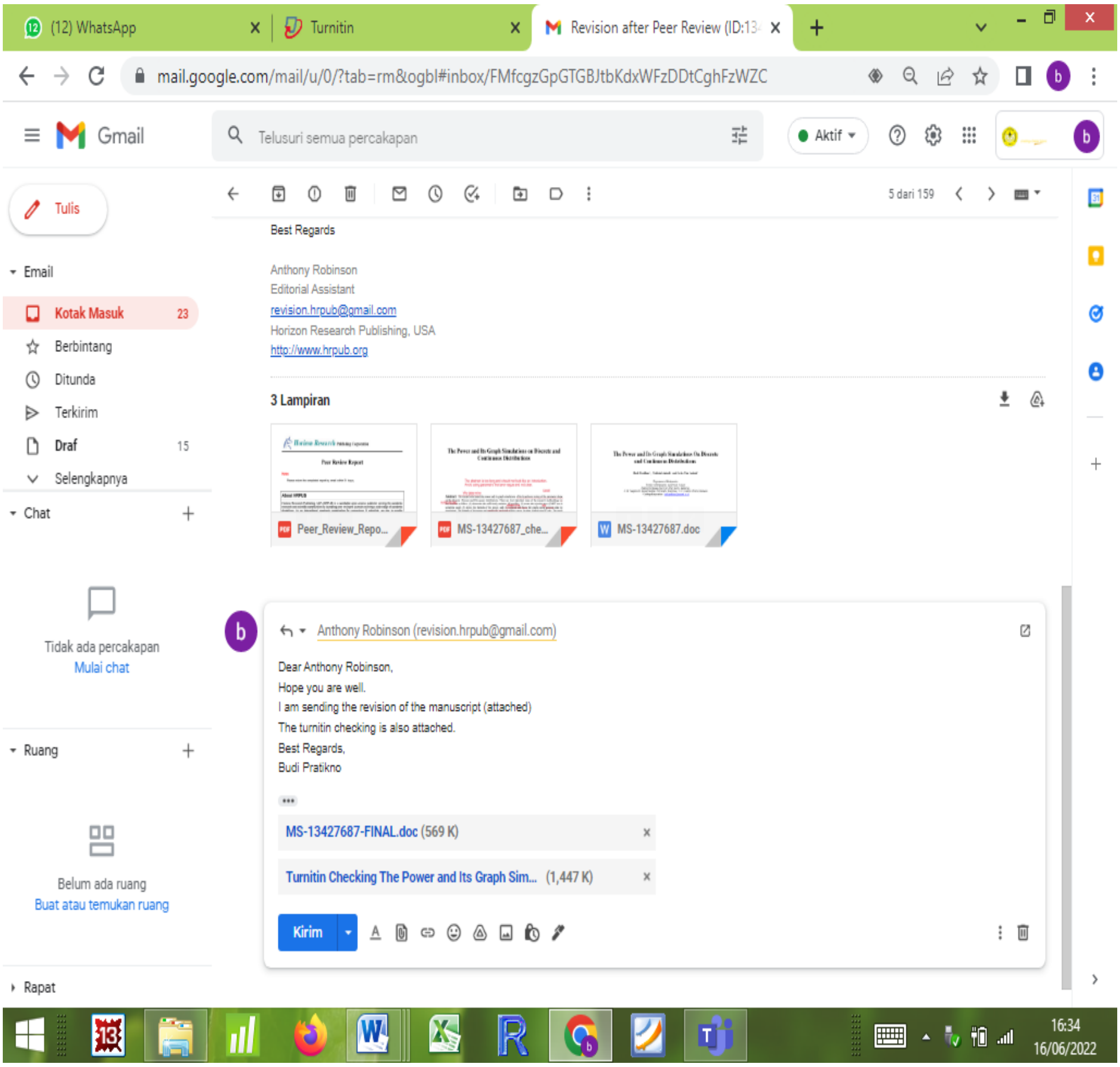
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3 Lampiran
Peer_Review_Repo...
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The turnitin checking is also attached.
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MS-13427687-FINAL.doc (569 K)
Turnitin Checking The Power and Its Graph Sim... (1,447 K)
Kirim
16:34
16/06/2022

Anthony Robinson 09.46 (6 jam yang lalu)

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* Please carefully check the whole manuscript to ensure consistency and accuracy in grammar, spelling, punctuation and formatting, especially those parts proofread by our team.

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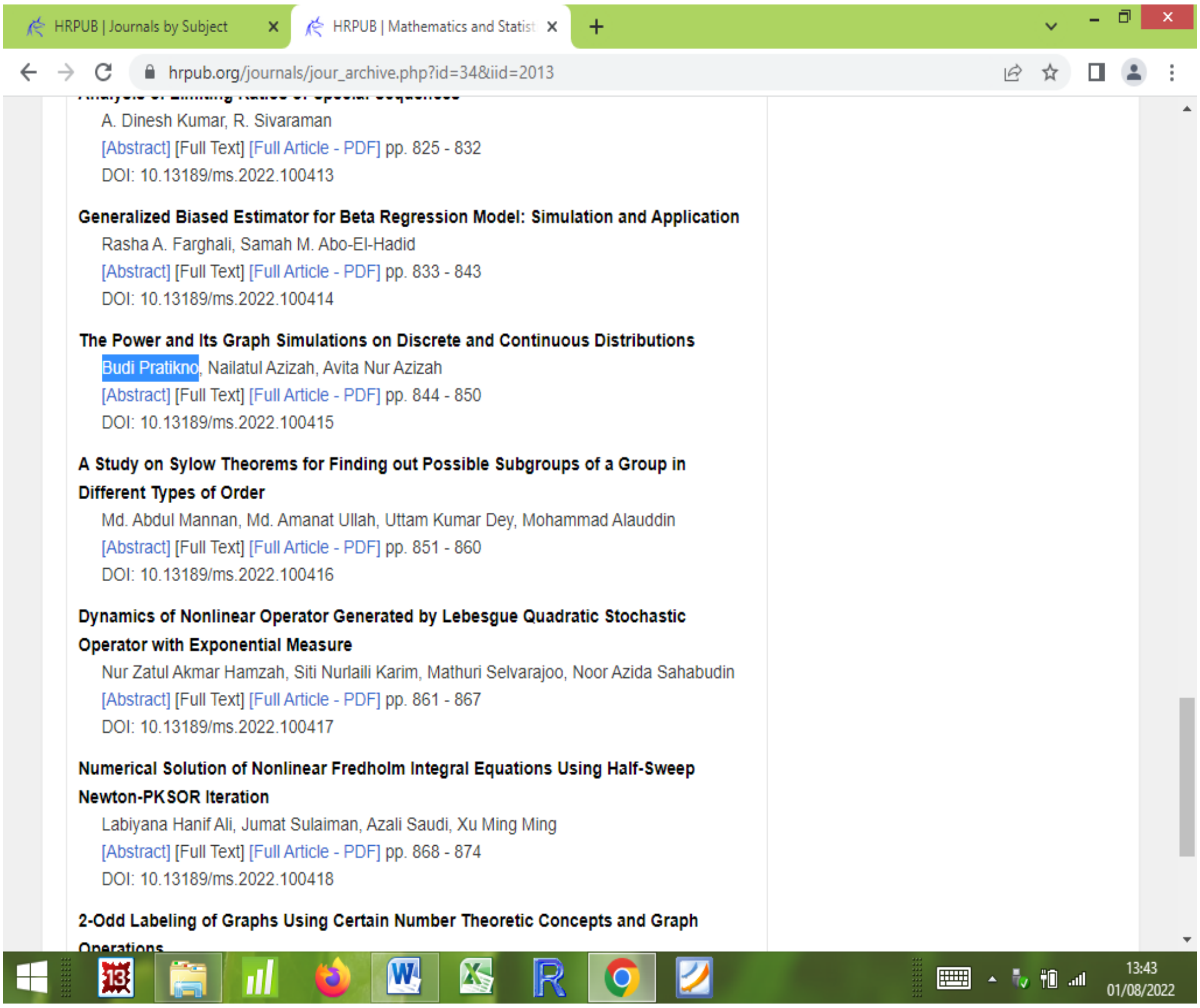

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A. Dinesh Kumar, R. Sivaraman
[Abstract] [Full Text] [Full Article - PDF] pp. 825 - 832
DOI: 10.13189/ms.2022.100413

Generalized Biased Estimator for Beta Regression Model: Simulation and Application
Rasha A. Farghali, Samah M. Abo-El-Hadid
[Abstract] [Full Text] [Full Article - PDF] pp. 833 - 843
DOI: 10.13189/ms.2022.100414

The Power and Its Graph Simulations on Discrete and Continuous Distributions
Budi Pratikno, Nailatul Azizah, Avita Nur Azizah
[Abstract] [Full Text] [Full Article - PDF] pp. 844 - 850
DOI: 10.13189/ms.2022.100415

A Study on Sylow Theorems for Finding out Possible Subgroups of a Group in Different Types of Order
Md. Abdul Mannan, Md. Amanat Ullah, Uttam Kumar Dey, Mohammad Alauddin
[Abstract] [Full Text] [Full Article - PDF] pp. 851 - 860
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Dynamics of Nonlinear Operator Generated by Lebesgue Quadratic Stochastic Operator with Exponential Measure
Nur Zatul Akmar Hamzah, Siti Nurlaili Karim, Mathuri Selvarajoo, Noor Azida Sahabudin
[Abstract] [Full Text] [Full Article - PDF] pp. 861 - 867
DOI: 10.13189/ms.2022.100417

Numerical Solution of Nonlinear Fredholm Integral Equations Using Half-Sweep Newton-PKSOR Iteration
Labiyana Hanif Ali, Jumat Sulaiman, Azali Saudi, Xu Ming Ming
[Abstract] [Full Text] [Full Article - PDF] pp. 868 - 874
DOI: 10.13189/ms.2022.100418

2-Odd Labeling of Graphs Using Certain Number Theoretic Concepts and Graph Operations

13:43
01/08/2022

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Journal Manager
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The Power and Its Graph Simulations on Discrete and Continuous Distributions

The abstract is too long and should not look like an introduction.
Avoid using parametrs that arer vague and not clear.

Abstract The research discussed the power and its graph simulations of the hypothesis testing of the parameter shape on the discrete Poisson and Chi-square distributions. There are four important steps of the research methodology on this research as follow: (1) determine the sufficiently statistics (if possible), (2) create the rejection area (UMPT test is sometime used), (3) derive the formula of the power, and (4) compute and figure the graphs using generate data (in simulation). The formula of the power and graphically analyzed of their curves are then created using *R* code. The result showed that the power of the illustration of the discrete (Binomial distribution) depended on the number of trials *n* and bound of the rejection area. The curve of the power is sigmoid (*S*-curve) and tend to be zero when theta greater 0.4. It decreases (started from theta = 0.2) as the parameter theta increases. In the Poisson context, the curves of the power of the Poisson distribution is not *S*-curve, and it is only depended on the parameter shape λ. We noted that the curve of the power of the Poisson is quickly to be one for n greater than 2 and λ less than 10. In this case, the size of the Poisson distribution is greater than 0.05, so it is not a reasonable thing even the power close to be one. In this context, we must have the maximum power and minimum size. In the context of Chi-square distribution, the graph of the power and size functions was depended on rejection region boundary (*k*). Here**,** we noted that *skewness* of the S-curve positive as the k increases. Similarly, the size are also depended of the k (and constant), and it decrease as the k increases. We here also noted that the power quickly to be one for large degree of freedom (*r*).

Keywords The power and size of the hypothesis testing, Poisson discrete distributions, Chi-square continuous distribution, parameter shape, and R-code

1. Introduction

In the theory of statistics, there are three important concepts of the hypothesis testing in rejecting or accepting null hypothesis (H_0), namely (1) a probability error type I (α), (2) a probability error type II (β) and (3) power of the test $(\pi(\theta))$ (Wackerly, et al. [5]). Here, the power is a significant method to test the hypothesis testing on parameter shape. Therefore, we then studied more detail the power of the hypothesis testing on some various discreet and continuous distributions. Furthermore, Wackerly, et al. [5] defined the power as a probability to reject H_0 under H_1 in testing hypothesis parameter shape, $H_0 : \theta = \theta_0$ versus $H_1 : \theta \neq \theta_0$, for parameter θ.

Following to the previous research, we noted many authors, such as Pratikno [2], Khan and Pratikno [22] and Khan [12], already used the power in testing intercept with non-sample prior information (NSPI). They used the probability integral of the cumulative distribution function (cdf) of the continuous distributions. Moreover, Pratikno [2] and Khan et al. [11] used the power and size to compute the cdf of the bivariate noncentral *F (*BNCF*)* distribution in multivariate and multiple regression models. Here, we also noted that many authors, such as Khan [12, 13, 14], Khan and Saleh [15,16,17, 20, 21], Khan and Hoque [19], Saleh [1], Yunus [6], and Yunus and Khan [7, 8, 9, 10], have contributed to the research of the power in the context of the hypothesis area. In the context of the hypothesis testing with NSPI on multivariate and multiple regression models, Pratikno [2] and Khan et al. [11] used the BNCF distribution to compute the power using *R-code*. This is due to the computational of the probability integral of the probability distribution function (pdf) and cdf of the BNCF distribution are very complicated and hard (see Pratikno [2] and Khan et al.[18]), so the R code is used.

As we noted that some the previous research studied the power of the hypothesis testing on the continuous distribution, but here we focused to have research on discrete distributions (Poisson and Binomial as initiate distributions) and continuous Chi-square distribution. Furthermore, the steps to compute the power of the Binomial (as initiate), Poisson and Chi-square distributions are similar with the previous theory (or research), that are: (1) we must determine the sufficiently statistics (if possible), (2) we then create the rejection area using *uniformly most powerful test* (UMPT, if needed), (3) we then must derive the formula of the power of the discrete and continuous distributions, and (4) finally, we do graphically analysed of the power. A simulation is then conducted using generate data.

* Unlike previous research focusing on continuous distribution,
we only consider discrete distributions (Poisson...)

In this paper, the introduction is given in Section 1. The concept of power and size (as initiate, Binomial distribution) of the testing hypothesis is presented in Section 2. The derive formula and graphically analysis of the power of the power and size of the Binomial, Poisson and Chi-square distributions are then given in Section 3. The conclusion is provided in Section 4.

2. The Power and Size of One-Side Hypothesis Testing

Following Pratikno [2], Khan [12,13,14], Khan and Saleh [15,16,17,20,21], Khan and Hoque [19], Saleh [1], Yunus [6], and Yunus and Khan [7, 8, 9, 10], we noted that the power and size of the tests are a significant method to find the significant conclusion of the hypothesis testing parameter shape. Here, we must choose the maximum power and minimum size as an indicator. Furthermore, Wackerly, et al. [5] generally defined that the power is a probability to reject H_0 under H_1 in testing hypothesis, and the size is a probability to reject H_0 under H_0. Following Pratikno [2], we then write the power and size in testing hypothesis, $H_0 : \theta = \theta_0$ versus $H_1 : \theta > \theta_0$ $\left(\text{or } H_1 : \theta = \theta_1\right)$ as, respectively,

not clear. What do you mean by probability? ??

not typed appropriately!

use center mode for example!

$$\pi(\theta_1) = P\left(\text{reject } H_0 \mid under\ H_1\right) = P\left(\text{reject } H_0 \mid \theta = \theta_1\right) \approx 1 - \beta \quad (1)$$

$$\pi(\theta_0) = P\left(\text{reject } H_0 \mid under\ H_0\right) = P\left(\text{reject } H_0 \mid \theta = \theta_0\right) \approx \alpha \quad (2)$$

The details

where α is probability of type error I and β is probability of type error II. Detail of the power and size in testing coefficient parameters on the regression models are found on Pratikno [2], and the power and size on several continuous distributions are also found Pratikno et al.[3,4].

3. The Power and Size of Discrete and Continuous Distributions

3.1. The Power and Size of the Binomial Distribution

Following Pratikno [2], we derived the formula of the power and size of the discrete (Binomial and Poisson) and continuous (Chi-square) distributions. As an initiate, we follow, Pratikno [2], the power and size of the binomial distribution are computed in one-side hypothesis testing on several *n* and bound of the rejection areas. Let, X_i follows Bernoulli distribution with parameter θ. Take a trial $n = 12$, the $Y = \sum_{j=1}^{n=12} X_j$ then follows Binomial distribution with $n = 12$ and $p = \theta$, is written as $Y : B(n,\theta)$. Here, we then decide (an example $\theta = 0.7$) to test $H_0 : \theta = 0.7$ versus $H_1 : \theta > 0.7(as\ \theta_1)$, with rejection area $\{(x_1,\ldots,x_{12}) : Y \le 5\}$, therefore the power function on the binomial distribution is then given as

not clear term]

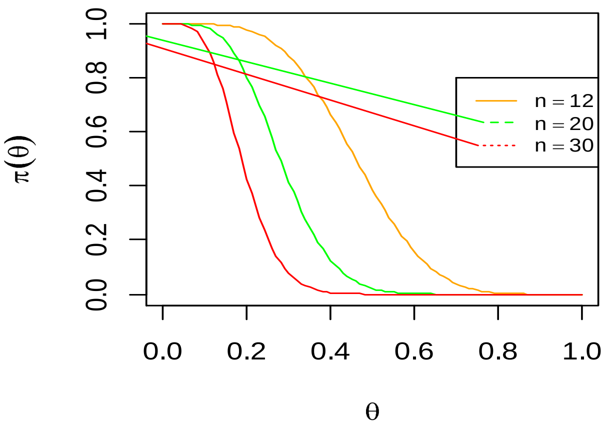
$$\pi(\theta) = P(reject\ H_0 | \text{under } H_1 : \theta) = \sum_{y=0}^{5} \binom{12}{y} \theta^y (1-\theta)^{12-y}$$

$$= \binom{12}{0}\theta^0(1-\theta)^{12} + \binom{12}{1}\theta^1(1-\theta)^{11} + \binom{12}{2}\theta^2(1-\theta)^{10} + \text{L} + \binom{12}{5}\theta^5(1-\theta)^7$$

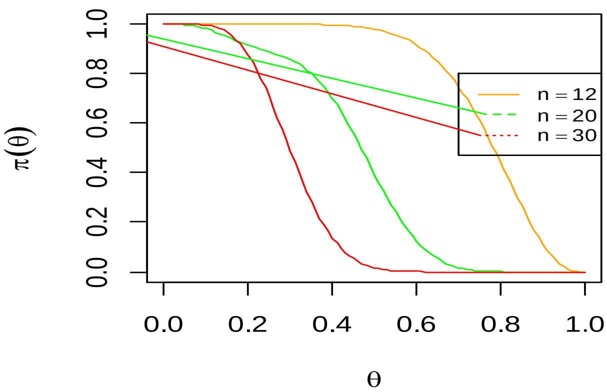
$$= (1-\theta)^7\left(1 + 7\theta + 28\theta^2 + 84\theta^3 + 210\theta^4 + 462\theta^5\right) \quad (3)$$

the typing of math symbols could be improved

Using the equation (3) and *R-code*, we then produced the graphs (curves) of the power in Figure 1.



(a)



(b)

Figure 1. The power of the Binomial Distribution at several *n* and *Y=5* and *9*

Figure 1. showed that the curve of the power of the Binomial distribution (Figure 1 (a) and (b)) are sigmoid (*S* curve) and depended by the number of trials (*n)* and the bound of the rejection area (*Y*). They tend to be (close) zero for $\theta > 0.4$. The curve decreases (started from $\theta = 0.2$) as the parameter increases. From Figure 1 (a) and (b), it is clear that both *n* and *Y* are significant affect in affecting the shape of the curve (see they move to the right as S-curve). Here, the maximum power is one and the minimum power is zero. The size is then produced using the equation (3) under H_0, as

$$\alpha = P(\text{reject } H_0 | \text{under } H_0) = P(Y \le 5 | \theta = 0,7) = 0.04.$$

It is clear that the size is constant and less than 0.05, so it is a reasonable thing.

3.2. The Power and Size of the Poisson Distribution

Let, $X_1, \ldots, X_n$ follow Poisson distribution, the probability distribution function (pdf) of random variable X is then given as

$$f(x, \lambda) = \frac{e^{-\lambda} \lambda^{x_i}}{x_i!} \tag{4}$$

with $x = 0, 1, 2, \ldots,$ and $\lambda > 0$. The pdf curve of the Poisson distribution (positive skew) tend to be normal for large λ, where the center of the pdf curve always move to the right when λ increases.

To find the power, we then derive sufficient statistics and rejection area using factorization theorem and UMP test, respectively, as follow. Let S be sufficient statistics, the join distribution of the Poisson distribution is then expressed as

$$f(x_1, \ldots, x_n; \lambda) = g(s, \lambda) h(x_1, \ldots, x_n) \tag{5}$$

where the pdf of the join distribution of the Poisson distribution is

$$f\left(x_1,\ldots,x_n;\lambda\right)=\prod_{i=1}^{n} f\left(x_i,\lambda\right)=\prod_{i=1}^{n}\frac{e^{-\lambda}\lambda^{x_i}}{x_i\,!}\;=\frac{e^{-n\lambda}\lambda^{\sum x_i}}{\prod_{i=1}^{n} x_i\,!}. \tag{6}$$

We therefore conclude that $s=\sum_{i=1}^{n} x_i$ sufficient statistics, this is due to the equation (6) can be expressed as

??

$$f\left(x_1,\ldots,x_n;\lambda\right)=\frac{e^{-n\lambda}\lambda^{\sum x_i}}{\prod_{i=1}^{n} x_i\,!}=\left(\frac{e^{-n\lambda}}{\prod_{i=1}^{n} x_i\,!}\right)\left(\lambda^{s}\right)=h\left(x_1,\ldots,x_n\right)g\left(s,\lambda\right) \tag{7}$$

The rejection area is then derived using *uniformly most powerful* (UMP) test as follows Using the properties of *maximum likelihood ratio* (MLR) of the $f\left(x_1,\ldots,x_n;\lambda\right)$ on $S=\sum_{i=1}^{n} X_i$ $\left(\sum_{i=1}^{n} X_i>k\right)$ and UMP-*test*, we then get the probability to reject H_0 under H_0 (the size or α) and the probability to reject H_0 under H_1 (the power) in testing $H_0:\lambda=\lambda_0$ versus $H_1:\lambda>\lambda_0$, are, respectively,

??

$$\alpha=\alpha\left(\lambda\right)=\alpha^{*}=P\left(\sum_{i=1}^{n} X_i>k\,\middle|\,\lambda_0\right)$$

-centered

$$=P\left(\sum_{i=1}^{n} X_i>Pois(n\lambda)\right)=\sum_{x=0}^{n}\frac{e^{-(n\lambda_0)}\left(n\lambda_0\right)^{x}}{x!} \tag{8}$$

-also use \displaystyle for sum
-the math symbols as fractions should be re-written

$$\pi\left(\lambda\right)=\left(\text{Probability reject } H_0 \textit{ under } H_1\right)$$

$$=P\left(\sum_{i=1}^{n} X_i>Poi(n\lambda)\,\middle|\,\lambda\right)=1-P\left(\sum_{i=1}^{n} X_i\le Pois(n\lambda)\,\middle|\,\lambda\right)$$

$$=1-\left(\sum_{x=0}^{n}\frac{e^{-n\lambda}\left(n\lambda\right)^{x}}{x!}\,\middle|\,\lambda\right) \tag{9}$$

Using the equation (8) and (9), we presented the graph of the power of the Poisson distribution (Figure 2.), and the value of the size and power for *n=3* in testing $H_0:\lambda=1$ versus $H_1:\lambda>3$, respectively, as

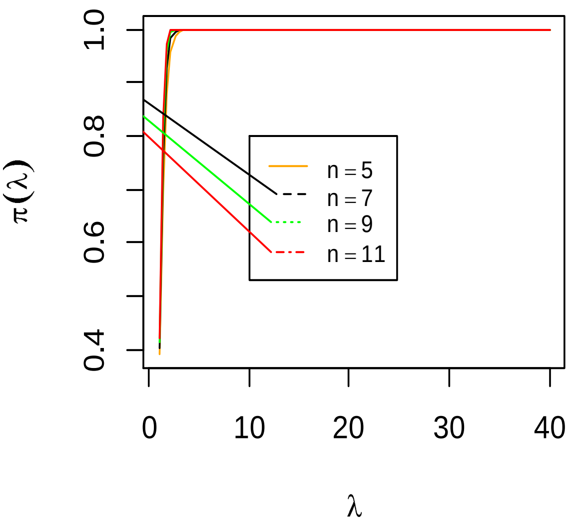


Figure 2. The power of the Poisson Distribution at several *n*

$$\alpha=1-\left(\sum_{x=0}^{n}\frac{e^{-n\lambda_0}\left(n\lambda_0\right)^{x}}{x!}\right)=0.40779>0.05,$$

$$\pi(\lambda) = 1 - \left(\sum_{x=0}^{n} \frac{e^{-n\lambda} (n\lambda)^x}{x!} \right) = 0.99985 ;\ 1.$$

From Figure 2, we see that the power of the Poisson distribution is really quickly to be 1 when $\lambda < 10$. Here, the simulation of the n has not influenced to the curve of the power yet. Thus, we conclude that the small and large n are not significantly to change the shape of the curve of the power. Similarly, for large λ, the shape of the curve of the power does not change. Here, the size 0.408 is greater than 0.05 (too high), so we conclude that it is not good thing.

3.3. The Power and Size of the Chi-square Distribution

Let, X be a random variable follow Chi-square distribution, the probability distribution function (pdf) of random variable X is then given as

$$f(x) = \frac{1}{2^{\frac{r}{2}} \tau\left(\frac{r}{2}\right)} x^{\frac{r}{2}-1} e^{-x/2}, x \geq 0 \quad (10)$$

with r is a degree of freedom (as parameter). The cdf of this distribution is the written as

$$F_x(x) = \int_0^x f(x) = \int_0^x \frac{1}{2^{\frac{r}{2}} \tau\left(\frac{r}{2}\right)} x^{\frac{r}{2}-1} e^{-x/2}$$

The power of this distribution in testing parameter shape $H_0 : r = r_0$ versus $H_0 : r > r_0$ (r_0 is determined as 1), is then obtained as

$$\begin{aligned}
\pi(r) &= P\left(\text{reject } H_0 \ \middle|\text{under } H_1, r_0 = r\right) \\
&= P\left(S > k \middle| r\right) = 1 - P\left(S \leq k \middle| r\right) \\
&= 1 - \int_0^s \frac{1}{2^{\frac{r}{2}} \tau\left(\frac{r}{2}\right)} s^{\frac{r}{2}-1} e^{-s/2} ds \\
&= 1 - \left(-\frac{1}{\tau\left(\frac{r}{2}\right)} \right) \left[\tau\left(\frac{r}{2}, \upsilon^{2/r}\right) \right]_0^k \\
&= 1 + \frac{\left[\tau\left(\frac{r}{2}, \frac{s}{2}\right) \right]_0^k}{\tau\left(\frac{r}{2}\right)} \qquad (11)
\end{aligned}$$

$s = \sum_{i=1}^{n} x_i$ is a sufficiency statistics and $\upsilon = \left(\frac{s}{2}\right)^{r/2}$. Using the equation (11), we then produced the graphs of the power and size are presented in Figure 3 and Figure 4.

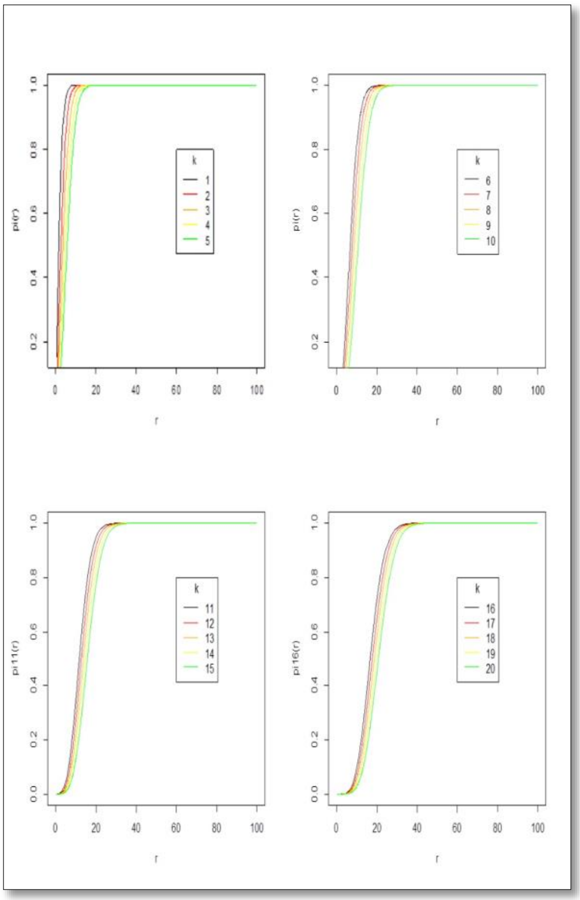


Figure 3. The power of the Chi-square Distribution at several *k*

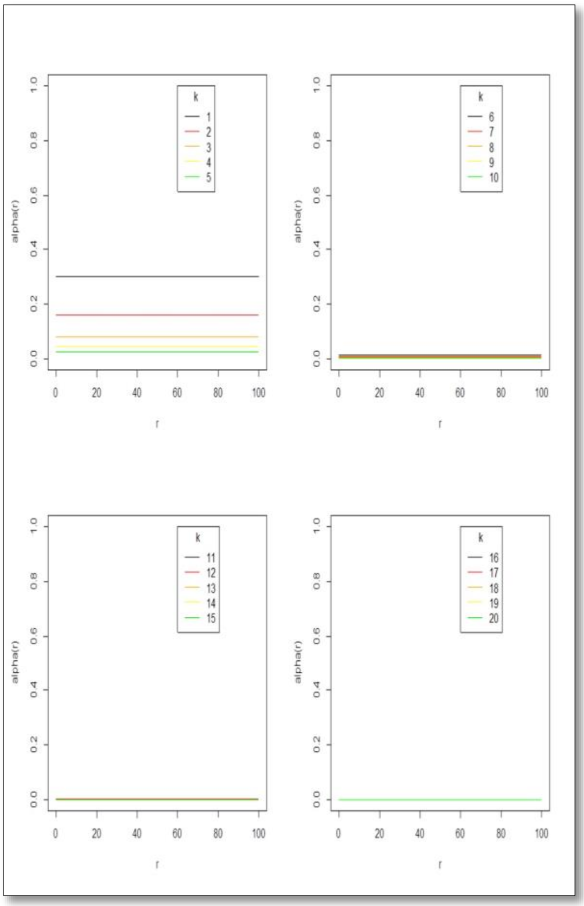


Figure 4. The Size of the Chi-square Distribution at several *k*

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From Figure 3, we see that the curves of the power are depended of the k. They skew to the right (S-curve positive) as the k increases. Similarly, we see from Figure 4 that the size are constant and depended of the k, and they decrease as the k increases. To illustrate the values of the size of the Chi-square distribution, we presented a simulation $k=5$ and 10, on $r=1$, as below, respectively

For k=5,

$$\alpha = \pi(1) = 1 + \frac{\left[\tau\left(\frac{r}{2}, \frac{s}{2}\right)\right]_0^5}{\tau\left(\frac{r}{2}\right)}$$

$$= 1 + \frac{\left[\tau\left(\frac{r}{2}, \frac{5}{2}\right) - \tau\left(\frac{r}{2}, 0\right)\right]}{\tau\left(\frac{r}{2}\right)} \approx 0.025$$

For k=10,

$$\alpha = \pi(1) = 1 + \frac{\left[\tau\left(\frac{r}{2}, \frac{s}{2}\right)\right]_0^{10}}{\tau\left(\frac{r}{2}\right)}$$

a better use of math typing skills is recommended

$$= 1 + \frac{\left[\tau\left(\frac{r}{2}, 5\right) - \tau\left(\frac{r}{2}, 0\right)\right]}{\tau\left(\frac{r}{2}\right)} \approx 0.002$$

4. **Conclusion**

To find the power of the Poisson distribution, we must consider sufficient statistics and *UMP test* for getting the rejection area. In the Binomial distribution context, the curve of the power is depended on the number of trials n and bound of the rejection area. The curves tend to be going to zero when $\theta > 0.4$, and they decreases (started from $\theta = 0.2$) as the parameter increases, and the curve is sigmoid (S curve). In the Poisson distribution context, the result showed that the power of the Poisson (not sigmoid, S curve) distribution is quickly to be 1 on several simulation $n(n \geq 2)$ and $\lambda(\lambda < 10)$. In the context of chi-square distribution, we noted that the curves of the power are depended of the k and the skewness of the S-curve positive as the k increases. Here, we noted that the size are constant and depended of the k and it decrease as the k increases.

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