Modelling Crime Data in Nigeria Using the Katz Criterion

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ARTICLE INFO	ABSTRACT
	This study considered a method of selecting discrete distributions based on the Katz criterion in fitting an appropriate probability distribution function to available crime data in Nigeria after reasonable transformation. The criterion selected the Negative Binomial distribution for the data under consideration. The adopted distribution provided good fit as evidenced by the Anderson Darling goodness of fit test. This study has therefore applied the Katz criterion to real life data.

Introduction

Crime is an economically significant human activity which is basically absolutely ignored by economists (Becker, 1968). Nigeria is a growing economy that is certainly better privileged compared to some others. It has petrol and in addition the population of the country is around one hundred and sixty million women and men, which clearly implies that the needs of the people are more than what the revenue earned from the petrol sector, can possibly satisfy. Among the effects of a big and increasing population are minimal and dwindling per capita income, the growth of huge and clear variations in wealth and lifestyles (Marenin & Reisig, 1995).

The increase in urban criminal offenses rate in Nigeria is one among the leading social problems confronting the country recently. The worry over armed theft makes Nigerians sleepless during the night; they often live a day each time, with the worry as to whether they will probably see the light of the next day. They really are particularly scared of armed-robbers, paid assassinations, political thugs as well as other crooks who consider living to be insignificant (Ahmed, 2012).This remark is further corroborated by Bello (2011) who noted that 'a potential renter or buyer of house would always be concerned with the crime rate in a neighborhood before making her/his choice'. The plausible reason for this is that 'the Nigerian Police Force numerical strength is not commensurate with the total population – one policeman to 5000 Nigerians; unlike in developed countries with one Policeman to about 400 people' (Agbola, 1997). Other reasons for this unfortunate situation include 'inadequate manpower, equipment and professionalism' (Danbazau, 2007), 'corruption' (Compass Newspaper, 2012) and 'poor public perception of the Nigerian Police Force' (Okereke, 1993)

According to Ferreira et al (2012), statistics and facts are an essential resource in crime evaluation and the police force in Nigeria are beginning to utilize it in a far more efficient manner to reveal valuable information, minimize misdeed and optimize the utilization of scarce resources. They employed the use of statistical method of cluster analysis and spatial models with GIS. Nigerian authors who have used some statistical methods in analyzing crime data include Shangodoyin et al (2006), Fajemirokun et al (2006), Ahmed (2012), Omotor (2010), Gulumbe et al (2012) and Usman et al (2012). A filter through these past studies reveals that the fitting of discrete probability functions to crime datasets is still under explored. It is in the light of this, that this present study is being undertaken. Of particular interest is the application of the Katz (1963) criterion to the crime dataset under consideration.

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The Katz Criterion

According to Ghahfarokhi et al (2010) 'One of the crucial questions in statistical analysis of count data is how to formulate an adequate probability model to describe observed variation of counts. The Poisson family of discrete distributions is used as a benchmark for statistical analysis of count data' .This is further supported by Douglas (1980) who noted that 'The Poisson distribution has been described as playing a similar role with respect to discrete distributions to that of the normal for absolutely continuous distributions. The Poisson distribution plays a vital role in distribution theory and is applied to many real life situations including industry, agriculture, ecology, accidents, telephony, medicine, insurance, commerce, geology, geography, birth processes, renewal processes, engineering, risk theory, demography, military, DNA breakage, reunion and sequence matching'. 'The Poisson distribution was discovered in 1837 by French mathematician and physicist, Simon Dennis Poisson (1781-1840)' (Sultan & Ahmad, 2012). Past studies of the following authors (Bortkiewicz (1898); Feller (1968); Parzen (1962); Taylor & Karlin (1984); Ripley (1981); Stoyan *et al* (1987); Sandland & Cormack (1984); and Ahmad (2007)) revealed different applications of the Poisson distribution.

Katz (1963) has recommended a category of discrete distributions, which generally takes the form:

$$\frac{P_{y+1}}{P_y} = \frac{\alpha + \beta y}{1 + y}; \ y \ = \ 0,1,2,...; \ y \ > 0; \ \beta < 1 \qquad \text{... (1)}$$

This category of distributions includes Poisson, binomial and negative binomial distributions. He further derived the higher moments for this group of distributions, estimated their parameters and also applied them to example datasets. He went ahead again to suggest a criterion for identifying discrete distributions. The criterion is

$$\frac{\mu_2 - \mu_1'}{\mu_1'} = \frac{\beta}{(1-\beta)}; \ \beta < 1 \qquad \text{………………………………… (2)}$$

$\mu_1', \ \mu_2$ are the mean and variance of Y while β is a constant. He pointed out that when (2) is zero, positive and negative respectively, we have the Poisson, negative binomial and binomial distributions in that order. The criterion in (2) will be used to properly identify which particular distribution in this family suits the data under consideration most.

Description of Data for Study

The dataset considered in this study was the crime data in Nigeria reported in Osowole et al (2013). The data consisted of offences against persons: manslaughter, murder and attempted murder, assault, rape, child stealing, grievous hurt and wounding; offences against property: armed robbery, house and store breakings, forgery, and theft/stealing; offences against lawful authority include: forgery of current notes, gambling, breach of public peace, bribery and corruption between 1994 and 2003. The authors attempted to fit an appropriate probability density function to these data from the Pearson system of distributions. The major difference between their work and this study is that they considered the crime data to be continuous while in this present study, the data are wholly discrete.

Results and Discussion of the Study

In order to achieve the objective of this study, that is the fitting of an appropriate probability distribution function to the data under study from the Katz (1963) family of discrete distributions, the disaggregated data on various crimes committed were initially aggregated and then transformed suitably. The estimates of the katz parameters obtained (Table 1) showed that

$\beta > 0$ suggesting a negative binomial distribution as established in (2). As noted by Ghahfarokhi et al (2010) 'the Poisson distribution is used as a benchmark for statistical analysis of count data', the fitness of the Negative binomial is compared with that of the Poisson (Table 2) using the Anderson-Darling (A-D) goodness of fit test. The lower value of the A-D statistic in Table 2 corroborated the fact that the Negative binomial is superior to the Poisson distribution under this setting. This fact is further justified and established by the Cumulative distribution function graph of the Negative binomial (Figure 1) when compared to the Cumulative distribution function graph of the Poisson distribution.

Table 1: Estimates of Katz Parameters

$\mu_1' = $ mean	6.0269
$\mu_2 = $ variance	12.824
β	0.5302 >0 $\Rightarrow$ Negative Binomial Distribution

Table 2: Anderson Darling (A-D) Goodness of Fit Result

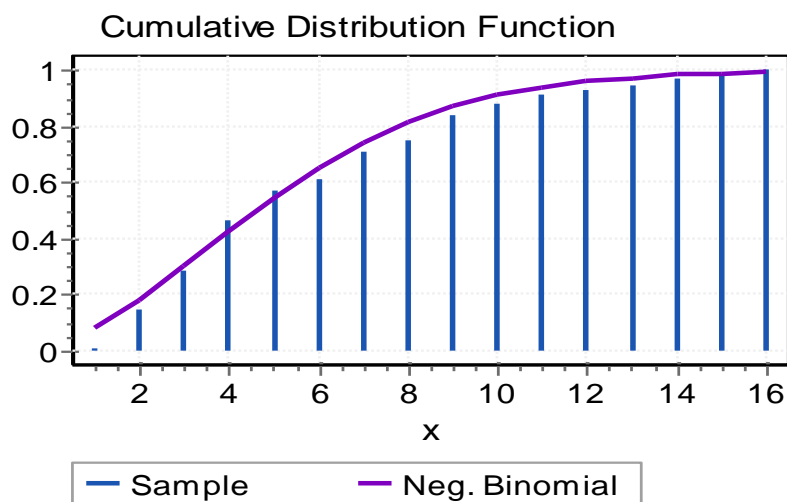| Distribution	A-D Statistic
Negative Binomial	11.299
Poisson	18.471

Figure 1: Cumulative Distribution Function Graph for the Negative Binomial Distribution
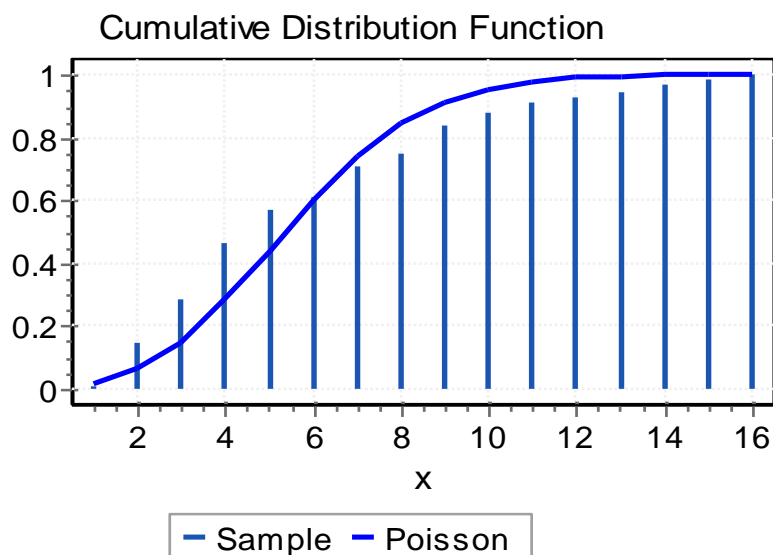
Figure 2: Cumulative Distribution Function Graph for the Poisson Distribution

Table 3: Parameter Estimates for the Negative Binomial and Poisson Distributions

Distribution	Parameter Estimate
Negative binomial	n = 5, p= 0.46961
Poisson	$\lambda = 6.0269$

Conclusion

The main objective of this study has been achieved. An appropriate probability distribution function has been obtained for the discrete crime data in Nigeria considered. The Negative binomial distribution has been shown to be adequate by the A-D goodness of fit test and this was supported by the graph of its cumulative distributive function. The Negative binomial distribution therefore can be used to model available crime data in Nigeria especially in future forecast of crime rates.

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