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On the Estimation of Crime Rate in the Southwest of Nigeria: Principal Component Analysis Approach

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On the Estimation of Crime Rate in the Southwest of Nigeria: Principal Component Analysis Approach

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Abstract- Crime is at alarming rate in this part of world and there are many factors that are contributing to this antisocietal behavour both among the youths and old. In this work, principal component analysis (PCA) was used as a tool to reduce the dimensionality and to really know those variables that were crime prone in the study region. Data were collected on twenty-eight crime variables from National Bureau of Statistics (NBS) databank for a period of fifteen years, while retaining as much of the information as possible.

We use PCA in this study to know the number of major variables and contributors to the crime in the Southwest Nigeria. The results of our analysis revealed that there were eight principal variables have been retained using the Scree plot and Loading plot which implies an eight-equation solution will be appropriate for the data.

The eight components explained 93.81% of the total variation in the data set. We also found that the highest and commonly committed crimes in the Southwestern Nigeria were: Assault, Grievous Harm and Wounding, theft/stealing, burglary, house breaking, false pretence, unlawful arms possession and breach of public peace.

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I. Introduction

There is no universal definition of crime. This is as a result of changes in social, political, psychological and economic conditions. An act may be a crime in one society, but not in another (Danbazau, 2007). For example, prostitution, adultery and homosexuality between consenting adults have been wholly or partially removed from the criminal law in USA (Feldman, 1997) but are considered as crimes in Muslim communities such as Saudi Arabia. The constant changes in time also change the perception of society on crime. Today, it is becoming a crime to pollute the air and water. Therefore, the perception of an "act" to be a crime varies with time and space.

Crime is a universal phenomenon and differs only in degree among the various nations of the world. The Nigerian crime – problem is multidimensional and is capable of undermining its corporate existence as well as efforts towards sustainable development. The Nigeria corporate existence can be undermined by a number of factors among which is an escalating and uncontrolled crime problem Tanimu (2006). Security and crime have been deeply rooted in the political history of this country, particularly in recent time, which has emerged as a key concept in Nigeria's struggle for good governance, sustainable democracy and development.

Without mincing words the violence perpetrated in some part of countries in recent time constitutes public order crimes. Security is very importance for all human being regardless of one's status in the country. This will not be guarantee if the security sector

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is greedy and corrupt. More also, poverty reduction and development of democracy in this country will be better enhancing when the security of the citizen is guaranteed. It has been noted that the cost of crime and its control is equivalent to 5% GDP in the developed world, the figure rises to about 14% in developing nation (ICPC 1999).

The growth in urban crime rate in Nigeria is one of the major social problems facing the country in recent time. The dominance of crime in developing countries increases the volatility of the issue, for it pyramids one fear upon others. The concentration of violent crimes in major urban centers worldwide is therefore heralded as an indicator of the breakdown of urban systems. In many urban centers of Nigeria today, criminal activities and violence are assuming dangerous tendencies as they threaten lives and property, the national sense of well-being and coherence, peace, social order and security, thus, reducing the citizens' quality of life. (Agboola, 2000; Ahmed, 2010).

Over the years the rate of crime in Nigeria has been on the increase and these crimes are being carried out with more perfect and sophistication. This has led to the formation of various vigilante groups, to combat crimes in some parts of the country (Fajemirokun et al., 2006). One of the fundamental techniques to combat criminal activities is the better understanding of the dynamics of crime. Crime is often thought of as a moral threat and injurious to the society. However, it has been observed that the entire world is experiencing high criminal rate. The report of international crime victim survey (ICVS) has confirmed the situation. The report which was conducted on six major world region including Africa, Asia, central and eastern Europe, Latin America, and western Europe for the 1989 – 1996 period as shown that more than half of the urban respondents reported being victim at least once regardless of what part of the world they inhabit (Ackermen and Murray, 2004).

In this research work, we use PCA in determining the numbers of principal components (PC) to be used in explaining the crime data in southwestern Nigeria.

II. Background of the Study

The major motivating factors of this study are centered on various socio-economic and political movements that transformed the country between 1995 and 2009. The country witnessed series of crime waves that transposed a new dispensation into the so-called modern democratic government". Hence, Nigeria witnessed different modes of governance from military to civilian regimes between these periods. The military, in the first instance, solely took advantage of its professional training by using violence to usurp power through coups and counter coups.

The politicians in their turn, and in their bids to absorb power, used hired-thugs, or paid assassins/hired killers to perpetrate violence and instill fears on their opponents. The frustrated masses took to armed robbery, formulation of militant groups as witnessed in the uproar of the youths from South-South and the Boko-Haram Sect from the North-Eastern path of the country disregarded the law. In view of the above, there is therefore, the need to look critically at the pattern and distribution of crime ascendant in some part of the country.

a) Research Questions

In the light of the foregoing, some questions are raised and should be clarified to articulate the problem and objectives of this study:

1. What is the degree of relationship between the different crimes committed in the study area in the last fifteen years?
2. Which of the crimes committed accounted for higher percentage of total crimes in Southwestern Nigeria?
3. What are the important components present in the data?

4. Which crime (s) has high loadings on each of the rotated components?

5. What type of policy measures can be employed to reduce crime patterns at the regional or urban scale in Southwestern Nigeria?

b) Objectives of this Study

1. To examine the degree of relationship between the different crimes committed in the study area in the last fifteen years.
2. To determine the crime that accounted for highest percentage of the total crimes in Southwestern Nigeria.
3. To conduct a principal component analysis to determine important components present in the data.
4. To examine the crime (s) with high loadings on each of the rotated components.
5. To recommend the policy measures that can be employed to reduce crime patterns at the regional or urban scale in Southwestern Nigeria.

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c) Statistics of Crimes in Nigeria

Nigeria has one of the highest crime rates in the world. Murder often accompanies minor burglaries. Rich Nigerians live in high – security compounds. Police in some states are empowered to "shoot on sight" violent criminals (Financial Times, 2009). There is no disagreement from both macro and micro level studies that the rate of crime in Nigeria has reached an unacceptable level. The fact file on losses between June 1999 and October 2001 painted a picture of robbery and murder victims akin to a declaration of war by hoodlums. Estimated properties cost is in billion of naira, while a total of 3680 people lost their lives. Assault related injuries, which include bruises, cuts black eyes and broken bones have severally been reported (CRSSYB, 2003). Some of these assault occurred as domestic violence, while other are inflicted by criminals on guards especially under volatile situation (Oshunkeye, 2004). These assault have resulted in damaged joint partial loss of hearing and vision, permanent disfigurement, scars from burns, knives and machete wound (Ikoh, 2002)

Aside from the human and sociological effect of violence crime, there is a significant economics cost to the country in which rate of crime and violence are high, such economic effect include increase absenteeism, decrease in labour market participation, reduced productivity that lower earning (Krug, Dahlberg, and Mercy, 2002). The growth in urban crime rate in Nigeria is one of the major social problems facing the country in recent time. The dominance of crime in developing countries increases the volatility of the issue for its pyramid one fear upon others. The concentration of violent crime in major urban centre world wide is therefore heralded as an indicator of the breakdown of urban system. In many urban centre of Nigeria today, criminals activities and violence are assuming dangerous tendencies as they threaten lives and properties, the national sense of well-being and coherence, peace, social order and security, thus reducing the citizen quality of life (Agboola, 2000; Ahmed, 2010)

III. Methodology

The data required for this study was obtained from secondary source (National Bureau of Statistics) and it covered reported crime cases in Southwestern Nigeria that comprises - Oyo, Osun, Ondo, Ekiti, Ogun and Lagos States. There are twenty-eight crime variables identified in an attempt to identify the most salient variables to adapt in explaining the main distributional pattern of crimes in the study area using principal component analysis.

a) The Study Area

The South-Western part of Nigeria comprises Ekiti, Lagos, Ogun, Ondo, Osun and Oyo states and is mainly inhabited by the Yoruba, who are renowned for their strong industrial base, modern bureaucracy, accomplished academics and strong

presence of a skilled labour force in various sectors. Thus the region attracts different categories of individuals and corporate bodies, including traders, professionals, businesspersons, administrators and students all of whom come from various parts of the country and beyond to explore the booming economic and educational opportunities. Due to the concentrated populations most especially in Lagos and Ibadan, the security of the region has always been undermined by criminal activities such as armed robbery, domestic violence etc.

b) Principal Component Analysis

Principal Components Analysis, is a data analysis tool that is usually used to reduce the dimensionality (number of variables) of a large number of interrelated variables, while retaining as much of the information (variation) as possible. PCA calculates an uncorrelated set of variables (factors or pc's). These factors are ordered so that the first few retain most of the variation present in all of the original variables. Unlike Factor Analysis, PCA always yields the same solution from the same data (apart from arbitrary differences in the sign).

Principal Component Analysis reduces multiple observed variables into fewer components that summarize their variance. Principal component analysis is a member of the general linear model (GLM) where *all* analyses are correlational term often used interchangeably with "factor analysis", however, there are slight differences. It is a method of reducing large data sets into more manageable "factors" or "components" method of identifying the most *useful* variables in a dataset and a method of identifying and classifying variables across common themes, or constructs that they represent.

Basically in principal component analysis, given p variables X_1, X_2, . . ., X_p measured on a sample of n subjects, then the ith principal component, Z_i can be written as a linear combination of the original variables. Thus,

$$Z_i = a_{i1}X_1 + a_{i2}X_2 + \ldots + a_{ip}X_p$$

The principal components are chosen such that the first one, $Z_1 = a_{11}X_1 + a_{12}X_2 + \ldots + a_{1p}X_p$ accounts for as much of the variation in the data as (i. e. in the original variables) as possible subject to the constraint that

$$a_{11}^2 + a_{12}^2 + \ldots + a_{1p}^2 = 1$$

Then the second principal component $Z_2 = a_{21}X_1 + a_{22}X_2 + \ldots + a_{2p}X_p$ is chosen such that its variance is as high as possible. A similar constraint applies – namely, that

$$a_{21}^2 + a_{22}^2 + \ldots + a_{2p}^2 = 1$$

Another constraint is that the second component is chosen such that it is uncorrelated with the first component. The remaining principal components are chosen in the same way. When you do a principal component analysis, we get what is called eigenvalues which are the variances of the principal components. In other words, the first eigenvalue is the variance of the first principal component, the second eigenvalue is the variance of the second principal component and so on. Thus, because of the way principal components are selected, the first eigenvalue is the largest, followed by the second etc. There will be p eigenvalues altogether but some may be equal to zero.

IV. Discussion of Findings and Conclusion

There are low pair-wise correlation in between many of the crimes and therefore cannot be used to explain one another, but however, at least moderate correlation exist in between sizeable number of the crimes. All the variables that are responsible for the causes of crimes committed in the study area are relatively important, though, there is

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variability in the contributions of each of these factors which could be obviously seen as the eigenvalues greater than one (table 1, appendix). From the varimax rotated factor loadings, factor I accounts for 31.415% of the total variance explained with its significant positive loading, Factor II exhibited a high positive loadings and accounts for 19.381% of the total variance, Factor III on the other hand, explained 10.217% of the total variance that has significant positive loadings on different crimes committed and reported. More importantly and again, Factor IV accounted for 8.307% of the total variance explained etc. The analysis and the scree plot (Figure 1, appendix) also revealed that only eight components are extracted. The eight components explain 93.806% (table 1, appendix) of the total variability of the data set. We also found that the highest and commonly committed crimes in the Southwestern part of Nigeria are Assault, Grievous Harm and Wounding, theft/stealing, burglary, house breaking, false pretence, unlawful arms possession and breach of public peace. The rotated factors give information about the extent to which the factors have been rotated. These rotated factors are just as good as the initial factors in explaining and reproducing the observed correlation matrix. Across each row, the highlighted are the factor that each variable loaded most strongly on.

-- The first12 crimes loaded strongly on Factor 1

-- The next 5 crimes loaded strongly on Factor 2

-- Forgery and arson loaded strongly on Factor 3

-- Murder, Armed Robbery and False Pretence loaded strongly on Factor 4

-- Perjury and slave dealing loaded strongly on Factor 5

-- Manslaughter and Forgery loaded strongly on Factor 6

-- Breach of public peace loaded strongly on Factor 7; while

-- Suicide loaded strongly on Factor 8

From table 2 (appendix), the equations of the principal components are:

$$Z_1 = 0.0993X_1 + 0.2455X_2 + \ldots - 0.0239X_{28}$$

$$Z_2 = 0.0995X_1 + 0.1469X_2 + \ldots + 0.3508X_{28}$$

$$Z_3 = -0.1685X_1 + 0.0775X_2 + \ldots + 0.0503X_{28}$$

$$Z_4 = 0.3868X_1 + 0.2711X_2 + \ldots - 0.1965X_{28}$$

$$Z_5 = -0.2984X_1 - 0.0331X_2 + \ldots + 0.0150X_{28}$$

$$Z_6 = 0.2011X_1 + 0.1469X_2 + \ldots - 0.3270X_{28}$$

$$Z_7 = 0.2711X_1 + 0.0625X_2 + \ldots + 0.0096X_{28}$$

$$Z_8 = 0.1496X_1 - 0.2092X_2 + \ldots - 0.1036X_{28}$$

The estimated principal components are displayed in Table 3 of the appendix.

V. Recommendations

Government intervention in the provision of infrastructure and other basic amenities that would make life more meaningful should be encouraged. Government must also make it as matter of policy to shift its thinking about crime and punishment and turn its focus to crime prevention, addressing the root causes of crime such as lack of employment which is rampant among the youth, and devoting our resources to community building, education, and workforce development that provides jobs at a living wage because the future of Nigeria and our democracy depends on them. The family institution must also play its role by monitoring all the people in the family particularly the youth. The entire society must shun all values that encourage criminal activities.

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Appendix

Table 1 : Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	%of Variance	Cumulative %
1	9.813	35.045	35.045	9.813	35.045	35.045	8.796	31.415	31.415
2	5.202	18.578	53.623	5.202	18.578	53.623	5.427	19.381	50.796
3	3.497	12.489	66.111	3.497	12.489	66.111	2.861	10.217	61.013
4	2.670	9.537	75.648	2.670	9.537	75.648	2.326	8.307	69.320
5	1.613	5.761	81.409	1.613	5.761	81.409	2.024	7.227	76.547
6	1.343	4.796	86.205	1.343	4.796	86.205	1.838	6.565	83.112
7	1.082	3.864	90.069	1.082	3.864	90.069	1.689	6.033	89.145
8	1.046	3.737	93.806	1.046	3.737	93.806	1.305	4.661	93.806
9	.551	1.969	95.775						
10	.382	1.363	97.138						
11	.298	1.065	98.203						
12	.237	.845	99.049						
13	.182	.649	99.698						
14	.085	.302	100.000						
15	5.366E-16	1.917E-15	100.000						
16	4.163E-16	1.487E-15	100.000						
17	3.230E-16	1.153E-15	100.000						
18	2.668E-16	9.530E-16	100.000						
19	1.447E-16	5.168E-16	100.000						
20	4.408E-17	1.574E-16	100.000						
21	2.843E-17	1.015E-16	100.000						
22	-6.922E-17	-2.472E-16	100.000						
23	-1.082E-16	-3.866E-16	100.000						
24	-1.720E-16	-6.144E-16	100.000						
25	-2.920E-16	-1.043E-15	100.000						

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26	-3.313E-16	-1.183E-15	100.000						
27	-4.790E-16	-1.711E-15	100.000						
28	-5.512E-16	-1.968E-15	100.000						
Extraction Method: Principal Component Analysis.									

Table 2 : Coefficient of the principal components (a's)

Notes

Variables	Components							
	1	2	3	4	5	6	7	8
1	0.099279	0.099527	-0.16845	0.386778	-0.29842	-0.20106	0.271104	0.149598
2	0.245485	0.146879	0.077539	0.271112	-0.03307	0.038831	0.062488	-0.20924
3	-0.0348	-0.14469	-0.11765	-0.37943	-0.17873	0.306331	-0.00288	0.466394
4	0.16919	-0.22141	-0.07005	0.148714	-0.05905	-0.07939	-0.47683	0.113421
5	0.270704	-0.08024	0.072726	-0.18788	-0.03386	0.111314	0.059604	-0.16133
6	0.111729	0.392846	-0.13262	-0.01408	-0.03779	-0.02761	0.06345	-0.03227
7	0.283792	-0.00482	0.099464	0.149938	-0.11338	0.12771	0.070179	0.071377
8	0.220586	-0.0798	0.173794	-0.04284	0.17401	-0.20623	-0.12402	0.427283
9	0.034157	-0.15039	-0.27647	0.253976	0.492111	-0.01985	-0.08268	0.019555
10	0.154186	0.316119	-0.12406	0.080171	0.178735	0.018984	-0.2288	0.052799
11	0.147483	0.292443	-0.09412	0.048347	-0.04173	0.349476	-0.06441	0.175998
12	-0.05491	-0.20037	-0.14492	0.401465	-0.2992	0.090605	-0.06633	-0.10267
13	0.140779	0.378378	-0.00267	-0.10526	0.055116	0.063855	0.046145	0.030311
14	0.200474	-0.19335	0.261494	-0.03856	0.237001	-0.04315	0.123054	0.098754
15	0.300073	0.074974	0.096255	-0.00306	-0.03071	0.035379	-0.06057	-0.01173
16	0.241335	-0.04341	0.208553	0.053243	-0.08897	-0.0233	-0.3134	0.087999
17	-0.1494	-0.11575	0.366305	0.029988	0.286605	0.046597	-0.05287	-0.28551
18	-0.04661	0.148194	0.411224	0.080171	0.071651	-0.15101	0.118247	0.379373
19	0.289539	0.037706	-0.01925	-0.03182	-0.0622	-0.21055	0.131706	-0.05769
20	0.290496	-0.1574	0.029946	0.017748	-0.07008	-0.03452	-0.025	-0.08213
21	-0.11205	-0.06533	0.327268	0.263768	-0.27716	0.115629	0.177852	0.132976
22	0.17334	-0.1631	-0.23636	-0.2295	0.007874	0.284758	0.267258	0.040088
23	0.258574	-0.0855	-0.22192	-0.04712	0.09606	-0.02071	-0.10863	-0.1496
24	-0.06544	0.212646	0.140105	0.23378	0.171648	0.520331	-0.24226	0.045955
25	0.073741	-0.07804	-0.14706	0.253976	0.421247	0.054363	0.481642	0.187731
26	0.186109	-0.02762	0.281279	-0.08078	-0.01181	0.297702	0.197079	-0.31582
27	0.282835	-0.14206	0.041176	-0.06671	-0.07401	-0.10873	0.034609	-0.03031
28	-0.02394	0.350756	0.050267	-0.19645	0.01496	-0.32704	0.009614	-0.10364

Table 3 : The principal components

PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8
5.825186	-0.68146	1.504577	-1.19408	0.193327	0.948643	-0.13663	-0.89394
4.57694	-0.59399	1.473616	-0.49565	-0.34718	0.864657	0.994138	-1.14359
3.549147	-0.39921	1.906892	0.343953	0.67018	-1.71153	-0.5453	2.049529
1.675142	-0.69044	0.347119	-0.29604	-0.71392	-0.44709	-0.53793	-0.01853
1.439421	-0.45448	-0.76772	0.065533	-0.12329	-1.48381	-1.40536	-0.2856
-1.60097	-1.97721	-2.33998	-3.89763	-0.71447	1.137476	0.452038	1.567791
1.521179	-1.44433	-2.89953	2.282488	2.347398	0.104053	1.750423	0.75081
-0.28285	-0.07645	-1.91988	1.520419	-1.72622	-0.27975	0.333432	-0.98158

-0.5335	0.155399	-1.72468	1.684103	-1.54625	-0.14447	0.329784	-0.56779
-3.58183	-0.24853	0.849903	0.150148	2.878182	0.938696	-0.9338	-1.06479
-4.38745	-0.059	2.201879	-0.52608	-0.25934	-2.18826	1.325417	-0.19313
-3.97182	-1.05605	0.532204	-1.70555	0.369656	-0.42268	0.350967	-0.97929
-2.98855	0.385129	3.269759	2.281612	-1.1662	2.083303	0.201995	1.309468
-1.67591	-0.8069	-1.46769	0.762995	-0.24809	0.459766	-2.2987	0.206917
0.435863	7.947505	-0.96647	-0.97623	0.38623	0.141	0.119528	0.243728

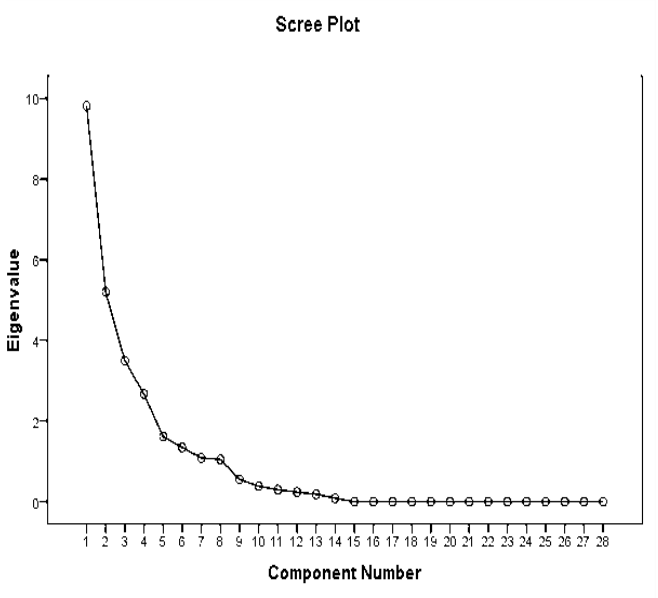

Figure 1 : The Scree Plot