

An Econometric Analysis of Crime Determinants in Nigeria

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This paper attempts to investigate the impact of some macro-economic variables such as absolute poverty, unemployment rate, inflation rate, lending interest rate and population growth rate on crime level in Nigeria. The study uses annual time series data of the six listed variables from 1970–2015. The unit root and stationarity properties of the series are examined using Augmented Dickey-Fuller (ADF) unit root test. Johansen cointegration, FMOLS, error correction model as well as Granger causality test based on Toda-Yamamoto procedure are employed to find the long-term relationship, impact of study variables on crime, the long-run and short-run dynamics, speed of adjustment as well as causality among study variables. The results shows that all variables are integrated of order one and hence cointegrated. The study finds population growth, unemployment, poverty and inflation as having positive and significant impact on crime level in Nigeria. The Error Correction Model identified a sizable speed of adjustment by 93.20% for disequilibrium correction annually for attaining long-run equilibrium steady state position. The Granger causality test results revealed that crime is Granger caused by population growth, absolute poverty, unemployment, inflation and lending interest rate in Nigeria. The study provides some policy recommendations.

Keywords: Crime; poverty; unemployment; population growth; econometric model; Nigeria.

1. Introduction

Crime has been a major source of insecurity and discomfort in every society. It inflicts numerous monetary and psychological pains on the society. The history of crime is as old as the history of mankind. The first crime ever committed on earth was when Cain, the first born of Adam and Eve murdered his brother Abel out of jealousy, (Genesis 4:8). This shows that crime has been in existence since time immemorial. Today, the act of criminality gives rise to the feeling of insecurity and fear to all including those who have not been a victim. This sense of panic of being victimized generates negative effects on well being.

Crime can be defined as a wrongdoing as classified by the state or the parliament of the country or law of the land. Each country sets out series of crime acts, which are prohibited, and punishes the offenders of these acts by a fine or imprisonment or both. According to Okpo (2013) Crime is defined as the violation of norms or values thought to threaten a society. It is more of a sociological concept which encapsulates the spectrum of other related components of negative events in the society.

There is no universally acceptable definition of crime. It differs in different times in different countries or regions. To Curzen, "A crime is an act or omission of human conduct harmful to others which the state is bound to prevent. It renders the deviant person liable to punishment as a result of proceedings initiated by the state organs assigned to ascertain the nature, the extent and the legal consequences of that person's wrongdoing". Of the 11 types of crime identified globally, six are very prominent in Nigeria. These are predatory crime, which harms others and benefits only the offender; Occupational crime, committed by a person in the process of his/her occupation which utilizes his/her occupational skills; Service crime, which encourages the purchase of illicit or illegal goods and services; Organized crime, which has an administrative structure; Companionate crime, which involves accomplices; and Episodic crime, a type of crime with low probability of repetition by the same person.

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These types of crimes which range from armed robbery to advanced free fraud popularly called 419, examination malpractices, tax evasion, abortion, child-abuse, smuggling, bribery and corruption, contract inflation, car theft, cultism and piracy, are concomitants of social change or development in a society. Thus, despite the combined efforts of law enforcement agencies and some aggrieved members of the public, crime rate is still on the increase as new tactics of such crimes emerge daily in our society (Okpo, 2013). Mostly, persons known to commit street crimes are the poor, uneducated, often unemployed and residents of low income neighborhoods (Anasi, 2010).

According to the World Bank Report (2004), poverty is pronounced deprivation in well-being, and comprises many dimensions. It includes low incomes and the inability to acquire the basic goods and services necessary for survival with dignity. Poverty also encompasses low levels of health and education, poor access to clean water and sanitation, inadequate physical security, lack of voice, and insufficient capacity and opportunity to better ones life. To Kuhe et al. (2016) poverty is a denial of choices and opportunities, a violation of human dignity. It means lack of basic capacity to participate effectively in society. It means not having enough to feed and clothe a family, not having a school or clinic to go to; not having the land on which to grow ones food or a job to earn ones living, not having access to credit. Poverty means insecurity, powerlessness and exclusion of individuals, households and communities. It also means susceptibility to violence, and it often implies living in marginal or fragile environments, without access to clean water and sanitation. Wenger (2007) describes poverty as a living condition in which individuals fail to achieve a minimum standard of living. Haralambos and Holborn (2000) assert that poverty is a situation where a person is unable to acquire the minimum necessities that make for well-being. Poverty is marked by the inability to get good livelihood, have good house to live in, support oneself without depending on others, inability to acquire good healthcare, good educational training etc.

Haralambos and Holborn (2000) identifies absolute, relative and subjective poverty as the three types of poverty. They describe absolute poverty as a state where the living condition is really critical and there is difficulty in survival. They define relative poverty in terms of adjustment from people of a particular society of what is taken as a reasonable and acceptable standard of living and way of life due to the conditions of the day. According to Nweze and Ojowu (2002), subjective Poverty is a concept of poverty which is expressed in a range of non-material and intangible qualities; it is based on respondents perception of their standard of living. The feeling of whether one is poor or not depends on the absolute minimum standard of living below which one is categorized as poor.

Poverty and crime have a very intimate relationship. Poverty and crime combined together leave people with two choices: either to take part in criminal activities or try to find legal but quite limited sources of income when there are none available. The unmistakable connection between poverty and crime is that they are both geographically concentrated - in a strikingly consistent way. In other words, crime is more common in a poverty stricken society.

Unemployment to a layman means a state of joblessness, while to economists, it is seen as the percentage of the labour force that is without job, but is able, willing, and qualified to work. In other words, no matter how unemployment is defined; the underlying philosophy is that those who are capable, qualified, ready and expected to work are indeed not working, (Gbosi, 2004; Kuhe et al., 2016). Inflation refers to the rate at which prices of goods and services rises. Inflation is a sustained increase in the average price of all goods and services produced in an economy. Money loses purchasing power during inflationary periods since each unit of currency buys progressively fewer goods. Interest rates are the amount of interest paid by a borrower to a lender. In general as interest rates are lowered, more people are able to borrow more money. The result is that consumers have more money to spend causing the economy to grow and inflation to increase. The opposite is also true for rising interest rates. As interest rates are increased, consumers tend to borrow less and have less money to spend. With less spending, the economy slows and inflation decreases (Tuller, 1997).

2. Literature Review

Economic of crime has become a new field of investigation, particularly due to the fact that there has been a rapid increase in criminal activities in various countries of the world. There is a vast amount of literature available on the relationship between crime and their major determinants in countries like United States, United Kingdom, Germany, Italy, Iran, India, China, Pakistan and Nigeria. Many studies have been conducted on the relationship between crime and its determinants. The results of these studies have shown that there are various factors responsible for promoting crime in the world.

Fleisher (1963, 1966) analyzed the effects of income and unemployment on juvenile delinquency and found that crime rates are positively associated with unemployment and low income levels. The argument that lower income levels lead to higher crime rates was confirmed by a study conducted in 1973 by Isaac Ehrlich. However, it was Gary Beckers path breaking work that viewed criminals not as poverty stricken oppressed groups but rational economic agents. Like any other person, the potential criminal weighs costs/risks and benefits when deciding whether or not to commit a crime. He, however, wrote that, "some individuals become criminals because of the financial and other rewards from crime compared to legal work, taking account of the likelihood of apprehension and conviction, and the severity of punishment" (Becker, 1968). Work by Ehrlich and Becker in late 1960s and in 1970s gave birth to the theory of deterrence which argues that potential criminals weigh both the possibility of detection (and conviction) and the resulting sanction, monetary and non-monetary (Becker, 1968; Ehrlich, 1973, 1975, 1996).

Fajnzylber et al. (2000) have shown that crime rates in underdeveloped countries tend to be equal to or higher than that of developed countries. Anderson (1990, 1999) and Massey (1995) discuss, on sociological grounds, the factors that affect poor residents living in isolated areas who have to adapt themselves to such social surroundings. This, according to these studies, is done by giving extra weight to reputational aspects in their neighbourhood to reduce the risk of their own criminal victimization where this reputation is maintained through use of force. Fajnzylber et al. (2002) conducted cross country comparisons and found that across countries crime rate differentials are linked to growth and poverty and, to some extent, by demographic factors. Separate studies on South Africa and Madagascar, using cross sectional data, conclude that local inequality is significantly correlated with both property and violent crimes and burglaries and crop theft are expected to increase with poverty as people turn to crime to mitigate the effect of the shock on their lives (Demombynes and Ozler, 2002; Fafchamps and Minten, 2002). Lott (1990) postulates that the poor are more likely to engage in criminal activity due to their relatively limited access to capital markets; therefore, property crime is the poor person's method of borrowing against future human capital. Deutsch et al. (1992), however, argue that the poor are more likely to commit a crime because cost of punishment is less for them compared to the relatively high income individual who has more accumulated wealth to lose.

Gillani, et al. (2009) investigated the relationship between crime and unemployment, poverty and inflation in Pakistan for the period 1975-2007 using cointegration and Granger causality based on Toda-Yamamoto procedure. Their empirical findings revealed evidence of the existence of long-run cointegration relationship among crime, unemployment, poverty and inflation. The Granger causality showed that crime is granger caused by unemployment, poverty and inflation in Pakistan. Fumio and Miki (2010) also examined the effect of unemployment rates on crime rates, using two types of Japanese data: time-series data from 1976 to 2008 and prefectural panel data from 1975 to 2005. The results of time series analysis showed that an increase in unemployment rates raises crime rates, while increase in the number of police officers decreases crime rates. An analysis using prefectural panel data shows similar results; however, the increase in poverty rates raises crime rates more than the increase in unemployment. The empirical evidence also suggests that occurrences of crime are attributed to both labour market conditions related to the opportunity cost of crime, and the number of policies related to crime deterrent, as the theory of crime suggests.

Majid (2013) conducted a study to examine the effect of unemployment rate on theft crimes among the provinces of Iran. The study covered annual data from 1997 to 2006. He used Generalized Method of Moment (GMM). Results showed a strong significant and positive relationship between unemployment and theft crimes in various categories. He observed that other factors such as poverty and demographic Characteristics influenced people to commit theft crime. Results from estimation of crime models demonstrated a significant and positive relationship between unemployment rate and theft crime in Iran.

Aurangzeb and Khola (2013) investigated macroeconomic determinants of unemployment for India, China and Pakistan for the period 1980 to 2009. The investigation was conducted using cointegration, granger causality and regression analysis. The variables selected for the study were unemployment, inflation, gross domestic product, exchange rate and the increasing rate of population. The results of regression analysis showed significant impact of all the variables for all three countries. GDP of Pakistan showed positive relation with the unemployment rate and the reason for this was the poverty level and underutilization of foreign investment. The result of granger causality showed that bidirectional causality does not exist between any of the variable for the three countries. Cointegration result showed the existence of long term relationship among the study variables for all the models. It was recommended that distribution of income needs to be improved for Pakistan in order to have positive impact of growth on the employment rate.

In Nigeria, Aminu et al. (2013) examined the relationship between crime level, unemployment rate, poverty rate, corruption level and inflation in Nigeria for the period 1980-2009 using OLS regression and causality analysis. The results of the OLS revealed that unemployment, poverty and corruption had negative impact on crime while inflation rate had positive impact on crime level in Nigeria. The causality results suggested one-way causality between poverty and crime level, feedback causality between corruption and crime level and between corruption and inflation and one-way causation between corruption and unemployment. This therefore establishes a link between crime level, unemployment, poverty, corruption and inflation in Nigeria. Archibong et al. (2014) assessed the impact of poverty on criminal behaviours among youths in Cross River State. Research questions were formulated to guide and give direction to the study, using the survey design, 150 respondents made up of adult men and women and youths were selected to participate in the study. The major instrument for data collection was questionnaire. Data collected was analyzed using Pearson Product Moment Correlation Coefficient. The result showed a positive and significant correlation between poverty and criminal tendencies among youths. Most youths with low socio-economic background are easily lured into criminal activities. It was recommended that the government, non governmental agencies and parastatals and the general public must embark on youth empowerment programs that would alleviate poverty at least to the barest minimum while enhancing their young minds and directing them towards better and rewarding activities.

Torruan and Abur (2014) investigated the relationship between unemployment, inflation and crime in Nigeria for the period 1980-2011 using cointegration and causality analysis. The Johansen approach of cointegration was applied to test for the long-run relationship among the variables. The result indicated three cointegrating relations between the variables; the Granger-causality suggested that there is unidirectional causality running from unemployment and inflation to crime in Nigeria. The study concluded that unemployment in Nigeria Granger causes crime. The reason is that unemployment rate in Nigeria is a complementary indicator of income opportunities in the legal labour market. Therefore, when unemployment rate increases the opportunities for earning income decreases which instigate the individuals to commit crime. The costs of committing crime are attributed to unemployed workers. The results of causality support this proposition that unemployment causes crime. From the above reviewed literature, it is glaring to know that while different approaches were employed by different researchers to investigate the causal relationship between crime and its determinants, all agreed that absolute poverty and unemployment are the key factors promoting crime all over the world including Nigeria. This study is

slightly different from those found in the literature as it adds more crime determinants variables such as lending interest rate and population growth rate in its investigation. The study therefore, contributes, confirms and extends the existing literature by investigating the relationship between crime level and its determinants such absolute poverty, unemployment rate, inflation rate, lending interest rate and population growth rate in Nigeria using econometrics tools and more recent data.

3. Materials and Methods

3.1 Data and source

The data used in this work are annual time series data covering the fiscal year 1970 to 2015. The total number of crimes committed each year in Nigeria is transformed to natural log. This reduces and stabilizes the mean and variance of the series and is used as proxy for Crime level, absolute poverty indices, unemployment rate, inflation rate, lending interest rate and population growth rate were all obtained as secondary data from International Monetary Fund, balance of payment database supplemented by data from the U.N conference on trade and development and official national sources; also from World Bank National Account data and OECD national account data files. The analysis of the data in this research work is implemented in Eviews version 8.0.

3.2 Augmented Dickey-Fuller (ADF) unit root test

Unit root test is a statistical test which determines the order of integration of a series. It shows whether a given time series is stationary or not. Let $\{Y_t\}$ be a given time series, the ADF unit root test is used to check whether the given series contains a unit root or whether the given series is stationary or not, Dickey and Fuller (1979). The Augmented Dickey-Fuller (ADF) test constructs a parametric correction for higher-order correlation by assuming that the series follows an AR(p) process and adding lagged difference terms of the dependent variable to the right-hand side of the test regression:

$$\Delta Y_t = \alpha Y_{t-1} + X_t \delta + \varphi_1 \Delta Y_{t-1} + \varphi_2 \Delta Y_{t-2} + \dots + \varphi_p \Delta Y_{t-p} + \epsilon_t \quad (1)$$

where X_t are optional exogenous regressors which may consist of constant, or a constant and trend, α and δ are parameters to be estimated, and the ϵ_t are assumed to be white noise. The null and alternative hypotheses are written as:

$$H_0 : \alpha = 0 \text{ against } H_1 : \alpha < 0 \quad (2)$$

and evaluated using the conventional t-ratio for α :

$$t_\alpha = \hat{\alpha} / \{se(\hat{\alpha})\} \quad (3)$$

where $\hat{\alpha}$ is the estimate of α and $se(\hat{\alpha})$ is the standard error of the coefficient. An important result obtained by Fuller is that the asymptotic distribution of the t-ratio for α is independent of the number of lagged first differences included in the ADF regression.

3.3 Johansen cointegration test

To investigate the long-term relationship among study variables, we employ Johansen cointegration trace and maximum eigenvalue tests. The Johansen cointegration test is only applied on variables which are integrated of the same order. A Vector Autoregressive based

cointegration test methodology developed by Johansen (1991, 1995) is as follows. Consider a VAR of order p :

$$y_t = \Phi_1 y_{t-1} + \Phi_2 y_{t-2} + \cdots + \Phi_p y_{t-p} + Bx_t + \epsilon_t \quad (4)$$

where y_t is the k -vector of non-stationary $I(1)$ variables, x_t is the d -vector of deterministic variables and ϵ_t is a vector of innovations. We may rewrite this VAR as:

$$\Delta y_t = \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + Bx_t + \epsilon_t \quad (5)$$

where

$$\Pi = \sum_{i=1}^p A_i - \mathbf{I}, \quad \Gamma_i = - \sum_{j=i+1}^p A_j. \quad (6)$$

Granger's representation theorem asserts that if the coefficient matrix Π has reduced rank $r < k$, then there exist $k \times r$ matrices α and β each with rank r such that $\Pi = \alpha\beta'$ and $\beta'y_t$ is $I(0)$. r is the number of cointegrating relations (the cointegrating rank) and each column of β is the cointegrating vector. Johansen cointegration test computes two statistics: trace statistic and maximum eigenvalue statistic. The trace statistic for the null hypothesis of r cointegrating relations is computed as:

$$LR_{tr}(r|k) = -T \sum_{i=r+1}^k \log(1 - \lambda_i) \quad (7)$$

The maximum eigenvalue test statistic is computed as:

$$LR_{max}(r|r+1) = -T \log(1 - \lambda_{r+1}) = LR_{tr}(r|k) - LR_{tr}(r+1|k) \quad (8)$$

where λ_i is the i -th largest eigenvalue of the matrix Π , $r = 0, 1, 2, \dots, k-1$.

3.4 Model specification for long-term relationship

To investigate the impact of poverty, unemployment, inflation, interest rate and population growth on crime level in Nigeria, we employ a multiple cointegrating regression model using fully modified ordinary least squares (FMOLS). The model is specified as follows:

$$\ln CRM = f[POV, UNP, INF, INT, POP] \quad (9)$$

The natural log of crime is a function of poverty, unemployment, inflation, interest rate and population growth. Our linear model is thus given by:

$$\ln CRM_t = \beta_0 + \beta_1 POV_t + \beta_2 UNP_t + \beta_3 INF_t + \beta_4 INT_t + \beta_5 POP_t + \epsilon_t \quad (10)$$

where $\ln CRM_t$ represents the natural log of crime at time t used as proxy for crime level, POV_t represents poverty at time t , UNP_t represents unemployment rate at time t , INF_t represents inflation at time t , INT_t represents interest rate at time t , POP_t represents population growth rate and ϵ is the error term assumed to be normally and independently distributed with zero mean and constant variance, which captures all other explanatory variables that influence crime level but are not captured in the model. β_0 is the intercept of

the regression model which represents the predictive value of the dependent variable when all the independent variables are kept constant. $\beta_1, \beta_2, \beta_3, \beta_4, \beta_5$ are the slope coefficients of the respective independent variables that measure the impacts of the explanatory variables on crime level. For the independent variables to have positive impacts on crime the slope coefficients $\beta_1, \beta_2, \beta_3, \beta_4, \beta_5$ must be positive and significant.

3.5 The error correction model

To determine the short run relationship among the study variables, we apply error correction model which is specified as:

$$\Delta \ln CRM_t = \beta_0 + \sum_{i=1}^p \beta_{1i} \Delta POV_{t-1} + \sum_{i=1}^p \beta_{2i} \Delta UNP_{t-1} + \sum_{i=0}^p \beta_{3i} \Delta INF_{t-1} + \sum_{i=0}^p \beta_{4i} \Delta INT_{t-1} + \sum_{i=0}^p \beta_{5i} \Delta POP_{t-1} + \lambda_6 EC_{t-1} + \epsilon_{2t} \quad (11)$$

where EC_{t-1} is the error correction term (the residuals that are obtained from the estimated cointegrating regression model), λ is the speed of adjustment, it provides the feedback and speed of adjustment which indicates how much of the disequilibrium that is being corrected in the system, Δ is the first difference of the variable. For a stable long-run relationship to exist among the study variables, the expected sign of lambda is negative and statistically significant. The non-positivity and significance of lambda means that the short-run relationship can be predicted, otherwise the relationship is unpredictable.

3.6 Granger causality based on Toda-Yamamoto procedure

Toda and Yamamoto procedure uses a Modified Wald (MWALD) test for restrictions on the parameters of the VAR (k) model. The advantage of using this procedure is that it is not necessary to pretest the variables for the integration and cointegration properties and therefore, it avoids the possible pretest biases (Toda and Yamamoto, 1995). The model is specified as follows:

$$Y_t = \alpha_1 + \sum_{i=1}^{k+d} \beta_{1i} Y_{t-i} + \sum_{i=1}^{k+d} \beta_{2i} X_{t-i} + \epsilon_{yt} \quad (12)$$

$$X_t = \alpha_2 + \sum_{i=1}^{k+d} \gamma_{1i} X_{t-i} + \sum_{i=1}^{k+d} \gamma_{2i} Y_{t-i} + \epsilon_{xt} \quad (13)$$

where k is the optimal lag order; d is the maximal order of integration of the series in the system; ϵ_{yt} and ϵ_{xt} are error terms which are assumed to be white noise. The usual Wald tests are then applied to the first k coefficient matrices using the standard χ^2 -statistic. The test checks the following pairs of hypotheses: X_t "Granger causes" Y_t if $\beta_{2i} \neq 0$ in equation (12) against Y_t "Granger causes" X_t if $\gamma_{1i} \neq 0$ in equation (13).

4. Results and Discussion

4.1 Result of ADF unit root test

To check whether the study variables have the same order of integration, we employ the popular Augmented Dickey-Fuller (ADF) unit root test both in levels and first differences of the series in the presence of intercept and linear time trend. The ADF unit root test result is presented in Table 1.

Table 1. ADF unit root test results

	ln CRM	POV	UNP	INF	INT	POP
Level	-1.9037	-2.1105	-2.0815	-1.1919	-0.1495	-1.8634
1st Diff.	-11.6409**	-17.2193**	-35.8017**	-9.4238**	-7.2206**	-21.1028**
Remark	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)

Note: ** denotes significant of the ADF test statistic at 1% and 5% level of significance.

The ADF unit root test results indicate that all the variables under review: crime level, poverty, unemployment, inflation, interest rate and population growth are non-stationary in levels, but stationary in first differences. We therefore conclude that all the study variables are integrated of order one, $I(1)$. This means that Johansen cointegration test can be conducted on the study variables.

4.2 Johansen cointegration test results

Having established that the variables under investigation are integrated of the same order, we are now in a better position to explore their long-term relationships using Johansen cointegration test procedure. The result of the Trace test is reported in Table 2 while the result of the maximum eigenvalue test is presented in Table 3.

Table 2. Johansen cointegration trace test results

Hypothesized No. of CE(s)	H_0	H_1	Eigenvalue	Trace statistic	0.05 Critical Value	Prob.**
None*	$r = 0$	$r \geq 1$	0.822438	177.7822	95.75366	0.0000
At most 1*	$r \leq 1$	$r \geq 2$	0.615089	105.1880	69.81889	0.0000
At most 2*	$r \leq 2$	$r \geq 3$	0.573435	65.08875	47.85613	0.0006
At most 3	$r \leq 3$	$r \geq 4$	0.422620	29.30517	29.79707	0.0569
At most 4	$r \leq 4$	$r \geq 5$	0.112867	6.236501	15.49471	0.6676
At most 5	$r \leq 5$	$r = 6$	0.028320	1.206589	3.841466	0.2720

Note: Trace test indicates 3 cointegrating equations at the 0.05 level. * denotes rejection of the null hypothesis at the 0.05 level. **denotes MacKinnon-Haug-Michelis (1999) p-values.

The Johansen cointegration trace test result indicates 3 cointegrating equations at 0.05 significance level while the maximum eigenvalue test result indicates 4 cointegrating equations at 0.05 significance level. These results show that the variables under study are cointegrated. This means the existence of long-term relationship between crime, poverty, unemployment, inflation, interest rate and population growth. This also means that the study variables share a common stochastic drift and cannot wander away from each other in the long-run.

Table 3. Johansen cointegration maximum eigenvalue test Results

Hypothesized No. of CE(s)	H_0	H_1	Eigenvalue	λ_{\max} statistic	0.05 Critical Value	Prob.**
None*	$r = 0$	$r = 1$	0.822438	72.59428	40.07757	0.0000
At most 1*	$r \leq 1$	$r = 2$	0.615089	40.09920	33.87687	0.0080
At most 2*	$r \leq 2$	$r = 3$	0.573435	35.78359	27.58434	0.0036
At most 3*	$r \leq 3$	$r = 4$	0.422620	23.06866	21.13162	0.0264
At most 4	$r \leq 4$	$r = 5$	0.112867	5.029912	14.26460	0.7380
At most 5	$r \leq 5$	$r = 6$	0.028320	1.206589	3.841466	0.2720

Note: Max-eigenvalue test indicates 4 cointegrating equations at the 0.05 level. * denotes rejection of the null hypothesis at the 0.05 level. ** denotes MacKinnon-Haug-Michelis (1999) p-values.

4.3 Estimates of cointegrating regression model

To investigate the impact of poverty, unemployment, inflation, interest rate and population growth on crime level in Nigeria, we employ cointegrating regression model using fully modified ordinary least squares. The result is presented in Table 4.

Table 4. Fully Modified Least Squares (FMOLS) estimation of long-run coefficients

Variables	Coefficient	Std. Error	t-Statistic	P-value
C	4.509048	3.983788	1.131850	0.2646
POV	0.151137	0.012815	-3.179628	0.0435
UNP	0.107047	0.023258	4.602599	0.0000
INF	0.012658	0.006576	1.924943	0.0166
INT	-0.041643	0.027319	-1.524311	0.1355
POP	3.058980	1.478192	2.069406	0.0452

$R^2 = 0.847922$, Adjusted $R^2 = 0.764323$, Durbin Watson statistic= 2.136846.

The result of Table 4 shows that poverty, unemployment, inflation and population growth have positive and significant impacts on crime. This means that an increase in these variables will lead to increase in crime level in Nigeria. Interest rate has negative and insignificant relationship with crime. The intercept of the regression line is positively related to crime, although not statistically significant. This indicates the level of crime when all independent variables are kept constant. This implies that poverty, unemployment, inflation, lending interest rate and population growth may not be the only determinants of crime; there may be other determinants of crime not included in this model.

The coefficient of determination, R^2 shows that about 84.79% of the variability in the model has been explained by the explanatory variables while the remaining 15.21% unexplained variations are being accounted for by the error term or by factors not included in the model. This means that apart from poverty, unemployment, inflation, interest rate and population growth which are considered in this study, there are also other variables having impact on crime but are not included in the model. The Durbin Watson statistic is greater than R^2 meaning that our long-run model is non-spurious. This study has identified population growth as having higher impact on crime in Nigeria followed by poverty, unemployment and inflation in the long-run. The findings of this study are in conformity with the findings of Gillani et al. (2009), Fumio and Miki (2010), Majid (2013), Aurangzeb and Khola (2013), Aminu et al. (2013), Archibong et al. (2013) and Torruam and Abur (2014).

4.4 The error correction model

Using the residuals obtained from cointegrating regression equation in Table 4, we estimate the Error Correction Model (ECM) which adjusts the speed of disequilibrium in the system. The result is presented in Table 5.

From the estimates of ECM in Table 5 the slope coefficients of Table 5. Parameter estimates of the error correction model

Variables	Coefficient	Std. Error	t-Statistic	Prob.
C	0.055905	0.094555	0.591246	0.5581
$\Delta \ln CRM(-1)$	-0.431239	0.159346	-2.706302	0.0103
$\Delta POV(-1)$	-0.007725	0.719252	-1.401287	0.0406
$\Delta UNP(-1)$	0.046184	0.042196	1.094506	0.0210
$\Delta INF(-1)$	-0.005242	0.005850	-0.896146	0.3761
$\Delta INT(-1)$	-0.002902	0.035199	-0.082432	0.9348
$\Delta POP(-1)$	0.162977	1.326633	3.122850	0.0029
$EC(-1)$	-0.932032	0.012660	0.736330	0.0003

$R^2 = 0.7629$, Adjusted $R^2 = 0.7195$, Durbin Watson statistic= 2.1835,
F-statistic=11.834030, Prob.(F-statistic)=0.000578.

$\Delta \ln CRM(-1)$, $\Delta POV(-1)$, $\Delta UNP(-1)$, $\Delta INF(-1)$, $\Delta INT(-1)$ and $\Delta POP(-1)$ are the short-run equilibrium coefficients whereas the slope coefficient of $EC(-1)$ is the long-run equilibrium coefficient known as the error correction coefficient. Econometric theory expects the coefficient of $EC(-1)$ to be negative and significant.

The short-run equilibrium coefficients tell us the rates at which the previous periods disequilibrium in the system is being corrected. In our *ECM* model the system corrects its previous period's disequilibrium at the speed of 43.12% between crime level and crime level lag one year, 0.77% between crime level and poverty lag one year, 4.62% between crime level and unemployment lag one year, 0.52% between crime level and inflation lag one year, 0.29% between crime level and interest rate lag one year and 16.30% between crime level and population growth lag one year. The small percentage values show how slow the previous periods disequilibria between crime level other explanatory variables in the model are being corrected. The slope coefficients of $\Delta \ln CRM(-1)$, $\Delta POV(-1)$, $\Delta UNP(-1)$ and $\Delta POP(-1)$ are statistically significant at lag one year indicating that the effect of poverty, unemployment and population growth on crime level is not just temporal but long lasting whereas the slope coefficients of $\Delta INF(-1)$ and $\Delta INT(-1)$ are not significant at lag one year indicating that the effect of inflation and interest rate on crime level is temporal and not long lasting.

The one lag period error correction model is represented by $EC(-1)$. This guides the independent variables in the system to restore back to equilibrium when it is negative and statistically significant. In our case this coefficient is negative and statistically significant at 5% level indicating that the system corrects its previous period's disequilibrium at a speed of 93.20% yearly. This means that the ECM model has identified a reasonable speed of adjustment by 93.20% for correcting disequilibrium annually for attaining long term equilibrium steady state position.

4.5 Granger causality test result based on Toda-Yamamoto approach

To conduct Granger causality test based on Toda-Yamamoto procedure, we estimate two equations in VAR model, the Akaike information criteria (AIC) suggests that we should specify a maximum lag length of 3 for each variable in the model as indicated in Table 6.

Since the estimated VAR must satisfy the stability condition before it could be used for modified Wald test, we conduct serial correlation LM test of residuals of the estimated VAR

Table 6. VAR lag order selection criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-472.9501	NA	1831.711	24.52143	26.25910	25.15836
1	-388.0506	117.2423	198.6531	22.19288	25.41999	23.37574
2	-316.0380	78.87088*	48.15599*	20.47800	25.19453*	22.20680*
3	-273.1681	34.70424	67.33079	20.15086*	26.35682	22.42559

Note: * indicates lag order selected by the criterion.

model which is presented in Table 7.

Table 7. Estimated VAR residual serial correlation LM tests and autoregressive roots table

Lags	LM-Stat.	P-value	Root	Modulus
1	66.73862	0.1404	0.742023 - 0.230246i	0.776924
4	55.22347	0.2127	0.742023 + 0.230246i	0.776924
7	34.29336	0.5499	0.686078 - 0.325127i	0.759217
10	54.68855	0.2137	0.686078 + 0.325127i	0.759217
11	27.72170	0.8370	0.555219	0.555219
12	25.63619	0.9002	0.151355	0.151355

The second and third columns contain the VAR residual serial correlation LM tests, and the last two columns contain the obtained results for the AR roots. The null Hypothesis of no serial correlation at lag order 12 is accepted since the p-values of the LM-statistics are not statistically significant at 5% level of significance and since no root lies outside the unit circle our estimated VAR model has satisfied the stability condition. This means that we can use the VAR to conduct Granger causality test based on Toda-Yamamoto procedure. The result of Granger causality test is presented in Table 8.

Table 8. Granger causality test result based on Toda-Yamamoto procedure (Modified Wald Test)

Variable	CRM	POV	UNP	INF	INT	POP
CRM	–	13.2865 [0.0034]*	17.2272 [0.0002]*	14.4544 [0.0007]*	11.4221 [0.0033]*	7.23291 [0.0269]*
POV	2.78854 [0.2480]	–	11.2441 [0.0042]*	0.30690 [0.8577]	1.40035 [0.4965]	11.2007 [0.0045]*
UNP	1.36668 [0.5049]	3.02901 [0.2199]	–	0.28321 [0.8684]	1.39069 [0.4989]	13.2596 [0.0036]*
INF	1.57927 [0.1137]	5.51481 [0.0635]	1.17180 [0.5566]	–	39.4203 [0.0000]*	5.43419 [0.0661]
INT	1.45664 [0.4827]	0.22088 [0.8954]	4.04459 [0.1324]	13.9766 [0.0009]*	–	1.85335 [0.3959]
POP	0.41479 [0.8127]	7.31576 [0.0231]*	3.91351 [0.1413]	3.50067 [0.1737]	0.85276 [0.6529]	–

The Granger causality test result shows that poverty, unemployment, inflation, interest rate and population growth, all Granger causes crime in Nigeria. The result also shows bidirectional causality between population growth and poverty. The result also reveals that poverty in Nigeria is Granger caused by unemployment while unemployment is Granger caused by population explosion. A bilateral causality also exists between inflation and interest rate.

5. Conclusion

This paper has attempted to investigate the impact of some macro-economic variables; absolute poverty, unemployment, inflation, lending interest rate and population growth rate on crime level in Nigeria, using annual time series data, from 1970-2015. The first step of the analysis examines the unit root and stationarity properties of the series using Augmented Dickey-Fuller unit root test. Johansen cointegration was employed to examine the long-term relationship among the study variables, cointegrating regression equation using FMOLS was applied to investigate the impact of study variables on crime level, error correction model was employed to determine the speed of adjustment for correcting disequilibrium in the system while Granger causality test based on Toda-Yamamoto procedure was used to find the direction of causality among study variables.

The unit root test result shows that all variables are integrated of order one, $I(1)$. The Johansen cointegration test indicates the existence of long-term relationship among study variables. The study finds population growth, unemployment, poverty and inflation as having positive and significant impact on crime level in Nigeria with population growth having the highest impact. The Error Correction Model has identified a sizable speed of adjustment by 93.20% for disequilibrium correction annually for attaining long-run equilibrium steady state position. Although the speed of adjustment between crime and the independent variables are found to be very slow. Population growth, poverty and unemployment are found to have permanent effect on crime in Nigeria while inflation and interest rate are found to have temporal effect on crime.

The Granger causality test results revealed that crime is Granger caused by population growth, absolute poverty, unemployment, inflation and lending interest rate in Nigeria. The result also shows bidirectional causality between population growth and poverty. The result also reveals that poverty in Nigeria is Granger caused by unemployment while unemployment is Granger caused by population explosion. A bilateral causality also exists between inflation and interest rate. The implication of the Granger causality test result is that when people are in absolute poverty and there are no paid jobs for them to earn a living when prices of commodities in the market are persistently increasing and the interest charge for borrowing money is high, they often resort to committing crime especially when the punishment associated with such crimes is minimal.

Based on the findings of this study, the following recommendations are suggested to help in preventing and reducing crime level in Nigeria.

- (1) Nigerian government should create more jobs for her citizens in order to reduce crime in the country.
- (2) Educational system and programmes in Nigeria should be redirected towards functionality, entrepreneurial, vocational and technical to enhance self-employment, self-reliance in order to reduce unemployment and crime. Also training/retraining of unemployed youths (graduates and non graduates) at Government expense in entrepreneurial, vocational and technical skills should be embarked upon.
- (3) To reduce crime in Nigeria, economic growth has to be favourable for the poor class of the society. More resources should be directed to agriculture and the rural areas where majority of the poor lives.
- (4) Government should moderate lending and borrowing interest rates to avail the poor access to loan and credit facilities in order to alleviate poverty and help them engage in productive ventures.
- (5) Government should enact laws to control childbearing in order to reduce the population of the country. This will go a long way in reducing crime in the country.

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