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Analysis of Correlates of Crime Severity among Young in Wolaiata Zone, Southern Ethiopia

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Abstract
The primary objective of this study was to identify and analyze the determinants that influence youth's to criminal activities in three zones of SNNPR. Second objective of the study was to model crime rates based on, monthly crime rates and the impact of sentence reforms on reported crime in Wolaiata Sodo, Ethiopia, over the data collection period of April 2007 to January 2017 GC by incorporating intervention effects. Monthly data were obtained from Wolaiata Sodo Police Commission and for a total of 118 months were used. The primary data collection was taken from Nov, 2017 to Dec 2018. For primary data Logistic regression model was used to predict the probability of dependent variable on the basis of independent variables. The study will help in understanding crime prevalence across various cities in SNNP regional state and Ethiopia as the whole. Based on logistic regression analysis for primary data: Age, sex, educational background, marital status, residence, employment status, partners education, attitude towards revenge, income status, awareness of criminal law, previous crime history and number of dependent families were found to be statistically significant risk factors.
The impact of sentenced legislation on reported crime rates was examined using time series approaches. In particular, structural time series models were employed for the intervention analysis. The model fitness was checked based on the model capturing the variations in the data accessed through R_s^2, AIC and BIC. The result of the secondary data analysis shows that the coefficient of intervention was negative to rate of murder, robbery, rape and larceny but it was significant only for larceny. The effect of macroeconomic variables such as food inflation, non-food inflation, general inflation and unemployment were statistically significant only for aggravated assault. It is recommended that the government and the concerned body should take some measures to tackle inflation and unemployment issues in the town.

Keywords: unemployment, attitude, government, concerned, Wolaiata

1. Introduction

1.1 Backgrounds of the Study

The study of crime and its determinants is closely related to poverty, social exclusion, income inequality, culture, family background, religion, unemployment, education, age, gender, race, urbanization and a host of other economic and socio-demographic factors that influence the mind and behavior of the individual in being participated in criminal activities (Gumus, 2004).

Crime Definitions and Classifications

Thaku r (2003) [12] defined crime as an act or omission of an act, which is punishable by law. However, an act that is considered as a crime in one place and time may not be true in another place or time. Crime is classified in to two broad categories as: personal/violent crime and property crime.
Personal/Violent Crimes: A violent crime is any criminal offense which involves the use of, or even the threat of force or violence and it has a broad legal category that encompasses a number of criminal offences. Crime such as Murder, Aggravated Assault, Forcible Rape Robbery, is categorized as Personal/ Violent crime.
Property Crimes: Includes those offences involving the loss of property during which there is no use of violence by the perpetrators. There are different types of crimes in this category such as Arson, Burglary, Larceny-theft.

Factors or Causes of Crimes

In Ethiopia, crime statistics has shown that the rate of crime was increasing steadily. There are a number of factors which may be responsible for the growing rate of crime such as unemployment, economic backwardness, over population, illiteracy and inadequate equipment of the police force (Thakur, 2003) [12].
The circumstances surrounding the individual offender such as his/her personality, physical characteristics, intelligence, family background, environmental surrounding such as peer groups and neighbors have been subject of the study of crime (Andargachew, 1988) [1]. Hence, understanding the attributes of criminals will be helpful to design and implement prudent crime prevention strategies. Thakur (2003) [12] suggested that intent and opportunity are two major factors that lead to the occurrence of a crime. An individual cannot commit a crime unless and otherwise he or she gets an opportunity even though intended to commit a crime. Therefore, the best strategy for crime prevention is to provide a system that denies any opportunity for a criminal to commit a crime. Madden and Chiu (1998) [10] mentioned that it seems reasonable to expect that the level of property crime will be influenced in some way by the distribution of income (and wealth) while Teles (2004) reiterated that monetary and fiscal policies have impacts on crime.
Lu Han (2009) [9] Tested broadly concerned unemployment and crime relationship using annual time series data in England and Wales over the period 1971-2000. He found that, in the long-run, the overall and individual property crimes are cointegrated with unemployment as well as law enforcement instruments. On the other hand, Britt (1997) [3]

only finds support for the criminal motivation effect. Controlling for the variation in the unemployment crime relationship by age group and over time, he concluded that unemployment has a greater motivational effect on property crime among young adults.

1.2 Statements of the Problem

Wolaiata Zone is one of fifteen zones in SNNPR. SNNPR is a multination, which consists of about 56 ethnic groups with their own distinct geographical location, language, cultures, and social identities living together. In addition, SNNP regional state had high population density, unemployment rate, poverty and other social problems, which may be the reason for occurrence of crime. Determining the major factors that may affect crime rates is important to design better strategy and policy which improves the prevention of crimes. Accordingly, this study focuses on identifying factors that explain the rate and occurrence of crime in the region.

Research Questions

What are the major factors that lead youths to participate in criminal activities in SNNPR?

Is there any relationship between youths demographic, economic and environmental information with crime severity?

Is there any association between different levels of crime?

Whether policy intervention (sentence reforms) affects the tragedy of series of crimes and determines the major factors of crime rates in Wolaiata Sodo.

1.3 Objectives of the study

The general objective of this study is to identify and analyze the factors that influence youth's in criminal activities.

Specific objectives

1. To model crime prevalence by including demographic, economic and environmental effects.
2. To investigate the relationship between demographic and socio economic factors and crime severity.
3. To assess crime rate pattern and identify its determinants in Wolaiata Sodo using structural time series models.
4. To provide scientific information for further studies based on empirical findings from this study.

2. Methodology

2.1 Description of the Study Area and Population

The basic goal of this study is to explore and enquire the major determinants of crime rates in Woliata zone, Ethiopia. Wolayta zone is one of the fifteen zones of the Southern Nations, Nationalities and People's Region (SNNPR) that is located in the Southern and South-western part of Ethiopia covering an area of 4471.3 km^2. For administrative purpose the zone is divided in to sixteen woreda and six administrative town. Based on the 2007 Census conducted by the Central Statistical Agency of Ethiopia (CSA), this Zone has a total population of 1,501,112, inhabitants of whom 739,533 are men and 761,579 women. Wolaita has a population density of 356.67 inhabitants per km2. Wolaita is bordered on the south by Gaamo, on the west by the Omo River which separates it from Dawro, on the northwest by Kembata Tembaro, on the north by Hadiya, on the northeast by the Oromia Region, on the east by the Bilate River which separates it from Sidama, and on the south east by the Lake Abaya which separates it from Oromia Region.

2.2 Sampling Techniques for unit analysis

Sampling methods are scientific procedures of selecting those sampling units that would provide the required estimator with associated margins of uncertainty arising from examining only a part not the whole of the population. Multi stage Stratified sampling with stratification formed by crime level will be applied to this study. The main purpose of stratification is to reduce sampling error. Moreover, stratified sampling is a technique which uses any relevant information that might be available, in order to increase efficiency. It involves the division or stratification of a population by partitioning the sampling frame in to non-overlapping and relatively homogeneous groups.

2.2.2 Sample size determination

In the planning of a sample survey or researches, a stage at which a decision must be made about the size of the sample is always required. However, too large a sample implies wastage of resources, and too small a sample diminishes the utility of the results (Cochran, 1977). Therefore, the decision should be made with a minimum cost but the estimate will explain the population characteristics with a high precision.

However, several formulas developed for sample size calculations that conform to different research situations. The sample size for this study will be determined based on stratified sampling at a 95 percent confidence level using general formula for sample size determination adopted (Cochran, 1977, p.105) as:

$$n = \frac{\sum_{h=1}^{2} \frac{W_h^2 S_h^2}{W_h}}{V + \frac{1}{N}\sum_{h=1}^{2} W_h S_h^2}$$

Let Z be the upper $\alpha/2$ point of standard normal distribution, where $\alpha = 0.05$ so that $z_{\alpha/2} = z_{0.025} = 1.96$. The total population $N = 13{,}745$ from 3 crime severity level and 3 sampled area wasselected for primary data which contain $N_1 = 5{,}510$ (Arbaminch), $N_2 = 4{,}325$ (WolaitaSoddo) and $N_3 = 3{,}910$ (Hawassa). This strata total is again allocated for three crime levelin the study.

After all, the proportional allocation using $W_h = N_h/N$ and S_h^2 are more convenient for computing the sample size n from the first minimum estimated sample size, n_0.

$$n = \frac{\sum_{h=1}^{2} W_h S_h^2}{V} \qquad \left(\frac{Z_{\alpha/2}}{Nd^2}\right)^2 \sum_{h=1}^{3} W_h S_h^2 = 830$$

2.3 Description of Data and Methods of Data Collection

Crimes are recorded by police on daily basis. This study will

be based on both primary data and secondary data. The questionnaire consisting poverty, social exclusion, income inequality, cultural and family background, religion, unemployment, education, age, gender, race, urbanization and a host of other economic, socio-demographic and environmental factors that influence the mind and behavior of the individual in making decision in participating in crime activity were designed. The primary data was collected by using a designed questionnaire and arrested persons in the prison were asked to complete the modified Amharic version questionnaire; while the secondary data of respondents was obtained from record of police commotion offices using identification number.

Dependent categorical Variable

The response variable in this study is crime severity categorized as serious crime, medium crimes, low crimes.

The correlates of crime severity

The most important and common factors that influence the incidence of crime is described as follows:

- Age: it is categorized as:-18-30,31-50 and 51+
- Sex: (Male or Female)
- Educational Background: Illiterate, Primary education, Secondary education and above.
- Marital Status :Single, Married
- Residence : Rural, Urban , Near to urban
- Employment Status: employed, Unemployed.
- Respondents Economic status: poor , medium, Rich.

2.4 Method of Data Analysis

In order to meet the objective set up on this study Ordinal logistic Regression Model, and State Space time Series Model were used

2.4.1 Logistic Regression Model

Logistic regression is used to predict the probability of dependent variable on the basis of independent variables and to determine the effect size of the independent variables on the dependent variable. The impact of predictor variables is usually explained in terms of odds ratio and hence the name logistic regression, also called the log-odds function. This model applies maximum likelihood estimation after transforming the dependent into a logit variable (the natural log of the odds of the dependent occurring or not).

Considering a collection of *P* explanatory variables, denoted by the vector $X' = (X_1, X_2, ..., X_p)$. The relationship between the predictor and response variables is not a linear function in logistic regression; instead, the logistic regression function is used, which is the logit transformation of π.

$$\pi_i = \frac{\exp(\alpha_i + \beta_1 X_1 + \cdots + \beta_p X_p)}{1 + \exp(\alpha_i + \beta_1 X_1 + \cdots + \beta_p X_p)} \quad (2)$$

Then the logit or log-odds of having pr($Y \leq i$) π_i is modeled as a linear function of the explanatory variables as:

$$logit[pr(Y \leq i)] = \alpha_i + \sum_{j=1}^{p} \beta_j X_j; i = 1, \ldots c-1 \text{ and } j = 1, 2, \ldots, p \quad (3)$$

The model assumes a linear relationship for each logit and parallel regression lines. Equation (3) is called proportional odds model.

Model Selection and Test of Overall Model Fit

It is much better to compare models based on their results, reasonableness and fit as measured, by the Akaike Information.AIC=-2(maximized log likelihood-number of parameters in model).This penalizes a model for having many parameters. With models for categorical *Y*, this ordering is equivalent to one based on an adjustment of the deviance by twice its residual degree of freedom (Agresti, 2002). For the selected model we should look at an overall test of the null hypothesis that the location coefficients for all of the variables in the model are 0 before proceeding to examine the individual coefficients. The change in likelihood function has a chi-square distribution even when there are cells with small observed and predicted counts. This value provides a measure of how well the model fits the data. The log likelihood statistic is analogous to the error sum of squares in multiple linear regressions

Goodness-of-Fit Measures

The parameters are estimated by maximizing the likelihood, or more usually, by maximizing the logarithm of the likelihood. The likelihood function is given by the equation:

$$L = \prod_{j=1}^{n}\left[\prod_{i=1}^{c} \pi_i(X_j)^{y_{ij}}\right] = \prod_{j=1}^{n}\left[\prod_{i=1}^{c}\left[\frac{\exp(\alpha_i + \beta' X_j)}{1 + \exp(\alpha_i + \beta' X_j)}\right] - \left(\frac{\exp(\alpha_{i-1} + \beta' X_j}{1 + \exp(\alpha_{i-1} + \beta' X_j}\right)^{y_{ij}}\right]$$

The deviance is also used to construct a goodness-of-fit test for the model. The goodness of fit statistics for ordinal logistic regression has a form:

$$D = 2\sum\sum O_{ij}\log\left(\frac{O_{ij}}{E_{ij}}\right)$$

Likewise, the Pearson chi-square statistic also compares the model fit to the actual data, defined

$$x^2 = \sum\sum \frac{(O_{ij} - O_{ij})^2}{E_{ij}};$$

E_{ij} is the expected value for the i^t observation .

Both goodness-of-fit statistics should be used only for models that have reasonably large expected values in each cell.

2.4.2 State Space Prediction and Smoothing

The state space form of a univariate time series model consists of a transition equation given by;

$$\alpha_{t+1} = T_t \alpha_t + \xi_t \qquad t = 1, \ldots, T \quad (4)$$

and a measurement equation;

$$y_t = Z_t' \alpha_t + \varepsilon_t \qquad t = 1, \ldots, T \quad (5)$$

where α_t is an *m x 1* state vector, Z_t is an *m x 1* fixed vector, T_t is a fixed matrix of order *m x m* and ε_t and ξ_t are, respectively, a scalar disturbance term and an *m x 1* vector of disturbances which are distributed independently of each other. It is assumed that ε_t is white noise with mean zero and variance h_t and ξ_t is multivariate white noise with mean vector zero and covariance matrix Q_t. In the models

considered here, ε_t and ξ_t will also be assumed to be normally distributed.

Let a_{t-1} be the minimum mean square estimator (MMSE) of α_{t-1} at time $t-1$ and let P_{t-1} be the covariance matrix of the estimation error $a_{t-1}-\alpha_{t-1}$. When y_t becomes available, a_{t-1} and P_{t-1} can be updated by the Kalman filter. If α_0 ~ N (a_0,P_0) and a_0 and P_0 are known, the Kalman filter produces a set of T one-step-ahead prediction errors $v_t, t=1,\ldots,T$, together with their variances, f_t. Estimates of future observations, together with their MSEs, can be made using the Kalman filter, while MMSEs of the elements of each α_t based on all the observations can be computed by a smoothing algorithm; see Anderson and Moore (1979) and Harvey (1981).

The basic structural model can be put in state space form very easily. Suppose, for simplicity, that s = 4. The transition equation is then;

$$\boldsymbol{\alpha}_t = \begin{bmatrix} \mu_t \\ \beta_t \\ \cdots \\ \gamma_t \\ \gamma_{t-1} \\ \gamma_{t-2} \end{bmatrix} = \begin{bmatrix} 1 & 1 & \vdots & 0 & 0 & 0 \\ 0 & 1 & \vdots & 0 & 0 & 0 \\ \cdots & \cdots & \cdots & \cdots & \cdots & \cdots \\ 0 & 0 & \vdots & -1 & -1 & -1 \\ 0 & 0 & \vdots & 1 & 0 & 0 \\ 0 & 0 & \vdots & 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} \mu_{t-1} \\ \beta_{t-1} \\ \cdots \\ \gamma_{t-1} \\ \gamma_{t-2} \\ \gamma_{t-3} \end{bmatrix} + \begin{bmatrix} \xi_t \\ \zeta_t \\ \omega_t \\ 0 \\ 0 \end{bmatrix}$$

From measurement equation above;

$y_t = (1\ 0\ 1\ 0\ 0)\boldsymbol{\alpha}_t + \varepsilon_t t = 1,\ldots,T$

The above equation is called the state space equation.

Both h_t and Q_t are time invariant with $h_t = \sigma_\varepsilon^2$ and $Q_t = diag.\{\sigma_\xi^2, \sigma_\zeta^2, \sigma_\omega^2, 0, 0\}$. In order to run the Kalman filter it is necessary that these parameters be known. Another important question concerns starting values for the Kalman filter. Since the components of the state vector are non-stationary, P_0 cannot simply be taken to be the covariance matrix of a stationary vector AR (1) process as in Gardner *et al.* (1980). There are several solutions one is to let α_t have a diffuse prior, i.e. $P_0 = \varkappa I$ where $\varkappa = \text{infinity}$. In practice, $\varkappa$ may be set equal to a large but finite number..

3. Results and discussions

The research results will help in understanding crime prevalence across Wolaiata Zone and various towns in South Nation Nationalities and People regional state of Ethiopia. By doing so, it will shed light on factors that contribute towards prevalence of crime and violence. The results had also important empirical and theoretical contributions to knowledge and strategies in preventing incidence of crime and violence in SNNP region and Ethiopia as a whole. In addition to these it will facilitate our understanding of the relationship, interdependence and interaction between crime occurrence and their impact on development and transformation goals in Ethiopia.

This study is also timely in view of current government initiatives like control of violence and to concerned bodies of development and transformation of Ethiopia as the whole. It will help in the formulation of national and local policies that would go a long way to address not only prevent violence and crime but also to reduce poverty, which goes hand in hand with the above issue.

Table 1: Parameter Estimates of Correlates of Crime Rate.

Variable Under Stdy	Response category	β	S.E β	Wald	Df	Sig	Exp(β)	95% CI β	
								Lo	Up
Crime level	Serious	-1.704	0.128	177.3	1	0.000*	0.181954	-1.955	-1.453
	Medium	-0.693	0.108	41.18	1	0.000*	0.500074	-0.905	-0.481
Age	18-30	-0.556	0.098	32.201	1	0.010	0.573498	-0.575	-0.364
	31-50	-0.466	0.071	43.078	1	0.001	0.627507	-0.605	-0.327
	Above 50(Rf)	-	-	--	-	-	-	-	-
Sex	Male	0.153	0.049	9.75	1	0.007	1.165325	0.057	0.249
	Female (Rf)	-	-	-	-	-	#VALUE!	-	-
Residence	Rural	2.72	0.656	17.167	1	0.000*	15.18032	1.433	4.006
	Near to urban	3.549	0.667	28.323	1	0.000*	34.77852	2.242	4.858
	Urban	-	-	-	-	-	-	-	-
Employment status	Unemployed	0.325	0.022	218.23	1	0.000*	1.384031	-0.368	-0.282
	Employed (Rf)	_			-	-	-	-	-
Economic status	Poor	-0.244	0.33	54.676	1	0.000*	0.783488	-0.891	0.402
	Medium	.069	0.022	9.81	1	0.002	1.071436	0.026	0.112
	Rich	-	-	-	-	-	-	-	-
Educational background in school	Illiterate	-2.72	0.656	17.167	1	0.000*	0.065875	-4.006	-1.433
	Primary	-3.549	0.667	28.323	1	0.000*	0.028753	-4.858	-2.242
	2ndary+(Rf)	-	-	-	-	-	-	-	-
Partners Education	Illiterate	-2.72	0.656	17.167	1	0.000*	0.065875	-4.006	-1.433
	Primary	-3.549	0.667	28.323	1	0.000*	0.028753	-4.858	-2.242
	2ndary+ (Rf)	-	-	-	-	-	-	-	-
Awareness of rule of law	Yes	0.506	0.101	25.127	1	0.000*	1.658643	0.308	0.704
	No(Rf)						-		
Previous crime history	Committed, but not arrested	0.602	0.111	29.61	1	0.002	1.83	0.384	0.82
	Committed & arrested	0.072	0.023	10.04	1	0.000*	1.08	0.027	0.117

	Never committed(Rf)	-	-	-	-	-	-	-	-
Have targeted to revenge	Yes	1.134	0.25	20.57	1	0.004	3.108064	0.64	1.62
	No (Rf)	-	-	-	-	-	-	-	-
-2Log likelihood			Chi-square((p-value)						
14,881.98			1532.51((0.000))						

From the Table 1, we see that the deviance based chi-square value, x^2=∑▒∑▒〖〖〖(O〗 _(ij-) O_ij)〗^2/E_ij ;〗 is equal to 1532.51 (pvalue=0.000) for model .This is an indication that model fits the data well. Moreover, the computed values for the Pearson and deviance test statistics were found to be significant for the models. Akaike Information Criteria (AIC) and Bayesian Information Criteria (BIC) were among the most commonly used statistics in the selection. The 2log likelihood for model is 14,881.98.

The results indicated that residence, age, sex, educational background, employment status, partner's education, target to revenge; economic status, awareness of criminal law; and previous crime history were found to be statistically significant correlates to crime rates. The adjusted odds ratio for residence (OR) [exp(2.72)=15.18] indicates that individuals from rural areas were 15.18 times more likely to commit serious crimes compared to individuals from urban areas. The odds ratio could be as low as 1.43 and as high as 4.00 with 95% confidence. The adjusted odds ratio for residence (OR) [exp(3.55)=34.78] indicates that individuals from near to urban areas were 34.78 times more likely to commit serious crimes compared to individuals from urban areas. The odds ratio could be as low as 2.24 and as high as 4.86 with 95% confidence.

Previous crime history was also significantly related with the dependent variable in this study. Comparing individuals in the prison, individuals who were committed but not arrested for that crime were 1.83 times more likely to commit series crime than those individuals who never committed before.

The current study showed that employment status is also significant covariate. The adjusted odds ratio [exp (0.325)=1.384] indicates that unemployed individuals are 1.384 times more likely to commit series crimes as compared to those individuals who are employed. The odds ratio could be as low as 1.33 and as high as 1.445 with 95 % confidence. The reason behind is that, unemployed youth can easily be manipulated for any cause of which one could be armed groups rebelling against governments. This will take our continent to the vicious circle of civil war and instability. And this result were consistent with Thakur, (2003) [12] who concluded "there are a number of factors which may be responsible for the growing rate of crime such as unemployment, economic backwardness, over population, illiteracy and inadequate equipment of the police force".

Table 2 displays descriptive statistics for the monthly crime rates out of 1000 populations in Wolaiata Sodo. The data consists of 118 months for all crime types and no missing value was observed in the study time interval. The empirical results showed that the average monthly rate of crime out of 1000 population for murder, aggravated assault, rape, robbery, burglary and larceny were 3.565, 66.245, 1.874, 9.042 1.414 and 43.629 with standard division of 1.481, 34.62, 0.47, 2.607, 0.657 and 6.683, respectively.

Table 2: Summary Results for Monthly Crime Rates under Study (Wolaiata Sodo, 2007-2017)

Crime type	Observation	Minimum	Maximum	Mean	SD
Murder	106	1.68	8.714	3.565	1.481
Agg_assault	106	32.78	155.36	66.245	34.62
Rape	118	0.863	3.138	1.874	0.47
Robbery	118	4.379	16.289	9.042	2.607
Burglary	118	0.404	3.848	1.414	0.657
Larceny	106	25.056	58.666	43.629	6.683

Table 3 displays summarized descriptive statistics of explanatory variables that are assumed to be correlated to rate of crime in Wolaiata Sodo. The result reveals that the average inflation rate from food items, non-food items and general inflation rate were 19.581, 11.941 and 15.974 with standard deviation of 20.645, 9.004 and 14.55, respectively from base period April 2007 GC to 2017 GC. Moreover, the average monthly unemployment rate was 27.301 with standard deviation 3.794.

Table 3: Descriptive Statistics for Monthly Explanatory Variables (Wolaiata Sodo, 2007-2017)

Explanatory Variables	Observation	Minimum	Maximum	Mean	SD
Unemployment rate	106	18.789	33.995	27.301	3.794
Food inflation	106	-13.6	91.7	19.581	20.645
Non-food inflation	106	-2.2	29.5	11.941	9.004
General inflation	106	-4.1	64.2	15.974	14.55

Parameter estimation of state space model

Table 4 displays results of parameter estimates of Kalman filters for the fitted model of selected crime with stochastic (level and cycle), deterministic (slope and seasonal), irregular component and inclusion of explanatory variables. The coefficient of food inflation, non-food inflation and unemployment rate are not statistically significant at 5% level of significance. Thus, there is no evidence to reject the

null hypothesis at 5% level of significance. Similarly, even if the coefficient of intervention effect is negative but the effect is not statistically significant at 5% level of significance, indicating that the new legislation adopted on the length of offender's spend in prison was not significant in reducing rate of murder. Table 4also displays results of parameter estimates using Kalman filters for the fitted model of aggravated assault with stochastic trend (level and slope), deterministic (seasonal), irregular component and inclusion of explanatory variables. The parameters of interest in table are the coefficients on explanatory variables and intervention effect. All explanatory variables considered: food inflation, general inflation and unemployment rate have statistically significant coefficients. Therefore, a percent increase in the unemployment rate to increase rate of aggravated assault by 2.166 %; a unit increase in the food inflation to increase rate of aggravated assault by 0.686 and a unit increase in the general food inflation to decrease the rate of aggravated assault by 1.05. The coefficient of intervention effect is positive but not statistically significant at the 5% level of significance, indicating that the new legislation adopted on the length of time offenders spend in prison was not significant in reducing or increasing the rate of aggravated assault. The same conclusion and discussion could be given to remaining results.

Table 4: ML Parameter Estimates of the State Space Models for Selected crime

Crime type	Variables	Coefficient	Standard error	t-value	Probability
Murder.	Policy Intervention	-0.275	0.661	-0.416	0.678
	Food inflation	0.010	0.01	1.062	0.291
	Non-food inflation	-0.065	0.039	-1.669	0.098
	Unemployment rate	0.101	0.072	1.403	0.164
Aggravated Assault.	Policy Intervention	1.158	6.799	0.170	0.865
	Food inflation	0.686*	0.292	2.351	0.021
	General inflation	-1.05*	0.446	-2.355	0.020
	Unemployment rate	2.166*	0.834	2.597	0.011
Rape	Policy Intervention	-0.028	0.258	-0.108	0.914
	Food inflation	0.002	0.004	0.450	0.654
	Non-food inflation	-0.007	0.016	-0.405	0.687
	Unemployment rate	-0.024	0.018	-1.324	0.189
Robbery.	Policy Intervention	-1.150	1.331	-0.864	0.39
	Food inflation	0.011	0.024	0.455	0.650
	Non-food inflation	-0.146	0.104	-1.408	0.162
	Unemployment rate	0.091	0.120	0.760	0.449
Burglary.	Policy Intervention	0.208	0.291	0.717	0.475
	Food inflation	0.005	0.005	1.081	0.283
	Non-food inflation	-0.003	0.025	-0.11	0.913
	Unemployment rate	0.012	0.023	0.513	0.609
Larceny.	Policy Intervention	-8.231*	3.600	-2.287	0.024
	Food inflation	-0.067	0.201	-0.334	0.739
	Non-food inflation	-0.304	0.312	-0.974	0.332
	Unemployment rate	-0.079	0.335	-0.235	0.815

* statistically significant at 5% level of significance.

Checking Adequacy of the Fitted Model

Diagnostic tests were performed to establish goodness of fit and appropriateness of the fitted models. First, it was examined whether the standardized residuals of the estimated models were free from serial autocorrelation. From Table 5, the Ljung-Box Q (k) and DW Diagnostic test indicate that the standardized residuals are independent and no significant autocorrelation. Ljung-Box Q test result shows the calculated value is less than the tabulated value of χ^2 (k-w+1) at 5% level of significance; where k is the number of lags and w is the number of estimated hyperparameters and DW test value result indicates that the calculated values are near value 2 which shows that there is no evidence to reject null hypothesis of no serial autocorrelation. Thus, the result of no autocorrelation in the standardized residuals suggests that residuals are independent and uncorrelated (white noise).

The result from the fitted model shows that standardized residuals have constant variance, based on the test values when compared to the F(h,h) critical value at 5% level of significance.

Table 6 shows the goodness of fit tests for the fitted models. A smaller value of p.e.v, positive value of R_s^2 and smaller value of AIC and BIC comparing the local level and local linear trend models shows that the model is good fit. This implies that the models were correctly specified to describe data on monthly crime series for murder, aggravated assault, rape, robbery, burglary and larceny rates observed.

Table 5: H-Statistics, Portmanteau Box-Ljung Q(p)Ttest and DW Diagnostic Test Results for Standardized Residuals from State Space Model for Selected crime

	Diagnostic Tests	Value	Critical Value
Diagnostic Tests for Murder	H(31)	0.382	1.822
	Q(8,4)	6.860	11.071
	DW	1.950	2
Aggravated Assault.	H(33)	0.498	1.788

	Q(8,5)	4.001	9.488
	DW	1.997	2
Rape.	H(33)	0.799	1.788
	Q(8,3)	9.904	12.592
	DW	2.045	2
Robbery.	H(35)	1.014	1.7571
	Q(8,3)	3.828	12.592
	DW	1.828	2
Burglary	H(31)	1.176	1.822
	Q(8,5)	7.743	9.488
	DW	1.871	2
Larceny	H(33)	1.358	1.822
	Q(8,4)	6.928	11.071
	DW	1.970	2

Table 6: AIC, BIC, p.e.v, and R_s^2 Goodness of Fit Test Result for the Fitted Model from State Space Model for all Crime Rates.

Goodness of fit test	Murder	Aggravated Assault	Rape	Robbery	Burglary	Larceny
p. e. v	0.512	41.008	0.144	2.836	0.225	13.983
R_s^2	0.195	0.024	0.169	0.185	0.432	0.056
AIC	-1.195	4.104	-1.550	1.364	-1.031	3.028
BIC	0.462	4.644	-1.010	1.810	-0.393	3.568

Together with the fact that adjacent error terms tend to be correlated and that the proposed model has to account for this type of noise as well, STS models include all these effects and are more effective approaches in analyzing time series intervention design. Once the sources of variance in the series have been controlled for, the impact of an intervention can be tested and measured with greater reliability. Therefore, the study should concentrate on discussing the estimation results obtained using STS models. All estimation results are reviewed in Appendix I. We do find some support for the deterrent impacts of the increases in time-served sentences for larceny crimes, but not for burglary and violent crimes. This can be justified by the fact that implemented legislation affected considerably more non-violent than violent crimes. The possible explanation for the non-significant effect on the violent crime such as aggravated assault would be the very method in which this category is reported.

In contrast to other crimes which are relatively well defined, aggravated assault requires discretion on the part of the police taking the report to distinguish it from simple assault. This way of reporting leaves room for the exercise of discretion and there is a possibility that the nature of this distinction has been changing over time (Blumstein, 2000). Hence, this might be a reason for the non-significant intervention coefficient of the aggravated assault which is a violent offense.

Furthermore, after including food inflation, non-food inflation and unemployment rates in the models, there is very limited support for the deterrent impacts of the intervention on any of the offenses. Specifically, we still find the coefficient of the intervention to be negative on the reported crime rates such as murder, rape, robbery among violent crimes and larceny for property crime and there is positive intervention coefficient for aggravated assault and burglary; but the effect is no longer significant in reducing or increasing rate of crime.

However, intervention effect is significant only in reducing rate of larceny. This result is in line with Levitt and Dubner (2005), empirical evidence which links increased punishment with lower crime rates. However, most empirical tests on deterrence do not separate the effect of deterrence from the effect of incapacitation. Short-run declines in crime are likely to be attributable to deterrence, whereas the incapacitation effect of sentence enhancements were occur only in the long-run (Kessler and Levitt, 1999).

To assess the factors causing crime in the study area, basic structural time series models with seasonal, cycle and macroeconomic variables are considered. Among the explanatory variables considered, inflation and unemployment rate have significant effect in reducing aggravated assault. This result is consistent with the finding by Ehrlich (1973), Coomer Nicole (2003), Leveson (1976) and Chapman (1976).

Even if the coefficient of unemployment rate is positive to all of violent crimes except for rape but significant effect of unemployment rate is observed only for aggravated assault. The empirical evidence on the link between unemployment and crime is not clear-cut. This result is in line with Chiricos (1987), Freeman (1999), Gottfredson, Hirschi (1990), Pyle and Deadman (1994) crime has a positive association with unemployment, suggesting that the relationship is weak or nonexistent. However, the present result is opposite to the sign with findings by Ehrlich (1973).

Similarly, the seasonal effects on economic crime such as robbery peaks in the winter (rainy) season specially on July and August, due to the increase in the cost of living and the facilitating environmental conditions during these months in line with Landau and Fridman (1993).

It was found out that there was no particular season with greatest number of murder in line with Cheatwood (1988). However, when looking at monthly distribution, September, August and April consistently ranked highest. This result shows that all crime types except for murder expected to increase in July and August this result is in line with Anderson (1989) and Anderson and Anderson (1998), For example, rape incidents have greatest occurrences in winter months, when social interaction are at its highest level and climatic conditions make victims more available this result is consistent with the findings of Landau and Fridman (1993).

4. Conclusions and Recommendations

4.1 Conclusions

Based on logistic regression analysis using primary data, current study revealed that age, respondents residents, educational background, marital status, residence, employment status, attitude towards revenge, wealth status, awareness of criminal law, previous crime history , partners educational level and number of dependent family's members are the most important determinants of crime severity in study area. High crimes are more likely among individuals from rural areas as compared to those from urban areas. Individuals with negative attitude on revenge are at higher risk to commit high crimes than those with positive attitude on revenge. Individuals with no dependent family are at higher risk of committing high crimes than those with dependent families. It has been also observed that high crime is more likely to be committed among individuals whose partners are not educated.

Based on results obtained from structural time series models, researcher investigated crime rate pattern and identify its determinants in Wolaiata Sodo using secondary data. The analysis was conducted for Wolaiata Sodo using monthly data over the time period from April 2007 to January 2017. Two property (burglary and larceny) and four violent (murder, aggravated assault, rape robbery) crime rates were investigated. Intervention and three types of macroeconomic variables were considered; the rate of food inflation, rate of non-food inflation and unemployment rate. The empirical analysis relied on regression and unobserved component models, which are structural time series models.

It was found out that estimation using regression approaches are biased and the measured effects We found some support for the deterrent impacts of the increases in time-served sentences for larceny, but not for the property crimes and violent crimes. However, it was found that with the inclusion of three macroeconomic variables (food inflation, non-food inflation and unemployment rates) in the models. There is very limited support for the deterrent impacts of the intervention on any of the offenses. Moreover, it was found out that the new legislation had no significant impact on both the property (larceny) and violent crime (murder, robbery and rape) rates except for aggravated assault.

We find that the three macroeconomic variables have, on average, a statistically significant impact on aggravated assault, a rise in food inflation and unemployment rate increases rate of aggravated assault. However, these macroeconomic variables are not statistically significant for any of property crime.

We conclude that containing these macroeconomic variables have the key contribution of significant effect for the crime aggravated assault but not for the rest like murder, rape, robbery, burglary, and larceny. Finally, the seasonal effect on both property and violent crime peaks in the winter (rainy) season especially in July and August.

5. Recommendations

From the results of our study, we see that individuals from rural areas are more likely to commit crimes as compared to those individuals from urban areas. This may be because of unemployment problem among societies living in rural areas. Therefore, we recommend for the concerned government agencies to work on job creation in rural area where 80% of people in study area resides.

Our study indicated that the distribution of crime had high variation among three different geographical areas, where its category is based on urbanization. Even though our study considered three different geographical areas, the space-time (Spatio-Temporal) variable is not taken in to consideration. Spatio-temporal should be taken into consideration, may improve the results more (Anselin et al 2000, Anserson MA and Brantingham (2007), Crutchfield et al 1982).. Therefore, further studies are recommended by taking space-time nature, our study area.

From the empirical findings of this study, the following recommendations are drawn: Intervention effect (new legislation) had statistically significant in reducing larceny. Thus, the government should update or give attention to the implementation of the new legislation to increase its efficiency. Since, the new legislation has negatively associated to most of crime rate.

Food inflation rate, general inflation and unemployment rate had statistically significant positive impact on aggravated assault. Therefore, the government and the concerned body should take some measures to tackle inflation and unemployment issues in the city. The rates of crime reported in violent and property crimes contained seasonality. Thus, prevention mechanisms based on seasonals need to designed

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