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Socioeconomic Variables and Crimes: Co-integration Analysis for the United States

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Abstract

The paper carries out a depth study of the crimes in the United States, considered as dependent variables, using six explanatory variables that are: Welfare, health Care, Education, Protection, Interest and Unemployment. The short and long-term relationships have been estimated by the ARDL/Bounds testing Methodology proposed by Pesaran, Shin and Smith (PSS). For each type of crimes, Violent, Property and Total crimes, a long-term equilibrium relationship has been validated and the Error Correction Model (ECM) has been built. The results show the adjustment speed towards equilibrium vary between 8.9% and 12.4%.

Keywords: Spending variables; Crime rates; Descriptive analysis; Unit roots; Co-integration

Introduction

When we study how the relationship between crime rates in the United States of America with a number of socio-economic variables is modeled, we achieve very important goals. We first facilitate a scientific measurement of the effect of short-term dynamics and their impact on the long-run equilibrium relationship, and this is intended for the role of the Error Correction Model (ECM) which strengthens making the decision by the decision makers. This study will reveal the short-run and long-run impacts of each explanatory variable on the crime rates, and this represents a work of great importance because it will be available to note how much the influence of an increase in unemployment rate; for example, produces some increase in crime rates because there is a negative impact of the unemployment rate on the behavior of the unemployed. As well as a reduction in spending on Welfare, Health Care, Education and Protection contributes to a positive climate of disobedience and poverty. In addition, the transition to the long-term impact of each explanatory variable on the crime rate will be available if there is agreement on a possible co-integration between the spending variables and the rates of crimes. This possibility offered by the co-integration technique is of great importance for the decision makers because it will help them to read carefully the future through an adequate policy based on the results confirmed by the models under consideration and by consequence, this study will respond in the long run to the specificity of the United States in terms of the relationship between the crimes and a set of socioeconomic variables. Indeed, the fundamental point of the co-integration domain is that the Engle-Granger (EG) two-stage procedure was rapid the induction of analytic techniques in econometric for testing for common trends in multivariate time series. Then it was the methodology of Johansen [1] that pushed the research to go further in the co-integration analysis. In fact, the two approaches are different for carrying out a long-run equilibrium between the variables. First of all, it may happen that the use of the technique (EG) could lead to a Co-integration relationship which is different from that proposed by the Johansen approach. With the (EG) procedure, the starting point is both of variables is integrated in the same order, let us say I(1), then we begin with an estimate of the linear relationship that links the variables in level and the work will be completed by the test of the stationarity of the corresponding residues, while, with Johansen methodology that is based on the maximum likelihood method for estimate, we can have several co-integration relationships and as a result, the co-integration relationship is not unique. Moreover, this research would be very beneficial for all politicians who govern their country in the light of knowledge and have the will to improve the quality of life for their people particularly to ensure a social well-being for all individuals. We can announce, in advance, that the benefit of this research is the achievement of a coherent measure for the short and long-term impacts of each of the selected socio-economic variables on the crime rates (per 100,000 People), more concretely, a set of spending variables as Welfare (X_{1t}), Health Care (X_{2t}), Education (X_{3t}), Protection (protect human and environmental health) (X_{4t}), Interest associated with public debt in United States (X_{5t}), and Unemployment (X_{6t}), will be taken as explanatory variables. The approach of the ARDL model with co-integration will be used according to the methodology according to the ARDL/Bounds Testing Methodology proposed by Pesaran, Shin and Smith (PSS) [2]. The advantage of this approach is that it does not impose the same order of integration, I(1), and it is applicable on time series which are a mixture of I(0) and I(1) but none of it is integrated of order two, i.e. I(2). Before talking about the sections which are included in this paper, we hope that even if the research deals with the United States of America (U.S.), it will have a great cognitive impact on our country Lebanon. We know about the crime in U.S. and its development during a long period 1960-2017 (58 years), and we do understand the impact of spending variables on both of the violent, property and total crimes and this provides us with important economic information that will crystallize through the short and long run relationships that we want to measure between social and economic variables and rates of crimes. We wish that our country had a data bank, so we would be able to study the reality of the crime and the social and economic factors affecting it. Of course, all agree on what America represents as a superpower which topped the list of countries as the largest economic power in the world and the one that has economic, financial and cultural effects on

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all countries whether large or small. The research is divided into the following seven sections:

The first section deals with a general introduction to the topic that allows for a general understanding the problem of the study and its purpose. In the second section, a review of literature is devoted and the ARDL Bounds Testing Procedure is dealt with in the third section. In fourth section, a panoramic view will be described to understand the evolution of the eighteen-time series giving a considerable focus on the different trends revealed during the period 1960-2017 (58 years). There are the seven types of crimes that are Murder (Y_{1t}), Forcible Rape (Y_{2t}), Robbery (Y_{3t}), Aggravated Assault (Y_{4t}), Burglary (Y_{5t}). Larceny Theft (Y_{6t}) and Vehicle Theft (Y_{7t}). After respecting the definition proposed by the Bureau of Justice Statistics (BJS), three variables will be used: The total number of Violent ($Z_{1t}=Y_{1t}+Y_{2t}+Y_{3t}+Y_{4t}$) and the total number of Property ($Z_{2t}=Y_{5t}+Y_{6t}+Y_{7t}$) and the crime "Index" that is defined as the total of all crimes, i.e., the sum of violent and property crimes ($Z_t=Z_{1t}+Z_{2t}$) with more weight is given to the property crime. The data associated with the six spending explanatory variables (X_{jt}, j =1,..,6) are expressed in billion dollars (bn USD). In fifth section, the unit root tests will be carried out using the most known tests used in the literature The (PSS) methodology will be used in sixth section to elaborate a co-integration analysis between both of Z_{1t}, Z_{2t}, and Z_t as a dependent variable and the six other independent variables (X_{jt},j=1,..,6) and by consequence, a conventional Error Correction Model (ECM) will be performed to conduct short-run effects and long-run effects of the spending variables on the crimes expressed by Z_{1t}, Z_{2t}, and Z_t. Finally, in the seventh section, a conclusion will be make from the findings then a recommendation for continuation of this research will be advanced by considering a panel analysis of co-integration for the fifty-one US states.

Review of Literature

The studies of crime and its causes have become an important area of interest for researchers in various countries of the world. The researches have appeared on the subject from different economic and social aspects. Mourad [3] studied the long-run equilibrium relationship between the highest daily value of the exchange rate for the EURO against the US dollar and the opening price in the short and long terms, Mourad [4] published an important book showing the importance of the ARDL model with co-integration, Mourad [5] has used the ARDL approach with co-integration to perform the impact of barrel oil prices on GDP and expenditures in the Gulf Cooperation Council (GCC), Mourad and Mourad [6] carried out a depth study of the crimes in the United States using the ARDL/ Bounds testing Methodology proposed by Pesaran, Shin and Smith (PSS) [2]. Mourad [7,8] investigated the impact of exports and imports on the nominal GDP per capita in the top ten economies in the world and demonstrated that the test statistics for co-integration ended to reject the null hypothesis of no co-integration using Pedroni procedure, and the impact of vital economic determinants on real GDP in GCC countries has been performed in the framework of the panel co-integration analysis. Zhu and Zilian [9] examined the long-run equilibrium between total crime rates, inequality variable and a set of control variables in China using the Johansen-Jesulius [10] procedure for co-integration. The inequality variable is chosen as a main independent variable which was measured by dividing the per capita available income in the urban community to the per capita net income in rural community. They showed a very significant positive relationship i.e. an increase in inequality leads to an increase in crime rates. Ghumro, Zaini and Karim [11] examined the short and long run relationships analysing the real broad money in Pakistan and using the (ARDL) bounds approach. Ahad [12] has confirmed the existence of the long run relationship between income inequality, crime, poverty and inflation for Pakistan. By applying a Johansen co-integration analysis and using Brazil data, Santos and Kassouf [13] performed a long-run relationship between crime, economic activity, and police performance in São Paulo city. Cheong and Wu [14] have shown that empirically there is a positive effect of the inequality between intra-provincial regional in China and the crime rates while the education level has revealed a negative effect on crime rates, that is, a high level of education leads to a reduction of the crimes. Following common practice in co-integration studies, Chintrakarn and Herzer [15] considered Pedroni's procedure to test the long-run equilibrium between the violent crime rate in USA as a dependent variable and the percentage share of income of the top 10% of income earners (explanatory variables). Baharom, Habibullah and Noor [16] investigated the relationship between crime and socio and macro-economic panel variables such as income, unemployment, inflation, interest rate, and also the political violence, both domestic and regional, analysing 21 countries. Baharom, Habibullah and Royfaizal [17] studied the unit root of the violent crime of each state in United States and the average of violent crime in United States using the KSS nonlinear unit root test proposed by Kapetanios Shin and Snell [18]. Habibullah and Baharom [19] carried out the impact of economic condition on the criminal activities in Malaysia by using ARDL Bound Testing Approach. Saridakis [20] used the Johansen's procedure to estimate in the United States, the dynamic relationships between the overall violent crime, murder, rape and assault as dependent time series and a set of weakly exogenous variables as the overall prison population, alcohol consumption expenditures, duration of unemployment, black males, Gini index and chain-type price index, all variables are taken at the national-level. Kuziemko and Levitt [21] demonstrated that the prison for the drug traffickers will reflect a reduction in the crimes in United States. Levitt [22] distinguished between the factors that lead to an increase of the crimes in United States and the factors that decrease the crime rates. Alison [23] used the log-linear approach to estimate the relationship that links the United States National Crime Rate as a dependent variable and the explanatory variables that are a number of national economic and social characteristics (deterrence and demographic variables). Testing for unit root in all variables, three tests will be used. These tests were referred by Augmented Dickey–Fuller (ADF) proposed by Dickey and Fuller [24,25], PP test carried out by Phillips and Perron [26] and KPSS test built by Kwiatkowski, Phillips, Schmidt and Shin [27].

ARDL Bounds Testing Procedure

Let's use the different steps described by Mourad [4] to reach the estimate of the ARDL model. In fact, the implementation of PSS procedure adheres to the following steps:

Step 1: Based on the unit-root analysis, assuming that the all variables are I(0) or I(1) and without variables integrated of order two in the model**,** the findings of the unit-root study respond well to this step.

Step 2: Since there are no constraints on the parameters associated with the variables in level, the Unrestricted Error Correction Model (UECM) will be considered:

$$\Delta Y_t = \alpha_0 + \sum_{j=1}^{p}\alpha_j\Delta Y_{t-j} + \sum_{j=0}^{q_1}\alpha_{1j}\Delta X_{1,t-j} + \sum_{j=0}^{q_2}\alpha_{2j}\Delta X_{2,t-j} + \sum_{j=0}^{q_3}\alpha_{3j}\Delta X_{3,t-j} + \sum_{j=0}^{q_4}\alpha_{4j}\Delta X_{4,t-j} + \sum_{j=0}^{q_5}\alpha_{5j}\Delta X_{5,t-j} + \sum_{j=0}^{q_6}\alpha_{6j}\Delta X_{6,t-j} + \beta_1 Y_{t-1} + \beta_2 X_{1,t-1} + \beta_3 X_{2,t-1} + \beta_3 X_{3,t-1} + \beta_4 X_{4,t-1} + \beta_5 X_{5,t-1} + \beta_6 X_{6,t-1} + \varepsilon_t \quad (1)$$

Using an automatic criterion such as the AIC, BIC, HQ and log(FPE), the orders (p) and (q_i, i = 1,..,6) will be determined taking into account that the residues are not correlated according to Ljung-Box statistic. For this purpose, we first determined the optimal order for p because there is a strong autocorrelation between the past and the present of the dependent variable in question. Since there are two types of crimes, Violent crimes Z_{1t} and Property crimes Z_{2t}, and so the total Z_t, both of these three variables will be considered as dependent. Determining the order of both of the spending variables will be done sequentially by introducing the variable that is most correlated with the dependent variable and we retain only the significant parameters.

Step 3: The long-run equilibrium relationship between the variables in levels will be tested:

H_0:$\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = \beta_6 = \beta_7 = 0$ no long – run relationship

H_1:$\beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq \beta_5 \neq \beta_6 \neq \beta_7 \neq 0$ no long – run relationship

The bounds testing statistic that is symbolized by $F_Y(Y|X_1, X_2, X_3, X_4, X_5, X_6)$ is calculated. This statistic is subject to a non-standard distribution related by the order integration I(1) or I(0), by the number of estimated parameters in the model and by the presence or absence of constraints on the intercept and trend. According to the PSS procedure, there are two sets of critical values: The first set is associated to the minimum values assuming all variables are $I(0)$ and, therefore, there is no co-integration. The second set is composed of large values and assuming all variables are $I(1)$ and, therefore, there is co-integration. If the calculated F is outside of the bound specified by PSS procedure, then three findings will be concluded:

- If the calculated F is greater than the upper critical value of the bound, then co-integration will be accepted.
- If the calculated F is smaller than the minimum critical value of the bound, then co-integration will be rejected.
- Finally, if the F statistic is included in the bound, then the decision will be inconclusive, indicating that the F statistic depends on the order of integration I(0) or I(1).

Step 4: After determining the optimal values (p, q_i, i = 1,..,6), the long-run linear relationship between the variables in levels will be estimated:

$$\mathbf{Y_t} = \boldsymbol{\theta}_0 + \sum_{j=1}^{6}\boldsymbol{\theta}_j\mathbf{X}_{j,t-1} + \boldsymbol{\eta}_t$$

And then we maintain the estimated residues $\hat{\eta}_t$ symbolized by EC_t :

$$EC_t = Y_t - \hat{\theta}_0 - \sum_{j=1}^{6}\hat{\theta}_j X_{j,t-1} \quad (2)$$

Step 5: The traditional error correction model:

$$\Delta Y_t = \alpha_0 + \sum_{j=1}^{p}\alpha_j\Delta Y_{t-j} + \sum_{j=0}^{q_1}\alpha_{1j}\Delta X_{1,t-j} + \sum_{j=0}^{q_2}\alpha_{2j}\Delta X_{2,t-j} + \sum_{j=0}^{q_3}\alpha_{3j}\Delta X_{3,t-j} + \sum_{j=0}^{q_4}\alpha_{4j}\Delta X_{4,t-j} + \sum_{j=0}^{q_5}\alpha_{5j}\Delta X_{5,t-j} + \sum_{j=0}^{q_6}\alpha_{6j}\Delta X_{6,t-j} + \gamma EC_{t-1} + \varepsilon_t \quad (3)$$

The parameter γ indicates the speed of adjustment to restore equilibrium if a deviation from equilibrium is produced. The sign of γ must be negative and with significance level 5% according to the Student distribution in order to ensure the dynamic adjustment towards equilibrium. In general, $-1 < \gamma < 0$, if its estimated value is close to (-1.0) then the return to equilibrium will be almost complete and immediate. In the final estimate of the Error Correction Model (ECM), the parameters with low significance ($|t|<1.64$) were removed.

Descriptive Statistical Analysis

In this section, an analysis of each time series will be carried out to understand its evolution during the period 1960-2017 (58 years) exploring the political and economic events that left their traces in the studied variable. The interested in this research will be allowed to focus on the different phases that have marked the variable in question. We also desire to investigate the causes if any obvious break in the trend took place after an event occurred nationally or globally. It is a kind of in-depth reading of each of 15-time series forming the data in this article. More clearly, the basic descriptive statistics will be used to measure the basic features of each variable helping to provide an important insight into the extent of change over the period under review. Among this statistics, the Min, the Max, the median, the mean, the standard deviation and the Compound Annual Growth Rate (CAGR) that is a specific term for the geometric progression ratio that provides a constant rate of evolution over the time period. For a time series X_t, the CAGR, between the first and the end observations, will be calculated using the following formula: $\mathrm{CAGR}(1,T) = \left(\frac{X_T}{X_1}\right)^{\frac{1}{T-1}} - 1$. However, if a break in the trend occurred at some point, the use of CAGR masks an interesting analysis. Indeed, this statistic loses its meaning if the measure concerns the beginning of an increasing trend and the end of a second decreasing trend. In the following, the graphs will be illustrated recalling that for each of seven types of crimes, it is the Crime Rate per 100,000 Person that is calculated each year.

In Table 1, the basic statistics have been calculated. When examining the set of graphs, it seems that one can consider two different trends (with reserve for the Murder and Burglary variables): The first is increasing and covers the period 1960-1991 while the second is decreasing over the period 1991-2017 with exception for Rape, the period was 1991-2014 and for Burglary on the period 1980-2017. This division will allow a more rigorous measurement of the CAGR statistics and for this reason it has been divided into two according to the two suggested periods. Generally, the minimum values correspond to the year 1960 with exception to Murder variable, the minimum was in the year 2014. The maximum values are associated to 1991 except for Murder and Assault variables, they were observed in 1980 and 1992 respectively. The Median and Mean values are very linearly linked with an excellent linear fit ($\widehat{Median} = 1.0166\,Mean - 8.613, R^2 = 99.93\,\%$) .

The relatively large values of the different standard deviations explain the presence of different trends. In fact, if we calculate the statistic $(Moyenne \mp 2\ Standard\ Deviations)$, the minimum and maximum values are within this interval except for Burglary variable, the max value (1684.1) slightly exceeds the right end point of this range. The most important point in this descriptive analysis is the values of CAGR and CAGR[2]. During the period of growth in the various crime rates, the CAGR[1] were very strong. The crime rates have increased with annual rates ranging from a minimum of (2.13%) for Murder to a maximum of (6.17%) for Burglary. While during the period of decline, the negative values of CAGR[2] reflect a decrease of a maximum of (3.62%) for Burglary and a minimum of 2% for Rape.

Now let's look at the graphs in the Appendix 1. The violent and property crimes have fallen sharply since 1991. This very significant decline prompts us to ask Well-directed questions and to try to find appropriate answers that help us to understand the crime situation in the United States. Is there a change in police strategies? Is there an inverse relationship between increases in imprisonment and reduction in crime? Was there an intervention of the Civil Security authority to trap the cocaine market? Was the downward trend in the unemployment rate from 6.8 in 1991 to 4 in 2000 then to 4.6 in 2007, played a certain role in the decline of any kind of crime? Does the growth in GDP per capita from (USD 24519) in 1991 to (USD 48357) in 2008 provide some explanation for this decline?

we cannot overlook the aging factor in the American population or the increase in the number of police. In fact, according to Levitt [22], the behavior towards crime of people aged 65 and over is completely different from that of young people aged 15 to 19 and this is well revealed by an arrest rate "fiftieth the level of 15-19 year-olds". Levitt cites four factors that caused the decline in crimes in United States since 1991: First, an increase in the number of police. This factor is already stated by Marvell and Moody [28] by using the Granger causality approach to conclude that an increase in the police force will have a negative impact on the number of crimes. Second, the rising number of prisoners with an important adult incarceration rate. In fact, by 2000, there were more than two million individuals incarcerated according to Kuziemko and Levitt [21] demonstrating that an increase in drug prisoners reduced the crimes. Third, the setback in drug dealing, and fourth, the legalization of abortion. For the spending variables, overall there is an evident trend in growth that has been revealed by important values of CAGR that have been varied by a minimum of 6.65% for interest variable and a maximum of 10.52% for Health Care variable (Table 1).

Unit Root Tests

Three tests will be used to conclude about the stationarity of each of eighteen variables. The ADF test carried out by Dickey and Fuller [24,25] has gained a great reputation since the late 1970s. The null hypothesis informs about the integration at order(d), noting I(d), of the time series Y_t against the alternative that it is I(0) assuming that the time series has an ARMA structure. Practically, it is enough to choose the order p for the ADF equation leading errors that behave like a white noise. The choice of p requires to fixe previously the maximum order using per example, the expression performed by Schwert [29], that is $p_{max} = 12\left(\frac{T}{100}\right)^{\frac{1}{4}}$. Under the unit root null hypothesis, the asymptotic distribution of ADF statistics are not the standard t–distribution and so the conventional critical values are no longer valid. According to Phillips and Perron [26], the null hypothesis considers that the time series is integrated of order 1. In fact, in comparison with the famous ADF test, the important point in PP test takes into account a higher order autocorrelation in the studied time series and consequently the lagged-one variable become endogenous invalidating the ADF test. However, the critical values remain those tabulated by Dicky-Fuller [24,25]. A remarkable advantage of the Philips-Perron test is its non-parametric nature. In fact, it doesn't need for an augmentation as the ADF tests but it follows the same pattern made by DF and then perform a correction of the standard deviation of estimators due to the autocorrelation in the residuals getting the Heteroscedasticity and Autocorrelation Consistent (HAC) estimators, see Mourad [30]. An inconvenience of PP test arises from the asymptotic theory itself which makes its poor power in the case of small samples. According to KPSS test proposed a time series can be decomposed into three

Variables	Min	Max	Median	Mean	STD.DEV	CAGR[1]	CAGR[2]
Murder	4.40	10.20	6.85	7.04	1.90	0.0213	-0.0234
Rape	9.40	42.80	31.40	29.11	9.50	0.0490	-0.0200
Robbery	59.70	272.70	157.65	165.19	60.39	0.0500	-0.0386
Assault	86.10	441.80	277.95	266.48	97.42	0.0535	-0.0211
Violent	160.90	758.10	471.25	467.82	158.07	0.0513	-0.0249
Burglary	430.40	1684.10	925.95	974.20	346.74	**0.0617**	**-0.0362**
Larceny Theft	1034.70	3228.80	2433.60	2361.34	636.66	0.0374	-0.0245
Vehicle Theft	183.00	658.90	433.30	408.47	131.79	0.0422	-0.0385
Property	1726.30	5353.30	3644.30	3744.02	1047.09	0.0358	-0.0295
Index	1887.20	5949.90	4139.70	4211.85	1188.62	0.0374	-0.0288
Crime numbers	3.38	14.87	11.32	10.53	3.10	0.0489	-0.0192
Welfare	8.65	670.70	147.83	199.27	175.81	**0.0718**[a]	
Health Care	5.24	1567.06	190.82	411.29	459.38	**0.1052**	
Education	19.40	1106.16	269.26	387.96	341.73	**0.0735**	
Protection	3.68	288.52	65.90	100.01	94.86	**0.0795**	
Interest	8.90	366.83	206.08	174.95	129.04	**0.0665**	
Unemployment	3.50	9.70	5.60	6.02	1.56	[b]	

[a]For the spending variables, the CAGR is calculated over the whole period 1960-2017.
[b]Because of the fluctuations in the employment rate, the calculation of CAGR was not done and it suffices to say that the unemployment rate (5.5 %) in 1960 became (4.4%) in 2017, a decline of 20 %.

Table 1: Descriptive Statistics of the Variables Period: 1960- 2017.

components: deterministic trend, a random walk and a stationary disturbance. Two cases will be considered. The first case considers that the null hypothesis stationarity is simply the variance of the random is zero and by consequence under the null, the tested time series is trend-stationary. The second case consists in assuming the nullity of the trend that means the time series is stationary around a level under the null hypothesis. The null hypothesis (stationarity about level υ_{μ} or stationarity about trend υ_{τ}) will be rejected if the calculated value of the KPSS statistic exceeds the critical value at 5% of level. In the two cases, the lag truncation parameter is used to estimate the long-run variance based on the partial sum process of the residuals due of the regression of the variable the regression of Y_t on an intercept and time trend or on an intercept only. In the following, all series are taken in natural logarithm.

In Table 2, for all series except the Robbery, Vehicle Theft and Unemployment, the null hypothesis of stationarity about level can be rejected. Likewise, according to KPSS test, for all variables except Unemployment, the hypothesis of trend stationarity is rejected at 5% level. The associated findings to ADF test reveal the stationarity in level for all explanatory variables except Welfare, and for Rape, Assault, Violent and Crime numbers variables at 10% level. According to PP test, the first difference is accepted for all variables. Investigating the findings in Table 3 and according to KPSS test, for all variables except unemployment, the trend stationarity hypothesis can be rejected and the unit root hypothesis cannot be rejected if we retain the findings due to the PP test and by consequence we cannot reject the null hypothesis of a unit root, that is, the first difference is accepted to acquire stationarity. Finally, the important information about this study of the unit root tests is that no variables need a second difference to become stationary. Regardless if the order of integration I(0) or I(1), we can use the procedure of co-integration according to the ARDL/ Bounds Testing Methodology proposed by Pesaran, Shin and Smith (PSS) [2].

Tests	ADF		PP		KPSS	
Variables	X	ΔX	X	ΔX	X	ΔX
Murder	**-2.07**	**-3.50**[b]	**-1.12**	**-4.04**[a]	**0.636**[r]	**0.362**[*]
Rape	**-2. 83**[c]	**-2.94**[b]	**-2.61**[c]	**-5.05**[a]	**1.084**[r]	**0.382**[*]
Robbery	**-2.40**	**-3.68**[a]	**-2.02**	**-3.44**[b]	**0.449**[*]	**0.803**[r]
Assault	**-2. 85**[c]	**-2.20**	**-3.63**[a]	**-3.27**[b]	**1.081**[r]	**0.944**[r]
Burglary	**-0.747**	**-3.39**[b]	**-0.398**	**-3.31**[b]	**0.673**[r]	**0.825**[r]
Larceny Theft	**-1.97**	**-4.19**[a]	**-2.76**[c]	**-4.13**[a]	**0.588**[r]	**1.007**[r]
Vehicle Theft	**-1.86**	**-2.89**[c]	**-1.66**	**-3.23**[b]	**0.451**[*]	**0.811**[r]
Violent	**-2.88**[c]	**-2.87**[b]	**-3.12**[b]	**-3.23**[b]	**0.837**[r]	**0.992**[r]
Property	**-1.58**	**-3.78**[a]	**-2.08**	**-3.68**[a]	**0.473**[r]	**0.971**[r]
Index	**-1.75**	**-3.71**[a]	**-2.29**	**-3.60**[a]	**0.486**[r]	**0.952**[r]
Crime numbers	**-2.74**[c]	**-3.58**[a]	**-4.40**[a]	**-3.81**[a]	**0.944**[r]	**0.987**[r]
Welfare	**-1.95**	**-4.43**[a]	**-2.23**	**-5.80**[a]	**1.443**[r]	**0.382***
Health Care	**-3.65**[a]	**-2.44**	**-3.08**[b]	**-3.79**[a]	**1.227**[r]	**0.592**[r]
Education	**-4.15**[a]	**-1.77**	**-5.85**[a]	**-5.49**[a]	**1.235**[r]	**0.936**[r]
Protection	**-3.45**[b]	**-1.21**	**-3.68**[a]	**-4.31**[a]	**1.232**[r]	**0.806**[r]
Interest	**-2.86**[c]	**-4.01**[a]	**-2.91**[b]	**-4.09**[a]	**2.695**[r]	**0.924**[r]
Unemployment	**-3.63**[a]	**-5.69**[a]	**-2.58**	**-5.08**[a]	**0.179**[*]	**0.059***

[a], [b] and [c] indicate, according to ADF and PP, the null hypothesis is rejected at the 1%, 5% and 10% level respectively.
[r] indicates that the null hypothesis of stationarity about level is rejected at the 5% level.
*indicates that the null hypothesis of stationarity about level is accepted at the 5% level.

Table 2: Unit Root Tests with intercept.

Tests	ADF		PP		KPSS	
Variables	X	ΔX	X	ΔX	X	ΔX
Murder	-2.69	-3.69[b]	-1.81	-4.48[a]	0.315[r]	0.102[a]
Rape	-2.58	-3.36[c]	-1.86	-5.46[a]	0.353[r]	0.159[r]
Robbery	-2.46	-3.70[b]	-1.68	-4.19[a]	0.344[r]	0.077[a]
Assault	-2.27	-3.48[b]	-1.16	-4.94[a]	0.380[r]	0.105[a]
Burglary	-2.82	-3.15	-1.90	-4.38[a]	0.336[r]	0.133[a]
Larceny Theft	-2.74	-5.20[a]	-1.82	-5.24[a]	0.376[r]	0.109[a]
Vehicle Theft	-2.66	-3.48[b]	-1.94	-3.80[b]	0.345[r]	0.064[a]
Violent	-2.53	-3.81[b]	-1.58	-4.33[a]	0.367[r]	0.098[a]
Property	-3.33[c]	-4.27[a]	-2.07	-4.86[a]	0.367[r]	0.126[a]
Index	-3.30[c]	-4.05[b]	-2.06	-4.75[a]	0.368[r]	0.126[a]
Crime numbers	-3.42[c]	-4.34[a]	-2.13	-5.06[a]	0.369[r]	0.125[a]
Welfare	-0.877	-3.87[b]	-1.328	-5.88[a]	0.312[r]	0.043[a]
Health Care	-1.391	-4.58[a]	-0.453	-4.67[a]	0.365[r]	0.052[a]
Education	0.081	-5.35[a]	-0.317	-7.47[a]	0.362[r]	0.040[a]
Protection	-0.158	-3.55[b]	1.401	-5.55[a]	0.371[r]	0.152
Interest	-0.669	-4.16[a]	0.110	-4.89[a]	0.368[r]	0.151
Unemployment	-3.59[b]	-5.67[a]	-2.548	-5.10[a]	0.112[a]	0.050[a]

[a], [b] and [c] indicate that the hypothesis of trend stationarity is accepted at the 1%, 5% and 10% level respectively.
[r] indicates that the hypothesis of trend stationarity is rejected at the 5% level.

Table 3: Unit Root Tests with intercept and trend.

Conventional Error Correction Model (ECM) and Empirical Results

According to the step one, all variables are integrated I(0) or I(1). The step two was conducted in the proposed orders of the four criteria that are presented in Table 4. After determining the optimal order for each variable, we retain only the parameters that are significantly different from zero. In Table 5, the results of the step three are presented and the null hypothesis of no co-integration is rejected because $F_Y(Y|X_1, X_2, X_3, X_4, X_5, X_6)>3.61$ at 5% level of significance. The long-run linear relationship between the variables at levels will be estimated and then we maintain the estimated residues $\hat{\eta}_t$ symbolized by EC_t. The three long-run linear relationship are the following:

For $Z_{1,t}$ variable:

$$EC_t=Z_{1,t}-(-0.870+0.296X_{1,t-1}-0.234X_{2,t-1}+2.505X_{3,t-1}-2.902X_{4,t-1}+1.012X_{5,t-1}-0.084X_{6,t-1})$$ t-stat (-0.84) (1.12) (0.98) (5.24) (-12.65) (12.52) (-0.38)

$R^2=0.896=89.6\%$

For $Z_{2,t}$ variable:

$$EC_t=Z_{2,t}-(1.673+0.436X_{1,t-1}-0.420X_{2,t-1}+2.535X_{3,t-1}-2.801X_{4,t-1}+0.857X_{5,t-1}-0.092X_{6,t-1})$$ t-stat (1.75) (1.78) (-1.90) (5.73) (-13.18) (11.44) (-0.45)

$R^2=0.8466=84.6\%$

For Z_t variable:

$$EC_t=Z_t-(1.781+0.420X_{1,t-1}-0.397X_{2,t-1}+2.516X_{3,t-1}-2.800X_{4,t-1}+0.871X_{5,t-1}-0.092X_{6,t-1})$$ t-stat (1.86) (1.72) (-1.80) (5.70) (-13.21) (11.66) (-0.45)

$R^2=0.851=85.1\%$

Step 4: After determining the optimal values $(p,q_i,i = 1,..,6)$.

(Conventional ECM) The traditional error correction model

Dependent variable: Violent crimes Z_1					
Variables	**AIC**	**SBC**	**HQ**	**log(FPE)**	**Orders**
Z1	5	1	5	5	4
Z1 X5	10	4	5	10	4 10
Z1 X5 X6	3	1	1	3	4 10 3
Z1 X5 X6 X1	10	1	2	2	4 10 3 10
Z1 X5 X6 X1 X3	8	1	8	8	4 10 3 10 8
Z1 X5 X6 X1 X3 X4	2	2	2	2	4 10 3 10 8 2
Z1 X5 X6 X1 X3 X4 X2	1	1	1	1	4 10 3 10 8 2 1
Dependent variable: Violent crimes Z_2					
Variables	**AIC**	**SBC**	**HQ**	**log(FPE)**	**Orders**
Z2	5	2	5	5	2
Z2 X2	5	5	5	5	2 5
Z2 X2 X6	1	1	1	1	2 5 1
Z2 X2 X6 X4	7	1	7	7	2 5 1 6
Z2 X2 X6 X4 X3	8	1	8	8	2 5 1 6 6
Z2 X2 X6 X4 X3 X1	8	1	8	8	2 8 1 6 6 8
Z2 X2 X6 X4 X3 X1 X5	8	4	8	4	2 5 1 6 6 8 4
Dependent variable: Total crimes Z					
Variables	**AIC**	**SBC**	**HQ**	**log(FPE)**	**Orders**
Z	2	2	2	5	2
Z X6	1	1	1	1	2 1
Z X6 X2	8	5	8	8	2 1 5
Z X6 X2 X4	5	5	5	5	2 1 5 3
Z X6 X2 X4 X3	1	1	1	1	2 1 5 3 3
Z X6 X2 X4 X3 X1	3	3	3	3	2 1 5 3 3 3
Z X6 X2 X4 X3 X1 X5	7	1	7	7	2 1 5 3 3 3 4

Table 4: Sequential determination of the optimal orders of the ARDL model (Unrestricted Error Correction Model (UECM)).

$$\Delta Y_t = \alpha_0 + \sum_{j=1}^{p}\alpha_j \Delta Y_{t-j} + \sum_{j=0}^{q_1}\alpha_{1j}\Delta X_{1,t-j} + \sum_{j=0}^{q_2}\alpha_{2j}\Delta X_{2,t-j} + \sum_{j=0}^{q_3}\alpha_{3j}\Delta X_{3,t-j} + \sum_{j=0}^{q_4}\alpha_{4j}\Delta X_{4,t-j} + \sum_{j=0}^{q_5}\alpha_{5j}\Delta X_{5,t-j} + \sum_{j=0}^{q_6}\alpha_{6j}\Delta X_{6,t-j} + \gamma EC_{t-1} + \varepsilon_t \quad (4)$$

The parameter γ indicates the speed of adjustment to restore equilibrium if a deviation from equilibrium is produced. The sign of γ must be negative and with significance level 5% according to the Student distribution in order to ensure the dynamic adjustment towards equilibrium. In general, $-1<\gamma<0$, if its estimated value is close to (-1.0) then the return to equilibrium will be almost complete and immediate.

In the final estimate of the Error Correction Model (ECM), the parameters with low significance ($|t|<1.64$) were removed. The results of three models are presented in Table 6.

In the first and second models where the dependent variables $\Delta Z_{1,t}$ and $\Delta Z_{2,t}$ there are a positive impact with immediate or delayed time for each of the changes associated to Welfare, Health Care, Education and Protection. How do we understand that? In fact, the increased spending in these social fields reflects the existence of problems in many families which may lead to violent crimes and property crimes. for the variable ΔZ_t, we see a positive impact of Welfare, Education and Interest. How we see the results for each dependent variable?

For the three equations associated with the variables $Z_{1,t}$ (violent crime rate), $Z_{2,t}$ (property crime rate), and Z_t (total crime rate), it appears that there is a positive impact of the increasing factor in the welfare variable on the increasing factor in each of these three variables. In fact, an increasing factor of 1% in the welfare variable will have a direct impact on the increasing factor in Z_t of 0.134%, of 0.065% on the increasing factor in $Z_{2,t}$ lagged six years, of 0.084% on the increasing factor in $Z_{1,t}$ lagged ten years. An increasing factor of 1% in the health care variable will have a direct impact on the increasing factor in Z_{1t} of 0.34%, of 0.138% on the increasing factor in $Z_{2,t}$ lagged one year. An increasing factor of 1% in the education variable will have an impact on the increasing factor in Z_t of 0.28% in the short term and an equilibrium multiplier is about 1.057%. It is also possible to consider the normalization by dividing each estimate coefficient on the total effect of 1.057% and by consequence, 26.58 % of the total effect of the increasing factor occurs at the current time, 78.71% occurs after one year and 100% after two years. Likewise, it leads to an increasing factor in $Z_{1t,}$ Z_{2t} of 0.29% lagged eight years and 0.54% lagged four years respectively. An increasing factor of 1% in the protection variable will have an impact on the increasing factor in Z_t of -0.5% at the short term and -0.505% at the long term, and it involves an increasing factor in Z_{1t}, Z_{2t} of 0.33% lagged one year and 0.33% lagged three years respectively. An increasing factor of 1% in the interest variable will have an impact on the increasing factor in Z_t of 0.11%, in Z_{1t} of -0.30% lagged two years and 0.12% lagged three years, in Z_{2t} of -0.16% lagged one year. Finally, the unemployment effect seems negative on the three variables Z_{1t}, Z_{2t} and Z_t but lagged one year. Indeed, an increasing factor of 1% in the unemployment variable will have an impact on the increasing factor in Z_{1t}, Z_{2t} and Z_t of -0.146%, -0.113% and -0.114% respectively.

(No intercept and no trend) Case III: Unrestricted intercept, no trend Pesaran, Shin & Smith 2001, pages: 300-301				Bound critical values	
Dependent variable	**F-statistic**	*p, q_1, q_2, q_3, q_4, q_5, q_6*		$F_Y(Y\|X_1, X_2, X_3, X_4, X_5, X_6)$ ***i*=1,2,3**	
Z_1	*8.67*	4 10 1 8 2 10 3	Significant level	I(0)	I(1)
Z_2	9.86	2 8 5 6 6 4 1	%5	3.15	4.43
Z_3	7.52	2 3 5 3 3 4 1	%10	2.45	3.61
			%10	2.12	3.23

Table 5: Bounds test for co-integration.

Model	**ARDL(1,10,0,8,2,4,1)**		**Model**	**ARDL(2,6,1,4,3,1,1)**		**Model**	**ARDL(2,3,2,4,3,0,1)**	
Variables	$\Delta Z_{1,t}$		**Variables**	$\Delta Z_{2,t}$		**Variables**	ΔZ_t	
	Coeff	**t-stat**		**Coeff**	**t-stat**		**Coeff**	**t-stat**
Constant	*-0.070*	*-4.84****	*Constant*	*-0.075*	*-6.54****	*Constant*	*-0.056*	*-4.79****
$\Delta Z_{1,t-1}$	*0.460*	*4.81****	$\Delta Z_{2,t-1}$	*0.820*	*9.30****	ΔZ_{t-1}	*0.553*	*4.55****
$\Delta X_{1,t-10}$	*0.084*	*2.37***	$\Delta Z_{2,t-2}$	*-0.484*	*-4.73****	ΔZ_{t-2}	*-0.225*	*-1.82**
$\Delta X_{2,t}$	*0.341*	*2.70****	$\Delta X_{1,t-6}$	*0.065*	*2.07***	$\Delta X_{1,t}$	*0.134*	*2.74****
$\Delta X_{3,t-8}$	*0.286*	*1.87**	$\Delta X_{2,t-1}$	*0.138*	*1.92**	$\Delta X_{1,t-3}$	*0.082*	*2.44***
$\Delta X_{4,t-2}$	*0.326*	*1.87**	$\Delta X_{3,t-4}$	*0.544*	*4.08****	$\Delta X_{3,t}$	*0.281*	*2.28***
$\Delta X_{5,t-3}$	*-0.301*	*-4.52****	$\Delta X_{4,t-3}$	*0.334*	*2.94****	$\Delta X_{3,t-1}$	*0.551*	*3.82****
$\Delta X_{5,t-4}$	*0.116*	*1.77**	$\Delta X_{5,t-1}$	*-0.157*	*-3.07****	$\Delta X_{3,t-2}$	*0.225*	*1.82**
$\Delta X_{6,t-1}$	*-0.146*	*-5.45****	$\Delta X_{6,t-1}$	*-0.113*	*-4.43****	$\Delta X_{4,t}$	*-0.504*	*-3.10****
EC_{t-1}	*-0.124*	*-3.10****	EC_{t-1}	*-0.089*	*-2.81****	$\Delta X_{4,t-1}$	*-0.347*	*-1.83**
*iiiiiiThe three ECM models are valid because the coefficient γ of the error correction is quite negative. T*he system will adjust itself toward equilibrium from a deviation made in the previous year by 12.4% 8.9% and 11.5% for the models ARDL(1,10,0,8,2,4,1), ARDL(2,6,1,4,3,1,1) and ARDL(2,3,2,4,3,0,1) respectively.						$\Delta X_{4,t-3}$	*0.346*	*2.45***
						$\Delta X_{5,t}$	*0.112*	*2.12***
						$\Delta X_{6,t-1}$	*-0.114*	*-3.33****
						EC_{t-1}	*-0.115*	*-3.51****
*Note: *, **, and *** show the results significance at the level of 10%, 5%, and 1% respectively*								

Table 6: Estimate of the Conventional Error Correction Model (ECM).

Now let's look at the long-run effects for the explanatory variables on the crime rates (variables expressed in logarithm). For the ARDL model associated with violent crime rates, it appears a positive effect of both education variable and interest variable but the effect is negative for protection variable. The other variables do not have significant effects. More precisely, if the education variable rises 1 % then the violent crime rate increases 2.51%. Likewise an increase of 1% in the interest variable involves a rising about 1% in Z_{1t}, while an increase of 1% in the protection variable leads a decline about 2.9% in Z_{1t}. For the ARDL model associated with property crime rates $Z_{2,t}$, an increase of 1% in welfare (respectively in education and interest) involves an increase in $Z_{2,t}$ of 0.436% (respectively 2.54 and 0.86%) while an increase of 1% in health care (respectively in protection) entails a decrease in $Z_{2,t}$ of 0.42% (respectively 2.8%). For the ARDL model associated with total crime rates Z_t, we find almost the same previous results: an increase of 1% in welfare (respectively in education and interest) creates an increase in $Z_{2,t}$ of 0.42% (respectively 2.52 and 0.87%) while an increase of 1% in health care (respectively in protection) entails a decrease in $Z_{2,t}$ of 0.40% (respectively 2.8%).

Conclusion

Both of the four spending variables represented by welfare, health care, education and protection had increasing trends while the crime rates Z_{1t}, Z_{2t} and Z_t had two different trends: an increasing trend followed by a decreasing trend. For this reason, it appears that the effect of these variables on crime rates was dominated by the increasing trend and not by the decreasing trend. However, the two variables health care and protection affects negatively the total crime rates. Focusing on the third long-run equilibrium relationship, if a deviation made in the previous year then the system will adjust itself toward equilibrium by 11.5% one year later. Finally, we give more confidence to the third equilibrium relation because it concerns all the crimes on the whole of American territories.

In this study, we saw how the relationship between crime rates in the United States of America and a number of socio-economic variables is modeled. This has facilitated a scientific measurement of the effect of short-term and the impact on the long-term and this is intended for the role of the estimated ECM which strengthens making the decision by the decision makers. This study has revealed the direct and long-term impact of each explanatory variable on the crime rates, and this represents a work of great importance because it will be available to note how much the influence of an increase in protection rate or in health care produces some decrease in total crime rates. This study will reveal to the Lebanese public opinion, and particularly to the political authorities, the importance of certain variables that influence the crime rates in the United States, the world's leading economic power and the largest military and scientific force on the planet.

Recommendations

1. Authorities responsible for combating all kinds of crimes in Lebanon are invited to put the statistics related to all kinds of crimes at the disposal of researchers as they do in the U.S.A. There are actually seven types of crimes divided into violent crimes (four types) and property crimes (three types). The

availability of such database will indeed enable researchers to study the social and economic factors affecting crimes and causing them. Consequently, the negative or positive impacts on crimes will be measured in terms of social and economic variables. Examples on such variables include spending rates on health, education, welfare, social security, protection and coverage of police services, fire prevention, prisons (buildings, utilities, salaries, and infrastructure repairs), public order and safety in the field of research and development, and unemployment rates among others.

2. This research will be advanced by considering a panel analysis of co-integration for the fifty-one United States.

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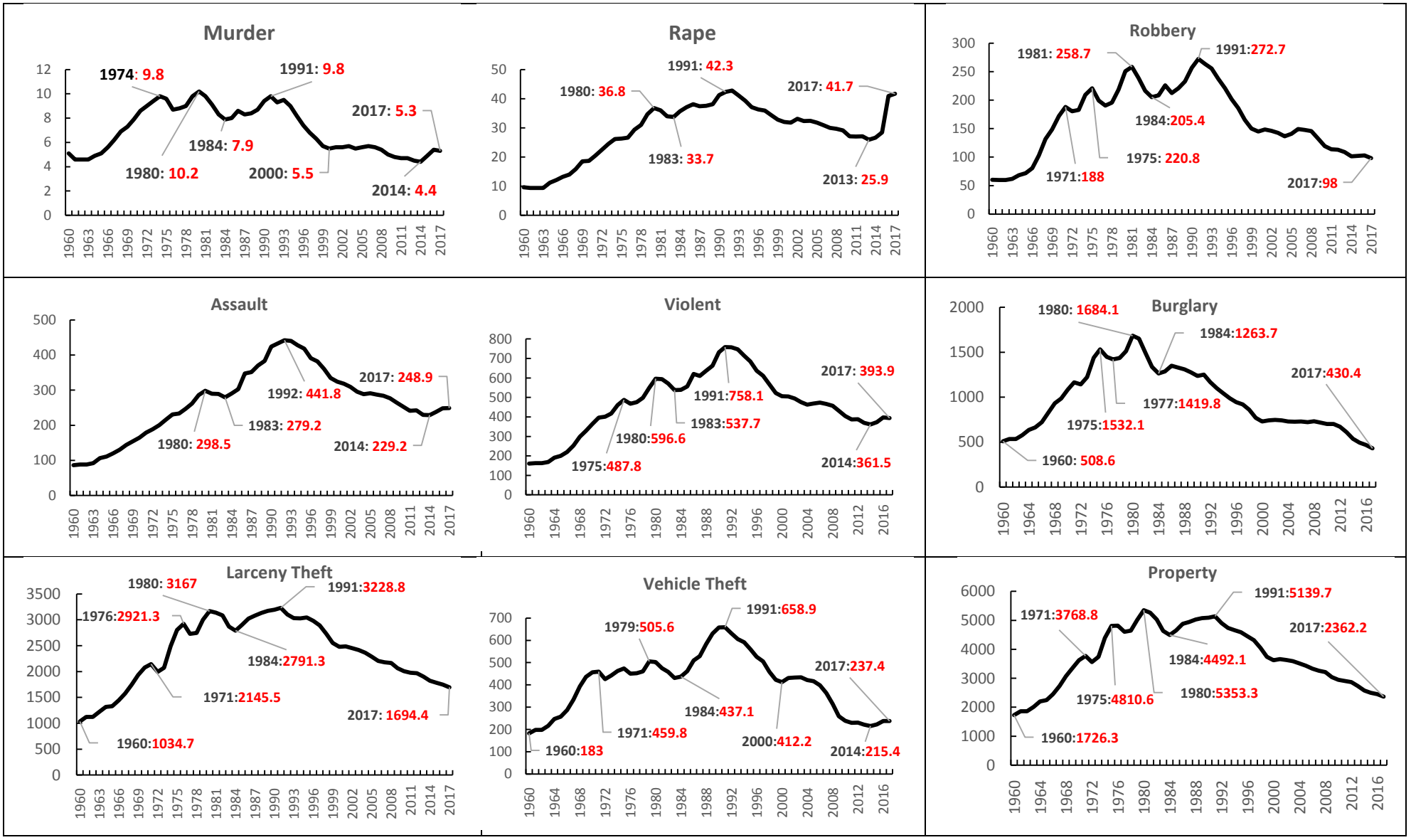
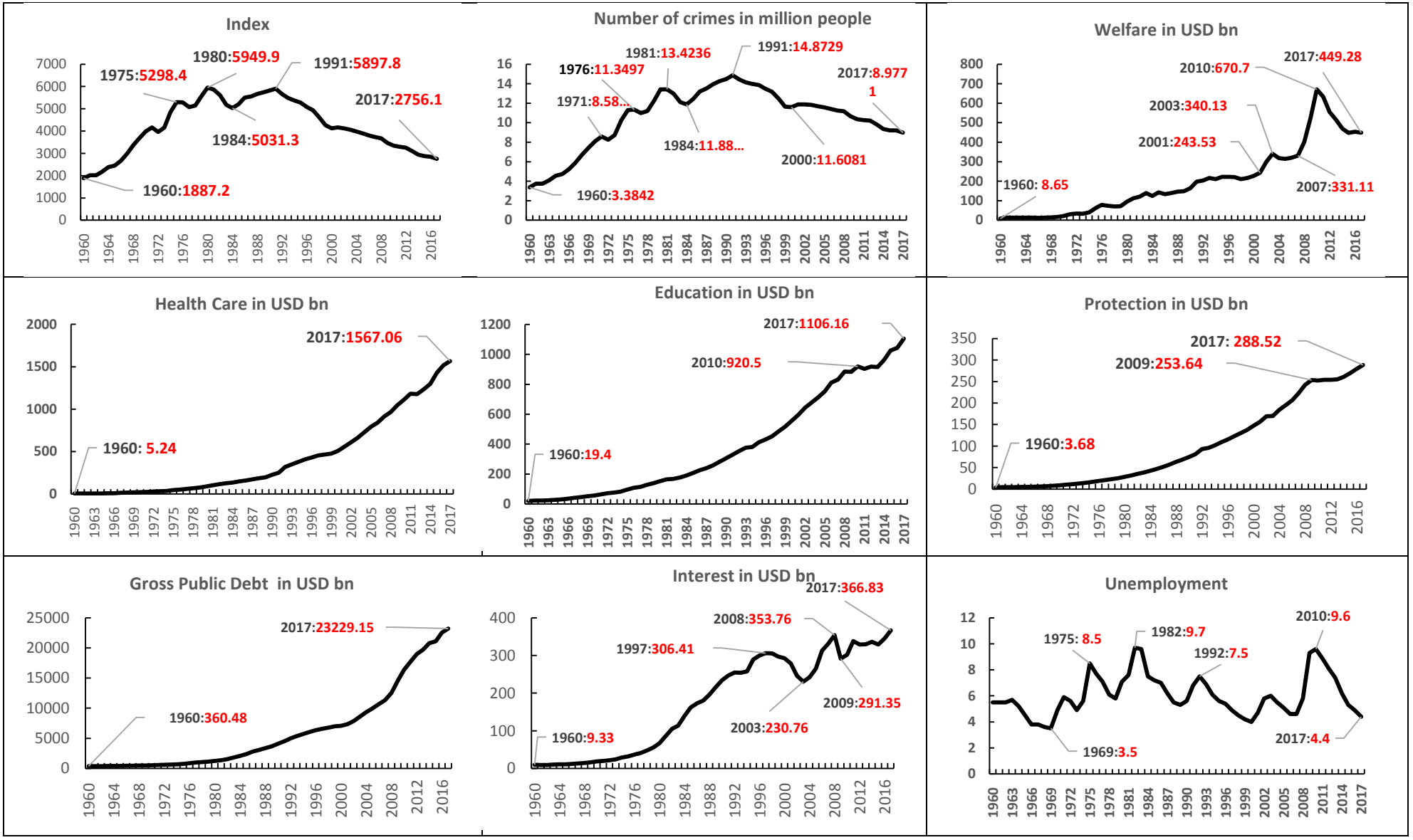
Appendix 1: The crime rates and several spending functions in the United States over the period 1960-2017




Index
1960:1887.2
1975:5298.4
1980:5949.9
1984:5031.3
1991:5897.8
2017:2756.1
Number of crimes in million people
1960:3.3842
1971:8.58...
1976:11.3497
1981:13.4236
1984:11.88...
1991:14.8729
2000:11.6081
2017:8.9771
Welfare in USD bn
1960: 8.65
2001:243.53
2003:340.13
2007:331.11
2010:670.7
2017:449.28
Health Care in USD bn
1960: 5.24
2017:1567.06
Education in USD bn
1960:19.4
2010:920.5
2017:1106.16
Protection in USD bn
1960:3.68
2009:253.64
2017: 288.52
Gross Public Debt in USD bn
1960:360.48
2017:23229.15
Interest in USD bn
1960:9.33
1997:306.41
2003:230.76
2008:353.76
2009:291.35
2017:366.83
Unemployment
1969:3.5
1975: 8.5
1982:9.7
1992:7.5
2010:9.6
2017:4.4