VIOLENT CRIME IN THE UNITED STATES OF AMERICA:

A TIME-SERIES ANALYSIS BETWEEN 1960-2000

by

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Abstract

This paper empirically assesses the effects of socio-economic and demographic variables on violent crime in the United States. Using national-level time-series data over the period 1960-2000, an unrestricted vector autoregressive (VAR) model was estimated for overall violent crime, murder, rape and assault. The results indicate that there is no long-run relationship among the examined variables, but significant short-run relationships hold. Imprisonment growth, income inequality, alcohol consumption, and racial composition of the male youth population are shown to influence the short-run behaviour of violent crime.

Keywords: Violent Crime, Rationality, Socio-economic and Demographic Determinants, Cointegration Analysis, Dynamic OLS

JEL Classification: K4

Since Becker's path-breaking article (Becker, 1968), economists have established quite successfully a robust link between property crime and incentives generated by the criminal justice system and background economic conditions (e.g. Pudney *et al.*, 2000; Pyle and Deadman, 1994; Corman *et al.*, 1987; Sjoquist, 1973).[1] Violent crime, however, has not received adequate attention by economists and there is little empirical information about what determines violent behaviour.[2] In recent years, violent crime has become an important public policy issue worldwide, and the empirical research concerned with the possible causes of violent felonies has intensified. An increasing number of recent studies (e.g. Cherry and List, 2002; Raphael and Winter-Ebmer, 2001; Entorf and Spengler, 2000; Levitt, 1996) have produced widely divergent results regarding the effects of the criminal justice system and economic activity on violent crime rates. This may cast serious doubts on the relevance of economic theory in the determination of violent offences and might suggest the collaboration of other disciplines in exploring this type of offence.

The objective of this study is to provide a systematic investigation of both economic and social causes of violent crime offences in the United States over the last forty years (1960-2000), with the intention of shedding more light on this issue. To narrow the focus in explaining violent crime, I omit robbery from the analysis as this might be dominated by economic incentives and could be incorporated in property crime offences. The econometric modelling technique adopted here is based on Johansen's cointegration approach (Johansen, 1988, 1995) which allows for the estimation of simultaneous relationships between variables, and of both the long and short-run effects of socio-economic determinants on violent crime rates.[3] I arrive at the following main conclusions. First, the explanation of violent crime is quite complex. Economic and social factors that influence the short-run behaviour of

violent crime do not determine it in the long-run. Second, the estimated short-run elasticities of imprisonment are substantially smaller than those obtained by Marvell and Moody (1997) and Devine *et al.* (1988). Third, my evidence is consistent with previous studies which suggest that unemployment plays a marginal role in violent crime (e.g. Levitt, 2001; Carmichael and Ward, 2001; Levitt, 1996; Elliot and Ellingworth, 1996). Fourth, I find a causal link between alcohol consumption and violent crime, which support findings reported by Raphael and Winter-Ebmer (2001). This might suggest that alcohol consumption should not be omitted from any violent crime specification when modelling violent offences.

The outline of this paper is as follows: Section 1 provides an overview of the violent crime literature focusing on the United States. In Section 2 the statistical framework and the data sources are presented. Section 3 discusses the empirical findings. The final section concludes the paper.

1. Background

1.1 Do Criminal Sanctions Alter Violent Crime Rates?

Over the past thirty years the United States has been engaged in the very costly policy of controlling crime by considerably increasing the incapacitation rate. The number of prisoners serving sentences of at least one year in state and federal institutions has more than quintupled since the early 1970s and more than doubled since the mid-1980s. However, the high increase in the incapacitation rate has been accompanied by a large decline in violent crime rates only during the 1990s (see Figure 1). There is considerable disagreement between national and state-level studies as to the extent that changes in imprisonment alter the violent crime rates. Two national-level

econometric studies including those by Devine *et al.* (1988) and Marvell and Moody (1997), found a high negative response of the increase in imprisonment on both homicide and robbery.[4] Using a state-level approach, however, Levitt (1996) found that for the offences of homicide and robbery, elasticities were approximately ten times and four times smaller respectively than those reported in the national-level studies.[5] Similar conclusions regarding the magnitude of the prison elasticity arise from an earlier state-level study by Marvell and Moody (1994). Although their estimates are less than one half of those of Levitt's (1996), their findings suggest that the prison elasticities reported in the existing national-level studies might be implausibly large.

[Figure 1 About Here]

There are two major reasons behind the higher national-level estimates. First, an increase in the prison population size in one state might reduce crime in other states (with a lax criminal justice system) where criminals would have moved, if they were not incarcerated. This is known as the free-rider or spill-over effect (see Marvell and Moody, 1998). Second, the use of annual national aggregated time-series data limits researchers to the inclusion of a small range of covariates in crime specification through their attempts to gain high degrees of freedom for estimation. As pointed out by Levitt (2001), this might be a weakness of studies based on national time-series data which seek to identify causal relationships between variables. Despite this general disagreement, the comparison in the empirical findings of national and state-level studies uncovers two important similarities. First, these studies do not distinguish the incapacitation effect from the deterrence and/or rehabilitation effects.

Second, in studies at both levels, the effect of imprisonment is higher and/or significant for the crimes with a direct economic motive (including robbery). A more recent study by Cherry and List (2002), who used county-level panel data and considered a wide variety of criminal justice variables (the probability of being arrested, convicted and imprisoned, police size), also conclude that sanctions were less influential in deterring murder or rape. Similarly, studies dealing with international and European violent crime rates (e.g. Fajnzylber *et al*., 2002a; Entorf and Spengler, 2000) found weak or mixed effects of the criminal justice variables (e.g., cleared-up rates, police size) on violent crime felonies.

1.2 Does Economic Activity Predict Changes in Violent Behaviour?

Although economic theory points towards a positive effect of unemployment on crime (see Ehrlich, 1973; Freeman, 1999), several recent studies found that unemployment exerts an insignificant or even negative effect on violent crime rates.[6] Recent studies by Levitt (1996, 2001) using state-level panel data for the United States found no significant impact of the unemployment rate on violent crime offences (with the exception of robbery). Similar conclusions come from Elliot and Ellingworth (1996) and Carmichael and Ward (2001) who applied the 1992 British Crime Survey and county-level data for England and Wales, respectively. Interestingly, other studies using national and state-level data for the United States (Greenberg, 2001; Raphael and Winter-Ebmer, 2001), and also the one carried out by Entorf and Spengler (2000) for Germany, reported a negative association between unemployment and the serious violent crime offence(s) of rape and/or murder. One plausible explanation for the negative effect of unemployment on violent crime could be given by making use of

the routine activity theory (Cohen and Felson, 1979).[7] My argument, however, is that if there is an attempt to establish a link between unemployment and violent crime, long-term indicators of unemployment rather than the overall unemployment rate might be better predictors.[8] Long-term unemployment may decrease the possibility of future employment, exhaust short-term financial resources (Cantor and Land, 1985), provoke frustration and social upheavals and may contribute to reducing the individual's moral values which may result in a turn to crime and delinquency (see Box, 1987).

Due to a possible motivation by the existing research on property crime, several authors incorporate in their violent crime models measures of absolute wealth (e.g., gross domestic product per capita or mean of family income). Economic theory predicts that an increase in wealth both increases the targets (returns) available for potential criminals (see Ehrlich, 1973) and at the same time increases the benefits from legitimate activities.[9] If the former effect dominates the latter then a positive relationship between measures of absolute wealth and crime should be expected. In contrast to property crime analysis, the empirical results on violent crime suggest a negative relationship between measures of absolute wealth and violent crime rates (see Fajnzylber *et al*., 2002a; Fajnzylber *et al*., 2002b; Entorf and Spengler, 2000). The main difference between these results lies in the emphasis the authors give to a change in legal (e.g., increase in legal employment opportunities) rather than illegal income opportunities. Nonetheless, since violent crime is not strongly related to economic incentives the effect of absolute wealth on violent crime is not straightforward. This in no way suggests that researchers should not attempt to find an association between these variables, however, and in this context the use of "relative

deprivation" indicators (e.g., Gini coefficient) might be more appropriate for violent crime analysis.

According to economic theory, in areas where there is a large gap in the income distribution and where low and high-income individuals are mixed there is an increase in the returns to time allocated to criminal activity (Kelly, 2000). The common observation that crime is usually carried out between poor individuals does not imply that the economic theory is invalid. Marris (2003) suggests that individuals with similar income levels share similar or the same risk premium and levels of economic incentives which might explain why they steal from each other. Apart from the economic explanation, sociological theories of crime also give an important view on this aspect. Strain theory (Merton, 1938), for instance, suggests that inequality increases the frustration of unsuccessful individuals and thus enhances the tendency to commit crime against either rich or poor. Both theories seem to apply to violent crime and the empirical results from several studies point to a strong relationship between income inequality and violent crime.[10] A recent study by Kelly (2000) found a strong effect of measured income inequality on both robbery and assault in 200 large metropolitan countries, but did not find any significant relationship for murder or rape. More recent studies by Fajnzylber *et al.* (2002a) and Fajnzylber *et al.* (2002b), which focussed on international homicide and robbery, produced strong evidence of a positive effect of measured income inequality on violent crime felonies. In an early meta-analysis study by Hsieh and Pugh (1993) violent crime was found to be strongly associated with both income inequality and poverty.

1.3 Do Violent Offenders Seem to Act Rationally?

The question regarding whether or not individuals rationally attempt to maximize their preferences might be one of the most enduring in social sciences. A study by Simon (1978), and more recently that by Rabin (1998), suggest that individuals act with limited or bounded rationality. Beginning with Becker's seminal work (Becker, 1968), the question as to whether criminals are rational individuals has been sharply debated by both economists and criminologists (see Garoupa, 2003; Manning, 2002; McCarthy, 2002; Hechter and Kanazawa, 1997). The debate has re-emerged in recent years especially regarding violent crime offenders. The empirical studies on violent crime as mentioned in the previous sections suggest that existing economic theory may not be appropriate to explore violent crime. Violent offenders seem to respond less to sanctions than property offenders to whom planning and sufficient time is needed, and economic conditions seem to have a weak or unclear effect on violent crime. This might be the reason why a number of researchers (e.g. Dilulio, 1996; Levitt and Donohue, 2001) have turned their interest to certain sociological aspects that might be associated with the incidence of violence.

In a sense, this study attempts to examine both economic and social determinants of violent crime. To achieve this goal I include in the model the prison population size corresponding to the criminal justice system effect on crime and economic indicators such as duration of unemployment (mean of weeks unemployed) and income inequality (measured by the Gini coefficient) as proxies of legal and illegal income opportunities, respectively. These economic variables may also capture the social consequences of economic change. Three more variables have been selected to emphasise the sociological aspects related to crime. The employed female

population is used as a proxy to one of the myriad changes that has occurred in U.S. families since the 1960s. Increases in the employed female population increase the time spent out of homes and contribute to low parental supervision of children and thus, could be associated with an increase in violent crime rates.[11] Alcohol consumption is a variable that has seen limited use in violent crime analysis although experimental findings suggest a causal link between alcohol and offending (see Seto, 1995; Collins, 1981). I consider on-premise alcohol consumption by the 16 to 44 age group since violent crime usually takes place in or out of pubs/clubs and places where young people meet. Finally, the percentage of black males in the male youth population aged 13 to 24 was seen as being more crime prone, and was therefore used to capture changes in racial composition (see Zimring, 1998; Freeman, 1996; Liska and Bellair, 1995). This variable corresponds to one used especially in criminological studies emphasizing the significance of structural or cultural factors on the explanation of black male violence (see Oliver, 2003). The statistical model and the data used are discussed briefly in the next section.

2. Statistical Framework and Data

2.1 The Statistical Model

The modelling strategy adopted in this paper is based on a system approach suggested by Johansen (1988, 1995). Violent crime ($lv_{j,t}$) and prison population size (lpr_t) are the variables of primary interest and I attempt to study these through other variables (lgi_t, lal_t, lfe_t, ldu_t, lbl_t), where the latter variables are assumed to be weakly exogenous (see Table 1 for definitions of variables used in this study).[12] The

assumption of weak exogeneity reduces the dimension of the system, improves efficiency and can be tested in the marginal model as described by Harbo *et al.* (1998). The vector error correction model (VECM) contains an unrestricted intercept and a restricted linear trend since the variables seem to contain a linear but not a quadratic trend (see Pesaran and Pesaran, 1997). I first estimate the model for overall violent crime and then individually for murder, rape and assault.[13] Under these assumptions the conditional and marginal models can be written as follows:

$$\Delta y_t = c_0 + c_1 t + \omega \Delta x_t + \sum_{i=1}^{p-1} \tilde{\Gamma}_{yi} \Delta z_{t-i} + \Pi_y z_{t-1} + \tilde{\Psi}_y w_t + \tilde{v}_{yt} \quad (1)$$

and

$$\Delta x_t = b_{x0} + \sum_{i=1}^{p-1} \Gamma_{xi} \Delta z_{t-i} + \Psi_x w_t + v_{xt} \quad (2)$$

where $c_0 \neq 0$, $c_1 = -\Pi_y \gamma$ and $z_t = \left(y_t', x_t' \right)'$,

with y_t being a $m_y x1$ vector of jointly determined (endogenous) $I(1)$ variables and x_t being a $m_x x1$ vector of weakly exogenous $I(1)$ variables and $t=1,..,T$. Moreover, Δ is the difference operator, $\Pi_y = \alpha_y \beta'$ is the long-run multiplier matrix of order $m_y x m$ (under the assumption that $\alpha_x = 0$), $\omega = \Omega_{yx} \Omega_{xx}^{-1}$, $\tilde{\Gamma}_{yi} = \Gamma_{yi} - \omega \Gamma_{xi}$ (with dimension $m_y x m$ and $i = 1,.., p-1$) captures the short-run dynamic effects, the deterministic component w_t contains dummies, $\tilde{\Psi}_y = \Psi_y - \omega \Psi_x$ and $\tilde{v}_{yt} = v_{yt} - \omega v_{xt}$ with variance $\Omega_{yy.x} = \Omega_{yy} - \Omega_{yx} \Omega_{xx}^{-1} \Omega_{xy}$ (see Johansen, 1995).[14] To test the hypothesis that $c_1 = 0$ the likelihood ratio test statistic can be applied. The estimated value is compared to the 95% critical value of the chi-squared distribution.

[Table 1 About Here]

2.2 Data

The empirical work of this paper employs annual time-series data for the United States from 1960 to 2000. The data on violent offences were obtained from the FBI's Uniform Crime Reports (UCR) and are expressed in per capita form.[15] An alternative source of crime statistics is the National Criminal Victimization Survey (NCVS) but this source only provides data from 1973. In this paper I did not deal with the problem of under-reporting, which might be an issue especially with crime that carries a social stigma to victims (rape). Homicide, however, is well-defined in the UCR and suffers little from under-reporting (see Marvell and Moody, 1997). The data used in this study are based on official information known to police. The overall number imprisoned for all crimes is the only available data which goes back as far as 1960. The prison population is defined as the number of prisoners serving sentences of at least one year in federal and state institutions and data have been used from various sources. Historical Statistics, Colonial Times to Present contains data for the years 1960-1970 and those for 1970-1999 are from the Statistical Abstract of the United States (1998, 2001). The Bureau of Justice Statistics, Bulletin, Prisoners 2000 supplies data for the year 2000. The variable is expressed in per capita form.[16] The Bureau of the Census provides data for the national population, age structure and race.[17] Data for the Gini ratio for families also come from the Bureau of Census, Table F-4.[18] The data for the duration of unemployment (the mean of weeks unemployed) and the rate of civilian employed female population were obtained from the Economic Report of the President (2002, see Tables B-44 and B-39 respectively). Finally, the on-premise alcohol consumption expenditure and the chain-type price index (1996=100) have been provided by the Bureau of Economic Analysis (BEA,

see Tables 2.4 and 7.20 respectively).[19] Table 2 provides summary statistics for the raw data. The empirical findings are given in the next section.

[Table 2 About Here]

3. Empirical Findings

3.1 Testing for Unit Roots (ADF and Perron Tests)

The initial objective is to obtain a stationary representation of the VAR, *Eq. (1)*. The Augmented Dickey-Fuller (ADF) test was carried out. The null hypothesis is that the time-series are non-stationary (i.e. series have a unit root or are integrated of order one, *I(1)*). Table 3 presents the ADF results on the logarithms of the variables.[20] The critical values used for accepting or rejecting the null hypothesis of non-stationarity for levels of the violent crime series depend on whether an intercept or intercept and time trend terms are included in the test regressions. Accordingly, the ADF tests without and with trend suggest that the violent crime series are *I(0)* or *I(1),* respectively. However, these results may reflect a change in the slope in each of the violent crime variables since 1993 (see Figure 1). Thus, I have used the Perron test (see Charemza and Deadman, 1997) to establish the order of integration subject to a structural break incurred by the introduction of the "three strikes" legislation in 1993. The results are not presented in detail here, but are available upon request. The calculated *t*-values lie above the upper level critical value for the Perron test therefore the null hypothesis that the violent crime variables are non-stationary cannot be

rejected.[21] On the basis of these results, the violent crime series are interpreted as *I(1)*. The ADF tests suggests that the explanatory variables used in the study are integrated of order one, *I(1)*.[22]

[Table 3 About Here]

The results of the unit root tests suggest that the use of a static regression by Ordinary Least Squares (OLS) may be expected to produce spurious results. To avoid the problem of non-stationarity of the time-series, the first difference of the variables can be used. However, using relationships where the variables are expressed in differences provide short-run information and leads to the loss of useful long-run information. For instance, previous research on violent crime (e.g., Levitt, 1996) provides estimates of short-run effects, but there is no information about long-run effects. However, economists who analyse criminal behaviour have become quite interested in establishing a stable long-run relationship between crime and its determinants (e.g., Witt and Witte, 2000; Scorcu and Cellini, 1998; Pyle and Deadman, 1994). The next section gives an answer to the question of whether a cointegrating relationship between violent crime and socio-economic variables holds.

3.2 Cointegration Analysis

A test for cointegration using the Johansen's maximum likelihood method described in the previous section (2.1) is applied, in order to identify the cointegrating rank *r* and to provide estimates of the cointegrating and adjusted matrices. Before determining the number of cointegrating vectors, it is necessary to choose the order of

the lags in the VAR, which should be large enough to ensure that the error terms in the equations are not autocorrelated, but small enough to enable estimation. Given that there are only 41 observations, I use a lag length of two *(p=2)* in the VARs, thus minimizing the loss in the number of observations that are available for estimation and ensuring that the errors are white noise. Table 4 presents the residual diagnostic tests for the unrestricted VAR models. The results suggest that there is no evidence of serial correlation, ARCH effect and nonnormality in the residuals.

[Table 4 About Here]

According to the economic crime literature, each violent crime offence and the prison population might be simultaneously determined and thus should be treated as endogenous (see Levitt, 1996). The other economic variables are treated as weakly exogenous according to the economic priors. Under this assumption, the cointegration analysis is performed assuming unrestricted intercepts and, since the variables seem to contain a linear trend, I conjecture the presence of a restricted trend to the cointegration space (see *eq.(1)*). The null hypothesis is in terms of the cointegration rank *r* and, for example, rejection of *r=0* is evidence in favour of at least one cointegrating vector. The non-uniformity among the trace statistic, the maximum eigenvalue and the use of model selection criteria to identify the existence of a long-run relationship is a common occurrence. However, in this case both trace statistic and maximum eigenvalue statistics do not reject the null hypothesis that there is no cointegration among the variables included in the VARs (namely *r=0*). Thus, Π_y in *eq. (1)* is completely deficient in rank, *rank*(Π_y)=0, for each violent crime model.

Table 5 presents the results of the cointegration test based only on the trace of the stochastic matrix for reasons of brevity.

[Table 5 About Here]

Violent crime has a variety of motives, and it may not operate in a predicted direction in the long-run as that which occurs to some extent with crimes which have economic incentives. As suggested by Field (1990), crime might be influenced by short-term influences which may be different from its long-term determinants. This makes the analysis of violent crime quite complex. Particular attention should be given to the lack of a long-run relationship for rape, which may need to be distinguished from the explanation of other types of violent crime. It can be argued that an increase in forcible rape might be due to either or both an increase in the effective rate of rape and/or the decision to report rape. Hence, the inability to distinguish between the determinants of these two factors might make the analysis problematic. Furthermore, the results of the cointegration analysis suggest that there is no long-run relationship between any of the violent crime felonies and prison population size. If imprisonment deters and incapacitates criminals, but has the opposite effect on rehabilitation of criminal preferences (especially for longer term prisoners), for instance, due to the stigma and depreciation of human capital associated with being in prison (see Avio, 1998), it might be expected that these two effects would cancel each other in the long-run. Additionally, Freeman (1996) suggested that a large number of inmates rejoin the society with reduced labour market skills and enhanced criminal skills and therefore have a high recidivism rate.

Similarly, some recent studies have failed to identify a stable long-run relationship between crime and economic conditions. For instance, Scorcu and Cellini

(1998) in considering the offences of homicide, robbery and theft did not find any long-run relationship between crime and economic conditions using similar econometric techniques.[23] The lack of long-run relationships has also been observed in property crime studies. For example, a study by Hale (1998) examining property crime in England and Wales using cointegration techniques found no long-run relationship between unemployment and property crime offences. Does the lack of cointegration suggest that there is no relationship between the variables? Britt (2001) proposes that while the lack of cointegration implies that there is no long-term equilibrium relationship between the series, it should not be concluded that no short-run relationship exists among the examined variables. The possibility that a slowly changing short-term relationship exists between violent crime and the explanatory variables is examined in the next section.

3.3 Short-run Determinants of Violent Crime

To examine the short run relationship we consider a dynamic Ordinary Least Squares (OLS) estimation, which is simply the VAR model for the process in logarithmic differences (growth rates). The short-run model can be simply written as:

$$\Delta lv_{j,t}=\beta_0+\beta_1\Delta lv_{j,t-1}+\beta_2\Delta lpr_{t-1}+\beta_3\Delta \lg i_t+\beta_4\Delta \lg i_{t-1}+\beta_5\Delta lal_t+\beta_6\Delta lal_{t-1}+\beta_7\Delta lfe_t$$
$$+\beta_8\Delta lfe_{t-1}+\beta_9\Delta ldu_t+\beta_{10}\Delta ldu_{t-1}+\beta_{11}\Delta lbl_t+\beta_{12}\Delta lbl_{t-1}+\beta_{13}d_t+\varepsilon_t \quad (3)$$

where Δ is a difference operator, t denotes time and j=1,..,4 (see Table 1). As can be seen in the short-run model, *Eq.(3),* the prison population growth rate in year t was

not included in the regression in an attempt to surmount possible simultaneity bias between crime and the prison population.

The OLS results are presented in Table 6.[24] The estimates obtained for the overall violent crime rate, which does not include robbery, are similar to those produced for assault. This is not surprising since assault accounts for about 60 percent of overall violent crime when robbery is included and approximately 90 percent otherwise. The estimated elasticity for imprisonment is highly significant for murder and rape. I found that a 10 percent increase in the prison population is associated with 6.2 and 6.5 percent fewer murders and rapes, respectively. My estimates are less than half of those obtained by previous national-level studies including those by Devine *et al.* (1988) and Marvell and Moody (1997), but are almost four times higher than those found by Levitt (1996) in a state-level study. The only exception is for assault and hence, for overall violent crime where I found a smaller elasticity but which was close to those reported by both national and state-level studies. Similar to previous findings, the analysis is limited to an estimation of the full effect of imprisonment and does not separate the incapacitation effect from those of deterrence or rehabilitation effects. The analysis, however, reveals that an increase in incarceration rates has contributed to violent crime reduction and can be assumed an effective policy in controlling crime. But is this the most effective policy? The answer is quite complicated. Imprisonment is a very costly exercise, which entails a large amount of spending from states' and Federal government's budget. Recently, there has been some shift in the policy recommendations from certain researchers towards the early prevention of crime (e.g. Witt and Witte, 2000; Greenwood, 1998) or to establishing private prisons (see Avio, 1998).

[Table 6 About Here]

Income inequality as measured by the index of income concentration (Gini coefficient) has a significant and positive effect only on murder. I found that a 10 percent increase in income inequality increase murders approximately by the same percentage. My results are consistent with previous findings (e.g. Fajnzylber *et al.*, 2002a ; Fajnzylber *et al.*, 2002b) that emphasise the role of income inequality in the determination of the offence of murder. The positive relationship between income inequality and murder implies on the one hand, that murders might be committed as a by-product of crime with economic incentives and on the other, might be committed due to sociological aspects as suggested by strain theory (Merton, 1938). The on-premise alcohol consumption variable is significant at or around the 10 percent level with murder and rape, but interestingly not so with assault. My results support those obtained by Raphael and Winter-Ebmer (2001) who found a positive effect for alcohol consumption on overall violent crime in a state-level study. Using data for England and Wales, Ensor and Godfrey (1993) and Field (1990) also found a positive effect for alcohol consumption on violent crime. There are some explanations behind this causal link. First, there are psychopharmacological theories that suggest that alcohol consumption is associated with violent behaviour (see Seto, 1995; Collins, 1981). In this circumstance, alcohol consumption might affect an individual's rationality during the process of the cost-benefit analysis of engaging in crime. Second, alcohol maybe consumed by offenders after committing the crime in an attempt to excuse their behaviour. Third, alcohol consumption might reduce the ability to assess or deal with potential dangers and thus, increase victimization.

The employed female population was found to have an insignificant effect on violent crime rates. In contrast to this study, Raphael and Winter-Ebmer (2001) found a significant positive effect for the employed female population on rape in the United States. Similarly, Witt and Witte (2000) reported a positive and significant effect for the female labour force participation on the U.S. overall crime rate. Focusing on the rape equation, even though I attempted to drop those variables with elasticities that were highly insignificant, no significant relationship was found between the employed female population and rape. Unemployment duration carried mixed signs in different violent crime felonies, but none of the estimated elasticities were statistically significant, hence supporting previous findings (e.g. Carmichael and Ward, 2001; Levitt, 2001, Levitt, 1996). In Greenberg's (2001) study, however, unemployment duration was found to have a negative and significant effect on homicide. Due to the fact that Greenberg's model omits potentially important explanatory variables in the murder specification (e.g. prison population, measures of inequality) the estimated elasticity for unemployment duration raises serious doubts (see Levitt, 2001).

Changes in the percentage of black males in the male youth population have a positive and significant effect on all types of violent crime. This is in line with previous studies (e.g. Levitt 2001; Liska and Bellair, 1995) that emphasize a positive relationship between racial composition and violent crime rates. However, behind the causes of the high level of black offending (see Freeman, 1996) there is also an important point given by Hindeland (1978) who emphasized the fact that blacks are overrepresented in arrest statistics and are more likely to be apprehended. This study does not deal with this aspect since there is limited data available. Finally, the "three strikes" policy adopted in 1993 might explain part of the recent fall in violent crime rates. This policy gives credit to selective incapacitation strategies by increasing the

prison term for criminals convicted of a third serious crime (see Blumstein and Wallman, 2000). The "three strikes" dummy carries the expected sign and is significant for all violent crime felonies. An issue for further research is whether the "three strikes" legislation operates as a deterrent or has an incapacitation effect. The diagnostic test statistic indicates that my estimates do not suffer from serial correlation, functional misspecification, nonnormality or heteroscedasticity in any of the violent crime equations.

4. Concluding Remarks

This study examines economic and social determinants of violent crime in the United States over the period 1960 to 2000. The econometric technique used is based on Johansen's (1995, 1988) cointegration approach and attempts to establish a long-run and short-run relationship between violent crime and its determinants. This research is distinguished from previous studies (e.g. Levitt, 1996) by focusing on both long and short-run determinants of violent crime rather than only on short-run effects. However, the results of the cointegration analysis indicate that there is no cointegrating vector for the examined variables making the question regarding the long-run determinants of violent crime quite complex. The analysis was forced to provide only short-run information.

The effects of prison population on violent crimes are substantially smaller than those produced by Devine *et al.* (1988) and Marvell and Moody (1997), and are closer to Levitt's (1996). Economic conditions are found to have a marginal role in violent crime rates with the exception of murder, where it was found to be strongly associated with income inequality. This suggests that murder might be related to economic crimes or more specifically, may be committed as a by-product of crimes

with economic incentives. On the other hand, I found a causal link between on-premise alcohol consumption and the serious offences of murder and rape. This emphasizes that alcohol consumption might be an important predictor of violent crime and should not be omitted from the violent crime specification. No significant relationship was found between the employed female population and violent crime felonies which is in contrast to previous studies. Finally, violent crime rates were found to be closely associated with changes in the racial composition of the male youth population.

In conclusion, the exploration of violent crime is much more complicated than property crime due to the variety of motivations that the former might have. The empirical results reveal that murder is better predicted in the short-run than other types of violent offences, however, it seems not to be affected by the long-run pattern of the socio-economic factors adopted in this study. The collaboration of other disciplines and the theoretical integration of different theories of crime may be required in order to explain and thus, curb this type of offence.

Notes:

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[1] According to the neoclassical economic approach to crime (Becker, 1968), criminals are viewed as rational individuals who base their decision to commit crime on an analysis of the expected cost and benefit of engaging in criminal activity.

[2] According to the F.B.I. Uniform Crime Reports (U.C.R.) violent crime consists of offences of murder and non-negligent manslaughter, forcible rape, robbery and aggravated assault.

[3] Cointegration techniques have seen considerable use especially within the United Kingdom in studying property crime (e.g. Hale, 1998; Pyle and Deadman, 1994). However, the application of this statistical framework to crime has been very limited in the United States. Concerning violent crime, as far as I am aware the one exception is the work by Greenberg (2001), who used cointegration methods to examine violent crime rates in the United States.

[4] The estimated elasticities reported by Devine *et al.* (1988) are –1.47 for the offence of homicide and -2.62 for robbery. Marvell and Moody's (1997) estimations for homicide and robbery are -1.33 and -2.57, respectively. Both studies did not examine the serious offence of rape, although Marvell and Moody (1997) did study assault and the estimated elasticity was found to be –0.53.

[5] Levitt's (1996) study accounts for the possibility of simultaneity bias between prison population size and crime rates and found that the elasticity for overall violent crime is –0.379 and statistically different from zero. However, in disaggregating the violent crime data into individual violent crime felonies, none of the reported elasticities for homicide (-0.147), assault (-0.41) or rape (-0.246) were found to be statistically significant at the 0.05 level. The estimated elasticity for assault was similar to Marvell and Moody's (1997) and statistically significant at around the 10 percent level.

[6] Ehrlich (1973) considers the time allocation model. This model assumes that crime and employment are substitute activities and thus, the more time one devotes to legitimate occupation, the less time one

has to develop criminal behaviour. This assumption has been criticized by a number of commentators (e.g., Entorf and Spengler, 2002) suggesting that it may not explain crime committed by juvenile and low-paid individuals.

[7] For instance, unemployment might reduce the exposure time of individuals in "unsafe" public places and increase the guardianship of property and children (Entorf and Spengler, 2002).

[8] Greenberg (2001) examined the effect of both the unemployment rate and the duration of unemployment (mean of weeks unemployed) on both homicide and robbery for the United States and found negative relationships. Recent studies by Fajnzylber *et al.* (2002a) and Fajnzylber *et al.* (2002b) did not consider the unemployment rate or long-term unemployment in modelling international homicide and robbery.

[9] Ehrlich (1973) found a low effect of the mean of family income for both murder and rape.

[10] Patterson (1991) failed to identify a significant relationship between measures of household income inequality and violent crime rates.

[11]Both the routine activity (Cohen and Felson, 1979) and differential association (Sutherland, 1942) theories introduce the importance of this variable in explaining crime rates. Previous studies (e.g. Entorf and Spengler, 2002; Witt and Witte, 2000) have considered the effect of the female labour force on crime. However, since the female labour force includes both the employed and unemployed female population, it can be argued that the size of female employment would be a better proxy.

[12] Levitt (1996) suggests that prison population size and crime rates might be simultaneously determined and therefore, should be treated as endogenous. An increase in prison population size affects crime rates, and also an increase in crime rates affects prison population size.

[13] In this study overall violent crime includes the offences of murder, rape and assault.

[14] There is much concern as to whether the inclusion of dummy variables in the vector autoregressive (VAR) model changes the asymptotic distribution of the trace statistic for cointegration rank (see Johansen *et al*., 2000; Johansen, 1995). This paper does not make an attempt to address this issue.

[15] Sourcebook of Criminal Justice Statistics Online, Section 3.

[16] I would like to thank Jo Ann Van Atta of the Uniform Crime Reporting Programme for informing me that data for the percentage of offences cleared, which could have been used as an alternative criminal justice variable, were not available at the national-level prior to 1970. An econometric

analysis using the post-1970 data would severely curtail the degrees of freedom available for estimation and therefore such a modelling strategy was not adopted in this study.

[17] I am grateful to the Department of Population and Housing Statistics, for providing me with data for the period 1960-1979.

[18] The index of income concentration (or Gini index) is a statistical measure derived from the Lorenz Curve. The Gini index rate ranges from "0" (indicating perfect equality) to "1" (indicating perfect inequality). The term "family" refers to a group of two or more persons related by blood, marriage, or adoption and residing together (For further details see Current Population Reports, 1979, pp. 264-265).

[19] The Bureau of Economic Analysis uses the term 'other alcoholic beverages' (Table 2.4 Personal Consumption Expenditures by Type of Expenditure) which includes alcoholic beverages purchased for on-premise consumption, such as at bars, sporting events, etc.

[20] For completeness I present the ADF results both without and with trend. The decision to include a trend in the ADF test is usually based on the plots of the time-series. If the DF or ADF test (without controlling for a time trend in the regression) is carried out on a trend-stationary series it will probably have little power of rejecting a unit root (see Wooldridge, 2000).

[21] The postulated break point lies 34/41 parts (or 0.829) through the sample data, hence the value of λ may be taken as (1-0.829) or 0.2. For a test at the 5% significance level with 41 observations and a value of $\lambda = 0.2$, the lower and upper critical values are –3.39 and –3.32 respectively (see Charemza and Deadman, 1997).

[22] Surprisingly, the first difference of the prison population per capita series appears non-stationary when the ADF test is applied (sample period 1963-2000). However, when the ADF unit root test was performed on the post-1969 sample for the imprisonment variable the results indicated that the series is clearly *I(1)*. Therefore, the imprisonment series is assumed to be *I(1)* rather than *I(2)* in this study.

[23] Allowing for the possibility of a regime shift, a long-run relationship was detected.

[24] I have also experimented with estimating the short-run models by adding two lags to the variables in differences to allow for the possibility of lagged effects. However, none of the estimated elasticities of the second lag in differences for each model were individually significant at the 0.05 level. I also conducted a joint test of zero restrictions on the coefficients of the second lag in differences for the violent crime models. In each case the values of the *F* test statistic (0.95, 0.69, 1.41 and 0.82) were

smaller than the theoretical value of $F_{7,17}^{0.05}$ and therefore the joint null hypothesis of zero coefficients cannot be rejected.

References:

Avio, K. (1998). The Economics of Prisons, *European Journal of Law and Economics*, 6:143-175.

Becker, G. (1968). Crime and Punishment: An Economic Approach, *The Journal of Political Economy*, 76/2:169-217.

Blumstein, A. and Wallman, J. (2000). *The Crime Drop in America*, Cambridge University Press.

Box, S. (1987). *Recession, Crime and Punishment*, London: MacMillan.

Britt, C. (2001). Testing Theory and the Analysis of Time Series Data, *Journal of Quantitative Criminology*, 17/4:343-357.

Cantor, D. and Land, K. (1985). Unemployment and Crime Rates in the Post-World War II United States: A Theoretical and Empirical Analysis, *American Sociological Review*, 50/3: 317-332.

Carmichael, F. and Ward, R. (2001). Male Unemployment and Crime in England and Wales, *Economic Letters,* 73: 11-115.

Charemza, W. and Deadman, D. (1997). *New Directions in Econometric Practice*, Second Edition, Edward Elgar.

Cherry, T. and List, J. (2002). Aggregation Bias in the Economic Model of Crime, *Economics Letters*, 75/1:81-86.

Cohen, L. and Felson, M. (1979). Social Change and Crime Rate Trends: A Routine Activity Approach, *American Sociological Review*, 44/4: 588-608.

Collins, J. (1981). *Drinking and Crime: Perspectives on the Relationships Between Alcohol Consumption and Criminal Behaviour*, The Guildford Press, New York.

Corman, H., Joyce, T. and Lovitch, N. (1987). Crime, Deterrence and the Business Cycle in New York City: A VAR Approach, *The Review of Economics and Statistics*, 69/4:695-700.

Devine, J., Sheley, J. and Smith, D. (1988). Macroeconomic and Social-Control Policy Influences on Crime Rate Changes, 1948-1985, *American Sociological Review*, 53/3: 407-420.

Dilulio, J. (1996). Help Wanted: Economists, Crime and Public Policy, *Journal of Economic Perspective*, 10/1:3-24.

Ehrlich, I. (1973). Participation in Illegitimate Activities: A Theoretical and Empirical Investigation, *The Journal of Political Economy*, 81/3:521-565.

Elliot, C. and Ellingworth, D. (1996). The Relationship Between Unemployment and Crime: A Cross-Sectional Analysis Employing the British Crime Survey 1992, *International Journal of Manpower*, 17(6/7): 81-88.

Ensor, T. and Godfrey, C. (1993). Modelling the Interactions Between Alcohol, Crime and the Criminal Justice System, *Addiction*, 88:477-487.

Entorf, H. and Spengler, H. (2002). *Crime in Europe: Causes and Consequences*, Springer.

Entorf, H. and Spengler, H. (2000). Socioeconomic and Demographic Factors of Crime in Germany: Evidence From Panel Data of the German States, *International Review of Law and Economics*, 20: 75-106.

Fajnzylber, P., Lederman, D. and Loayza, N. (2002a). What Causes Violent Crime? *European Economic Review*, 46:1323-1357.

Fajnzylber, P., Lederman, D. and Loayza, N. (2002b). Inequality and Violent Crime, *Journal of Law and Economics*, 45/1:1-40.

Field, S. (1990). *Trends in Crime and Their Interpretation: A Study of Recorded Crime in Post-War England and Wales*, Home Office Research Study No.119, Home Office, London.

Freeman, R. (1999). The Economics of Crime, *Handbook of Labour Economics*, Ashenfelter Card Editors, 3C:3529-3571.

Freeman, R. (1996). Why Do So Many Young American Men Commit Crimes and What Might We Do About It? *The Journal of Economic Perspective,* 10/1: 25-42.

Garoupa, N. (2003). Behavioral Economic Analysis of Crime: A Critical Review, *European Journal of Law and Economics*, 15:5-15.

Greenberg, D. (2001). Time Series Analysis of Crime Rates, *Journal of Quantitative Criminology*, 17/4: 291-327.

Greenwood, P. (1998). Investing in Prisons or Prevention: The State Policy Makers' Dilemma, *Crime & Delinquency* 44/1:136-142.

Hale, C. (1998). Crime and Business Cycle in Post-War Britain Revisited, *British Journal of Criminology*, 38/4:681-698.

Harbo, I., Johansen, S., Neilsen, B. and Rehbek, A. (1998). Asymptotic Inference on Cointegrating Rank in Partial Systems, *Journal of Business and Economics Statistics*, 16:388-399.

Hechter, M. and Kanazawa, S. (1997). Sociological Rational Choice Theory, *Annual Review of Sociology*, 23:191-214.

Hindelang, M. (1978). Race and Involvement in Common Law Personal Crimes, *American Sociological Review,* 43/1: 93-109.

Hsieh, Ching-Chi and Pugh, M.D. (1993). Poverty, Income Inequality, and Violent Crime: A Meta-Analysis of Recent Aggregate Data Studies, *Criminal Justice Review*, 18/2: 182-202.

Johansen, S., Mosconi, R. and Nielsen, B. (2000). Cointegration Analysis in the Presence of Structural Breaks in the Deterministic Trend, *Econometrics Journal*, 3: 216-249.

Johansen, S. (1995). *Likelihood-Based Inference in Cointegrated Vector Autoregressive Models*, Oxford University Press.

Johansen, S. (1988). Statistical Analysis of Cointegration Vectors, *Journal of Economic Dynamics and Control*, 12: 231-254.

Kelly, M. (2000). Inequality and Crime. *Review of Economics and Statistics*, 82: 530-539.

Levitt, S. (2001). Alternative Strategies for Identifying the Link Between Unemployment and Crime, *Journal of Quantitative Criminology*, 17/4: 377-390.

Levitt, S. and Donohue, J. (2001). The Impact of Legalized Abortion on Crime, *Quarterly Journal of Economics*, 116/2: 379-420.

Levitt, S. (1996). The Effect of Prison Population Size on Crime Rates: Evidence from Prison Overcrowding Litigation, *The Quarterly Journal of Economics*, 111/2: 319-351.

Liska, A. and Bellair, P. (1995). Violent-Crime Rates and Racial Composition: Convergence Over Time, *American Journal of Sociology*, 101/3 : 578-610.

Manning, D. (2002). How Useful is the Economic Model of Crime in Assisting the War Against Terrorism? *Economic Affairs*, 22/3: 21-28.

Marris, R. (2003). *Survey of the Literature on the Criminological and Economic Factors Influencing Crime Trends*, Forthcoming in Modeling Crime and Offending: Recent Developments in England and Wales, Occasional Paper, Home Office, London.

Marvell, T. and Moody, C. (1998). The Impact of Out-of-State Prison Population on State Homicide Rates: Displacement and Free-Rider Effects, *Criminology*, 36:513-535.

Marvell, T. and Moody, C. (1997). The Impact of Prison Growth on Homicide, *Homicide Studies*, 1/3: 205-233.

Marvell, T. and Moody, C. (1994). Prison Population Growth and Crime Reduction, *Journal of Quantitative Criminology*, 10/2: 109-140.

McCarthy, B. (2002). New Economics of Sociological Criminology, Annual Review of Sociology, 28:417-442.

Merton, R.K. (1938). Social Structure and Anomie, *American Sociological Review*, 3: 672-682.

Oliver, W. (2003). The Structural-Cultural Perspective: A Theory of Black Male Violence in *Violent Crime Assessing Race and Ethnic Differences*, ed. by Hawkins, D.F., Cambridge University Press.

Patterson, E.B. (1991). Poverty, Income Inequality and Community Crime Rates, *Criminology*, 29:755-776.

Pesaran, H. and Pesaran, B. (1997). *Working with Microfit 4.0: Interactive Econometric Analysis*, Oxford University Press.

Pudney, S., Deadman, D., and Pyle, D. (2000). The Relationship Between Crime, Punishment and Economic Conditions: Is Reliable Inference Possible When Crimes Are Under-Recorded? *Journal of the Royal Statistic Society Series A (Statistics in Society)*, 163/1:81-97.

Pyle, D.J. and Deadman D.F. (1994). Crime and the Business Cycle in Post-War Britain, *British Journal of Criminology*, 34/3: 339-357.

Rabin, M. (1998). Psychology and Economics, *Journal of Economic Literature*, 36/1: 11-46.

Raphael, S. and Winter-Ebmer, R. (2001). Identifying the Effect of Unemployment on Crime, *Journal of Law and Economics*, XLIV: 259-283.

Scorcu, A. and Cellini, R. (1998). Economic Activity and Crime in the Long Run: An Empirical Investigation on Aggregate Data from Italy, 1951-1994, *International Review of Law and Economics*, 18: 279-292.

Seto, M. (1995). The Role of Alcohol in Sexual Aggression, *Clinical Psychology Review*, 15/6: 545-566.

Simon, H. (1978). Rationality as a Process and Product of Thought, *American Economic Review*, 8:1-16.

Sjoquist, D. L. (1973). Property Crime and Economic Behaviour: Some Empirical Results, *The American Economic Review*, 63/3: 439-446.

Sutherland, E.H. (1942/1973, revised edition). *On Analysing Crime*. Edited with an Introduction by Schuessler, K. Chicago: University of Chicago Press.

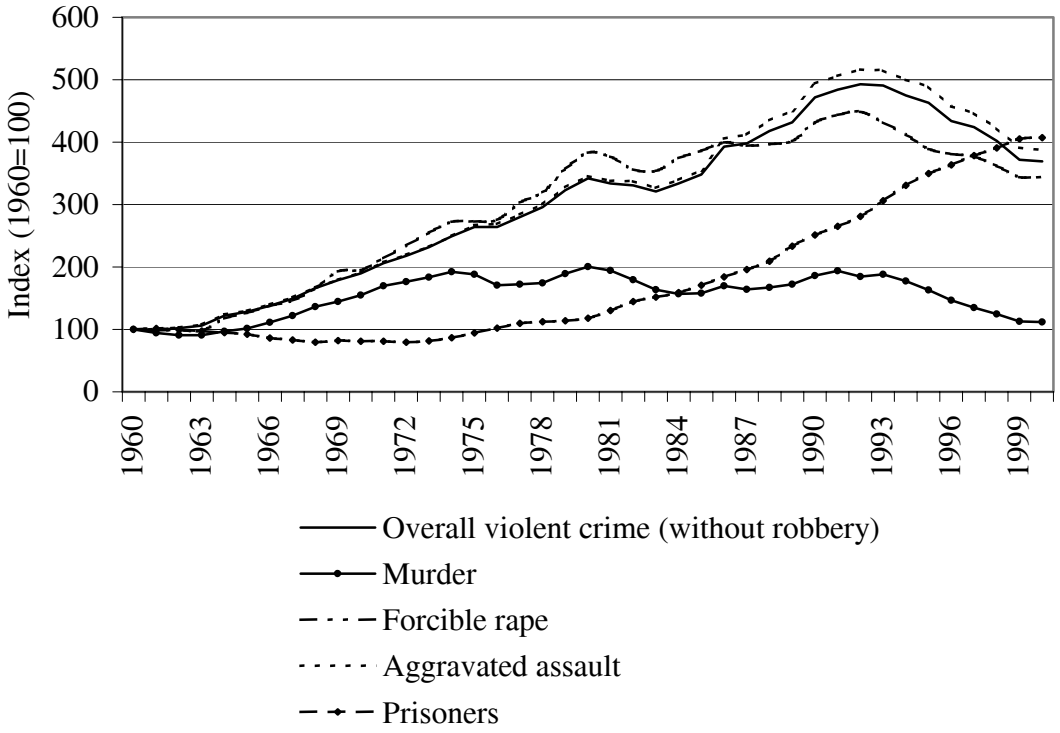
U.S. Department of Commerce, Current Population Reports (1979), *Money Income in 1977 of Families and Persons in the United States*, Series P-60, No.118.

Witt, R. and Witte, A. (2000). Crime, Prison, and Female Labour Supply, *Journal of Quantitative Criminology*, 16/1: 69-85.

Wooldridge, J.F. (2000). *Introductory Econometrics: A Modern Approach*, South-Western College Publishing

Zimring, F. (1998). *American Youth Violence*, Oxford University Press.

Figure 1: Prison Population and Violent Crime Rates, 1960-2000[a]



[a]Data are indexed using 1960 as a base year. All underlying variables are in per capita form.

Table 1: List of Variables and their Descriptions in the VAR Analysis[b]	
$lv_{j,t}$:	Violent crime per capita. j indicates different types of violent crime (j=1: Overall violent crime (lvc_t); j=2: Murder (lmu_t); j=3: Rape (lra_t); j=4: Assault (las_t))
lpr_t:	Prison population per capita
lgi_t:	Gini coefficient
lal_t:	Real on-premise alcohol consumption expenditures per persons aged 16-44
lfe_t:	Percentage of employed female population
ldu_t:	Duration of unemployment (mean of weeks unemployed)
lbl_t:	Percentage of black males in the male youth population (13-24)
d_t:	"Three Strikes" dummy variable (d=1 for $t \geq 1993$ and d=0 for $t \leq 1992$)

[b]All the violent crime and socio-economic variables are in natural logarithms.

Table 2: Summary Statistics, 1960-2000

Variables	Mean	SD	Minimum	Maximum
Overall violent crime (without robbery)	718,016.8	362,269.1	180,620	1,266,147
Specific felony offences				
Murder and non-negligent manslaughter	17,855.2	4,805.6	8,530	24,703
Forcible rape	66,950.9	30,645	17,190	109,062
Aggravated assault	633,211.1	328,522.2	154,320	1,135,607
Other				
Overall population (thousands)	227,861.7	27,647.6	180,671	275,372
Population aged 16-44 (thousands)	97,700.5	17,333.7	68,957	116,950
Overall prison population	508,784.5	370,699.6	187,914	1,321,137
Gini index	0.38	0.03	0.348	0.43
Alcohol consumption expenditures (billions of dollars)	18.9	14.25	4.3	52.1
Chain-type price index (1996=100)	54.3	31.16	18.48	112.74
Employed female population (%)	46.8	7.38	35.4	57.7
Duration of unemployment (mean of weeks unemployed)	13.56	2.96	7.8	20
Black males aged 13-24 (%)	13.15	1.43	10.79	15.04

Table 3: ADF Unit Root Tests[c]

	Without trend		With trend	
Variable	Levels	First Diff.	Levels	First Diff.
lvc	-3.094	-1.704	0.259	-3.464
lmu	-2.759	-2.575	-1.749	-3.673
lra	-3.444	-2.661	-0.544	-4.849
las	-3.028	-1.642	0.404	-3.322
lpr	-0.227	-2.118	-3.074	-2.074
lgi	0.406	-5.069	-2.770	-5.567
lal	-0.212	-3.362	-0.502	-3.971
lfe	-1.473	-4.390	-2.144	-4.591
ldu	-2.936	-4.990	-3.833	-4.912
lbl	-2.808	-2.364	-0.206	-3.727

[c]The figures reported are the *t*-ratios of the estimated coefficients α in the regression $\Delta\chi_t = \mu + \alpha\chi_{t-1} + \delta\Delta\chi_{t-1} + \varepsilon_t$ (without tend) or $\Delta\chi_t = \mu + \gamma t + \alpha\chi_{t-1} + \delta\Delta\chi_{t-1} + \varepsilon_t$ (with trend), and β in the regression $\Delta\Delta\chi_t = \mu + \beta\Delta x_{t-1} + \delta\Delta\Delta\chi_{t-1} + \varepsilon_t$ (without trend) or $\Delta\Delta\chi_t = \mu + \gamma t + \beta\Delta x_{t-1} + \delta\Delta\Delta\chi_{t-1} + \varepsilon_t$ (with trend) for the levels and first differences (sample period 1963-2000), respectively. Critical values at the 5% level are as follows: without trend -2.94 and with trend –3.5313.

Table 4: Residual Diagnostic Tests for the VAR Equations[d]

Model 1			
Endogenous Variables	LMSC(2)	ARCH(1)	N(2)
lvc	1.07 [0.3]	0.11 [0.7]	1.37 [0.5]
lpr	1.06 [0.4]	0.03 [0.8]	2.72 [0.2]
Model 2			
lmu	0.48 [0.6]	0.62 [0.4]	0.79 [0.7]
lpr	1.18 [0.3]	0.06 [0.8]	1.98 [0.4]
Model 3			
lra	0.16 [0.8]	0.37 [0.5]	1.31 [0.5]
lpr	1.04 [0.4]	0.3E-3 [0.9]	2.16 [0.3]
Model 4			
las	1.37 [0.3]	0.15 [0.7]	1.53 [0.5]
lpr	1.07 [0.3]	0.04 [0.8]	2.86 [0.2]

[d]LMSC(2) is a test for up to second-order serial correlation F (2,26). ARCH is a test for conditional heteroscedasticity F (1,26) and N(2) is the Jarque-Bera test for normality. The p-values are in square brackets.

Table 5: A Cointegration Analysis of U.S. Violent Crime[e]

A Cointegration Analysis of Overall Violent Crime (without Robbery)		
	Hypothesis	
	r = 0	*r ≤ 1*
Eigenvalues	0.564	0.167
Trace statistics	39.51*	7.14
95% quantile	49.3	25.3
A Cointegration Analysis of Murder		
	Hypothesis	
	r = 0	*r ≤ 1*
Eigenvalues	0.58	0.18
Trace statistics	42*	7.74
95% quantile	49.3	25.3
A Cointegration Analysis of Rape		
	Hypothesis	
	r = 0	*r ≤ 1*
Eigenvalues	0.56	0.26
Trace statistics	44.19*	12
95% quantile	49.3	25.3
A Cointegration Analysis of Assault		
	Hypothesis	
	r = 0	*r ≤ 1*
Eigenvalues	0.56	0.17
Trace statistics	40.1*	7.51
95% quantile	49.3	25.3

[e] The critical values have been obtained from Harbo *et al.* (1998)

*Insignificant at the 5 % level.

Table 6: OLS Estimates [f]

Variables	Δlvc_t	Δlmu_t	Δlra_t	Δlas_t
Δlvc_{t-1}	-0.12 (0.17)			
Δlmu_{t-1}		0.17 (0.16)		
Δlra_{t-1}			-0.29 (0.18)	
Δlas_{t-1}				-0.093 (0.17)
Δlpr_{t-1}	-0.29 (0.18)	-0.62* (0.21)	-0.65* (0.22)	-0.25 (0.19)
Δlgi_t	0.35 (0.42)	1.009* (0.47)	0.067 (0.5)	0.36 (0.44)
Δlgi_{t-1}	0.49 (0.41)	1.1* (0.48)	0.2 (0.49)	0.49 (0.43)
Δlal_t	0.20 (0.17)	0.37† (0.2)	0.36† (0.21)	0.18 (0.18)
Δlal_{t-1}	0.15 (0.20)	0.42† (0.24)	0.3 (0.24)	0.11 (0.21)
Δlfe_t	-0.18 (0.69)	-1.02 (0.77)	1.08 (0.82)	-0.3 (0.72)
Δlfe_{t-1}	0.45 (0.82)	0.97 (0.93)	0.27 (0.99)	0.48 (0.86)
Δldu_t	-0.0065 (0.08)	-0.046 (0.1)	0.08 (0.1)	-0.016 (0.09)
Δldu_{t-1}	-0.09 (0.06)	-0.12 (0.08)	-0.075 (0.08)	-0.085 (0.07)
Δlbl_t	4.32* (1.98)	4.64† (2.4)	5.08* (2.33)	4.1† (2.1)
Δlbl_{t-1}	-1.1 (1.82)	-2.3 (2.02)	-0.19 (2.17)	-1.2 (1.91)
d_t	-0.085* (0.02)	-0.074* (0.02)	-0.07* (0.02)	-0.085* (0.02)
Const	0.03 (0.02)	0.01 (0.02)	0.017 (0.02)	0.033 (0.02)
R^2	0.753	0.806	0.74	0.73
σ	0.031	0.035	0.037	0.033
N(1962-2000)	39			
LMSC(2), F(2,23)	1.73 [0.199]	1.9 [0.171]	1.44 [0.257]	1.86 [0.18]
ARCH(1), F(1,24)	0.56 [0.461]	0.03 [0.86]	4.3† [0.5]	0.62 [0.44]
N(2)	4.92† [0.08]	2.35 [0.309]	1.08 [0.582]	5.25† [0.07]
Het, F(1,37)	0.04 [0.84]	2.43 [0.13]	1.44 [0.24]	0.03 [0.87]
RESET, F(1,24)	0.92 [0.35]	0.98 [0.33]	0.39 [0.54]	1.03 [0.32]

[f] In the first panel standard errors of coefficients are in brackets. In the second panel p values are in square brackets.

* Statistically significant at the 5% level, † Statistically significant at the 10% level.