PROPUESTA PARA LA MODALIDAD DE PONENCIA GENERAL

LONG AND SHORT RUN RELATIONSHIPS BETWEEN ECONOMIC CONDITIONS AND PROPERTY CRIME. EVIDENCE FOR UNITED STATES[1].

Amor DIEZ-TICIO
Dpto. de Estructura e Historia Económica y Economía Pública
Facultad de Derecho
C/Pedro Cerbuna,12
50009 Zaragoza.
adiez@posta.unizar.es
Teléfono: 761447
Fax: 976 761499

Abstract:

Modelling the relationship between crime and economic conditions has received considerable attention over many years. Recently a range of new approaches that make use of cointegration tools has been tried. This paper examines the association between economic conditions and crime and presents new evidence for the United States. Using national time series data over the period 1950-1996, we explore the influence of the unemployment rate, personal consumption and inequality of income on robbery, burglary and motor vehicle theft rates. The model also includes the clear up rate and youth population in order to represent the impact of deterrence and demographic factors on crime. We follow the methodology, based on an error correction model that Pyle and Deadman (1994) used to study this issue in England and Wales. The results show strong and significant both short and long term effect of the economic variables on criminal activity.

[1] This paper was written while the author was in the Public Sector Economic Research Centre at the University of Leicester. I am thankful to Derek Deadman and David Pyle for the helpful comments on developing this work.

In recent years there has been an extensive increase in Social Science literature concerning the empirical study of the relationship between economic conditions and crime. Although the link between these aspects is not new, the development of economics of crime and the improvements in econometric methods have stimulated such investigation.

Until the mid of eighties, the empirical papers used correlation analysis, uniequational regressions or simultaneous equation systems to study these kinds of effects (see Tarling, 1982; Freeman, 1983; Chiricos, 1987 or Pyle and Deadman, 1994 for a review of the literature). In some cases, the purpose was to know the influence of a unique magnitude related with the economic conditions on the level of crime. In others, mainly in the simultaneous equation systems, the economic variables were accomplished on other demographic, deterrence or social factors that could have an influence on criminal activity. Most of them used cross section data[2]. However, as Field (1990) and Pyle and Deadman (1994) pointed out, it is difficult to discover a causal relationship between crime and variables related to the economic conditions in cross section studies. The crime spillovers among areas and the influence of third factors which may simultaneously affect both economic variables and crime are the main problems.

Since the mid eighties, several studies have followed different data oriented approaches. Some researchers (Reilly and Witt, 1992; Cornwell and Trumbull, 1993; Marselli and Vanini, 1997 or Levitt, 1998) have used panel data to control the unobservable characteristics of the units of observation that can be correlated with certain explicative variables of the model. Other papers have used time series techniques to test the relationship between economy and recorded crime. Initial studies using time series data usually transformed the variables of the model to solve some statistical problems only providing evidence of the determinants of crime on the short run context (Cook and Zarkin, 1985; Cantor and Land, 1985 or Field, 1990). However, recent literature based on cointegration analysis does not make it necessary to transform the variables and, at the same time, tell us of the short and long run influence of different variables on crime (Viren, 1994; Pyle and Deadman, 1994; Osborn, 1995 or Hale, 1998).

Surprisingly, literature applying cointegration to study the relationship between economic conditions and crime are not widely extended. Although certain studies exist which were developed out of England (Corman, Joyce and Lovich, 1987; Scorcu and Cellini, 1998 and Viren, 1994) most of them originated there. This fact plus the contrary effects that different theories show on this relationship and the opposite results reached in previous papers

[2] There is also some work using time series data in this period. For example, Wolpin (1978), Phillips (1972) or Danzinger and Wheeler (1975).

do not allow us to draw general conclusions. Nevertheless, ultimately, weather or not a relationship between economic conditions and crime exists is an empirical issue.

The purpose of this paper is to provide new evidence for these subjects using annual data from the United States during the period 1950-1996. We make use of the cointegration tools provided by Johansen (1988) and Sims, Stock and Watson (1990) to approach the question of modelling this issue and derive both the long and short term effects of economic variables in crime. In common with other works, the model includes additional explanatory variables in order to know the impact of deterrence and demographic factors in the crime behaviour. In particular, it is studied the influence of the probability of being caught as representative of the deterrence factors and it is introduced the proportion of young population because it is considered to be a group which is more prone to act illegally.

To develop our work the plan of the paper is as follows. Section 2 describes the theories related to economic conditions and crime as well as the main results given in recent papers. Section 3 presents the data used in the estimation procedure and the trends of criminal activity in both the United States and England and Wales. Section 4 shows the empirical analysis that it is used to derive the long and short run relationship and discusses the results obtained. The paper closes with a brief section of conclusion remarks.

The Relationship between Economic Conditions and Crime

One of the fundamental dilemmas of the studies interested in the determinants of crime is the role of the economic conditions in explaining the variations of criminal activities. The association between these magnitudes is far from being a simple one, especially when taking into consideration the conflicting results yield on both theoretical and empirical grounds.

In general terms and following Field (1990), the relationship between economic conditions and crime can be explained through three different ways namely motivational, opportunity and lifestyle effects. The first two approaches are closely related with the economic model of crime in which it is assumed that the individuals examine both legal and illegal options and choose the mixture of activities with the highest expected returns. The main difference between them lies in the emphasis that they give to either the benefits or the costs of crime. The motivational theory assumes that the condition of the economy determines the expected returns of legitimate activities. Hence, whilst economic prosperity enhances the possibility of acting legally, economic deprivation makes it more difficult to find a legal job with a legal income. Some researchers like Ehrlich (1973) and more recently Sala-i-Martin (1997) defend this perspective but have gone more deeply into it pointing out that this influence depends on the effects of the economic conditions in the social circumstances. If

economic growth reduces the gap between the richer an the poorer it could deter criminal inclination, otherwise, it could be associated with an increase on criminal activity.

The opportunity theory emphasises the benefits of illegal action instead of the returns of legal activities. From this point of view, it is argued that changes in economic conditions alter the number of suitable crime targets. In periods of economic growth more goods are available and the expected benefits from crime will be higher than in periods of bad economic conditions, providing favorable circumstances to criminal activity.

In addition to these two approaches, there is other general explanation that focus on the victims of crime instead of the potential offender. This is known as the lifestyle or the guardianship effect and is more closely related to sociological oriented disciplines. The lifestyle effect relates economic conditions with changes in the pattern of routine activities. Economic growth contributes to drawing more people into the job market or allowing more families to leave home for pleasure activities and all these factors will increase the probability of being a victim of crime.

Although these three perspectives share the idea that the state of the economy plays an important role in explaining the variations of crime, there are no consensus in the direction of the relationship. Whilst the second and the third effects expect a positive sign between economic growth and crime, the first one defends an inverse association, at least, if there is an improvement in social conditions.

From a theoretical point of view, there are no strong grounds for preferring one argument to another. They all seem to be relevant in the explanation of the influences of the economic conditions in crime and, perhaps, each perspective may be applicable in some situations though not in others. In particular, while some theories could be relevant in explaining criminal behaviour in the long run, others might well be conceivable in the short term. This possibility makes especially interesting the empirical studies account for finding both short and long run causal relationships because they will confirm the explanatory significance of the different theories throughout time.

This kind of research was only recently developed in Europe, firstly by Pyle and Deadman (1994) for England and Wales, using the modern tools supplied by cointegration methods and error correction models[3]. This pioneer work builds on a interesting study developed by Field (1990) who analyses the short run impact of several variables on twelve different categories of offences. Pyle and Deadman improve this previous work in the extent that it is modelled the long-run relationship between crime and economic conditions. They also react to one of main Field's conclusions that suggests that consumption is the best single

[3] In 1993, Koskela and Viren developed an error correction model to study motor vehicle thefts in Finland. However, they mainly investigated the impact of deterrent variables instead of those related to economic conditions.

explanatory factor of crime rates. Their results indicate that consumption is as important as unemployment rate or gross domestic product to explain criminal behaviour and reveal a long run relationship between these variables (independently considered) and crime rates.

Since then, a small but increasing number of studies has been elaborated based on the same methodology. Most of these works have used data from England and Wales either to re-examine some Pyle and Deadman's conclusions (Osborn, 1995 and Hale, 1998); or to investigate some additional issues related to the criminal activity (Pudney et al., 2000 or Deadman and Pyle, 1997). Alternatively, several researches have applied the same approach to analyse other countries (Viren, 1994; Scorcu et al, 1998 or Beki et al., 1999) in order to provide new evidence of the influence of economic conditions on crime in different contexts.

In a general sense and leaving on one hand the divergences yield in the results, this still scarce literature confirms that the economic situation is important in explaining either the trends of crime, the short run movements or both. The findings also show differences in the direction of the relationship between these two temporal scopes. Hence, the results yield in this incipient applied work acknowledge the importance of distinguishing between the long and short run determinants of crime to study the effects of the economic conditions. Moreover, they support the view that several conflicting theories are compatible and provide some explanation in different situations. These ideas are taken as a point of departure of this paper to examine such relationship using United States data. We have destined the following sections to this task, building an empirical model based on the cointegration methods that allow us to analyse both the long and short run influence of the economic conditions on crime rates.

Data

To specify our model, we have annual data on aggregated crime rates, clear up rates, and variables representing the economic conditions of the United States from 1950 to 1996. Full details of the definitions of the variables and sources of data are given in Appendix 1 of this paper.

The aim of this paper is to determine the influence of several factors, mainly economic conditions, on criminal activity. However, our analysis does not take into account all criminal offences. We only consider robberies (ROB), burglaries (BUR) and motor vehicle thefts (AUT). In spite of this supposed leaving aside other crimes that do not fall in with any of these three categories[4], there are two reasons to follow this criterion. On one hand, other

[4]In the year 1996 these categories represented around the 33% of the total crime index that includes murder, nonnegligent manslaughter, forcible rape, robbery, aggravated assault, burglary, larceny-theft, motor vehicle theft and arson.

papers have previously examined similar crime categories (for example, Pyle and Deadman, 1994, Osborn, 1995 or Hale, 1998). To concentrate in the same offences will let us compare our results with theirs[5]. And on the other hand, these crimes are expected to have been more related to both economic and deterrence variables, according to the economic models of participation in criminal activities. Although some works have found that sexual and violence against the person crimes are related to economic conditions (Field, 1990, Scorcu and Cellini, 1998), the property crimes seem more suitable for studying that kind of relation to the extent that they respond directly to economic motivations. Therefore, this restriction offers the advantage of reducing the heterogeneous nature of crimes and let us compare our results with those reached in previous papers.

The main sources of statistical information on crime in the United States are both the Uniform Crime Report (UCR) and the National Crime Survey (NCS). The former presents estimates of the main categories of offence known and recorded by the police from 1930. The latter provides victimisation information of different types of offences from 1972. In order to obtain a longer time series, an important requirement in applying econometric methods, we make use of the information provided for the UCR. However, one of the most widely recognised disadvantage of these official criminal statistics is that there are a reporting and recording bias which can provoke, if it is systematic, a spurious correlation among several variables, particularly deterrence factors. Although this paper does not deal with the problem of underreporting that the official statistics suffer, some works developed in United States and England and Wales (Levitt, 1998; Pudney, Deadman and Pyle, 2000 and MacDonald, 1999) show that measurement error is not an important problem[6]. Accepting the results of these

[5] In fact, the studies mentioned above consider different kinds of offence categorised as theft instead of the single category of motor vehicle thefts. In the United States larcenies have being the object of different definitional changes during the period under consideration. To avoid inconsistencies in the data we are only taking into account motor vehicle theft.

[6] Levitt (1998) addresses the possible bias in the estimators of the arrest rates as a result of error measurement in the crime variables using panel data for the 59 largest cities of the United States in the period 1970-1992. It is compared, for different crimes, the estimated coefficients associated with the arrest rates when estimated using first through fourth differences. The measurement bias are presented in the first differences estimator. So if there are substantial variations among this coefficient and the others there are evidence of a measurement error problem. For most of the crimes, there appears to be little systematic change in the coefficients moving from first to fourth differences. Pudney et al. (2000) using time series data for England and Wales study the impact of the under reporting problem on the estimated coefficients of economic, deterrence and demographic variables. A simulated maximum likelihood procedure is developed that estimates simultaneously measurement error and crime process. Taking as a departure point an error correction model of burglary, it is concluded that there are no important differences between the coefficients estimated by OLS (without taking into account the measurement problem) and those estimated using simulated maximum likelihood estimator. Finally, MacDonald (1999), using information provided by several British Crime Surveys, develops a probit analysis to study the determinants of under-reporting of property crime. His findings show that most of the variation in the hidden crime is systematic instead of random, providing additional arguments to rely on the criminal statistics.

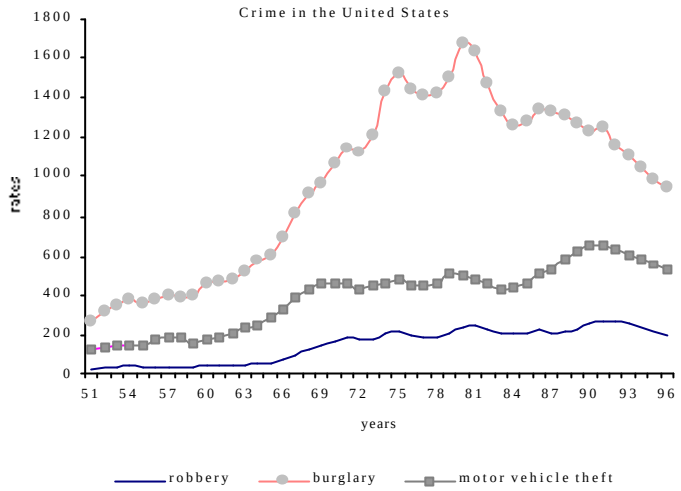
papers, we assume that the criminal statistics are a suitable source of data to realise our analysis.

The trends of robbery, burglary and motor vehicle theft rates in the United States from 1950-1996 are presented in figure 1. As the plot shows, crime rates grew sharply in the 60´s. This upward trend is especially important in burglaries since the middle of this decade. In the 70s, the crime rates fluctuate showing times of downward and upwards in robbery, burglary and motor vehicle theft. In the beginning of the 80´s the crime rates fell. This pattern continued in burglary rates until the end of the period while robbery and motor vehicle thefts fluctuated. However, since the beginning of the 90s these two latter crimes took a downward trend. An interesting point is to compare these trends with those of other countries. In appendix 2, figures A, B and C show robbery, burglary and motor vehicle theft for both the United States and England and Wales[7]. A similar pattern of burglary rates is found to the early 80's. From then burglary rates in England and Wales are larger than in United States and the trend turns in the opposite direction. The robbery series indicates that this offence is much more important in United States than in England and Wales and the growth rates have been lower in the latter than in the United States[8]. In the case of motor vehicle theft, the existence in the English series of a break at the end of the sixties prevents making comparisons but, since the seventies the trends fluctuated in a similar pattern showing this offence more often in the European countries than in the United States.

Figure 1. Crime rates in the United States.

[7] The author would like to thank Dr. Deadman for generously providing the crime series for England and Wales. The source of these data is Criminal Statistics.

[8] Recall that we take into consideration crime series based on offences recorded by the police. Langan and Farrington (1998) point out that the trends are different if crime rates are measured by crime surveys. In particular, in their study about Crime and Justice in the United States and England and Wales over the period 1981-96, they show that the U.S. robbery rates as measured in victim survey was nearly double England's in 1981, but in 1995 the English robbery rate was only 1.4 times than America. As a result the gap between the two countries in the robbery rates would be lesser than the gap that figure B in appendix 2. shows.



To explain the criminal behaviour, a range of economic, deterrent and demographic factors are included in the model. As pointed out above, there is no consensus to what is the best variable representative of the economic conditions. Given the importance of choosing the proper indicator, our investigation is conducted using three different specifications: a) in the first, we include the personal consumption per capita (CONS), b) in the second, the CONS is substituted for the unemployment rate (UNEM) and c) in the last one both variables are considered together[9]. Whatever the chosen indicator may be, *a priori*, we do not know the influence of these variables on crime. Opportunity and lifestyle theories expect a positive relationship between crime and economic growth. By contrast, motivational perspective expects a negative effect.

The measurement of economic conditions through anyone of the indicators mentioned above can hardly take into account the effects of the economic conditions on the social circumstances. For this reason, we include a measure of income inequality (INC). Two alternative measures are available for the whole period. The first is the standard index of income concentration (gini index). The second is the ratio of the share of income going to the highest 10% of income earners compared with that going to the lowest 10%. Given the scarce variability that the gini index shows in the years under consideration, we have finally chosen the latter indicator. The expected effect between these measures and crime is positive. As the inequality of income increases, so should criminal activity.

The model is completed with other variables related to illegal activity: the clear up rates of the different crime categories studied (CROB,CBUR,CAUT) and the proportion of the population aged between 15-24 years (YO). The former indicates the impact of the Criminal

[9] Some papers include additional indicators of the economic conditions. For example, Pyle and Deadman (1994) or Hale (1998) investigate the importance of the gross domestic product. In the case of the United States, there is a strong correlation between this variable and the personal consumption. For this reason, only the influence of the latter is taken into account.

Justice System on the crime while the latter is set to show weather crime rates are affected by the age structure of the population.

Methodology

Once the relevant factors for explaining the criminal behaviour have been chosen, we seek to select and estimate the adequate econometric model that allows us to derive their impact on the United States' case. The convenience in distinguishing between the long and the short term to the extent that the effects of the economic conditions could be different in one or another context has being recognised above. Hence, the estimation of an error correction model (ECM) is proposed as this is one of the most common approaches to incorporate both the long run relationship between the variables and short run behaviour (see Charemza and Deadman (1997) for a description of this method).

This section is organised in conformity with three steps that should make-up any study carry out by way of error correction model. Firstly, it is studied the properties of the series we are dealing with. Secondly, it is applied a test for cointegration relationships among the variables we are interested in. And finally, it is estimated the model chosen according with the results of the previous stages.

Order of Integration

Before any estimation work can properly begin, we first need to establish the properties of the series we are dealing with. The regression analysis would yield efficient estimates provided that the variables are stationary. However, time series could behave like random walk and, in this situation, conventional regressions can lead to spurious relationships among variables.

Taking into account previous papers, it is assumed that economic and demographic variables are integrated of order one. There is, however, some ambiguity regarding the order of integration of crime variables. While Pyle and Deadman (1994) supported the view that these series are integrated of order two, Hale (1998), Osborn (1995), Scorcu and Cellini (1998) and Beki et al. (1999) found evidence to the hypothesis of stationarity in first differences. Recently, Pudney, Deadman and Pyle (2000) after adjusting the burglary series in England and Wales for the effect of the break as a result of the Theft Act in 1968, conclude that the burglary rates are integrated of order one.

In this paper, it is used Augmented Dickey Fuller unit roots test to analyse the stationarity of the crime indexes and the clear up rates for the offences under consideration. The level of augmentation has been chosen taking into account Akaike Information, Schwarz

Bayesian and Hannan-Quinn criterions. The results of the test (without trend) are reproduced in table 1. They provide evidence that the crime series for the United States in the period studied are integrated of order one.

Table 1. Augmented Dickey-Fuller unit roots test applied to crime variables.

Variable	I(0)	I(1)
ROB	-1.3885 * (2.9303)	-3.6536 (2.9320)
BUR	-1.8096 * (2.9303)	-3.5586 (2.9320)
AUT	-1.4838 * (2.9303)	-3.0966 (2.9320)
CROB	-1.0070 (2.9303)	-3.2848 * (2.9320)
CBUR	-0.6272* (2.9303)	-4.7294 (2.9320)
CAUT	-2.8952 (2.9303)	-7.3479 (2.9320)

The variables are as defined in the text. Critical value for Augmented Dickey Fuller test is in parenthesis. Results presented in this table are a test of stationarity around a non zero constant. We also test for stationarity of the level of the variables around a linear trend and none of the variables are found to be stationarity in levels. Same results are confirmed with the Phillips and Perron (1988) test. The asterisk indicates one level of augmentation.

In 1957 the estimated procedures used in the Uniform Crime Reports to reach the crime index changed. This fact could cause an alteration of the trend of the criminal statistics. As is well known, in such cases the Dickey Fuller tests are biased towards non-rejection of the non stationary null hypothesis. For this reason the Perron type test that let test for unit roots in presence of a structural break is applied. The results, which are omitted here to save space, do not reject the null of unit roots in levels. In other words, the stationarity status of the variables does not change when this test is applied.

Since we have found evidence to assume the order one of the variables, the next issue to investigate is weather there is a linear stationary combination of them (cointegrated). In the following we turn our attention to cointegration analysis.

Testing for Cointegration Relationships

The aim of this section is try to find a cointegrated relationship between the variables of interest that lets us specify a long run relationship and an error correction model that shows us the deviations of the long run path.

It is well known that there are different ways to test for the cointegration relationships between any set of variables. In this paper, we perform the test on long run relationships between crime and economic conditions that it is given by the maximum likelihood method introduced by Johansen (1988). One advantage of this methodology, based on a vector autoregressive modelling, is that the long run relationship can be analysed with a system including all the variables without being necessary the endogenous-exogenous division between them. The possible simultaneity between some variables of our model makes this

method especially fruitful. In particular, according to the economic model of criminal participation developed initially by Becker (1968) it is assumed that a feedback exists between the crime rates and the clear up rates. In other words, the criminal activity responds to the performance of the criminal justice system but, at the same time, the success of these institutions in solving offences could depend on the level of crime[10]. To avoid any simultaneity bias between the crime and the deterrence variables included in the model, both crime and clear up rates are treated as endogenous. The rest of the variables of the model (those representative of the economic conditions, income inequality and young population) is considered exogenous to gain efficiency in estimation.

In order to determine the number of cointegrated relationship (cointegration rank) we have carried out the long-run structural modelling approach described by Pesaran and Pesaran (1997) and we have estimated an unrestricted vector autoregressive model (VAR) for each offence studied as follows[11]

$$\Delta y_t = a_{0y} + a_{1y} t - \Pi_y z_{t-1} + \sum_{i=1}^{p-1} \Gamma_{iy} \Delta z_{t-1} + y w_t + u_t$$

where $z_t = (y_t^{'}, x_t^{'})^{'}$ being y_t a column vector of jointly determined variables (both crime and clear up rates) and x_t a column vector of exogenous variables integrated of order one variables (economic indicators, youth population and inequality index); w_t is a column vector of exogenous I(0) variables (a dummy variable to allow for the change in recording practice in 1957); a_0 is an intercept, t is a trend; p the order of the augmented VAR model and u_t is a serially uncorrelated shocks vector.

The lag order and the inclusion of trends and intercepts in the implicit VAR are important issues to obtain accurate conclusions. The lag order was chosen as p=1 for robbery and burglary and p=2 for motor vehicle theft which is the value preferred by both Akaike's information criterion (AIC) and Schwarz Bayesian criterion among p=1,…4. With respect to the treatment of the intercept and trend, following a general criterion, we have considered unrestricted intercept and trend[12].

The maximum likelihood approach provides two likelihood ratio tests for the number of cointegration vectors that may exist as well as empirical estimates for each of the

[10] The consideration of crime rates as a determinant of the clear up rates is usually founded on the production theory grounds. It is said that the level of criminal activities determines the workload of the police centres. The more the criminal activity, the less the possibility of solving offences by the police.
[11] This is a generalised version of Johansen's (1991,1995) maximum likelihood approach to the problem of estimation in the context of vector autoregressive error correction models.

cointegrated relationships. We consider both of them in testing for cointegration but if there is no agreement between these procedures we consider the test based on the maximal eigenvalue instead of the test based on the trace of stochastic matrix because, as Johansen and Juselius (1990) pointed out, the former is more powerful than the latter.

Results of the test for the number of cointegrating relations in robbery, burglary and auto-theft models are presented in table 2. According to the maximal eigenvalue, the hypothesis of no cointegrating vectors is clearly rejected in all the specifications with the exception of motor vehicle theft when the economic variable included in the model is the unemployment rate. In the other cases, the null hypothesis r=1 against the alternative r=2 can not be rejected at the 95% significant level. In consequence, there is only one cointegrating vector for the crimes analysed and it indicates an independent direction where a stable, long-run equilibrium state exists. Moreover, almost always is found a cointegration relation with unemployment and consumption either single or in combination. This result is in accordance with those of Pyle and Deadman (1994) and Scorcu et al. (1998) who analyse three different variables individually and Pudney et al. (2000) who considered the role of unemployment and consumption jointly. By contrast, Hale (1998) and Osborn (1995) find only a cointegrated relation when the economic variable considered is consumption, a result that they use to argue that this magnitude is the best indicator of the economic conditions for explaining criminal activity. Finally, Beki et al. (1999) can not obtain a cointegration relationship between the 13 categories of Dutch theft rates analysed and each of the economic variables considered. This forces them to restrict their analysis to estimating the regressions in first differences[13].

Table 2. Testing for cointegration. Maximal eigenvalue test

	Null	Alternative	Test Statistic	95% critical value
Rob 1.	r=0	r=1	66.5687**	29.74
	r≤1	r=2	21.1974	22.35
Rob 2.	r=0	r=1	65.4678**	26.95
	r≤1	r=2	17.9206	19.62
Rob 3.	r=0	r=1	49.6666**	26.95
	r≤1	r=2	15.4438	19.62
Bur 1.	r=0	r=1	531150**	29.74
	r≤1	r=2	14.8368	22.35
Bur 2.	r=0	r=1	49.7331**	26.95

[12] We also calculated the cointegrating vector with restricted intercept and no trend and the results were quite similar.

[13] Pyle and Deadman (1994), Osborn (1995) and Hale (1998) consider three different specifications with three alternative economic indicators: the gross domestic product, personal consumption and unemployment rate. The same procedure is found in Scorcu and Cellini (1998) but, in this case, gross domestic product is substituted for nonhuman wealth in real per capita term. Beki et al. (1999) choose five alternative variables: real personal consumption per capita, number of unemployed people, basic social security benefits, number of cars and new cars and number of births.

	r≤1	r=2	14.7814	19.62
Bur 3.	r=0	r=1	41.1309**	26.95
	r≤1	r=2	12.4264	19.62
Aut 1.	r=0	r=1	32.7818**	29.74
	r≤1	r=2	7.1425	22.35
Aut 2.	r=0	r=1	24.34	26.95
	r≤1	r=2	7.4892	19.62
Aut 3.	r=0	r=1	33.3823**	26.95
	r≤1	r=2	4.7684	19.62

The order of the vectors autoregressive underling is: 1 for both robbery and burglary and 2 for motor vehicle theft.
Model 1. Included unemployment and consumption.
Model 2. Included unemployment.
Model 3. Included consumption.
All regressions include INC variable.
** denotes rejection of the null hypothesis.

The cointegrating vector estimates of the economic conditions after being normalised on the crime rates variables are presented in table 3. The results show a similar pattern in all the models estimated. In the long run, the economic conditions have a strong influence on robbery, burglary and motor vehicle theft rates considering both unemployment and personal consumption (either independently or jointly). Economic growth, associated with an increase in the personal consumption and a reduction of unemployment, produces increases in the United States crime rates. These findings suggest that, in the long run, the relationship between the economic conditions and crime can be explained in terms of the opportunity theories which associated economic conditions and criminal targets. This analysis, however, finds no evidence of the effect of inequality of income on crime.

Table 3.Estimated coefficients of the economic variables in the cointegrated vector

Model	UNEM	CONS	INC
Rob 1.	-0.7113	1.2270	0.5930
	(0.2368)	(1.0982)	(0.6981)
Rob 2.	-0.8763		0.5403
	(0.2288)		(0.7564)
Rob 3.		3.4050	-0.0390
		(0.9167)	(0.6157)
Bur 1.	-0.3932	1.4379	0.2096
	(0.1576)	(0.7298)	(0.5163)
Bur 2.	-0.5647		0.1924
	(0.1910)		(0.6054)
Bur 3.		2.1794	0.4162
		(0.6188)	(0.3833)
Aut 1.	-0.8782	0.6738	1.9456

	(0.42)	(2.4743)	(1.6679)
Aut 2.		0.8245	1.8020
		(0.2916)	(1.4014)

See notes of table 2 for a description of the models.
Note: the error standards in parenthesis.

The results related to the influence of consumption on crime are in accordance to those of Hale (1998) and Osborn (1995)[14]. However, our findings on the relation of unemployment on robbery, burglary and motor vehicle theft are in mark contrast with those of previous literature. Hale and Osborn find no a long run relationship when the economic conditions are represented by unemployment rate. Pudney et al. (2000) obtain a cointegrating relation but coefficients appear not significant. By contrast, our results yield a significant and negative effect and it is, as the influence of consumption, consistent with the opportunity or lifestyle effect.

Error Correction Models

Having found a cointegration vector between the variables of interest, it is possible to derive an error correction model (ECM) that incorporates both short run and long run relationships between the variables. The error correction mechanism describes how the system is adjusting in each time period towards its long-run equilibrium state. In the short-run, deviation from the long-run equilibrium will feed back on the changes in the dependent variables in order to force their movements towards the long-run equilibrium state.

There are several ways to estimate error correction models such as Engle and Granger (1987) procedure, the Sims, Stock and Watson short-dynamic model and those based on a vector autoregressive models. Whichever is chosen between one or another depends, to some extent, on the characteristics of the underlying theoretical model. If there is no clear division between the exogenous and endogenous variables it is best to estimate an ECM based in a vector autoregressive model. If there is only one endogenous variable, either the Sims, Stock and Watson specification or Engle and Granger procedure are also suitable.

The ECM estimates derived from the analysis developed previously (including consumption and unemployment in all crime categories) are presented in Table 4. The coefficients associated to the error term in the equations of robbery, burglary and motor vehicle theft in first differences (Δ ROB, Δ BUR, Δ AUT) are all significant and negative. It

[14] Although Scorcu and Cellini (1998) obtain significant findings between economic conditions and crime in the long run, it is difficult to compare our results with those of them. They investigate if the series are cointegrated in presence of a structural break. As a result, the long run regression includes the economic variables both before and after the break. The inestability presents by the coefficients in such situations prevent to derive a general conclusion about the influence of the economic conditions in crime.

indicates the role of the variables in correcting for any deviation from the long run. The error correction terms for burglary and robbery are similar and much more larger than for motor vehicle theft which suggests a larger adjustment for the formers than for the later.

Table 4. Error correction specification for the models

	Δ ROB	Δ BUR	Δ AUT
ECM	-0.3131	-0.3530	-0.1573
	(-7.8236)	(-8.6452)	(-1.7999)
TREND	-0.0068	0.0046	0.0033
	(-7.2449)	(4.3014)	(-1.1967)
INTER	1.7117	-3.4151	-0.1758
	(8.0593)	(-8.4375)	(-1.7399)
Diagnostic Tests			
$\overline{R}^2$	0.63	0.75	0.53
SC	0.1517 [.697]	1.9908 [.158]	3.2937 [.070]
FF	0.0023 [.959]	0.1058 [.745]	0.0335 [.855]
N	1.2109 [.546]	0.9289 [.628]	0.6926 [.707]
H	0.5156 [.473]	0.1215 [.727]	0.7922 [.373]

Note:
The error correction terms are given by

ECM_{ROB}=ROB+2.1796CROB+0.7113UNEM-1.2276CONS+0.593INC-1.4379YO

ECM_{BUR}=BUR+1.2541CBUR+0.3932UNEM-1.4379CONS-0.2096INC-3.3245YO

ECM_{AUT0}=AUT+1.9536CAUT+0.8782UNEM-0.6738CONS-1.9456INC-0.9890YO

The t-statistics are given in parenthesis. The diagnostic tests are chi-squared statistics for serial correlation (SC), functional form (FF), normality (N) and heteroscedasticity (H).Numbers in square brackets refer to the probability of rejecting the null hypothesis.

The error correction terms are in accordance with those that appear in other works. For example, the error correction terms that Hale (1998) obtains are -0.223 for burglary and -0.208 for theft. Osborn (1995) reaches -0.63 for property crimes while Scorcu and Cellini (1998) results range from -0.63 in the case of homicide to -0.19 in robbery regression. Our estimates of the error correction term are -0.31, -0.35, -0.15 for robbery, burglary and motor-theft models respectively, and seem to be coherent with the findings of previous literature.

Sims, Stock and Watson models The estimation process developed in the previous section shows a significant long run effect of economic conditions on crime rates. However, the influence of these factors could be different in the short term. This is especially relevant in

our context if we take into consideration the opposite effects that, as different theories argue, can be presented in this relationship. For this reason, an interesting point to investigate is to try to find out if the impact of the economic factors on crime is the same in both the long run and the short run.

One way to analyse the short run influence of different variables on the crime rates is to estimate the Sims, Stock and Watson model (1990). This approach is a derivation of the Engle and Granger (1987) procedure involved in estimating the long and the short run parameters of the model in a single step. The dynamic model in this case, once it is demonstrated that there is a cointegrating relationship between the variables, implies the estimation of the following equation:

$$\Delta y_t = a + J_t \Delta X_t + J_2 y_{t-1} - J_2 b_0 - J_2 b_1 x_{t-1} + e_t$$

in which the long run regression is given by

$$y_t = b_0 + b_1 x_t + u_t$$

where y is the variable to be explained and x represents the explanatory variables.

As shown above, one of the requirements for applying this error correction model is to ensure that there is only one dependent variable and, in consequence, all of the variables on the right- hand side are exogenous. If this is not the case, the estimated coefficients will show a simultaneous bias and the model will be miss-specified. Therefore, if we wish to apply this method in our analysis we need to determine if the explanatory variables of the criminal activity are actually exogenous or, by contrast, there is a feedback between them which advised against using this procedure.

The number of cointegrating vectors found in the Johansen procedure and the analysis of the error correction terms developed in the previous section are used to examine the causality between the crime and the clear up rates (see for this issue Charemza and Deadman, 1997). If there is only one cointegrating vector and the ECM is only significant in the equation representative of the crime rates, there are no reasons to support any simultaneity from the crime rates to the clear up rates[15]. Our previous analysis found only one cointegrating vector for all crime categories analysed (see table 2) and at the same time, the error correction mechanism is insignificant in robbery, burglary and motor vehicle theft clear up rate

[15] This second condition is based on the concept of short run causality provided by Engle and Granger (1987). A variable can be regarded as weakly exogenous if the error correction mechanism is not significant in the regression representing the short-run dynamics of this variable.

regressions[16]. For these reasons, we assume the exogeneity between the crime rates and the clear up rates. These results are in accordance with those of Corman et al (1987). Using a Vector autoregressive regression to examine the simultaneity between the arrest rates and the crime rates in New York City, they found no evidence of it. Given that the causality is going in only one direction from the crime rates to the deterrence variables, we can take into account Sims, Stock and Watson's model to analyse the offences.

In a first step, regressions are conducted adding two lags to the economic variables in first differences to test for the possibility of lagged effects. Following the general-to-specific approach it is dropped those variables in differences with a t-value less than one in order to obtain a ECM model with most significant parameter estimates.

The results of the final models are presented in table 5, 6 and 7. They all pass the main tests of mis-especification and have a rather high coefficient of determination, indicating that they are well-specified with an suitable goodness of fit. Further, the signs of the long run estimated coefficients are similar to those calculated in previous section although in the regressions based on the Sims, Stock and Watson model the influence of unemployment appear to be stronger than the influence of consumption. In addition to that, the indicator of income inequality has a strong positive effect on robbery rates, indicating that when the differences in income increase, the rates of robbery are higher. Clear up rates are significant and with the expected sign in all offences analysed and it corroborate the deterrent capacity of the Criminal Justice System.

Table 5. The Sims, Stock and Watson model for Robbery.

	Coefficient	T-ratio
INTER	-0.9581	-0.5444
ROB(-1)	-0.3352	-2.8064
CROB(-1)	-0.5340	-2.2456
UNEM(-1)	-0.3205	-5.0401
CONS(-1)	0.0569	0.2802
INC(-1)	0.7698	2.7058
YO(-1)	1.1157	3.3855
D57	0.1441	3.5641
Δ CROB	-0.9914	-6.3523
Δ CONS	-1.1635	-1.993
Δ CONS(-2)	0.6823	1.61
Δ UNEM	-0.0794	-1.1055
Δ UNEM(-1)	0.1226	1.7480
Δ UNEM(-2)	0.0687	1.1584
Δ INC	0.7064	2.7640
Δ D57	0.1635	2.6011

Δ indicates that the variables are in first differences.

[16] The ECM are 0.0203, -0.1651, -0.1573 with a t-value of 0.558, -0.5332, -0.936 for robbery, burglary and motor vehicle theft clear up rate equations, respectively.

Diagnostic tests: $\overline{R}^2 = 0.84$,
test for serial correlation $c^2(1) = 1.9865(p = 0.159)$,
functional form $c^2(1) = 1.4923(p = 0.222)$,
normality $c^2(2) = 1.5863(p = 0.452)$
and heteroscedasticity $c^2(1) = 0.1250(p = 0.724)$.

First differences regressors indicate short run influences of explanatory variables on each categories of crime. Again, economic conditions play an important role as the estimated coefficients of consumption and unemployment are quite often significant.

Consumption per capita appears significant in all regressions (current value in both robbery and burglary regressions and two lagged value in motor vehicle theft). The negative effect is opposite to that yield in the long run. It provides support to the motivational theory and indicates that an improvement of the economic conditions reduces the criminal activity. These results are in accordance to those of Pyle and Deadman (1994), Pudney et al. (2000) Hale (1998) and Beki et al. (1999)[17]. By contrast, Osborn (1995) fail to find any short run relationship between whatever economic variable considered and crime rates.

Table 6. The Sims, Stock and Watson model for Burglary.

	Coefficient	T-ratio
INTER	-1.2856	-0.8149
BUR(-1)	-0.3844	-4.0845
CBUR(-1)	-0.0625	-0.2986
UNEM(-1)	-0.1192	-3.2548
CONS(-1)	0.3419	1.3129
INC(-1)	0.1123	0.5509
YO(-1)	1.0202	4.1654
D57	0.0640	2.4806
Δ CBUR	-0.4228	-2.1350
Δ CONS	-1.1823	-3.4011
Δ CONS(-2)	0.7151	1.4506
Δ UNEM(-2)	0.05314	1.3183
Δ INC	0.2950	1.5497

Δ indicates that the variables are in first differences.
Diagnostic tests: $\overline{R}^2 = 0.79$,
test for serial correlation $c^2(1) = 1.3293(p = 0.249)$,
functional form $c^2(1) = 1.4107(p = 0.235)$,
normality $c^2(2) = 7.3288(p = 0.26)$
and heteroscedasticity $c^2(1) = 0.1522(p = 0.696)$.

The effects of unemployment rate is less straightforward. It is only found a negative significant current relation in motor vehicle theft equation (table 7). The signs of the lagged

[17] Like us, Hale (1998) and Beki (1999) include current and lagged values of the economic variables. In general, their results support a current motivational effect and an a lagged opportunity. The signs in our

variables in robbery and burglary rates are positive although the level of signification is not high. It indicates that changes in current unemployment cause a negative effect on crime while the lagged values seem to be in the opposite direction. These results are in mark contrast with those of Pyle and Deadman (1994), Pudney et al. (2000) and Hale (1998) who find a clear positive relation. However, they are in accordance to some work developed with United States data (Cantor and Land, 1985 or Allen, 1996).

Table 7. The Sims, Stock and Watson model for motor vehicle-theft.

	Coefficient	T-ratio
INTER	-0.1538	-0.2356
AUT(-1)	-0.1093	-1.3397
CAUT(-1)	-0.2850	-1.2406
UNEM(-1)	-0.1278	-3.0739
CONS(-1)	0.0574	0.3514
INC(-1)	0.0495	0.2862
YO(-1)	0.1540	0.8944
D57	0.1399	3.6546
Δ CAUT	-0.1077	-1.998
Δ CONS(-2)	-0.901	-2.2022
Δ UNEM	-0.1299	-3.4172
Δ YO	1.0509	1.5212

Δ indicates that the variables are in first differences.

Diagnostic tests: $\overline{R}^2 = 0.62$,

test for serial correlation $c^2(1) = 2.5728(p = 0.109)$,

functional form $c^2(1) = 0.5265(p = 0.468)$,

normality $c^2(2) = 1.3683(p = 0.505)$

and heteroscedasticity $c^2(1) = 0.3997(p = 0.527)$.

regressions presents a similar pattern but we only find significant relationships to support the view of motivational theory.

Concluding Remarks

This paper has estimated the effect of the economic conditions on robbery, burglary and motor vehicle theft rates in the United States in the post-war period. There is a good deal of theoretical and empirical literature that supports the assertion that the variation of the level of wealth is associated with the difference in the rate of crimes. But there are few studies that apply cointegration tools to discover both the short and the long run effects of the economic conditions and crime. Following the methodology used firstly in this area by Pyle and Deadman (1994), we have developed an error correction model to study these issues trying to discover weather the role of economic conditions is the same in both the long and the short run.

Our findings are consistent with those of other recent studies. The economic conditions play an important role in explaining the criminal behaviour. Moreover, the influence of the economic conditions in the short run seem to be different to those in the long run. While in the latter it is found a clear evidence of the opportunity effect, the motivational effect seem to dominate in the short run.

In summary, our results confirm the usefulness of the error correction models to deal with these issues to the extent this approach captures both short run dynamics and long run relationships. However, little empirical work has been done up to now. It would be valuable to examine weather the results can be replicate or confirm with other data. It is hoped that, in the future, new research using the same methodology would be developed to study the relationship between economic conditions and crime.

Appendix 1: Variable and data source (1950-1996)

All variables used in logarithmic form.

ROB: number of robberies known to the police per 100,000 inhabitants. Uniform Crime Reports and Crime in United States. Federal Bureau of Investigation.

BUR: number of burglaries known to the police per 100,000 inhabitants. Uniform Crime Reports and Crime in United States. Federal Bureau of Investigation.

AUT: number of motor vehicle thefts known to the police per 100,000 inhabitants. Uniform Crime Reports and Crime in United States. Federal Bureau of Investigation.

CROB, CBUR and CAUT: percentage of robberies, burglaries and motor vehicle thefts cleared by arrest. Uniform Crime Reports.

UNEM: United States unemployment rate. Bureau of Labour statistics.

CONS: Personal consumption expenditures per capita, 1992 prices. Survey of Current Business.

YO: youth population. Number of people between 15-24 years as a proportion of U. S. population. Historical Statistics of the United States and The Digest of Education Statistics (Table 14).

INC: Share of aggregate income received by the lowest fifth related to the highest fifth. March Current Population Survey.

Appendix 2 Crime rates in England and Wales and the United States.

Figure A. Robbery rates.

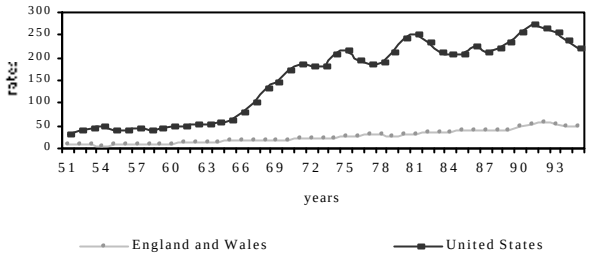
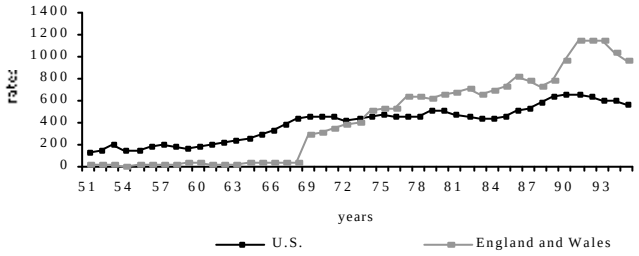


Figure B. Burglary rates

Figure C. Motor vehicle theft rates



References

Allen, R.C. (1996), "Socioeconomic Conditions and Property Crime: A Comprehensive Review and Test of the Professional Literature", *American Journal of Economics and Sociology*, vol. 55, pp. 293-307.

Becker, G.(1968) “Crime and Punishment: an Economic Approach”, *Journal of Political Economy*, vol.76, pp.107-23.

Beki, C.; Zeelenberg, K. and Monfort, K. (1999), "An Analysis of Crime in the Netherlands 1950-93", *British Journal of Criminology*, vol. 39, pp. 401-15.

Cantor, D. and Land, K. C. (1985), “Unemployment and Crime Rates in Post World War II United States: a Theoretical and Empirical Analysis”, *American Sociological Review*, vol. 50, pp. 317-32.

Charemza, W. W. and Deadman, D. F. (1997), *New Directions in Econometric Practice*, Edward Elgar, Cheltenham, UK.

Chiricos, T. G. (1987), “Rates of Crime and Unemployment: an Analysis of Aggregate Research Evidence”, *Social Problems*, vol. 34, pp. 187-212.

Corman, H.; Joyce, T. and Lovitch, N. (1987), "Crime, Deterrence and Business Cycle in New York city: a VAR Approach", *The Review of Economics and Statistics*, vol. , pp.695-700.

Cornwell, C. and Trumbull, W. N. (1993), “Estimating the Economic Model of Crime with Panel Data”, *The Review of Economics and Statistics*, vol.75, pp. 360-66.

Cook, P. J. and Zarkin, G. A. (1985), "Crime and the Business Cycle", *Journal of Legal Studies*, vol. 14, pp. 115-28.

Danzinger, S. and Wheeler, D. (1975), "The Economics of Crime: Punishment or Income Redistribution", *Review of Social Economy*, vol. 33, pp. 113-31.

Deadman, D. F. and Pyle, D. J. (1997), " Forecasting Recorded Property Crime using a Time-Series Econometric Model", *British Journal of Criminology*, vol. 37, pp. 437-45.

Ehrlich, I. (1996), “Crime, Punishment and the Market for Offences”, *Journal of Economic Perspectives*, vol.10 (1), pp. 43-67.

Engle, R. F. and Granger, C. W. J. (1987), "Co-integration and Error Correction: Representation, Estimation and Testing", *Econometrica*, vol. 55, pp. 251-276.

Field, S. (1990*) Trend in Crime and their Interpretation. A Study of Recorded Crime in Post-War England and Wales*, Home Office Research Study, 119.

Freeman, R. B. (1983), “Crime and Unemployment”, in J. Q. Wilson (ed*), Crime and Public Policy*, Institute of Contemporary Studies Press, London, pp. 89-106.

Hale, C. (1998), “Crime and the Business Cycle in the Post-war Britain Revisited*”, British Journal of Criminology*, vol. 38, pp. 681-698.

Johansen, S. (1988), "Statistical Analysis of Cointegration Vectors", *Journal of Economic Dynamics and Control*, vol.12, pp. 231-54.

Johansen, S. (1991), "Estimation and Hypothesis Testing of Cointegrating Vectors in Gaussian Vector Autoregressive Models", *Econometrica*, vol. 59, pp. 1551-80.

Johansen, S. (1995), *Likehood-based Inference in Cointegrating Vector Autoregressive Models*, Oxford, Oxford University Press.

Johansen, S.and Juselius, K. (1990), "Maximum Likelihood Estimation and Inference on Cointegration-with Applications to the Demand for Money", *Oxford Bulletin of Economics and Statistics*, vol. 52, pp. 169-210.

Koskela, E. and Viren, M. (1993), "An Economic Model of Auto-Theft in Finland", *International Review of Law and Economics*, vol. 13, pp.179-191.

Langan, P. A. and Farrington, D. P. (1998*), Crime and Justice in the United States and England and Wales, 1981-96*, U. S. Department of Justice, Bureau of Justice Statistics, NCJ 169284.

Levitt, S. D. (1998), "Why do Increased Arrest Rates Appear to Reduce Crime: Deterrence, Incapacitation or Measurement Error?", *Economic Inquiry*, vol. 36, pp. 353-72.

MacDonald, Z (1999), "Revisiting the Dark Figure: a Microeconomic Analysis of Underreporting of property crime and its implications"???

Marselli, R. and Vannini, M. (1997), 'Estimating a Crime Equation Model in Presence of Organised Crime', *International Review of Law and Economics*, vol. 17, pp. 89-113.

Osborn, D. R. (1995), *Crime and the UK economy*, European University Institute, Robert Schuman Centre, Working Paper, no. 95/15.

Perron, P (1989), "The Great Crash, the Oil Price Shock and the Unit Roots Hypothesis", *Econometrica*, vol.57, pp. 1361-1401.

Pesaran, M. H. and Pesaran, B. (1997), *Working with Microfit 4.0*, Oxford, Oxford University Press.

Pyle, D. J. (1983), *The Economics of Crime and Law Enforcement*, Macmillan, London.

Pyle, D. J.(1995) "The Economic Approach to Crime and Punishment", *The Journal of Interdisciplinary Economics*, vol.6, pp. 1-22.

Pyle, D. J. and Deadman, D. F. (1994), "Property Crime and Business Cycle in Post-War Britain ", *British Journal of Criminology*, vol. 34, pp. 339-57.

Pudney, S.; Deadman, D. F and Pyle, D. J (2000). "The Relationship between Crime, Punishment and Economic Conditions. Is Reliable Inference Possible when Crimes are Under-recorded?", *The Journal of the Royal Statistical Society*, vol. 163, Part.1.

Reilly, B. and Witt, R. (1992), "Crime and Unemployment in Scotland", *Scottish Journal of Political Economy*, vol. 39, pp. 213-28.

Sala-i-Martin, X. (1997), "Transfers, Social Safety Nets, and Economic Growth", *International Monetary Fund Staff Papers*, vol.44, pp. 81-102.

Scorcu, A.E. and Cellini, R. (1998), "Economic Activity and Crime in the Long Run: an Empirical Investigation on Aggregated Data from Italy, 1951-1994", *International Review of Law and Economics*, vol.18 (3), pp. 279-92.

Sims, C. A.; Stock, J. H. and Watson, M. W. (1990), "Inference in Linear Time Series Models with Some Unit Roots", *Econometrica*, vol. 58, pp. 113-44.

Tarling, R. (1982), *Crime and Unemployment*, Home Office Research and Planning Bulletin, 112.

Viren, M. (1994), "A Test of an Economics of Crime Model", *International Review of Law and Economics*, vol. 14, pp. 363-70.

Wolpin, K. I. (1978), "An Economic Analysis of Crime and Punishment in England and Wales, 1894-1967", *Journal of Political Economy*, vol. 86, pp. 815-40.