The effect of socio-economic determinants on crime rates:
An empirical research in the case of Greece
with cointegration analysis

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Abstract

The present paper analyzes the relationship between the criminal offences, the function of the justice system and some of their socio-economic determinants in the case of Greece by estimating their dynamic interactions. The analysis covers the period 1971-2006 and the cointegration methodologies of Johansen (1988) and Johansen-Juselius (1990, 1992) are applied to the VAR model. From the cointegration results, a cointegrating vector is shown among total offences, convicted persons and socio-economic variables. Moreover, Error Correction Models are estimated for the short-run dynamics of the explanatory variables and their convergence to a long-run equilibrium state.

Keywords: Crimes, Socioeconomic determinants, Greece, Cointegration, Error Correction Model.

JEL classification: I2, K42

1. Introduction

Criminality is presented as a historical social phenomenon, which does not rule out from a person's life, but it keeps pace with the social and technological evolution. It has the tension to readjust all the time and as a result, a large variety of criminal activities is shown worldwide during different time periods. Lately, types of organized, violent and profiteering crime appear to be the most prevalent, but without ruling out the different kinds of single crimes. Moreover, the criminal's character becomes even more unscrupulous and provocative, thus more dangerous towards the rest of the people.

The proper actions for a significant reduction and an effective prevention of crime rates has become a prior issue for every country, since criminal actions are presented through different forms, everywhere and in every time. There are no certain causes for committing crimes, but every time criminal actions come from different kinds of motives. In fact, there are many incentives that drive a person to criminal activities, due to the special socioeconomic and political conditions that characterize every country.

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Many approaches have been made in order to analyze the economics of crime and the relationship between the motives and the illegitimate activities, which appear to be different for each country. In fact, more attention has been paid to specific types of crime, such as homicides, violent assaults, thefts, burglaries and robberies. Due to the complexity of a criminal action, the results are not unanimous, so no *a priori* theoretical approach can be extracted.

Over the past 30 years crime rates in Greece are continuously growing, especially in robberies, violent assaults and the so-called economic crimes, in which digital, electronic and tax frauds are included. On the other hand, in no way can all the criminal activities remain without any punishment, either by imposing a fine, or by imprisoning in special institutions. But surprisingly it seems that, as time passes, the number of convicted persons becomes lower. Perhaps the ineffectiveness and the elastic calls of the Greek justice system and the insufficiency of the police force to proceed to arrests and solve the crime cases as well could be the main reasons.

According to official data tables, during the last decades there is a constant rise of criminal acts in developed countries and countries of the Western World, Greece included. Even though Greece is theoretically considered as one of the safest countries in the European Union, due to relatively lower crime rates than other major countries, criminality is something that cannot be ignored. Indeed, criminal behaviour has recently become a subject of discussion among specialists and politicians, paying more attention to issues such as the prisoner's way of living, the application of rehabilitation programs (employment, education, learning) and corrections to the legislative system (Lambropoulou, 2005).

Economics of crime are mostly related with factors such as poverty, income inequality, social exclusion, cultural characteristics, age, sex, education level and family background (Buonanno, 2003). In the case of Greece, delinquent actions are more likely to burst because of its crucial geopolitical position, some economic problems, the growth of legal and illegal immigration, the loose moral values through family and school environment, the improper organization of the Greek justice system. Moreover, the impact of television addiction and alcohol consumption is important for the rise of crime rates.

The present paper presents the long-term relationship between criminal offences and some of the socio-economic factors in the case of Greece. The structure of the paper is the following: Section 1 refers to criminality as a social phenomenon that keeps pace with the social and technological evolution. Section 2 presents the theoretical and empirical approaches. Section 3 describes the specification of the multivariate VAR model and the data that will be used in it. Section 4 presents the results of the unit root test and the integration order of the variables. Section 5 shows the results from the cointegration analysis among the explanatory variables. Section 6 presents the results of the Error Correction Model, and finally in section 7 final conclusions are drawn.

2. Theoretical and empirical approaches

Many studies that refer to criminality for decades were based previously on theoretical and sociological approaches, but only recently economic analysis has been applied. Although Fleisher (1963, 1966) was the first who worked on criminality from its economic view, Becker's study (1968) became the major breakpoint by designing a model, analyzing a criminal's decision. In particular, the criminal behaves in a rational way and decides how to allocate time between legitimate and illegitimate activities, based on an income benefit-cost comparison, plus the likelihood of apprehension and conviction. The above studies paved the way for the field of empirical research, which aims in verifying the socioeconomic variables that determine criminal decisions and behaviours.

The crime-unemployment relationship has been ambiguous in most studies, leading to different approaches. The first one indicates a positive relationship (Reilly and Witt, 1992; Papps and Winkelmann, 2000; Raphael and Ebmer, 2001; Edmark, 2005), known as 'motivation effect', where a rise in unemployment rates leads to economic problems and increases the motivation to engage in criminal acts. The second one comes from the work of Cantor and Land (1985), who found a negative correlation known as 'opportunity effect' (Britt, 1994; Melick, 2004) and indicates that, during economic depression a rise in unemployment rates leads to decrease in median family income and discourages a person from the decision to commit a crime.

No consensus is also found in the case of income earnings and income inequality. Several studies show that changes in income can affect crime in three ways: first, an income decrease makes the need for returns from illegal activities, known as 'motivation effect' (Grogger, 1998; Machin and Meguir, 2000; Gould et al. 2002). Second, an income increase sets the opportunities for criminal offences, due to the large amount of stolen goods, known as 'opportunity effect' (Levitt, 1999). Finally, the third way is known as 'routine-activity effect' (Beki et al. 1999), indicating that an income increase leads to outdoor activities, thus increasing the likelihood of potential crime victims. In addition, when the crime-income inequality relationship is studied, motivation effects for criminal actions are more likely to happen when inequality measure is rising (Blau and Blau, 1982; Hsieh and Pugh, 1993; Fajnzylber et al. 2002), but in some cases the present relationship does not appear to be so significant (Stack, 1984; Neumayer, 2003).

A number of empirical studies has set the question how the authorities and the prevention policies can better combat crime. Different variables have been tested, such as the growth of police force (De Oliveira, 2003), the money spent for the appropriate equipment (Imrohoroglu et al. 2000), people who have been arrested (Corman et al. 1987, Corman and Mocan, 2000), convicted (Pudney et al. 2000; Funk and Kugler, 2003) or sentenced to imprisonment (Levitt, 1996). The results are still ambiguous, but it seems that the possibility of sentence and conviction are more effective ways for crime prevention than the others. That is because, in most cases, criminal actions are not always connected with arrests, and arrests do not always lead to convictions and imprisonments.

Not much effort has been made to analyze the crime rates with the cointegration and causality method. One of the first attempts was by Masih and Masih (1996), who bound cointegration with Granger causality for several types of crime in Australia, but few studies followed the methodology. For the rest of the researches, several were the ones that came up with mixed results, trying to relate different crime types with socio-economic factors (Scorcu and Cellini, 1998; Witt and Witte, 2000; Lee, 2002; Narayan and Smyth, 2004; Lee and Holoviak, 2006; Kuştepeli and Őnel, 2006), while the rest failed to find a cointegrating vector (Hale and Sabbagh, 1991; O'Brien, 1998; Luiz, 2001; Saridakis, 2004).

Returning to the crime-unemployment relationship and the 'opportunity effect' approach, Cantor and Land's (1985) dimension negatively correlates the two variables. Specifically, they indicate that during times of economic depression, a rise in unemployment rates lowers the consumption expenditures, mostly in households, so the potential earnings from illegitimate activities become lower and discourage a person from committing a crime. Moreover, the long-term unemployment drives the unemployed persons to allocate more time in their places, thus preventing from crimes such as offences against properties and from violent assaults as well, since the latter ones mostly occur in public places. In general, Cantor and Land (1985) stress that in a present time period, unemployment operates as a means of prevention from crime activities, while in lagged period the poverty problem leads to illegitimate actions. Consequently, the present approach indicates that changes in opportunity effects for delinquent actions appear in the same time levels as changes in unemployment rates, whereas motivation effects appear in lagged times from unemployment changes, which means that unemployment first differences are added. The contribution of Cantor & Land's (1985) work was very important, despite the fact that other researchers criticized the 'first-difference' approach of unemployment rates (Greenberg, 2001), while others have the dilemma concerning whether the cointegration technique or the 'first-differences' regression model can better describe the crime-unemployment relationship for time series analysis (Britt, 2001).

To summarize, the crime-unemployment relationship is not characterized by unanimity, but their results remain ambiguous. Examples come from the correlation studies of Box (1987) and Chiricos (1987), in which the crime rates consist the dependent variables. The former noted that 33 of the 50 studies examined supported a positive correlation, while the rest were characterized by an insignificant and negative correlation mix. Respectively, the time series studies search of the latter showed that 46 studies supported positive correlations and 22 negative correlations, pointing out that less than half of them were statistically significant. Beside the cases where the crime-unemployment relationship is proved to be insignificant (Timbrell, 1990**,** Young, 1993), there are researchers that argue even for the existence of such a causal relationship between the two variables. For example, Field (1990) and Pyle and Deadman (1994) stressed that unemployment might be a less important factor than the rest economic variables in order to investigate the crime rates fluctuation in Great Britain.

Many support the view that different methodology approaches used for empirical analysis can lead to ambiguous results. For example, Levitt (1999) expressed that the national time series data usually fail to show a crime-unemployment relationship

due to the fact that the fore mentioned variables perform divergences in local levels. So, he suggests the use of cross-section data and panel data as a more effective way of solution.

The failure for the crime-unemployment relationship consensus usually derives from the belief that total unemployment is not a proper way of measure, since the official total number of unemployed in every country or state is proved to be inadequate for giving satisfactory answers to fix this problem. For example, the prohibition of a large percentage of long-term unemployed is one of the most prevalent cases. That is because of their frustration and the quit of the labor search, since the lack of specialty does not allow them to meet the high standards of the labor supply. So a stoppage from labour search causes an underestimation of unemployment, because it is assumed wrong that the present percentage does not belong to the workforce, and as a result, they are not considered as unemployed.

3. Data and specification of the model

The present model is mostly based on Becker's (1968) model, who has expressed the view that an individual's decision to commit a crime depends on the income returns of legitimate activities, the possibility for the crime to succeed and the severity of punishment that can be imposed, if the person gets arrested.

Other researchers have designed their Economics Crime Models (ECM) based on Becker's view as well (Pyle and Deadman, 1994), but some adjustments must be made in the present paper. For example, the justice system function would be more preferred than the total force of the authorities because the high probability for someone to be sentenced or convicted could be a more effective way to prevent crimes. More-over, the variable that refers to migration could be inserted into the model, considering the two major immigration flows that took place recently in Greece: the first was the comeback of many exiled people after the dictatorship period in 1974, and the second in the early 90's, where a massive flow of immigrants appeared, especially coming from the former socialistic countries-unions.

After the content of the model has been defined, its form must then be examined. Since the present paper works on the application of recent econometric techniques, the main is the existence or not of stationarity and long-term equilibrium among the time series data. So, the present paper must use time-series of raw data and the following model will be used in the economic analysis of crime rates in the case of Greece:

$$CR_t = f(UN_t, RC_t, CONV_t, MIG_t) \quad (1)$$

where:

CR is the number of total offences per 100.000 people known by the Greek police and refers to Greek Penal Code and Special Penal Law infringements,

UN is the number of unemployed per 100.000 people who belong to the work force,

RC shows the real compensation per employee adjusted with GDP deflator and 2000 is used as a base year (2000=100).

CONV is the total number of people who have been convicted by the Greek Courts of Law per 100.000 people, and

MIG is the net migration per 100.000 people, consisting of the algebraic sum of immigrations and emigrations.

The variables represent annual time series, covering the time period 1971-2006. The total offences and the convicted person's data come from the respective bulletins of Justice Statistics by the National Statistical Service of Greece (NSSG). As for the economic variables, real compensation per employee and unemployment, their data come from the AMECO database by Eurostat and finally the total population data, as well as the net migration data come from the respective Statistical Yearbooks of NSSG. All variables will be expressed in logarithms to explain the multiplicative effect of the time series and they will be symbolized with the letter L in front of their names.

3. Unit root tests

Many macroeconomic time series contain unit roots that are characterized by the existence of stohastic trends (Nelson and Plosser, 1982). Unit root tests are essential for the existence of stationarity of time series, because a non-stationary regressor can rule out many empirical results. The existence of stochastic trends is determined by the tests for the existence of a unit root among the time series. In the present research, the unit root is checked by the Augmented Dickey-Fuller (1979) and Phillips-Perron (1988) tests.

Table 1 presents the Augmented Dickey-Fuller (1979) and Phillips-Perron (1988) tests for the variables of total offences, unemployed people, real compensation, convicted people and net migration. The results, according to the calculated ADF and PP statistics, show that all the explanatory variables are integrated of order one I (1).

Table 1: Unit root tests

Variables	DF	PP
LCR	-1.528	-1.672
ΔLCR	-5.178**	-12.479**
LUN	-2.198	-0.960
ΔLUN	-3.828**	-3.828**
LRC	-1.683	-1.683
ΔLRC	-4.171**	-4.193**
LCONV	-0.217	-0.209
ΔLCONV	-4.396**	-7.212**
LMIG	-2.756	-3.149
ΔLMIG	-3.690**	-7.642**

Notes:
Δ denotes the first differences.
DF = Dickey-Fuller PP=Philips-Perron (unit root tests).
The critical values for 1% and 5% levels of significance are -3.95 and -3.08 for DF and PP.
* and ** denote 5% and 1% levels of significance respectively.

4. Cointegration tests

Since it has been determined that the crime and the socioeconomic variables under examination are integrated I(1), then the cointegration techniques of Johansen (1988) and Johansen-Juselius (1990, 1992) can be performed, determining the number of available cointegrating vectors through the variables. The present approaches are used for the number of cointegrating vectors, taking into account that all variables can be endogenous, thus avoiding the arbitrary choice of the dependent variable. Moreover, they provide a unified framework for the estimation of the cointegrating relations within the Vector Error Correction Model (VECM). The estimation method of Johansen-Juselius presupposes the estimation of the following form:

$$\Delta Y_t = \mu + \Gamma_1 \Delta Y_{t-1} + \Gamma_2 \Delta Y_{t-2} + \ldots \ldots + \Gamma_{p-1} \Delta Y_{t-p+1} + \Pi Y_{t-p} + u_t$$

where:

Y_t is a 5X1 vector of stochastic variables,
μ is a 5X1 vector of intercepts,
Γ_i (i=1,2…p-1) is a 5X5 coefficient's matrix,
Π is a 5X5 coefficient's matrix,
e_t is the 5X1 residuals vector.

Before the application of the Johansen technique, a sufficient lag length is required for the VAR model estimation, so a procedure based on Likelihood Ratio tests (Sims, 1980) is first applied. The results showed that a lag length p = 2 is the best specification, so the order of the model is VAR(2). The next step is to determine the number of cointegrating relations, under the condition that the rank of the Π matrix is $r < n$ (where n = 5). Table 2 presents the results of the cointegration analysis for the long-run equilibrium relationship:

Table 2: Cointegration tests based on the Johansen and Johansen-Juselious approach (LCR, LUN, LRC, LCONV, LMIG VAR lag = 2)

	Trace test	**5% critical value**	**1% critical value**
H_0: r = 0	76.59	68.52	76.07
H_0: r ≤ 1	40.27	47.21	54.46
H_0: r ≤ 2	19.82	29.68	35.65
H_0: r ≤ 3	9.470	15.41	20.04
H_0: r ≤ 4	2.690	3.76	6.65

Notes:
Critical values are taken from Osterwald – Lenum (1992).
r denotes the number of cointegrated vectors.
Akaike Criteria (FPE) was used to select the number of lags required in the cointegration test.

The results according to the above Table confirm the existence of one cointegrating relation that describes the long-run crime rates in Greece (with absolute asymptotic t-statistics in brackets):

LCR = 4.003 + 0.774LRC + 0.094LUN - 0.055LCONV + 0.026LMIG
[4.999] [-5.771] [3.983] [1.064] [0.796]

where the coefficients estimated in the above relation show a significant elasticity of crime rates in unemployment rates and real compensations, an insignificant elasticity in net migration flows, and an insignificant inelasticity in conviction rates.

No restrictions a priori should be imposed, due to the unconcensus of the results in previous references, except for the intercept, where a positive sign must be expected. That is because criminal actions consist of multiple factors, some of them have not been entered into the present model and others are unable to be measured in a quantitative analysis. Since the above restriction is satisfied, the residuals of the cointegrating vector can then be used in a Vector Error Correction Model (VECM).

5. VAR model with an Error Correction Mechanism

After determining the cointegrating vector among the model variables, the residuals can be used as an error correction term in the VEC model, which is resulted from the long-run equilibrium relationship and is expressed as:

$$\Delta LCR_t = \text{lagged}(\Delta LCR_t, \Delta LRC_t, \Delta LUN_t, \Delta LCONV_t, \Delta LMIG_t) + \lambda\, u_{t-1} + V_t \quad (2)$$

where Δ denotes the first differences of the variables,

u_{t-1} are the estimated residuals of the cointegrating regression (long-run relationship) and represents the deviation from the equilibrium state, during a time period t,

$0 < \lambda < -1$ is the short-run convergence coefficient, which represents the dependent variable's reaction from the equilibrium state in the beginning of each time period t,

V_t is the 5X1 vector of white noise errors.

The purpose of the VECM estimation is to determine the way in which the short-run dynamics of the time series eventually get to a stable long-run equilibrium state. The estimation of the dynamic VEC model of crime rates in the case of Greece is expressed in Table 3:

Table 3: Estimation of the VEC model

$$\Delta LCR_t = 0.234\Delta LUN_{t-i} + 0.052\Delta LMIG_{t-i} + 0.135\Delta LCONV_{t-i} - 0.433\Delta LRC_{t-i} - 0.990\ \lambda u_{t-l}$$
$$[0.0039] \qquad [0.1838] \qquad [0.1762] \qquad [0.0013] \qquad [0.000]$$

$R^2 = 0.638$ $DW = 2.43$

A: $X^2[1] = 3.910\ [0,047]$
B: $X^2[1] = 0.159\ [0,689]$
C: $X^2[2] = 0.038\ [0,981]$
D: $X^2[1] = 1.030\ [0,449]$

A: Lagrange (LM) multiplier of residual serial correlation
B: Ramsey's reset test for the functional form of the model
C: Jarque-Bera's normality test based on a test of skewness and kurtosis of residuals
D: White heteroscedasticity test (no cross terms)

The above Table shows the VECM estimation results, including the sum of statistically significant variables, the error correction term which should be negative and statistically significant as well, measuring the convergence velocity in the present dynamic model required for the equilibrium restore and the diagnostic tests for the VECM residuals. In particular, a short-run rise in both the macroeconomic variables (unemployment and real compensations) can actually affect the decision to engage in illegitimate activities, while a rise in sentenced persons and in migrant flows has a small affluence in crime rates, due to their insignificant coefficients. Finally, the error correction term coefficient and its t-ratio present a normal convergence to the long-run equilibrium state.

6. Conclusions

The analysis of crime rates by using statistical and econometric techniques is of great importance for two main reasons: First, to find the appropriate socioeconomic factors that affect more intensely the trend for criminal actions in every country and second, according to the possible results, proper actions for a successful reduction and an effective prevention of crime rates can be applied.

First, the ADF test for non-stationarity is performed for the integration order of the individual time series. The same integration order leads the path for Johansen's maximum likelihood procedure, where the existence of a long-run equilibrium relationship among total offences, unemployment, real compensations and convicted persons is supported within the examined period. The estimated cointegrating residual is then used as an error correction term in the VECM, where the short-run dynamics are appeared through the statistical significance of all the regressors. Moreover, the negative and statistically significant sign of the error correction term shows that there is a convergence from a short-run condition to the state of a long-run equilibrium.

Concerning the economic activities' behaviour towards the crime rates, it appears that the results yielded are mixed. Both the macroeconomic series (unemployment and real compensation) used in the present model cause an effect to crime rates through different directions. Specifically, a rise in wages operates as an 'opportunity effect' in crime rates, whereas the unemployment rise has a 'motivation effect' to criminal activities with higher sensitivity appeared in the case of wages and compensations, as proved from the variables coefficients. This means that, during fluctuations of the business cycles, an economic depression creates the motive for criminal activities, whereas in times of economic prosperity more opportunities are created for gaining profits from illegitimate actions.

The conviction rates from the Greek justice system can be one of the factors to successfully combat crime, but it proves to be of lower significance. So, further measures concerning the structure and the function of the judicial authorities must be taken in order to increase the prevention from criminal activities.

As for the migration contribution to criminal activities, it proves to be much more insignificant than conviction rates. Perhaps there should be a search in illegal immigrants, because their economic incentives are much greater than the rest immigrants.

There is not certainty from the results yielded that the present variables can best explain the criminal's behaviour. Gross Domestic Product, for instance, could be an alternative type of economic activity, accepted by many economists, although it has the drawback that every monetary exchange is considered as a measure of prosperity, while a percentage of the exchanges are sometimes proved to be baneful for economic development. Another suggestion is the use of other variables that better describe the Greek reality, such as the alcohol consumption, a factor mostly related with violent assaults and car accidents[1], but there is a difficulty due to the limitations of Greek statistics data.

Nevertheless, further analysis of crime rates in the case of Greece must be made, so as to extract more reliable results and be used as policies for their best combating.

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[1] Car accidents hold an important percentage in criminal offences, according to official Greek crime.

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