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Is Polish Crime Economically Rational?

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Abstract. This study investigates whether crime in Poland is governed by economic rationality. An economic model of rational behavior claims that the propensity to commit criminal activities is negatively related to deterrence. The potential presence of higher risk profiles for certain population segments is investigated. Panel data aggregated to sub-regional levels and observed annually for the years 2003 to 2005 are applied. Controls for endogeneity among criminal activity level and deterrence, intra-regional correlation, inter-temporal heterogeneity and spatial spillover are implemented. A negative effect of deterrence on criminal activity is found, confirming the hypothesised economic rationality. Thus, local initiatives aiming to improve deterrence rates indeed pay off. Furthermore, certain population segments are identified as obvious target groups for regional policy initiatives aiming to reduce criminal activities. These are, in particular, the unemployed, youngsters and inhabitants in large urban areas. On the other hand, those with lower educational attainment, lower-wage earners and males are less obvious target groups. Finally, spatial spillover patterns related to criminal activities seem to be less relevant, thus implying that initiatives toward criminal activities may well be formed at the regional level and that coordination across regions is less called for.

1. Introduction

The investigation of determinants of crime is important not only because of the serious nature of the problem in itself but also in terms of public policy implications (income, immigration, employment, etc.). The study of Becker (1968) represents a starting point of the economics of crime. His paper explains how changes in the probability and severity of punishment can alter the individual's decision to commit crime. Later, Ehrlich (1973) extended the Becker model by considering how individuals divide their time between illegal and legal activities. If legal income opportunities are scarce relative to the potential benefits of crime, people allocate more time to illegal activities and crime is likely to occur. Since then, an extensive empirical literature has attempted to test the central results of the Becker-Ehrlich model for a number of countries. These studies have focused on Canada (Avio and Clarke, 1976), Finland (Wahlroos, 1981), the UK (Car-Hill and Stern, 1973; Wolpin, 1978), Australia (Whithers, 1984; Bodman and Maultby, 1999), the US

(Trumbull, 1989; Cornwell and Trumbull, 1994; Baltagi, 2006), New Zealand (Small and Lewis, 1996; Papps and Winkelmann, 1998), Italy (Marselli and Vannini, 1997; Buonanno and Leonida, 2006), Sweden (Sandelin and Skogh, 1986), Germany (Entorf and Spengler, 2000), and Norway (Aasness et al., 1994).

This formal literature estimates the supply of crime employing different types of data set (aggregate data, cross-sectional data and panel data) where the crime rate is related to some deterrence as well as socio-economic and demographic variables. So far, the empirical literature has provided mixed evidence; see Eide (2000) for a review. More recently, some papers have addressed the importance of controlling for other socioeconomic factors in the criminal behavior, such as drug abuse (Entorf and Winker, 2001), gun possession (Miron, 2001), juvenile delinquency (Mocan and Rees, 1999), income inequality (Fajnzylber et al., 2002), immigration (Butcher and Piehl, 1998), social capital (DiIulio, 1996), and minimum wages (Hansen and Machin, 2003).

Problems related to criminal activity are highly relevant from a regional policy perspective. Criminal activity is commonly seen to be a phenomenon that varies strongly across regions of any country. Furthermore, criminal activity is something that can be learned through a social interaction process. It is very likely that criminality in one region can affect criminality in neighbor regions. This diffusion process of criminality implies that a spatial dependence or a spatial spillover exists among cities or areas. Such effects have been identified by Cohen and Tita (1999), Baller et al. (2001), Messner and Anselin (2002), Buttner and Spengler (2003), and Puech (2004). Conceptually, such spatial spillover may assume two potential forms. One form is an endogenous spillover, i.e., a high criminal activity in a certain area in itself leads to high criminal activity in neighbour regions. Another form is exogenous spillover which is related to spatial clustering of determinants of crime. Thus, if there is a high concentration of risky population segments in a certain area, then the criminal activity will be high not only in this region but also in neighbor regions.

The present study examines the determinants of crime rates in Poland based on data aggregated to sub-regional levels during the period 2003 to 2005. Data were collected from the national statistical agency of Poland. Certainly, data availability at the regional level puts some restrictions on the set of determinants which could be included. The study thus includes the key variable deterrence. Further, some variables are included to control for varying risk profiles across certain population segments. These concern wages, education, percentages of foreigners, age and gender (young people and males), urbanisation, and unemployment.

While the set of variables extracted is somewhat narrow, it corresponds well to suggestions of existing evidence. The effect of deterrence is well documented for the US (Levitt, 1996; Levitt, 1997, Levit, 1998; Corman and Mocan, 2000) and Western Europe (Edmark, 2005; Entorf and Spengler, 2000; Buonnano et al., 2006). However, the causal relationship among deterrence and crime rates is ambiguous in an aggregate setting. Obviously, a high deterrence rate of a region reduces the crime rate of the region, as the opportunity cost of committing crime goes up. On the other hand, it may well be the case that a high crime rate in a region stimulates policy initiatives to raise the deterrence rate.

Wage is identified as another key determinant, however, with an ambiguously signed effect. One argument is that high incomes lead to higher opportunities of people to engage in legal activities. On the other hand, high incomes may serve as a proxy for

illegal opportunities, as wealthy areas may be more attractive for criminals (Ehrlich, 1973; Entorf and Spengler, 2000). The unemployment rate is a central part of models of criminal activity since Becker (1968) and applies as a measure of lack of social capital and legal income opportunities. Education may also be an important determinant of criminal activity. Specifically, higher educational attainment increases the opportunity cost of crime, as the expected loss from deterrence becomes higher. Recent research tends to support that education is negatively related to crime (Buonnano et al., 2006).

Gender is known to exert an influence. Males, in particular young males, are known to possess a higher risk profile (Witte, 2002), and young people might in general have a lower opportunity cost of committing crime. Urban areas with high population densities are furthermore commonly seen to have higher crime rates than rural areas, even after controlling for socio-economic characteristics of the areas.

Finally, the percentage of foreigners is known to correlate positively with crime rates (Entorf and Winker, 2008). Insufficient educational and earning opportunities of immigrant groups may potentially reduce their opportunity cost of committing crimes. Similarly, immigration is a process where people leave home, family, friends, etc. This may further stimulate criminality among immigrant groups.

From a regional policy perspective, these selected determinants are highly relevant, as most of them may be - more or less - affected by regional policy initiatives. Such policy initiatives may readily aim to reduce unemployment, increase income or stimulate educational attainment. Other initiatives or interventions may be targeted toward risky population segments, for example, information campaigns directed toward young people, initiatives to stimulate the integration of immigrants, etc.

In order to allow for more variability in these key determinants and to improve the efficiency of estimation, pooled data are analysed. Thus, a Seemingly Unrelated Regression approach is called for in order to account for intra-regional heterogeneity and inter-temporal correlation. Further, as the data are observed at sub-regional levels, the potential presence of spatial spillover as discussed above has to be controlled for. Finally, the above mentioned potential endogeneity among deterrence and crime rates needs attention. The study addresses this by applying an instrumental variable estimation.

The outline of the study is as follows. Section 2 outlines the methodological approaches, and Section 3 briefly presents the data for the study. After this, empirical results are presented and discussed in Sec-

tion 4. Finally, Section 5 presents the essential conclusions of the study.

2. Methodology

The point of departure is a linear regression model defined for each year for the $N = 45$ sub-regions by

$$y_t = X_t \beta + v_t, \quad v_t \sim N(0, \sigma^2 I) \quad (1)$$

where X_t is an N by K -dimensional matrix of K explanatory variables, y_t an N -dimensional vector of endogenous observations, and β a K -dimensional coefficient vector. Since pooled data for $T=3$ years are used, the residuals between years are correlated, and the variances within each year will vary across years, i.e., between any two years, the residual covariance reads as

$$E(v_t' v_s) = \sigma_{ts}^2 \quad t, s = 1, \dots, T. \quad (2)$$

To obtain efficient estimates of β , we apply Feasible Generalised Least Squares (F-GLS) estimation to obtain the Zellner (1962) Seemingly Unrelated Regression (SUR) estimates for β .

As the model is estimated using sub-regional data, spatial dependencies between the sub-regions have to be taken into account. It is intuitively clear that crime is not restricted to occur within a single sub-region, but rather flows over the sub-regional borderlines. Operationally the crime rate (y_t) may be determined not only by the explanatory variables in the sub-region itself (X_t), but also by values of X_t in the surrounding sub-regions. Further, if the criminal activity in the surrounding sub-regions is high, this activity may spill over and induce criminal activities in the sub-region in question. Like any other omission of relevant variables, ignorance of spatial spillover may bias the results obtained (Anselin, 1988). Operationally, spatial

spillover is specified as part of the residuals, thus obtaining the spatially autocorrelated (SAC) specification (Anselin, 1988)

$$y_t = X_t \beta + \varepsilon_t, \quad \varepsilon_t = \lambda \varepsilon_t^W + v_t. \quad (3)$$

where λ is a parameter specifying the magnitude of spillover, formally restricted to the interval between (-1) and (+1), but for most practical purposes restricted to be non-negative, while ε_t^W denotes the average of ε_t in the neighbouring sub-regions. Combining the features of the SUR specification (1)-(2) with the SAC specification (3) leads to an integrated specification conveniently denoted the SAC-SUR.

Next, potential endogeneity among crime rate and deterrence has to be accounted for. This is done by applying a two-stage least squares instrumentalization. Specifically, deterrence is in a first step regressed on the lagged values of crime rates, and predicted values of deterrence are obtained. In the second step, the above estimations are performed, replacing deterrence with these predicted values.

3. Data

Data on crime rates and the explanatory variables were obtained at the sub-regional level. Data were available for the years 2003 to 2005. One exception is foreigners, as this variable was only available from a 2002 census at the level of 16 larger regions. The values of the larger regions were imputed to the sub-regions forming the region in question, and the 2002 figures were further extrapolated to all three years from 2003 to 2005. Another exception is unemployment, which, at the sub-regional level, is available for 2004 only. These figures were extrapolated to 2003 and 2005. Table 1 provides full definitions of variables together with descriptive statistics.

Table 1. Definition of variables and descriptive statistics.

Variable	Definition	Mean	Std. Devn.
Crime rate	Ascertained crimes in completed preparatory proceedings/10,000 inhabitants	373.01	118.48
Deterrence	Percentage of crimes taken to a final sentence	61.51	12.63
Predicted Deterrence	Deterrence as predicted from previous year's crime rate	61.51	8.92
Wage	Average monthly gross wage and salary (PLN, 2003 prices)	2123.3	299.57
Education	Number of students and graduates in higher education per 100 inhabitants	5.91	6.88
Foreigners	Percentage of population who is non-Polish (2002 census for 16 regions)	1.12	2.17
Percentage 20-29	Percentage of population 20-29 years old	16.65	1.14
Percentage males	Percentage of population males	48.47	0.85
Urbanization	Percentage of population living in urban areas	59.65	19.62
Unemployment	Unemployment rate (2004)	20.38	6.29
Regional level	45 sub-regions		

Source: Central Statistical Office of Poland (GUS): Regional Data Bank

4. Results

The empirical estimation of a baseline pooled ordinary least square (OLS) model (i.e., unadjusted for intra-regional correlation, inter-temporal heterogeneity and spatial spillover) is provided by the second column of Table 2. The third column of Table 2 reports results for the SAC-SUR model (i.e., adjusted for intra-regional correlation, inter-temporal heterogeneity and spatial spillover), while finally an instrumentalized SAC-SUR (adjusted for endogeneity between deterrence and crime rate) appears in the fourth column. Throughout, all variables (except the constant term and the time trend) enter estimation in log transforms.

The simple OLS results do not provide evidence of any statistically significant relation between crime rate and deterrence, while the SAC-SUR results provide evidence of a counter-intuitive *positive* effect of deterrence on crime rate. Opposed to these simpler specifications, the final SAC-SUR instrumentalizes deterrence with lagged crime rate, whereby endogeneity between deterrence and crime rate is accounted for. Indeed, the results from this specification provide evidence of the expected negative effect of deterrence on crime rate.

Table 2. Estimated models for crime rate.

Variable	OLS	SAC-SUR	SAC-SUR (instrumentalized)
Constant	-0.572 (-0.10)	20.846 (2.12)**	8.693 (2.07)**
Time trend	-0.052 (-3.64)***	-0.073 (-6.58)***	-0.045 (-6.42)***
Deterrence	-0.032 (-0.36)	0.650 (7.67)***	-1.043 (-10.05)***
Wage	0.426 (3.02)***	0.087 (0.42)	0.282 (2.49)**
Education	0.015 (2.03)**	0.005 (0.87)	0.004 (0.70)
Foreigners	-0.016 (-1.63)	-0.023 (-1.17)	0.002 (0.19)
Percentage 20-29	1.191 (4.46)***	1.099 (2.97)***	0.240 (1.09)
Percentage males	-0.652 (-0.45)	-6.348 (-2.54)***	-0.737 (-0.70)
Urbanisation	0.530 (5.96)***	0.779 (5.35)***	0.289 (3.84)***
Unemployment	0.148 (2.97)***	0.085 (0.95)	0.141 (3.52)***
Spatial spillover (λ)	NA	0.423 (2.56)***	0.015 (0.08)
Number of observations	135	135	135
R ²	0.824	0.719	0.921

Note. T-values in parentheses. Significance indicated by ***(1%), **(5%), and *(10%).

The final column of Table 2 points to a negative time trend in the crime rates, i.e., the crime rate falls over time. Obviously, this tendency is highly desirable from a policy point of view. Further, the table provides evidence regarding varying risk profiles across certain population segments. A positive relationship between urbanization and crime rates is consistently reported for all three specifications and indicates that the tendency to commit crime is higher among urban

groups. Thus, policy initiatives directed toward urban areas is something that should be considered for the case of Poland.

Wage is positively related to crime rates, thus indicating that crime merely takes place in wealthy regions. This is in accordance with the arguments of Ehrlich (1973) and Entorf and Spengler (2000), who pointed out that income may be a proxy for illegal income opportunity, while it contradicts the argument of

Trumbull (1989) that high incomes should provide more opportunities for engaging in legal activities. For the present case, a potential policy implication is that stimulating wage increases is not a particularly important initiative. Rather, other aspects of social capital are more important target variables for policy initiatives. Thus, unemployment is, as expected and in accordance with the arguments and outcomes of previous studies (Entorf and Spengler, 2000; Small and Lewis, 1996; Papps and Winkelman, 1998), positively related to crime rates, i.e., an increase in unemployment leads to a fall in the opportunity cost of criminal activity.

In contrast to previous studies focused on Europe (Entorf and Spengler, 2000), the proportion of foreigners is not significantly related to crime rates. It should, however, be kept in mind that this variable is crudely operationalized, as it is only available from a 2002 census for the 16 larger regions. However, the result indicates that immigration may not be of major concern for Polish policy makers when it comes to initiatives directed toward the reduction of criminal activity.

Education seems to be unrelated to crime rates. However, the poor relationship may be due to the operational measure of education. Specifically, the proportion of population enrolled to higher education is measured, rather than the proportion of population holding higher education. Thus, it cannot definitely be rejected that policy initiatives aiming to stimulate educational attainment may reduce criminal activity.

Criminal activity seems to be unrelated to gender, as the percentage of males is unrelated to crime rates. This is not completely surprising, as the expected positive relationship was merely based on arguments concerning young males. However, the Polish data do not facilitate a cross tabulation of gender and age, so the issue cannot be pursued any further. There seems to be some evidence supporting the expected positive relationship among young people and criminal activity. Thus, regional policy initiatives directed toward young people, aiming to reduce their potential criminal tendencies, may be relevant.

Finally, a positive spatial spillover is reported. However, this spillover is not statistically significant when adjusting for the endogenous relationship between crime rates and deterrence. This result does not necessarily imply that spatial spillover effects are not in play; the regions forming the basis of the study are relatively large, and it may well be the case that a division into smaller observational regions may reveal the expected significantly positive spatial spillover.

5. Conclusions

The study shows that crime in Poland is governed by economic rationality, i.e., that the propensity to commit criminal activities is negatively related to deterrence. Thus, local efforts to increase the rate of deterrence indeed pay off. However, this conclusion does not occur in an easy, simple specification. The necessity of adjusting for endogeneity among deterrence and criminal activity is underlined, as an unadjusted specification lead to erratic conclusions in the form of positive relationship.

Further, the potential presence of higher risk profiles for certain population segments is shown. These profiles correspond to some extent to what is obtained by previous empirical studies based on European data. Specifically, it is found that urbanization, high proportions of young people and high unemployment rates are driving forces for criminal activity. Thus, from a regional policy perspective, initiatives aiming to reduce unemployment are worth considering. Likewise, policy initiatives and campaigns aiming to reduce criminal activities in urban areas and among young people may pay off. On the other hand, crime rates seem to be less related to educational attainment, percentages of foreigners and percentages of males. Thus, these population segments do not seem to be the most obvious target groups for policy initiatives.

Finally, the potential presence of spatial spillover patterns in criminal activity is shown to be less relevant. From a regional policy perspective, this implies that initiatives and policies directed toward criminal activities may well be formulated on a regional level and that coordination across regional borders of such an effort is less relevant.

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