



Crime in Colombia: more law enforcement or more justice?

Catalina Gómez¹ · Hermilson Velásquez¹ ·
Andrés Julián Rendón¹ · Santiago Bohórquez¹

Published online: 8 February 2017

© Springer Science+Business Media Dordrecht 2017

Abstract This study considers the effect that judicial and police efficiency exercised on crime in 25 of the 33 political-administrative divisions in Colombia during the period 2000–2011. Specifically, the study seeks to determine whether the reduction of crime was the result of increases in the cost of crime as a result of the strengthening of the country's security forces, especially the National Police, or instead was due to the greater efficiency of the penal system resulting from a structural change stemming from Act 906 of 2004. To view this we propose a model of dynamic panel data that not only includes the individual and temporal effects of the variables of interest, but also allows us to understand the inertia in criminal behavior. The results indicate an inverse relationship between the number of crimes and the greater efficiency of the police and judicial action, which is consistent with the evidence reported in other international work. Robustness checks confirmed the validity of the findings.

JEL classifications D61 · H83 · I38 · K14 · K42

✉ Catalina Gómez
cgomez11@eafit.edu.co

Hermilson Velásquez
evelas@eafit.edu.co

Andrés Julián Rendón
arendonc@eafit.edu.co

Santiago Bohórquez
sbohorqu@eafit.edu.co

¹ Department of Economics, School of Economics and Finance, Universidad EAFIT, Carrera 49 # 7 sur 50, Medellín-, Colombia

Introduction

Classical models of the Economic Theory of Crime argue that the criminal act reflects a rational choice made by an individual resulting from a comparison between the expected utility of a crime and the cost of committing the crime [1, 2]. Thus, the person engages in criminal activity if the expected gain derived from the criminal activity is higher than the expected sanction. If the penalty is greater than the gain, then we say that the potential offender has been deterred from committing a crime [3]. Thus, we can identify two approaches to crime reduction: increasing the probability of being caught or increasing the punishment as a sanction for the crime.¹ Studies on the reduction of crime have focused their analysis of deterrence on the availability of police, assuming that more police officers will increase the probability of catching criminals. However, few studies have considered the potential deterrent effect of judicial system efficiency on the potential criminal, as the sanction could outweigh the gain realized from crimes committed, and even fewer studies have simultaneously analyzed police and judicial efficiency.

Violence in Colombia was intense² at the beginning of the last decade, and in response, the national government initiated two separate processes: the consolidation and expansion of its security and defense sector, especially during the two administrations of President Uribe (2002–06 and 2006–10); and the implementation of the *Defense and Democratic Security Policy (DSP)*. Under both aspects a fiscal strategy was adopted to expand the defense sector, and consequently the budget increased from 4.6% of GDP in 2002 to 5.2% in 2009. These resources enabled investments in infrastructure, logistics, communications, intelligence and manpower. Between 2002 and 2010, the total number of members of the security forces, including military and police units, increased from 313,406 to 441,828. The most recent data shows growth of over 40% in manpower at the national level (Ministerio de Defensa Nacional [4]).

Higher investment in safety resources matches significant changes in the pattern of criminal activity, but the extent to which a causal relationship can be established in this area remains unclear. Little is known about the efficiency that was achieved by increasing resources to strengthen the coercive and state intelligence apparatus. Moreover, it is uncertain whether the reduction of some forms of crime comes from the efforts of the armed forces, particularly the police, or from institutional changes in the judicial system.

The Colombian justice system has undergone recent reforms intended to increase its efficiency, but it still suffers from a backlog in the cases it handles. In the late 1990s, the

¹ It is noteworthy that literature has considered additional causes that have an impact on the deterrence of crime: informal institutions, civic norms, and building social capital (see [5, 6]). This approach assumes that civic norms may attach guilt and shame to criminal behavior, thus increasing its opportunity cost. Besides, associated networks may increase returns to noncriminal activities and raise detection probabilities. Despite the relevance of this analysis, the interest of this paper is to study the effects of two approaches mentioned above, which are directly related to police and justice efficiency.

² Arbeláez [7] states that in 2002, there was “[...] a daily average of 79 murders, eight kidnappings, six terrorist attacks; 14% of municipalities without police presence; one of three mayors exiled from his jurisdiction by threats from guerrilla groups, which had a presence in 30 of the 32 departments of Colombia, or paramilitary forces, present in 27 of them.”

country's judicial institutions were described as only slightly independent, corrupt and inefficient, with a rate of 60% or less of new cases resolved each year [8]. The creation of the Attorney General's Office³ (a body between investigator and prosecutor) and the switch from an inquisitorial criminal justice system to an oral accusatory system with the Act 906 of 2004 have been important measures. However, delays and a limited capacity to expedite legal processes still restrict the efficiency of the legal system. Despite this situation, the initial results of the implementation of the new accusatory system seem promising as the system seeks to increase deterrence by being more flexible and increasing the expected punishment of the individual offender. The effect of this reform on the number of crimes committed is measured directly through the index of judicial efficiency and indirectly with a dichotomous variable. We also link, as control variables, the amount of drugs seized, the number of weapons seized, and economic growth, to the estimations of this study.

It is also important to highlight that, "the example of Colombia shows that economic factors can explain the ubiquitous nature of violence in that country only in the context of a socio-culturally rooted propensity to use violence" ([9], p: 62). Political violence exists since the time of the National Front, and then go through the drug war, guerrillas, paramilitaries, criminal gangs, and sophisticated groups that launder money with smuggling, corruption and "white collar" crimes, among many other criminal acts that have permeated all social, urban, and rural estates. Also, Pecaut [10] questions why actors of different manifestations of violence in the country have found a favorable territory for the development, which has been dynamically spread and have taken heterogeneous forms.

This article evaluates the effect of law enforcement and justice on the commission of crimes in 25 of the 33 political-administrative divisions in Colombia during the period 2000–2011. Toward this end, a model of dynamic panel data that explains the number of total offenses by two variables of interest and a set of control variables is proposed. The first two indices contain annual and political-administrative unit's information: one index measures the performance of the police and examines the effect of the policy (DSP) throughout the time period studied, and the other measures the judicial efficiency of the Attorney General's Office in the prosecution of the cases investigated. For the construction of these indices, data from crimes⁴ and arrests are used from five different offenses as well as criminal cases that are opened, closed or in process.

The results reveal that rates of police and judicial efficiency have a statistically significant and negative effect on crime. Additionally, the results show that the transmission mechanisms operate with a delay.

The article is divided into five parts. After the introduction, a theoretical framework is presented. Then, data, variables and strategy are described in a methodological section. Later, the calculated variables are described and the econometric results of the estimated model are shown. Finally, the Results are discussed in a concluding section.

³ Article 250, Colombian Political Constitution. The change was introduced by the Constitution of 1991 and therefore it is not an essential part in this research, it is mentioned only as illustratively.

⁴ The analysis presented in this paper is related to a period where the Defense and Democratic Security Policy (DSP) was prevailing. Thus, the main objective of police and justice was in reducing high-impact crimes such as murder, kidnapping, extortion, and theft. Some alternative crimes like corruption, fraud, money laundering and other "white collar" crimes, are not taken into account in this investigation. Probably, the deterrent effect of social control (informal institutions, civic norms) can be much clearer in those cases.

Theoretical framework

In the research on the causes of the deterrence of crime, many authors agree that there is an inverse relationship between the probability of being convicted and/or punished and the number of crimes committed. The greater the spending on police, prosecutors and specialized equipment, the greater the chance of solving crimes and catching criminals, according to Becker [1]. Thus, the analysis framed in *The Economics of Crime* concluded that a decrease in crime results from a greater effectiveness of the police force, the judiciary or both.

Since Becker, many authors have performed empirical studies to test the first of the three relationships described. Ehrlich [2] associated crime with arrests and noted that there are disincentives that deter criminals from committing crimes and positive incentives that lead to legitimate alternatives to criminal behavior. In this same line of thought, Garcia, Rodriguez and Dominguez [11] introduced a police efficiency variable based on the expected preventive effect of police efficiency on crime.

In addition, Gius [12] reported that higher per capita spending on police should lead to lower rates of crime over time given the odds of being convicted and imprisoned, which suggests that criminal behavior is an elastic variable in response to increased police strength, as stated by McCormick and Tollison [13]. Additionally, and as a complement to Kessler and Levitt [14] and Levitt [15], an immediate decrease in crime should be attributed to the deterrence concept that must be differentiated from the incapacitation one, as described by Di Tella and Schargrotsky [16].⁵

Empirically, DEA (Data Envelopment Analysis) is one of the most common methods that have been implemented, and has provided evidence of the deterrent effect of police on crime efficiency. Thanassoulis's work [17] examining the performance of the police in England and Wales is an example of the use of DEA. The DEA methodology corresponds to a nonparametric technique developed by Charnes, Cooper and Rhodes [18] and inspired by Farel [19] that requires the determination of *inputs* (inputs) and *outputs* (products) selected by the researcher.

For case of Spain and then in a global study, García et al. [11, 20] applied DEA to study the effect of police efficiency and effectiveness on crime. This effect is divided into operational efficiency and goal effectiveness. The former is the ability of the police at a given station to solve cases that were committed within the station's geographic area of responsibility, and the latter is the annual change in the crime rate.

The authors define efficiency as the impact of the police on the total welfare of the people for the next three years. They consider operational efficiency as the number of crimes committed, and goal efficiency as the operational effectiveness of past periods. In addition, efficiency has as an input the variation in the number of crimes. The outputs are the number of arrests, the inverse of the variance of the crimes committed for each of the efficiencies and population changes, and indicators of economic activity and tourism rates for three years after a given level of efficiency is achieved.

⁵ Deterrence refers to the reduction of crime that occurs due to police presence, and incapacitation is the reduction of crime after catching criminals and therefore the emergence of minor criminals engaging in criminal activity.

One of the most visible consequences of adopting the approach of the police force as the main deterrent to crime is the disproportionate increase in this force in election years, which is a strategy for collecting votes. Crime is a critical political issue, as in the opinion polls of citizens, this item is a top priority, and even more so when the economy is doing well. Therefore, this bolstering of the police force during election years as a response to crime, reinforces the findings in the literature that law enforcement is a critical deterrent to criminal behavior.

In addition, the operation of the judicial system has been studied in several investigations that propose strategies to reduce crime rates. These studies have found, for example, that changes in the certainty of punishment are better predictors of changes in crime rates than changes in the severity of punishment. Additionally, in the short term, immediate crime reduction is attributable to deterrence, whereas in the long term, the certainty of judgment plays a leading role as a deterrent in reducing the crime rate [14].

The deterrent effect of the judicial system depends on its effectiveness, which, according to Buscaglia and Dakolias [8], depends on predictability, speed in resolving cases and accessibility to the public, as it is the whole system that conducts the investigation of crime reported, solves the case and then dictates a sentence to punish the offender. Judicial efficiency has also been analyzed by the DEA method by Deyneli [21], Pedraja and Salinas [22], Tulkens [23] and Yeung and Azevedo [24]. In these studies, the inputs include the number of judges and administrative staff and the outputs are resolved cases.

Certain studies that examine performance of the police and the judicial system as crime deterrents use Becker [1] as a foundation. Becker argued that higher spending on police, prosecutors and specialized equipment increases the probability of solving crimes and apprehending criminals, which Rivera, Núñez and Villavicencio [25] demonstrated in the case of Chile. In contrast, Durlauf and Nagin [26] point out that there is little evidence showing that increases in the severity of punishment result in significant effects on deterrence, as in the case of the death penalty currently enforced in some U.S. states, which does not seem to reduce crime [3].

In addition to these two deterrent mechanisms that have been the focus of several studies, there are, according to other authors, additional types of causes of crime reduction. Corman and Mocan [27] consider the unemployment rate, the minimum wage and the number of residents in jail. The authors argue that in communities with a high level of social organization, it is more difficult and therefore expensive to victimize people for three primary reasons. First, potential victims and witnesses take greater risks to protect themselves from offenders. Second, criminal behavior is not socially acceptable. Third, it is common for police officers to stop and interrogate individuals who are acting in a suspicious manner, which ends in the apprehension of the offender. Furthermore, the number of weapons distributed in society has elicited important discussions involving those who believe in the deterrent effect of weapons [28] and those who do not [29, 30].

Levitt [31] also assigned importance to events and additional variables, showing that the unexpected decline in crime during the 1990s in the U.S. was the result of increased police, imprisonment, a reduction of crack use and the legalization of abortion. Similarly, to analyze the experience of Latin America, Soares and Naritome [32] referred to inequality, police presence and incarceration rates as determinants of crime incidence. Soares also argued that crime and violence are the second most important political issues in Latin America because they produce substantial losses in welfare and present a major obstacle to growth.

Methodology

The use of dynamic panel data is considered the most appropriate strategy for explaining the behavioral determinants of the total crimes per department. The independent variables of interest are indices that reflect the operational capacity of the police and the judicial system. The control variables that are considered appropriate in the Colombian context are related to drug trafficking, weapons, regional economic growth and a dummy variable that captures the effect of a structural change in the management of justice for the country since 2004.

Data

The empirical approach for the construction of indicators, which will be finally aggregated in the model, requires quantitative primary sources. Table 1 presents the descriptive statistics of this information, including data on occurrences for 13 crimes: manslaughter, kidnapping, auto theft, robbery of commercial establishments, robbery of financial institutions, motorcycle theft, robbery of people, robbery of residences, extortion, terrorism, and seizure of drugs and weapons. Table 1 also presents information regarding the way the judicial criminal system works: finished cases (processes) by year, new cases (processes) per year and cumulative cases (processes) that come from prior periods for each year. Series of departmental gross domestic product are also used. The frequency of these data is annual for the 2000–2011 period. The basic units of observation were 25 of the 33 political-administrative divisions of Colombia, comprising 32 departments and the metropolitan area of Bogotá.⁶

Data on crime occurrence and arrests per crime were obtained from the National Crime Police Magazine (issues 46–52). Information on incoming, outgoing and accrued lawsuits were obtained from the Attorney General's Office. The National Administrative Department of Statistics (DANE) provided regional GDP data.

Variables

The endogenous variable is the total number of crimes in a given year and department. The exogenous variables are synthetic indices that refer to police operability and judicial efficiency. By synthetic indices we refer to the fact that this are not directly measured on our original dataset, so neither the Attorney General nor the Police use these indices to determine efficiency.

The control variables considered are the seizure of drugs, weapons, economic growth and a dummy variable that captures the effect of institutional change, which led to the introduction of the accusatory criminal system in 2004. Each of these variables is briefly explained and defined below.

⁶ No individual data are available for eight departments because in these branches, there is no attorney's office. These departments include Amazonas, Arauca, Casanare, Guainía, Guaviare, Vaupes, Vichada and San Andrés, Providencia and Santa Catalina.

Table 1 Descriptive statistics from primary information

Variable		Observations	Media	Standard deviation	Minimum	Maximum
Crimes	Common homicide	300	763.2	1005.9	30	7269
	Culpable homicide	300	164.8	163	1	855
	Auto theft	300	463.8	1081.7	0	6923
	Robbery of local commercial establishments	300	475.6	783.8	2	5768
	Robbery of financial institutions	300	6.1	13.2	0	130
	Motorcycle theft	300	456.9	680.9	1	3874
	Robbery of people	300	1595.7	2602.4	12	16,676
	Residential robberies	300	589.1	944.5	13	5765
	Kidnappings	300	51.9	83.8	0	719
	Extortion	300	61.8	76.3	0	600
	Terrorism	300	26.4	38	0	342
Arrests	Common homicide	300	241	275	21	1293
	Culpable homicide	300	43.4	119.5	0	1549
	Auto theft	297	104.9	285	0	3348
	Robbery of local commercial establishments	275	325.6	553.4	0	3880
	Robbery of financial institutions	271	2.8	6.4	0	68
	Motorcycle theft	275	66.5	132.1	0	1395
	Robbery of people	300	1135	1859.4	2	13,825
	Residential robberies	275	181.7	311.4	0	3032
	Kidnappings	300	31.9	37.1	0	271
	Extortion	300	69.5	79.2	0	537
Lawsuits	Terrorism	300	7.7	11.6	0	87
	New processes	297	18,576.9	33,082.3	75	250,625
	Processes from prior periods	296	10,829.6	17,346.4	57	121,608
	Evacuated processes	296	19,533.8	33,476.3	97	224,445
	Seized drugs (kg.)	300	5295.5	9450.4	25.62	60,508
	Seized arms	299	2018.8	3141	109	24,949
	GDP	300	13,517.7	20,115.4	277	116,988
	Population	300	165,3368	1,612,173.0	89,038	7467,804

- Endogenous Variable

$del_{j,t}$: Total crime rate. This is defined as the rate of total number of crimes committed in department j in year t per 10.000 inhabitants. To calculate this occurrence, information for all offenses referred to in the data paragraph is used with the exception of seizures of drugs and weapons.⁷

⁷ The last two are introduced as control variables used in the econometric specification because their behavior is guided more by characteristics of the internal armed conflict (public safety) than by crimes commonly associated with citizen safety, which is the subject of police action more than of military forces.

- Exogenous Variables

$poi_{j,t}$: Police operability index is a synthetic measure of the comparative effectiveness of policing action in department j in year t , weighted by a bounded version of the rate of police efficiency, which is then normalized with respect to its distribution range per crime and department throughout the entire period.⁸ $iop_{j,t}$ is a value between 0 and 1, being 0 when the rate of efficiency (defined as the number of seizures per crimes committed) from all types of crime are at the minimum for a given year and department and 1 when the maximum occurs.

$jei_{j,t}$: Judicial efficiency index is a measure of the performance of general attorney's offices in processing criminal investigations in a specific department j in year t , which involves their ability to work through the backlog of cases.⁹ The index is a

⁸ The rate of police operation, $iop_{j,t}$, results from the weighted sum of apprehension for the five different types of crime committed. The variable $iop_{j,t}$ considers the same 11 crimes as $del_{j,t}$ but groups together two types of homicides and six types of robberies, resulting in five major types: homicide, theft, terrorism, extortion and kidnapping. The relative weight of apprehensions associated with each type of crime are given by a standard indicator from the rate of police efficiency, indicator $_{i,j,t}$, here understood as the number of captures for crimes committed for each offense type, in each year and department. Thus,

$$iop_{j,t} = \frac{\sum_{i=1}^n \left(\text{Apprehensions}_{i,j,t} * \text{Indicator}_{i,j,t} \right)}{\sum_{i=1}^n \text{Apprehensions}_{i,j,t}}$$

where $\text{apprehensions}_{i,j,t}$ is the number of seizures associated with criminal type i in department j in year t , and the average weight of seizures is defined as

$$\text{Indicator}_{i,j,t} = \frac{\text{EfficiencyRate}_{i,j,t} - \text{Min}_{i,j} \left(\text{EfficiencyRate}_{i,j,t} \right)}{\text{Max}_{i,j} \left(\text{EfficiencyRate}_{i,j,t} \right) - \text{Min}_{i,j} \left(\text{EfficiencyRate}_{i,j,t} \right)}$$

This, by construction, shows a measure whose range is between 0 and 1, where 0 represents a combination of no seizures and the worst relative efficiency rate for all crimes and 1 the best efficiency rate for each offense. The rate of police efficiency is defined as

$$\text{EfficiencyRate}_{i,j,t} = \frac{\text{Seizures}_{i,j,t}}{\text{Crimes}_{i,j,t}}$$

which may be greater than 1 when the number of seizures is greater than the number of crimes committed, either because there are more arrests or because seizures are made for crimes committed in prior periods.

⁹ The index of judicial efficiency is defined as

$$iej_{j,t} = \frac{\text{Evacuated}P_{j,t}}{\text{New}P_{j,t} + \text{Prior}P_{j,t}}$$

where $\text{Evacuated}P_{j,t}$ refers to the processes that leave the system in the department j and year t , $\text{New}P_{j,t}$ indicates the processes that entered the system in the same department and period t , and $\text{Prior}P_{j,t}$ refers accumulated processes by the system until t in j department.

bounded indicator between 0 and 1, which takes the minimum value when the system is unable to resolve any case in a given year, and the maximum when it is able to resolve both cases entering the system during the period in question and those from prior periods.

- Control Variables

$drugs_{j,t}$: Rate of number of kilograms of drugs seized in department j in year t per 10.000 inhabitants [33–35].

$arms_{j,t}$: Rate of the ratio between the number of weapons seized and the number of common homicides in department j in year t per 10.000 inhabitants [36].

$growth_{j,t}$: Growth rate of logarithm of the GDP per capita in department j in year t [32].

$dummy_{j,t}$: Dummy variable that takes the value of 1 for all departments in all years greater than or equal to 2004, when the new accusatory criminal system was introduced with Act 906 of the same year, which issued oral procedures into the Code of Criminal Procedure System.

Estimation methodology

The central purpose of this study is to evaluate the effect of police and judicial action on criminal behavior in the departments of Colombia during the period 2000–2011. In the estimating exercise, particular control variables were specifically chosen for Colombia: $drugs_{j,t}$, $arms_{j,t}$, $growth_{j,t}$ and $dummy_{j,t}$. The functional form of the model to be estimated is as follows:

$$del_{j,t} = f(poi_{j,t}, jei_{j,t}, arms_{j,t}, drugs_{j,t}, growth_{j,t}, dummy_{j,t})$$

The proposed specification corresponds naturally to an econometric panel data model in which it is necessary to consider the dynamics required to recover the history of the behavior of the total crimes for which certain inertial characteristics are presumed as well as the probable delayed effect caused by deterrent action and state repression against crime. It is expected that some increases in the rates of police and judicial efficiency will adversely affect the overall measure of crime.

Indeed, the first of them corresponds to the capacity for police action compared in a given department and given year considering the number of arrests for crimes committed. The second corresponds to the increased ability of the judicial system to manage, from beginning to end, all the cases (processes) it receives. Therefore, according to conventional economic theory on the commission of crime in response to containment and persuasion mechanisms - which would tend to reduce the total number of crimes committed- crimes can be forecasted.

The dynamic part of the estimation lets us take into account the effects that the indices may have over time on the crime rate. We capture the immediate effect where

we expect that an increase on the police efficiency and a higher justice efficiency in the previous period lead to a decrease in the crime rate. And by including lags of the dependent variable and using the Blundell Bond technique, it allows to disentangle the effect that higher efficiency may lead to higher crime reports over time as the percentage of non-reported crimes decreases, as this effect is captured by the lagged variables.

The model specification is estimated as follows:

$$\begin{aligned} del_{j,t} = & \delta + \beta_1 del_{j,t-1} + \beta_2 del_{j,t-2} + \beta_3 \Delta poi_{j,t} + \beta_4 jei_{j,t-1} + \beta_5 drugs_{j,t-1} + \beta_6 arms_{j,t} \\ & + \beta_7 growth_{j,t} + \beta_8 dummy_{j,t} + u_{j,t} \end{aligned}$$

with

$$u_{jt} = v_j + \varepsilon_{j,t}$$

$\varepsilon_{j,t}$: White sound random variable

v_j : Individual heterogeneity among the departments

Results

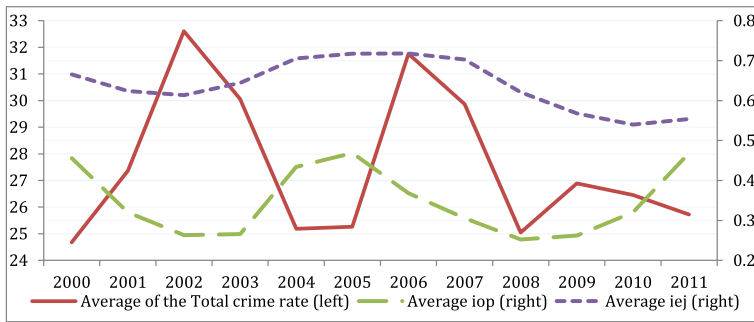
Stylized facts

The dynamics of the criminal activity in different departments of Colombia appear to follow a trend contrary to police and judicial system performance at different times for the period 2000–2011. Graph 1 shows the average total crime rate per 100,000 people and judicial efficiency indices throughout 25 political-administrative units considered here and during the analysis period. The results show a relative increase in crime over the course of the decade analyzed. Between 2000 and 2011, the average crime rate increased slightly (from 24.7 to 25.7 crimes per 100,000 pop.); the average from *iej* fell significantly (from 0.665 to 0.554); and the *iop* index ended at approximately the same level (from 0.456 to 0.469).¹⁰

Graph 2 shows maps that gather the overall crime rate directly from politico-administrative units in 2000 and 2011.¹¹ Criminality showed a declining tendency in the interior departments and an increasing tendency in the Atlantic Coast and border departments to the east and southwest of the country. Only in 12 of the 25 units did crime decrease. The departments that showed increasing crime rates per capita at the end of the decade were Meta, Caquetá, Valle del Cauca, Sucre, Magdalena and Boyacá, where the rate increased 373.7%, 105.7%, 102.5%, 100.3%, 96.6% and 76.7%, respectively. However, crime showed a greater reduction in Norte de Santander,

¹⁰ When calculating the total crime rate directly from 100,000 people in the population over the whole territory, and not as an average among political and administrative units, it is possible to identify a slight reduction between 2000 and 2011. Indeed, in that scenario the crime rate fell from 26.73 to 26.43. However, this reduction is relatively insignificant considering the length of the period.

¹¹ The scales of the maps are identical, and the quintiles represent the joint distribution of the 50 data points per crime committed in both 2000 and 2011.



Source: Based on data from the National Police Crime Magazine; and the Attorney General's Office

Graph 1 Averages of the Total crime rate, *poi* and *jei* for 25 political-administrative units in Colombia, 2000–2011

Atlantic, Risaralda, Santander, Antioquia and Chocó, where the rate fell 93.2%, 89.2%, 88.1%, 74.2%, 57.9% and 45.1%, respectively.

Analyses from the spatial distribution of the three variables of interest suggest that the changes over the course of the decade with regard to committed crimes and *poi* were different from one unit to another. The change in *jei* was almost totally negative. The police operability showed better performance in most of the departments at the end of the decade, but there were many cases in which the opposite occurred and the average level remained virtually unchanged.¹² Besides, the judicial efficiency index has consistently reduced over the course of the decade throughout the whole territory.¹³

Estimation results

The model

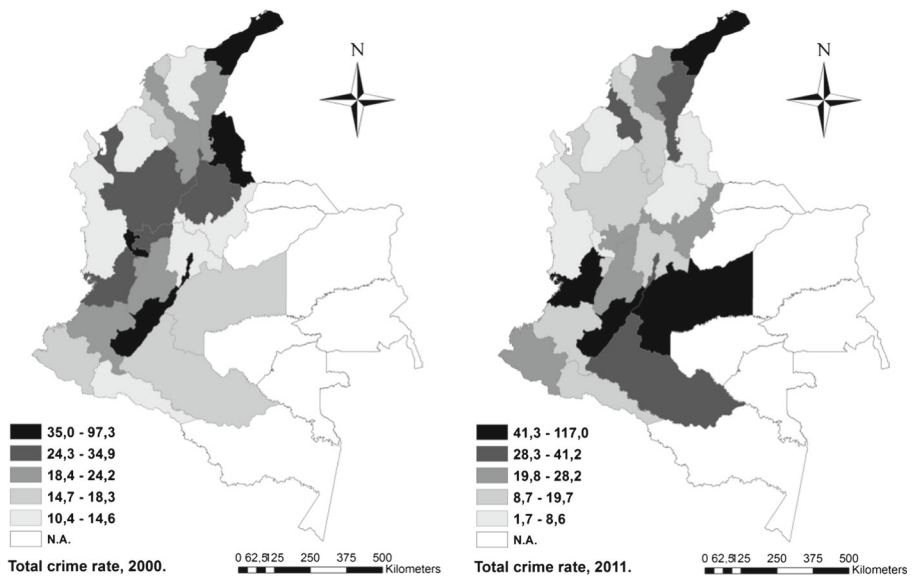
$$\begin{aligned} del_{j,t} = & \delta + \beta_1 del_{j,t-1} + \beta_2 del_{j,t-2} + \beta_3 \Delta poi_{j,t} + \beta_4 jei_{j,t-1} + \beta_5 drugs_{j,t-1} + \beta_6 arms_{j,t} \\ & + \beta_7 growth_{j,t} + \beta_8 dummy_{j,t} + u_{j,t} \end{aligned}$$

was estimated as a dynamic panel following the methodology of Arellano and Bover [37] and Blundell and Bond [38], which uses lagged variables as instruments to avoid problems of serial correlation that bias the parameters.

The estimation methods used are robust to heteroscedasticity problems; reports of statistical tests in relation to the unit roots, correlation, and endogeneity that are needed to ensure the theoretical assumptions under which the results are valid are provided in Appendix 1. Table 2 presents the report of the estimation model.

¹² The political-administrative units with a value in *iop* below 0.5 increased from 12 in 2000 to 17 in 2011. However, the change was positive in 13 units, among which Risaralda, Cauca, Norte de Santander, Santander, Atlántico and Chocó stand out. The situation was different in departments such as Guajira, Valle del Cauca, Meta, Magdalena, Huila and Cesar, where the indicator deteriorated.

¹³ The index of judicial efficiency was below 0.57 in 60% of the political-administrative units that were studied in 2011, whereas in 2000, only one of the units was below that level. Also, the indicator was worse in 2011 than in 2000 in all units except Caldas and the Atlantic departments. The worst judicial performance departments were Huila, Meta and Cesar.



Note: The considered ranks were based on the quantiles of variables' distributions.

Software: ArcGIS

Graph 2 Maps of the total crime rate in 25 political-administrative units in Colombia 2000 and 2011

The results confirm that for the exogenous variables rates of police effectiveness, *poi*, and judicial efficiency, *jei* have the expected sign and are statistically significant. The transmission mechanism also operates with a delay that goes in line with the

Table 2 Estimation results

Variable	abgmm1
Total crime rate	
L1.	.845***
L2.	.0956***
Poi	
D1.	-12.871***
Jei	
L1.	-8.729*
Drugs	
L1.	-0.002
Arms	-.1872***
Growth	-159.777**
Dummy	-4.455***
Constant	171.026**

* $p < 0.10$; ** $p < 0.05$;

*** $p < 0.01$

economic theory of crime and this paper's hypothesis. In the case of prosecution, the results suggest significant effects on crime one year after its implementation, and deterrence seems to be mitigated by the high volume of pending cases. Additionally, the police action seems to have had an impact based on the positive changes in the operational effectiveness of the police from one year to another.

Regarding control variables, the results show that, although not statistically significant, the rate of drug seizure is inversely related to the crimes. For the growth of GDP in each department and the rate of seizure of arms, the findings show that the effect is statistically significant and negative. These findings suggest that an increase in the proxy of legal income (departmental GDP) would decrease crime, which is consistent with Becker's [1] proposition that committing crimes is more expensive compared to the expected returns from legal activity. Additionally, the negative sign of the parameter associated with the weapons seizure can be explained from two perspectives: first, by the appellant hypothesis in the literature that argues "more guns, more crime" [30], and second, based on the increased potential cost of crime that demands the use of weapons, whose use is reduced by police action. Finally, the results validate the hypothesis that institutional change of the judicial system in 2004 reduced crime.

To evaluate the robustness of the results, different specifications were taken into account with the final objective of considering variant forms of exogenous variables, endogenous variables and estimation methods. Table 3 reports five of the

Table 3 Robustness tests

Variable	Model 2	Model 3	Model 4	Model 5	Model 6
Total crime rate					
L1.	.829***	.881***	.9049805***	.874***	.849***
L2.	.108***	0.026	-0.009	.0806***	.0875**
Poi					
D1.	-13.437***	-13.861***	-13.935***		-12.020***
L1.				6.003**	
Jei					
L1.	-9.432**	-8.496**	-6.517		
D1.					9.197**
Drugs					
L1.	-0.001	-.007**	-.006*	-.003*	-0.001
Arms	-.188***	-.233***			-.184***
Growth	-170.067**	-189.307**	-165.757**		-155.708**
Dummy	-5.170***	-4.942***	-3.734***	-4.873***	-4.724***
iej2 (=EvacuatedP/NewP)					
L1.				1.249	
Arms/population (rate × 10,000 pop)			0.148	0.142	
Growth					0.916
Constant	174.874**	199.774**	15.108*	173.606**	161.697**

* $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$

estimated models, and overall, we can conclude that the variables of interest retain the significance and expected signs under the assumptions, as shown by the fact that the confidence intervals for the parameters have very similar features, ensuring the consistency of the estimates. However, when considered variables change its specification, the parameters undergo a change of sign, which is a counterintuitive result that is not supported by economic theory. Then, the obtained results in the experiment verify the robustness of the model estimated initially. Robustness tests designed with partial changes in the specification of checks and the structure of the variables of interest support the validity of the findings.

Conclusions

Over the past decade, Colombia has made substantial efforts to expand and strengthen its military and police forces while making major changes to its criminal law. These efforts have unevenly affected the commission of certain crimes in time and space, but little research has been conducted to establish the extent to which a causal relationship between these phenomena exists. In fact, it is interesting to estimate the direction of the potential impact to test the theoretical hypothesis that the criminal acts rationally, conducting a cost-benefit analysis that considers the threat of arrest by the police or prosecution by the judges as an opportunity cost for committing crimes.

The results support our initial hypothesis indicating that increased efficiency in police or judicial operations reduces the overall crime rate.¹⁴ Nonetheless, the effect of repressive police action seems to have a stronger statistical relationship than the action of justice persuasion. The dummy variable that captures the effect of changing the criminal law adversely affects the dependent variable, which would strengthen the traditional effect of the greater efficiency of the judicial system as a whole. Thus, in terms of public policy, police personnel will require access to adequate technical, mobility and research resources. Further, the police must have support from departmental and local authorities to improve the operational and research capabilities of these forces. They must allocate its own resources to complement the fiscal effort of the national government in this subject. On the other hand, the findings suggest that the prosecuting body requires strategies that will allow for a better use of resources to reduce the caseload of its various units.

Increased access to legal income, as seen through regional economic growth, reduces criminal activity, presumably as a result of lower incentives to engage in this activity. Specifically, efforts to foster regional economic growth will facilitate the realization of legal opportunities.

The number of weapons seized also adversely affects the magnitude of crimes because it increases the cost of the means to commit a crime. As the deterrent effect

¹⁴ As mentioned above, in this paper we take into account only crimes affecting democratic and public security (as were called by the policing strategy implemented during the period 2002–2010), but not those “white collar crimes” related to other criminal actions such as corruption and fraud. Therefore, even though the impact informal institutions may have in reducing crime is recognized, this is not the approach taken into account in this analysis.

of the seizure of weapons on crimes showed, it is appropriate for different levels of government to promote the seizure of arms in order to facilitate the operation of authorities in reducing crime.

From the point of view of public policy promoting regional security, these results are relevant. Certainly, it seems that the effectiveness of the police and judicial system at the regional level are the factors that affect criminal activity in the territory rather than increasing the severity or length of sentences. Thus, conducting research on the specific institutional mechanisms through which positive, significant and stable changes can be induced in the performance of these factors is vital.

Now, one cannot ignore that in addition to all the problems of drug trafficking in Colombia, from later time there are inherent problems of a society and its cultural rootedness to illegality, forcing us, although this is not the focus of this study, to think about the institutional aspects. In addition, As Toumi [39] expressed the drug problem that perhaps has been a permanent “excuse” to hide structural problems of the Colombian society, has also been subject of Andean countries such as Bolivia and Peru. However, the proper characteristics of their society, the formal and informal institutions of each country, and many other cultural aspects, make the violence indicators very different, particularly, informal social control seems to be an important factor in keeping Peru’s crime rate low [40]. In the same line, Toumi quotes Betancur and Garcia [41] who refer to the importance of political, cultural, and moral values environments in Colombia, which have been enablers for the development of organized crime in the country.

Thus, when you want to analyze the inertia of the violence in the country, you cannot keep thinking that Colombia is a victim of the demand of cocaine. In this regard, Toumi [39] states that economic incentives are one of the factors that promote crime, but the social attitudes toward illegal activities and the weakness (or strength) of the behavior control internalized by each individual, are also important variables.

Appendix 1: Statistical tests

The results of statistical tests that validate the robustness of the model are presented in the table. Among these are unit root tests and the Sargan and Hansen tests to eliminate possible endogeneity problems.

Test	Characteristic	Statistical value	<i>P</i> value	Conclusion
Pesaran-Shin	Unit Root	-21.086	0.018	Some panels are stationary
AR(1)	Autocorrelation	-2.41	0.016	First lag correlation
AR(2)	Autocorrelation	-1.39	0.166	No second lag correlation
AR(3)	Autocorrelation	1.18	0.237	No third lag correlation
Sargan	Instrument validation	216.47	0.347	Instruments are valid
Hansen	Instrument validation	18.7	1	Instruments are valid
Hansen in levels.	Instrument validation in levels	-4.36	1	At levels, the instruments are valid
Hansen subgroup	Instrument validation in levels	14.56	0.951	The main instruments are valid

The Arellano-Bond test considering three lags ensures no autocorrelation between errors and lagged exogenous variables.

The Sargan and Hansen tests help ensure the validity of the instruments used in the estimated individual and overall models.

References

1. Becker, G. S. (1968). Crime and punishment: An economic approach. In *The Economic Dimensions of Crime* (pp. 13–68). Palgrave Macmillan UK. London, UK.
2. Ehrlich, I. (1974). Participation in illegitimate activities: an economic analysis. *National Bureau of Economic Research*, 68–134.
3. Levitt, S., & Miles, T. (2006). Economic contributions to the understanding of crime. *Annual Review of Law and Social Science*.
4. Ministerio de Defensa Nacional. (2010). *Logros de la política de consolidación de la seguridad democrática - PCSD* (1st Ed.). Bogotá, Colombia.
5. Lederman, D., Loayza, N., & Menéndez, A. (2000). Violent crime: Does social capital matter? *University of Chicago Press*, 50(3), 509–539.
6. Buonanno, P., Montolio, D., & Vanin, P. (2009). Does social capital reduce crime? *The journal of law and economics* 2009, 52(1), 145–170.
7. Arbeláez, A. (2012). *La Política de Seguridad Democrática en Colombia: Análisis de su discurso, políticas y resultados durante la administración de Uribe*. Washington, DC: NDU.
8. Buscaglia, E., & Dakolias, M. (1999). An analysis of the causes of corruption in the judiciary. Legal and judicial reform unit, Legal Department, The World Bank.
9. Waldmann, P. (2007). Is there a culture of violence in Colombia? *Terrorism and Political Violence*, 19(4), 593–609.
10. Pecaut, D., & González, L. (1997). Presente, pasado y futuro de la violencia en Colombia. *Desarrollo Económico*, 36(144), 891–930 Retrieved from <http://www.jstor.org.ezproxy.eafit.edu.co/stable/3467131>.
11. García Sánchez, I., Rodríguez Domínguez, L., & Parra Domínguez, J. (2015). Relationship between police efficiency and crime rate: a worldwide approach. *European Journal of Law and Economics*, 39(1), 203–223.
12. Gius, M. (1999). The economics of the criminal behavior of young adults. *American Journal of Economics and Sociology*, 58(4), 947–957.
13. McCormick, R. E., & Tollison, R. D. (1984). Crime on the Court. *Journal of Political Economy*, 92(2), 223–235.
14. Kessler, D., & Levitt, S. (1998). Using sentence enhancements to distinguish between deterrence and incapacitation. NBER Working Paper Series.
15. Levitt, S. (1995a). Why do increased arrest rates appear to reduce crime: deterrence, incapacitation, or measurement error? NBER Working Paper Series.
16. Di Tella, R., & Schargrodsky, E. (2004). Do police reduce crime? Estimates using the allocation of police forces after a terrorist attack. *The American Economic Review*, 94(1), 115–133.
17. Thanassoulis, E. (1995). Assessing police forces in England and Wales using data envelopment analysis. *European Journal of Operational Research*, 87(3), 641–657.
18. Charnes, A., Cooper, W., & Rhodes, E. (1978). Measuring the efficiency of decision making units. *European Journal of Operational Research*, 2(6), 429–444.
19. Farrell, M. J. (1957). The measurement of productive efficiency. *Journal of the Royal Statistical Society. Series A (General)*, 120(3), 253–290.
20. García-Sánchez, I. M., Rodríguez-Domínguez, L., & Domínguez, J. P. (2013). Evaluation of the efficacy and effectiveness of the Spanish security forces. *European Journal of Law and Economics*, 36(1), 57–75.
21. Deyneli, F. (2012). Analysis of relationship between efficiency of justice services and salaries of judges with two-stage DEA method. *European Journal of Law and Economics*, 34(3), 477–493.
22. Pedraja, F., & Salinas, J. (1996). An assessment of the efficiency of Spanish courts using DEA. *Applied Economics*, 28(11), 1391–1403.
23. Tulkens, H. (1993). On FDH efficiency analysis: some methodological issues and applications to retail banking, courts, and urban transit. *JPA*, 4, 183–211.
24. Yeung, L., & Azevedo, P. (2009). Measuring efficiency of Brazilian courts with data envelopment analysis (DEA). *IMA Journal of Management Mathematics*.

25. Rivera, J., Núñez, J., & Villavicencio, X. (2004). Crimen y disuasión: evidencia desde un modelo de ecuaciones simultáneas para las regiones de Chile. *El trimestre económico*, 811–846.
26. Durlauf, S., & Nagin, D. (2011). Imprisonment and crime. *Criminology*, 10(1), 13–54.
27. Corman, H., & Mocan, N. (2002). *Carrots*. NBER Working Paper Series: Sticks and Broken Windows.
28. Lott, J. (2010). *More guns, Less crime*. Chicago: University Of Chicago Press.
29. Ayres, I., & Donohue III, J. J. (2002). *Shooting down the more guns, less crime hypothesis* (No. w9336). National Bureau of Economic Research. Cambridge, Massachusetts.
30. Duggan, M. (2000). *More Guns, More Crime*. National Bureau of Economic Research: Working Paper.
31. Levitt, S. (2004). Understanding why crime fell in the 1990s: four factors that explain the decline and six that do not. *Journal of Economic Perspectives*, 18(1), 163–190.
32. Soares, R. R., & Naritomi, J. (2010). Understanding high crime rates in Latin America: The role of social and policy factors. In *The economics of crime: Lessons for and from Latin America* (pp. 19–55). University of Chicago Press. Chicago, Illinois.
33. Buonanno, P. (2003). *The socioeconomic determinants of crime: a review of literature*. Working Paper Series: Department of Economics, University of Milan-Bicocca.
34. Freeman, R. (1991). Crime and the employment of disadvantaged youths. NBER Working Paper Series.
35. Uppimmy, R., Esther, D., & Parra, J. (2013). Addicted to punishment: the disproportionality of drug laws in Latin America. *Colectivo de Estudios de Drogas y Derecho*.
36. Sánchez, F., Espinosa, S., & Rivas, S. (2003). ¿Garrote o Zanahoria? Factores Asociados a la Disminución de la Violencia Homicida y el Crimen en Bogotá, 1993–2002. CEDE.
37. Arellano, A., & Olympia, B. (1995). Another look at the instrumental variable estimation of error-components models. *Journal of Econometrics*, 68(1), 29–51.
38. Blundell, R., & Bond, S. (2000). GMM estimation with persistent panel data: an application to production functions. *Economic Review*, 19(3), 321–340.
39. Toumi, F. (2001). Drogas ilegales, economía y sociedad en los Andes. In *Centro de Estudios y Observatorio de Drogas y Delito-CEODD-Facultad de Economía*. del Rosario: Universidad.
40. Walters, G. D. (1992). *Foundations of Criminal Science: The development of knowledge* (Vol. 1). Greenwood Publishing Group.
41. Betancourt, D., & Martha Luz García Bustos García B. (1994). *Contrabandistas, marimberos y mafiosos: historia social de la mafia colombiana, 1965–1992*. Bogota: TM Editores.