



**LUND UNIVERSITY**

School of Economics and Management

**Master programme in Economic History**

## **Temporal Persistence of the Homicide Rates in the Colombian Municipalities.**

**Jairo Céspedes Arias.**

**jairo.cespedes\_arias.809@student.lu.se**

*Abstract: The objective of this paper is to determine the existence of temporal persistence in the homicide rates in the Colombian regions, or in other words, to determine the existence of a relationship between the past and present homicide rates. In order to achieve this objective, in this study was analyzed longitudinal data with annual observations for all the municipalities of the country. The results from this analysis suggests the presence of a certain degree of criminal inertia, which implies that in the Colombian context, the homicide rates in the present can be predicted to some extent by the homicide rates in the past.*

*Key words: Colombia, Homicide rate, Criminal inertia, Criminal dynamics.*

**EKHM53**

Master thesis, (15 credits ECTS)

August 2015

**Supervisor: Lennart Schön**

Examiner: Erik Green

Word Count:

## 1. Introduction.

Over the last decades Colombia has experienced one of the highest homicide rates in the world. At its historical peak in the early 1990s, the national rate reached the figure of 81 homicides per 100,000 inhabitants, which was three times higher than that presented in particularly violent countries like Brazil and Mexico (Gaviria, 2000, p. 2). From this historical peak, the homicidal violence in Colombia has exhibited a clear downward trend, however, even today the national homicide rate is at alarming levels<sup>1</sup>.

As would be expected in this context, several studies from different disciplines have attempted to understand the causes underlying the high levels of homicidal violence in the country. In broad terms, these studies have focused on estimating the effects of socioeconomic and conflict-related variables over the homicide rate. However, despite this great academic interest on the subject, little is known about the temporal interactions of homicide, and in particular, about the presence of temporal persistence in the homicidal violence.

With the above in mind, the aim of this research is to determine the existence of a relationship between the homicide rates in the past and the homicide rates in the present. In other words, this paper seeks to provide some clarity on whether the levels of violence in the past can predict to some extent the levels of violence in the present. In order to achieve this objective, will be analyzed official longitudinal data with annual observations for all the Colombian municipalities. In particular, this data will be analyzed using two methodological approaches, the first consists in a correlation analysis using scatter plots, and the second consists in an econometric estimation of a panel data model. In broad terms, the period of time covered by this study is 1993 - 2013.

---

<sup>1</sup> According to information from the United Nation Office on Drugs and Crime, the global average homicide rate in 2013 was 6.2 homicides per 100,000 inhabitants, in the same year, Colombia presented a homicide rate of 34.12 homicides per 100,000 inhabitants.

It is important to point out that a research of this nature contributes to the literature on the determinants of violence and crime, and at the same time, can provide new elements to understand the temporal dynamics of the homicide rates in the Colombian regions. The above is highly relevant from an academic point of view, but it is also relevant for its multiple implications for public policy.

With these considerations in mind, the rest of the paper is organized as follows. Section two presents an overview of the evolution of the Colombian homicide rate in the last decades. The third section briefly discusses the costs associated with violence and crime. Section four presents a literature review on the determinants of homicide, and introduces the concept of criminal inertia. The fifth section exposes the dataset and its sources. Section six presents the methodological approach. Section seven discusses some implications of the findings of the study. Finally, section eight draws some general conclusions.

## **2. Historical Evolution of the Homicide Rate in Colombia.**

This section presents a brief overview of the historical behavior of the homicidal violence in Colombia for the period 1946 - 2013, and additionally, discusses the evolution of this variable for the three major cities of Colombia for the period between 1985 and 2013.

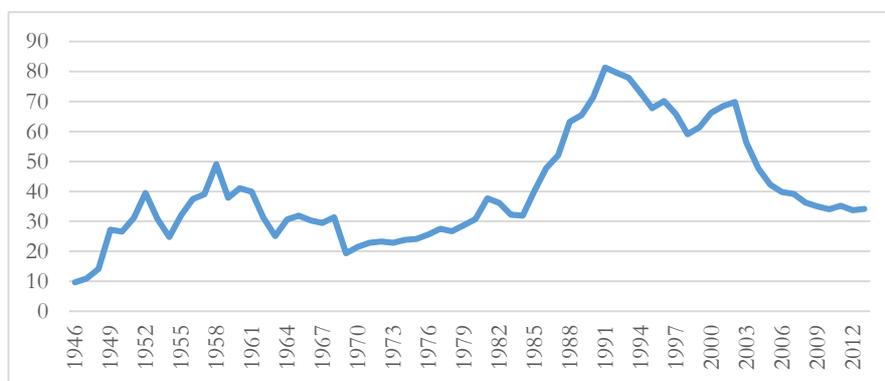
### **2.1. Evolution of the National Homicide Rate**

As can be observed in Figure 1, since the mid twentieth century the national homicide rate has presented periods of rapid growth, periods of decline and periods of stability. The first period of intensification of the homicidal violence occurred between 1946 and 1958, when the total homicide rate increased by a factor of nearly five, from a level of 10 homicides per 100,000 inhabitants, to 49 homicides per 100,000 inhabitants. This sharp growth was associated with a historical period known as *La Violencia*, which was characterized by intense confrontations between the supporters of the two main political parties. This violent period came to an end in 1958, when the parties reached an agreement to share the political power and alternate the presidency of the country

(Henderson, 2001, p. 374). As a result of the agreement, the national homicide rate experienced a period of rapid decline, which was followed by a period of almost two decades of relative stability.

As can be seen in Figure 1, the stable trend changed in the late 1970s, when the national homicide rate started to grow dramatically, peaking in 1991 with a striking figure of 81 homicides per 100,000 inhabitants. At this historical peak, the Colombian homicide rate was three times higher than that presented in traditionally violent countries like Brazil and Mexico, seven times higher than that of the United States, and fifty times higher than the European average (Gaviria, 2000. p. 82). According to some authors, the rapid progression of the homicide rate during this period can be attributed largely to the economic and military consolidation of the drug cartels, and the direct confrontation of some of these cartels against the Colombian authorities. (Levitt and Rubio, 2000 & UNODC, 2006)

**Figure 1. Homicide rate in Colombia (x 100,000 inhabitants) 1946-2013.**



*Source: Conflict Analysis Resource Center (CERAC) based on data from the National Police of Colombia and the National Planning Department (DNP).*

After this historical peak, the national homicide rate experienced a marked downward trend, which was interrupted between 1999 and 2002, when the homicidal violence experienced once again a significant increase, reaching the 70 homicides per 100,000 inhabitants. According to Sánchez, Diaz and Formisano (2003), this temporal growth of the homicide coincided with a period of consolidation and strengthening of the guerrillas and the right-wing paramilitary groups.

From 2002 onwards, the national homicide rate has experienced a systematic decrease. However, it is important to note that this decrease has significantly reduced its pace in the recent years, and additionally, it is relevant to highlight that the current homicide rate is at a level similar to that experienced during the mid-1980s. To put the figures in perspective, according to data from the National Police, the homicide rate in Colombia in 2013 was 34.12 homicides per 100,000 inhabitants, meanwhile, according to information from the United Nation Office on Drugs and Crime, the world average in the same year was only 6.2 homicides per 100,000. In this sense, despite the steady decline in recent years, the homicide rate in Colombia still remains at alarming levels.

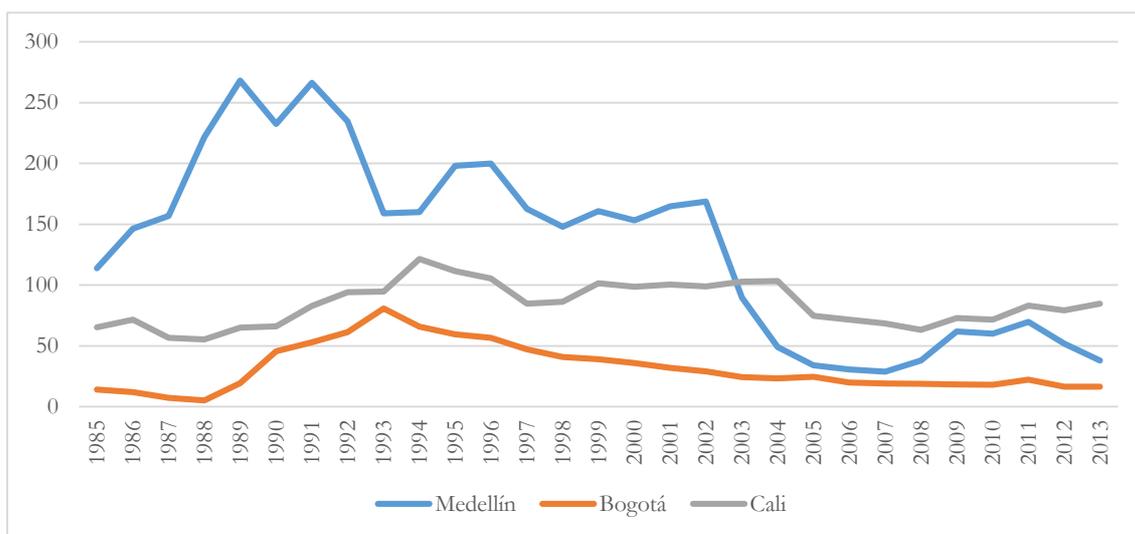
## **2.2. Evolution of the Homicide Rate in Colombia's Three Major Cities.**

Given the particularities of the Colombian case, the behavior of the homicidal violence has not been homogenous among the different cities and regions. With this in mind, the aim of this section is to present a brief overview of the recent evolution of the homicide rates in Bogotá, Medellín and Cali, the three major cities of Colombia.

It is important to note that the behavior of the homicidal violence in these cities has largely determined the national homicide rate. For instance, at the peak of violence in 1991, the homicides of Bogotá, Medellín and Cali represented 38% of the national total (Levitt & Rubio, 2000, p. 8). In the same direction, Levitt and Rubio (2000) graphically show that the rapid decrease of the national homicide rate between 1991 and 1997, was mostly due to the reduction of the homicidal violence in the three cities.

With that in mind, Figure 2 illustrates the behavior of the homicide rate per 100,000 inhabitants in Bogotá, Medellín and Cali for the period between 1985 and 2013.

**Figure 2. Homicide rates (x 100,000 inhabitants) in Colombia's three largest cities.**



*Source: Conflict Analysis Resource Center (CERAC) based on data from the National Police of Colombia and the National Planning Department (DNP).*

From the graphic it is clear that every city has followed a distinctive pattern. For instance, Bogotá, the country's capital, presented a stable and relatively low level of homicidal violence between 1985 and 1988. From that year, the homicide rate grew rapidly, peaking in 1993 with a figure of 81 homicides per 100,000 inhabitants. After this peak, the homicide rate in Bogota presented a steady and slow decline.

Medellín for its part, showed a rapid progression of the homicidal violence between 1985 and 1989, in this year, the homicide rate displayed a shocking figure of 268 homicides per 100,000 inhabitants. The city's homicide rate remained at these remarkably high levels for a couple of years, but since 1991 the rate started to decline sharply. This decline stops in 1993, and from that year until 2002, the homicide rate presented a relatively stable level at approximately 170 homicides per 100,000 inhabitants. From 2002 until 2008, the homicidal violence decreased markedly, however, this trend was reversed between 2007 and 2011, when the homicide rate presented a temporal increase. After this period of growth, the homicide showed once again a downward trend. According to Levitt and Rubio (2000), the marked fluctuations in the city's homicide rate in the 1980s and 1990s were closely related with the periods of consolidation and fall of the Medellín Cartel.

In the case of Cali, the homicide rate showed a period of constant growth between 1985 and 1994 when reached its peak, at this moment, the homicide rate was 121 homicides per 100,000 inhabitants. From that year until 1997, the homicidal violence experienced a slight fall, however, from 1997 onwards, the homicide rate exhibited a relatively stable pattern. It is important to note that contrary to the case of Medellín, the city of Cali has been unable to consistently reduce its homicide rates. According to the UNODC (2006), this phenomenon can be understood to the extent that the drug cartels of that region were never completely dismantled.

### **3. Costs of Violence in Colombia.**

Given the high levels of violence experienced by Colombia in the past decades, it is important to understand and measure the social and economic costs that this entails. In broad terms, the literature identifies three different types of costs imposed by violent crime. The first cost is related with the reallocation of public and private resources to prevent and control crime. The second is associated with the destruction of human and physical capital. And the third is related with overall losses in productivity (Levitt & Rubio, 2000, p. 9).

In the Colombian context, some studies have tried to measure this costs. For instance, the research of Rubio (1997) estimates that during the 1990s, the private expenditure on security and protection represented nearly 1.4% of the GDP. Meanwhile, Trujillo and Bandel (1998) attempted to calculate the costs associated with the destruction of human capital. According to the authors, between 1991 and 1996, the human capital losses associated with homicides imposed a cost of about 1% of GDP. In a more recent study, Pinto et al. (2004) conclude that for the period 1999 – 2003, the costs of the armed violence were approximately 7.4% of the national GDP of 2003. In last place, the study of Villamarín (2011) represents an important attempt to measure the costs related with the homicidal violence in Colombia. In this research the author uses a value of life approach, and found that between 1990 and 2005, the homicides generated a loss of welfare of 7,3% of the real GDP of 2009.

In this sense, it is possible to conclude that besides the obvious moral and social costs, the high levels of homicidal violence in Colombia impose heavy economic and welfare losses. Therefore, to study the determinants of crime and violence is a highly relevant task, to the extent that it can provide elements to prevent and intervene in contexts of high violence.

#### **4. Literature Review and Theoretical Framework.**

Having in mind the recent historical evolution of Colombia's homicide rate, and taking into account the potential costs that this phenomenon entails, this section presents a literature review on the determinants of the homicide and crime in Colombia, and additionally, exposes the concept of criminal inertia. Both subjects are highly relevant for the development of this research and provide elements for a better understanding of the temporal dynamics of the homicidal violence in the country. This literature review is not meant to be exhaustive, but rather, it is meant to focus in the most relevant studies.

##### **4.1. The Determinants of Homicide and Crime.**

In broad terms, the literature about the determinants of homicide and crime can be grouped into two trends. In the first group, the crime is understood as a result of poverty, inequality, unemployment and in general, social exclusion. Some authors in the literature refer to this approach as the hypothesis of the objective causes of violence. The second group of literature is based on the economic theory of crime developed by Becker (1968). According to this theory, the criminal behavior of an individual is the result of a rational, maximizing behavior, in which the agent evaluates the costs and benefits of committing crime.

In the Colombian context, several studies have attempted to assess the causes of the homicides and violence. One of the first researches on this subject was conducted by the

Commission for the Studies on Violence<sup>2</sup> in 1987. The main objective of this commission was to establish the causes of the growing violence of the 1980s. In broad terms, the commission concluded that the high levels of violence were caused by the lack of education, poverty and inequality of the Colombian population. In this sense, the results of the study lend some support to the hypothesis of the objective causes. However, as Sánchez and Núñez (2001) indicate, it is important to note that the findings reached by this commission are not very solid, as they are based on very limited empirical evidence. In a different study, Sarmiento (1999) uses a quantitative approach to determine the causes of the homicidal violence in the Colombian municipalities for the periods 1985-1988 and 1990-1996. The author found that the rise in homicidal violence is positively related with the income inequality, and negatively related with the educational level of the population. According to Sánchez and Núñez (2001), the conclusions of this study are limited, to the extent that the model ignores important explanatory variables such as the presence of drug trafficking activities, the presence of illegal armed groups or the inefficacy of the law enforcement system.

In an innovative study, Gaitan (1995) estimated cross-country regressions and concluded that the GDP, the level of poverty and the income inequality does not provide a comprehensive explanation of the exceptionally high level of violence in Colombia. In fact, according to the estimates of the author, the GDP per capita and the income inequality only account for 25% of the variance of the homicides, while in the other countries of the sample, these variables explain the 63%. In addition, contrary to the hypothesis of the objective causes of violence, the author found that the richest Colombian regions tend to present highest levels of homicidal violence. This apparent contradiction can be understood using Becker's approach, in the sense that the richest regions can potentially offer greater economic benefits to criminals, and therefore, it is expected that these regions present higher crime rates. In the same direction, Rubio (1999) presents evidence against the hypothesis of the objective causes of violence, in particular, the author shows that the municipalities with better poverty indicators tend to exhibit higher homicide rates. In the same study, the author points out the existence of a positive relation between the homicide rates and the presence of illegal armed groups

---

<sup>2</sup> Comisión de Estudios Sobre la Violencia (1987)

(guerrilla, paramilitaries or drug cartels). In fact, 93% of the homicides committed in 1995 occurred in municipalities with presence of any of the three illegal groups (Rubio, 1999, p. 45). Another interesting finding of the study of Rubio (1999), is that the efficiency of the law enforcement system is negatively related to the crime rate, and in particular to the homicide rate. The above is intuitive using Becker's theoretical framework, to the extent that a more efficient legal system rises the likelihood of prosecuting the criminals, or in other words, an efficient legal system increases the risks and costs associated with committing a crime.

Consistent with the above, Montenegro et al. (2000) found that the inefficiency of the law enforcement system is the variable that best explains the accelerated growth presented by the homicide rate in the 1980s. Moreover, the authors show that the presence of drug trafficking activities is positively related to the levels of homicidal violence in the Colombian municipalities. Reinforcing these findings, Sánchez (2007), using data from 711 municipalities between 1991 and 1998, found that the differences in the homicide rate between violent and non-violent municipalities are largely explained by the presence of armed groups (guerrilla and paramilitary), the intensity of the activities of drug trafficking, the efficiency of the law enforcement system and the interaction between the illegal armed groups and drug trafficking (Sánchez, 2007, p. 27).

Based on this brief literature review, it is possible to conclude that the exceptionally high levels of homicidal violence in Colombia are not caused by individuals "forced into crime" by an unfavorable socioeconomic situation, but rather, is the result of the rational decisions of individuals in a context of armed conflict, high presence of drug trafficking, and inefficiency of the law enforcement system (Sánchez and Núñez, 2001, p. 7).

## **4.2. The Concept of Criminal Inertia.**

According to the theoretical models proposed by Sah (1991), Glaeser et al. (1996) and Fajnzylber et al. (1998), the present crime rates can be explained to certain extent by the crime rates of the past. This phenomenon implies that criminality tends to exhibit a persistent behavior over time, or what is the same, implies the existence of criminal

inertia. In a cross-country study, Fajnzylber et al. (1998) tested this hypothesis by introducing the lagged crime rate as an explanatory variable. After the estimates, the authors found that the rates of robbery and homicide of the past explains to some degree the criminal rates of the present. In the same direction, but in the context of the major Colombian cities, the study of Sánchez (2007) concludes that the lagged homicide rates are positively and significantly related to the present homicide rates. According to Fajnzylber et al. (1998), this intertemporal relation can be explained by two mechanisms. In first place, the criminal technology can be transferred, in this sense, higher crime rates in the past can be associated with lower costs of committing crime in the present. In second place, the criminality of the past can undermine the “civic moral values” of the society, and therefore, can increase the predisposition toward crime of the population (Fajnzylber et al., 1998, p. 8).

In a similar way, but having in mind the Colombian context, Gaviria (2000) presents three models that can contribute to understand the mechanisms underlying the phenomenon of the criminal inertia. The first model indicates that high levels of crime congest the law enforcement system, reducing the likelihood of apprehension and punishment, and hence, encouraging the emergence of new criminals. In the second model, the career criminals transmit their know-how and technology to potential criminals, in this case, the learning and technological spillovers are the mechanisms behind the connection between the criminal rates of past and the future. In the third model, the continuous interaction between criminals and the rest of the population impairs the values of the society, in this sense, the past incidence of crime increases the general willingness to commit crime. According to Gaviria (2000), the empirical evidence from Colombia, provides support the theoretical models in general, and particularly to the model of congestion of the law enforcement system. For instance, the author found that the escalation of violent crime in Colombia in the 1980s and 1990s coincided with a marked decrease in the likelihood of being arrested and punished by the law enforcement system (Gaviria, 2000, p. 4).

Based on all the above, it is possible to conclude that there are theoretical and empirical reasons to expect a positive and significant relationship between the homicide rates in the past and the homicide rates in the present.

## 5. Data.

Given the nature and the objectives of this research, the dataset used consists of a panel of annual observations for all the municipalities of Colombia. The main variable of the dataset is the homicide rate per 100,000 inhabitants, which is calculated from the figures of total number of homicides and total population. These data in particular are available for the period between 1993 and 2013. In addition to the homicide rates, the panel contains information on other relevant variables such as the incidence of poverty, the presence of illegal armed groups, the presence of political violence between 1948 and 1953, the presence of drug trafficking activities and an index of rurality. The data availability for these variables differ, but in general, there is information for the period between 1993 and 2008.

### 5.1. Sources and Definition of Variables.

The data used in this research was extracted from a bigger dataset denominated the *Municipal Panel*, which is the result of an initiative of The Center for Economic Development Studies (CEDE) to consolidate in a single database information about the Colombian municipalities (Acevedo and Bornacelly, 2014). The data available in the *Municipal Panel*, and hence, the data used in this paper proceed from multiple sources of information.<sup>3</sup>

Specifically, the data on the total number of homicides were taken from the National Police of Colombia, meanwhile, the data on the total population were collected from the National Administrative Department of Statistics (DANE for its acronym in Spanish). The population figures for the period 1993 - 2005 are based on estimates from the national censuses, and the figures for the period 2006 - 2013 are the result of population projections. For its part, the data about the presence of illegal armed groups were constructed from information about the presence of the two largest guerrilla groups

---

<sup>3</sup>The information on the sources was obtained from the CEDE data center. [www.datoscede.uniandes.edu.co](http://www.datoscede.uniandes.edu.co)

(FARC<sup>4</sup> and ELN<sup>5</sup>), and the presence of the major right-wing paramilitary group (AUC<sup>6</sup>). These data were obtained from information of the National Police and the Administrative Department of Security (DAS for its acronym in Spanish). This data are available for the period between 1993 and 2008.

The presence of coca crops was used as a proxy variable of the presence of drug trafficking activities. Evidently, the existence of coca crops does not fully capture the phenomenon of drug trafficking, however, it is the only variable available on this subject at the municipal level. This data proceed from the Integrated Illicit Monitoring System (SIMCI for its acronym in Spanish), which is a project lead by the United Nations Office on Drugs and Crime. The information on this variable is available from 1999 to 2008.

The incidence of poverty is calculated based on the unsatisfied basic needs (UBN) methodology. This approach measures the poverty as the percentage of the population living with any unsatisfied basic need. In this context, an unsatisfied basic need refers to five indicators: inadequate housing materials, housing with inadequate public services, housing with critical overcrowding, households with high economic dependence and households with school-age children not enrolled in formal education. This information is provided by the DANE, based on the national population censuses and the national household surveys. The data on this subject is available for the period between 1993 and 2008. In last place, the rurality index is measured as the percentage of the population living in rural areas. These figures are provided by the DANE and are available from 1993 to 2008. A summary of the interest variables, its availability and its sources can be consulted in Table 1.

---

<sup>4</sup> Fuerzas Armadas Revolucionarias de Colombia

<sup>5</sup> Ejército de Liberación Nacional

<sup>6</sup> Autodefensas Unidas de Colombia

Table 1. Main Variables and Sources of Information.

Variable	Description	Years with available data	Source
<b>Total Population.</b>	1993-2005: Estimates. 2006-2013: Projections.	1993 - 2013	DANE
<b>Homicide.</b>	Total number of homicides.	1993 - 2013	National Police of Colombia
<b>Homicide Rate.</b>	(Total Homicides / Total population) *100,000	1993 - 2013	Author's calculations based on information from the National Police of Colombia
<b>FARC</b>	Dummy variable on the presence of the FARC (guerrilla group)	1993 - 2008	National Police of Colombia and DAS
<b>ELN</b>	Dummy variable on the presence of the ELN (guerrilla group)	1993 - 2008	National Police of Colombia and DAS
<b>AUC</b>	Dummy variable on the presence of the AUC (paramilitary group)	1993 - 2008	National Police of Colombia and DAS
<b>Presence of illegal armed groups</b>	Dummy variable on the presence of any of the illegal armed groups (FARC, ELN, AUC)	1993 - 2008	Author's calculations based on information from the National Police of Colombia
<b>Violence 1948 – 1953</b>	Dummy variable on the presence of political violence between 1948 and 1953	1993 - 2008	National Police of Colombia and DAS
<b>Coca</b>	Dummy variable on the presence of coca crops	1999 - 2008	SIMCI
<b>Poverty</b>	Percentage of the population living in poverty according to the UBN methodology.	1993 - 2008	DANE
<b>Rurality Index</b>	Rural population / Total population	1993 - 2008	DANE

## 5.2. First Approach to Data and Descriptive Statistics.

Before proceeding with the formal analysis and the econometric model, this section presents a first approach to the data and exposes some descriptive statistics of the most important variables. This first approach represents a relevant exercise, to the extent that allows a better understanding of the nature of the dataset.

The first variable to analyze is the municipal population. Table 2 summarizes the descriptive statistics associated with this variable over the period from 1993 to 2013. From this information it is possible to conclude that the average size of the municipal population has grown steadily in the last years, from a level of 32,386 inhabitants in 1993, to 42,084 inhabitants in 2013. Additionally, the marked differences between the mean and the standard deviation indicate the existence of high dispersion in terms of population among the Colombian municipalities. This dispersion can be exemplified by looking at the dramatic differences between the most populated and the least populated municipalities. A last point to highlight is the fact that the standard deviation has tended to rise over time, indicating a process of divergence of the municipal population. This means that the differences in population among municipalities have tended to be deepened over time, which is consistent with the continuous and rapid process of urbanization occurred in Colombia.

**Table 2. Descriptive Statistics of the Municipal Populations. 1993 - 2013**

<b>Year</b>	<b>Mean</b>	<b>Std. Deviation</b>	<b>Min</b>	<b>Max</b>	<b>Obs</b>
1993 - 2013	37,575	225,965.7	170	7,674,366	22,105
1993	32,386	186,847.8	170	5,413,484	1,122
2003	37,432	226,408.7	211	6,627,568	1,122
2013	42,084	260,464.1	326	7,674,366	1,122

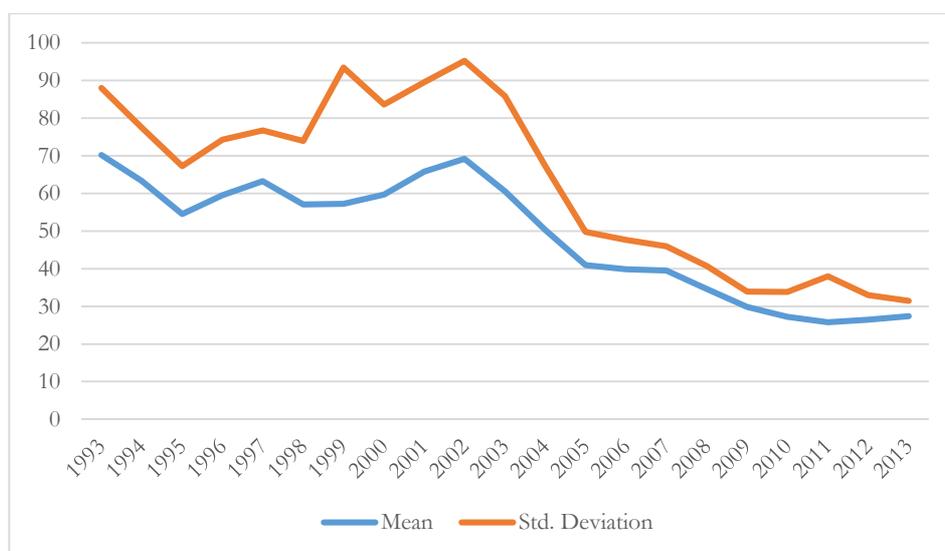
*Source: Author's calculations based on information from the National Police of Colombia*

With regard to the municipal homicide rates, the Figure 3 illustrates the evolution of its mean and its standard deviation over the period from 1993 to 2013. The Figure shows that between 1993 and 2002, the average homicide rate presented a relatively stable behavior, staying at a level around 65 homicides per 100,000 inhabitants. From 2002 onwards, the average homicide rate presented a clear downward trend, however, it is relevant to note that in the recent years this variable has tended to remain stable at approximately 26 homicides per 100,000 inhabitants.

For its part, the behavior of the standard deviation suggests that the dispersion of the homicide rates was almost the same in 1993 and 2003. Additionally, the rapid decline of the

standard deviation since 2002, indicates convergence of the municipal homicide rates, or in other words, a reduction of the municipal disparities in homicidal violence. A last issue to note, is that the sharp increase of the standard deviation between the late 1990s and 2002, concurred with a period of rapid progression of the national homicide rate. This stylized fact is consistent with the findings of Gaviria (2000), in the sense that periods of growing violent crime are associated with periods of regional divergence in the crime rates.

**Figure 3. Mean and Standard Deviation of the Homicide Rates in the Colombian Municipalities (1993 – 2013)**



*Source: Author's calculation based on information from the National Police of Colombia*

Regarding to the illegal groups, the data indicate that between 1993 and 2002, the percentage of municipalities with presence of illegal armed actors increased significantly, from 40% in 1993, to 61% in 2002. From that year, this proportion started to decline rapidly, and for 2008, just 30% of the Colombian municipalities experienced the presence of at least one armed group. Meanwhile, the percentage of municipalities with presence of coca crops has tended to rise over time, from only 8.2% in 1999, to 18% in 2008.

Finally, Table 3 presents descriptive statistics associated with the incidence of poverty in the Colombian municipalities. A first point to highlight, is that in the period 1993 - 2008, the average Colombian municipality presented an incidence of poverty of 46.9%. In the same period, the minimum incidence of poverty was 5.36% and the maximum 100%. In a dynamic perspective, the incidence of poverty in the average Colombian municipality has tended to decrease over time, from 52.9 % in 1993, to 45% in 2008.

**Table 3. Descriptive Statistics of the Incidence of Poverty (UBN methodology). 1993 - 2008**

Year	Mean	Std. Deviation	Min	Max	Obs
1993-2008	46.98	20.94	5.36	100	16,536
1993	52.98	19.21	9.15	100	1,086
1998	47.61	21.53	7.72	100	1,071
2003	44.47	19.76	6.10	100	1,071
2008	45.04	20.91	5.39	100	1,114

*Source: Author's calculations based on information from the DANE*

## 6. Methodological Approach.

After a first approximation to the data, this section presents the methodological strategy used in the present research. In broad terms, the strategy follows two steps, the first consists in a correlation analysis based on scatter plots, and the second, consists in the econometric estimation of a panel data model. Given the availability of data, the correlation analysis covers the period from 1993 to 2013, meanwhile, the panel data model covers the period from 1993 to 2008.

### 6.1. Correlation Analysis.

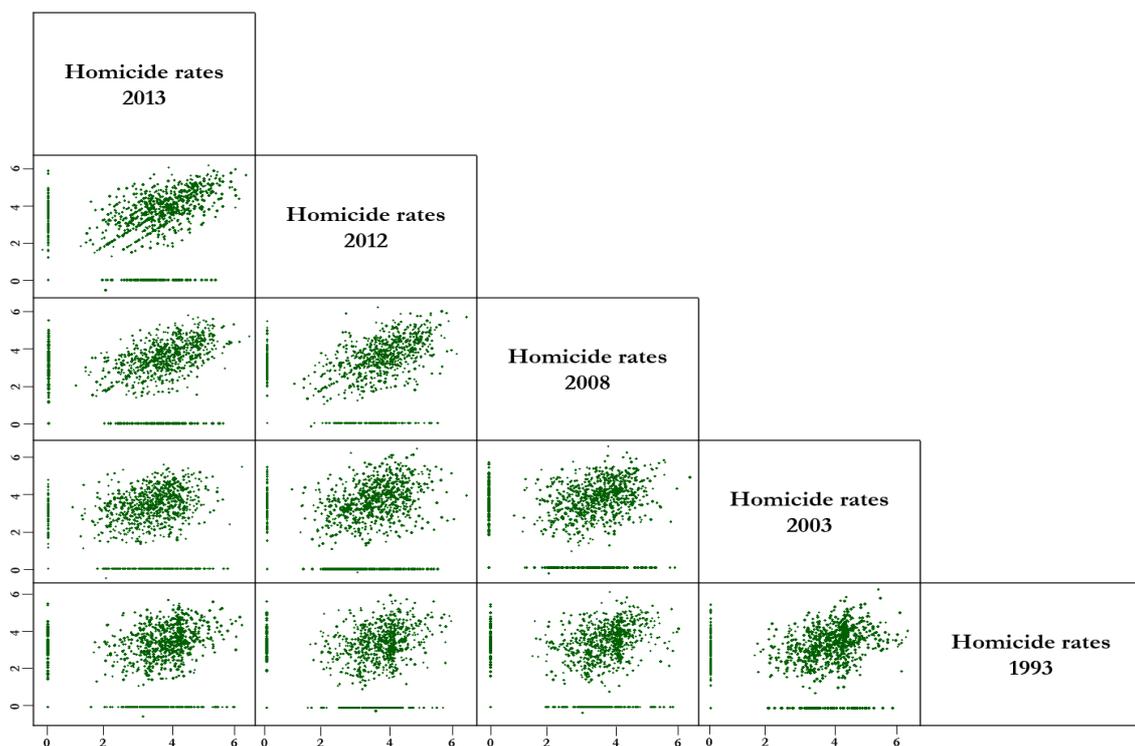
As mentioned before, the first step of the methodological strategy proposed in this research consist in a correlation analysis based on scatter plots. In the context of the present study, the scatter plots represent a valuable tool, to the extent that provide a graphical glance of the correlation between the municipal homicide rates at two different moments in time. In this particular situation, a positive correlation suggests the existence of a certain degree of temporal persistence of the municipal homicide rates.

Before proceeding further, it is important to highlight that the figures used in the construction of the scatter plots were log transformed, this with the aim of improving

the visualization of the correlation patterns. Evidently, given the features of the natural logarithm, the observations with value of zero were left untransformed.

After this transformation of the data, a total of ten scatter plots were calculated. The first four illustrate the relationship between the municipal homicide rates in 2013 and the municipal homicides rates in 2012, 2008, 2003 and 1993. These years were selected in order to capture the differences associated with longer time lags. The remaining six scatter plots are the result of the interaction between the municipal homicide rates in the years mentioned above. The results of the exercise can be seen in Figure 4.

**Figure 4. Correlation between the past and future homicide rates in the Colombian municipalities. (1993 – 2013)**



*Source: Author's calculations based on information from the National Police of Colombia.*

In broad terms, there are three issues to highlight from Figure 4. The first is the presence of peculiar outliers, in particular, those who exhibit homicide rates equal to zero in one year, and positive and high homicide rates in the other. This phenomenon can be understood in the context of the Colombian regions, to the extent that there are

municipalities with very low populations, and hence, small changes in the total number of homicides result in large changes in the homicide rate per 100,000 inhabitants.

The second issue to note, is that the general pattern exhibited by the scatter plots indicates a positive correlation between the homicide rates and the lagged homicide rates. This positive pattern can be observed even in the relationship between the homicide rates in 1993 and 2013. In statistical terms, all the ten correlations are positive and significant with 99% of certainty<sup>7</sup>. This evidence suggests the existence of certain degree of inertia in the homicide rates, or what is the same, suggests the existence of temporal persistence of the municipal homicide rates, even in the medium and long term.

The last point to highlight, is that the positive correlation between the homicide rates and the lagged homicide rates, becomes weaker over time. The above is particularly clear when analyzing the behavior of the four scatter plots associated with the homicide rates in 2013. In this particular case, the relationship between the homicide rates and the homicide rates of the previous year is very clear, however, as can be seen in the scatter plot that illustrates a time lag of twenty years, when the time lag increases the correlation turns more diffuse. This phenomenon can be understood to the extent that the mechanisms that explain the criminal inertia become weaker over time.

In conclusion, the empirical evidence derived from this correlation analysis suggests the existence of temporal persistence in the municipal homicide rates, in this sense, it is possible to state that in the context of the Colombian municipalities, the homicide rates in the present can be predicted to some degree by the homicide rates in the past.

---

<sup>7</sup> To test the statistical significance were estimated ten linear regression model, one for each scatter plot. The outputs of the regressions can be consulted in the appendix of this document.

## 6.2. Panel Data Model.

Having in mind the results exposed above, this section presents the features and results of a panel data model. In broad terms, the model seeks to explain the municipal homicide rate, using as explanatory variables the lagged homicide rate and other characteristics of the municipality. In formal terms, the model can be expressed as follows.

$$Y_{i,t} = c + \delta * Y_{i,t-x} + \rho * X_{i,t}'\beta_i + \varepsilon_{i,t} \quad (1)$$

Where  $Y_{i,t}$  is the homicide rate in the municipality  $i$  in the year  $t$ , and hence,  $Y_{i,t-x}$  represents the homicide rate with a lag of  $x$  years. Meanwhile,  $X_{i,t}$  contains the other explanatory variables for the municipality  $i$  in the year  $t$ . Specifically, the other explanatory variables are: the presence of illegal armed groups, the presence of coca crops as a proxy of drug trafficking activities, the incidence of poverty measured with the UBN approach, the presence of political violence in the period 1948 – 1953, and the index of rurality.

Before proceeding further, it is necessary to discuss two limitations of the econometric model presented above. In first place, there is a potential bias associated with the exclusion of relevant explanatory variables. In particular, with the exclusion of a variable about the efficiency of the law enforcement system, which according to the literature is a key issue to understand the development of the crime in Colombia. The second potential weakness of the model is related with the use of the presence of coca crops as a proxy of the presence of drug trafficking activities, to the extent that the illicit crops are just one part of the complex phenomenon of drug trafficking. These two potential limitations are closely related with the issue of data availability. In this sense, the variables included in the model are those with information available for all the municipalities in Colombia.

Having said that, and bearing in mind the restrictions imposed by the data availability, three different regressions were estimated. The first includes the homicide rate with a lag of one year, excludes the variable on coca crops, and covers the period 1993 – 2008. The second is exactly as the previous, but includes the homicide rate with a lag of five years. For its part, the third regression incorporates the variable on presence of coca crops and

covers the period between 1999 and 2008. The lag structure was selected in order to capture the immediate and medium term effects, but at the same time, no longer lags were used in order to maintain a considerable number of observations. The regressions were estimated using the methodology of generalized least squares (GLS), and its outputs can be consulted in Table 4.

**Table 4. Regressions output**

<b>PERIOD</b>	<b>(1)</b>	<b>(2)</b>	<b>(3)</b>
<b>VARIABLES</b>	<b>1993-2008</b>	<b>1993-2008</b>	<b>1999-2008</b>
	<b>Homicide_rate</b>	<b>Homicide_rate</b>	<b>Homicide_rate</b>
L1.Homicide_Rate	0.416*** (0.00681)	0.223*** (0.00855)	0.149*** (0.00943)
L5.Homicide_Rate		0.0878*** (0.00737)	0.0346*** (0.00799)
Dummy_IGroups	23.36*** (1.730)	31.19*** (2.097)	33.58*** (2.418)
Dummy_Coca			19.04*** (3.353)
Incidence_Poverty	-0.169*** (0.0438)	-0.187*** (0.0532)	-0.336*** (0.0636)
Violence_48_53	-0.250 (2.475)	-1.025 (2.994)	-1.106 (3.390)
Rurality_index	-0.674 (3.881)	-1.005 (4.656)	-2.464 (5.266)
Constant	29.95*** (2.745)	29.47*** (3.298)	38.78*** (3.757)
Observations	16,159	11,891	9,782
Number of codmpio	1,114	1,114	1,114

Standard errors in parentheses  
 \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

*Source: Author's calculations*

There are several issues to note from these results. In first place, all the coefficients associated with the lagged homicide rate are positive and statistically significant with a certainty of 99%. This implies that the past homicide rates predict and explain to some extent the present rates, even when controlling for other variables. The above is consistent with the findings of the past section, and suggests the existence of certain criminal inertia in the Colombian municipalities. A second issue to point out is the difference between the coefficients of the lagged variables. In particular, is interesting the

note that the coefficients decrease significantly when considering longer time lags. Once again, this is consistent with the results obtained in the analysis of the scatter plots.

A third point to highlight, is that the behavior of the other explanatory variables is consistent with the finding of previous studies. Specifically, the results of the regressions show that the presence of illegal armed groups and the presence of drug trafficking activities have a positive and significant effect over the municipal homicide rate. In fact, by looking at Table 4, it is evident that these two variables present the highest estimated coefficients, which means that are the variables that better explain the municipal homicide rate.

With regard to the variable poverty, the results of the models suggest a negative relation between the incidence of poverty and the homicide rate in the municipality. This relationship is statistically significant, and implies that the poorer municipalities tend to be less violent in term of homicides. Once again, the above is consistent with the findings of previous research, and in addition, is completely contrary to the hypothesis of the objective causes of violence.

A final issue to note, is that the presence of political violence in the period 1948 - 1953 does not affect the municipal homicide rate. This implies, that the relationship between past and future violence disappears when considering very long time periods. The above can be understood to the extent that the nature of violence can vary considerably between different historical moments. For instance, the violence of the mid twentieth century was primarily motivated by political reasons, meanwhile, the wave of violence of the late 1980s and early 1990s, was mainly explained by the externalities generated by drug traffickers and illegal armed actors.

As an additional exploratory exercise, two more regressions were estimated. The specification of the regressions is the same, the only difference lies in the periods analyzed. The first regression covers the years between 1999 and 2002, which coincides with a period of rapid progression of the national homicide rate. Meanwhile, the second regression focuses on the period from 2002 to 2008, which was characterized by a continuous decrease of the homicidal violence. In this sense, the aim of this exercise is

to identify potential differences when considering periods with different patterns of violence. The results of these regressions are summarized in Table 5.

**Table 5. Regressions Output**

<b>Period:</b>	<b>(4)</b>	<b>(5)</b>
<b>VARIABLES</b>	<b>1999-2002</b>	<b>2002-2008</b>
	<b>Homicide_rate</b>	<b>Homicide_rate</b>
L1.Homicide_Rate	0.291*** (0.0154)	0.140*** (0.0102)
L5.Homicide_Rate	0.00485 (0.0135)	0.0401*** (0.00846)
Dummy_IGroups	35.97*** (3.149)	23.47*** (2.526)
Dummy_Coca	19.75*** (4.531)	24.27*** (3.646)
Incidence_Poverty	-0.451*** (0.0818)	-0.251*** (0.0679)
Violence_48_53	-0.150 (4.540)	0.619 (3.575)
Rurality_index	-13.30* (7.019)	-3.488 (5.567)
Constant	52.99*** (5.288)	33.67*** (3.961)
Observations	3,188	8,778
Number of codmpio	1,070	1,114

Standard errors in parentheses

\*\*\* p < 0.01, \*\* p < 0.05, \* p < 0.1

*Source: Author's calculations*

In broad terms, the results of these regressions are not different from those discussed above, which suggests that the main determinants of the recent homicidal violence are the same regardless the specific period analyzed. However, there are two important issues to note. In first place, in the regression that covers the period 1998 – 2002, the coefficient of the homicide rate with a five years lag is not significant. This implies that the explanatory power of the lagged homicide rate is lower in a context of rapid progression of the homicidal violence.

The second point to note, is that in the same regression, the estimated coefficient of the

index of rurality is negative and statistically significant with 90 % of certainty. In this sense, it is possible to conclude that the escalation of violence of the late 1990s and early 2000s, was concentrated in municipalities with higher proportion of urban population.

At this point of the document it is necessary to highlight explicitly the contributions of the model and the study in general. In first place, it is important to note that despite the great interest in the Colombian case, there are no studies that focus specifically on the topic of criminal inertia. Additionally, most of the studies on the determinants of violence and crime, analyze only the 1980s and 1990s, and few of them use data on all the municipalities of Colombia. A last issue to point out, is that the analysis presented in this study involves time lags associated with the short, medium and long term. This represents a contribution to the extent that the previous studies on the subject only consider immediate lags.

## **7. Discussion.**

The findings from the previous section suggests the existence of temporal persistence in the municipal homicide rates. To a certain extent, this implies that the most violent municipalities in the past tend to be the most violent in the present. In terms of public policy, the above has multiple implications.

In first place, if violence is persistent over time, then it is possible to think in municipalities stuck in what might be called “*violence traps*”, that is, a situation in which a municipality is caught within a vicious circle of high and persistent levels of violence. In this context, a clear public policy recommendation is to identify those municipalities, in order to intervene this phenomenon of criminal inertia. Related with the above, it is highly relevant to determine the causes of the temporal persistence in the municipal homicide rates. In other words, it is relevant to identify the particular characteristics of the municipalities that have exhibited a high degree of criminal inertia. In general, this identification can provide better tools for designing and implementing the interventions mentioned before. As a complementary exercise, it would be very interesting to study the specific cases of municipalities and regions that have been able to break the “*violence*

*traps*". The relevance of an exercise of this nature relies on the fact that it could yield concrete policy recommendations.

All the above is even more relevant if it is considered that the phenomenon of homicidal violence in Colombia has tended to be concentrated geographically (Sánchez, Diaz & Formisano, 2003 and Sánchez et al., 2012). In this sense, if violence is persistent over time and concentrated in space, it is possible to expect very clear and persistent clusters of homicidal violence, making more imperative the external intervention.

## **8. Concluding Remarks.**

Colombia represents an exceptional and complex case to study issues related with violence, crime and conflict. In this general context, the aim of this study was to determine the existence of temporal persistence in the municipal homicide rates.

The empirical evidence found, suggests that the homicide rates tend to exhibit a certain degree of inertia. The above implies that past incidence of violence can predict to some extent the present incidence. To this extent, the findings of the study are consistent with the common view according to which, the violence breeds more violence.

## References.

- Acevedo, K. & Bornacelly, I. (2014). "Panel municipal del CEDE". Documento CEDE N° 2014-26.
- Barón, J. D. (2009) "Did Plan Colombia Reduce Homicides?", Mimeo. CEER - Banco de la República, Cartagena.
- Becker, G. (1968) "Crime and Punishment: An Economic Approach", *Journal of Political Economy* 76, No. 2: pp. 169- 217
- Bourguignon, F., Núñez, J. & Sánchez, F. (2003). "What part of the income distribution matters for explaining property crime? The case of Colombia". Documento CEDE. No. 2003-7
- Comisión de Estudios sobre la Violencia (1987). "Colombia: violencia y democracia". Bogotá: COLCIENCIAS, Universidad Nacional de Colombia.
- Fajnzylber, P., Lederman, D. & N. Loayza (1998). "Determinants of Crime Rates in Latin America and the World". Washington, D.C.: World Bank.
- Fajnzylber, P., Lederman, D. & N. Loayza (2002). "Inequality and violent crime. *Journal of Law and Economics*" 45 (1), 1-40.
- Gaitán, F. (1995). "Una indagación sobre las causas de la violencia en Colombia", in Deas, M. and Gaitán, F. "Dos ensayos especulativos sobre la violencia en Colombia". FONADE-DNP, Bogotá.
- Gaviria, A. (2000). "Increasing returns and the evolution of violent crime: the case of Colombia". *Journal of Development Economics*, 61 (1), 1-25.
- Glaeser, E., Sacerdote, B. & Scheinkman, J. "Crime and Social Interactions." *Quarterly Journal of Economics* 111 (1996): 507-48.
- Griliches, Zvi, & Hausman, J. "Errors in Variables in Panel Data." *Journal of Econometrics* 31 (1986): 93-118.
- Henderson, J. D. (2001) "Modernization in Colombia: The Laureano Gómez Years, 1889-1965". Gainesville: University Press of Florida
- Levitt, S. & Rubio, M. (2000). "Understanding Crime in Colombia and What can be done about it". Documentos de Trabajo. No. 20. Fedesarrollo.
- Montenegro, A., Posada, C. E. & Piraquive, G. (2000). "Violencia, criminalidad y justicia: otra mirada desde la economía", en *Coyuntura Económica*, Vol. XXX, No. 2, Junio, Fedesarrollo. Pg. 85-132

Peceny, M. & Durnan, M. (2006). "The FARC's best friend: U.S. antidrug policies and the deepening of Colombia's civil war in the 1990s". *Latin American Politics and Society*. Vol. 48, pp. 95 – 116.

Pinto, M., Vergara, A. & La Huerta, Y. (2004). "Costos generados por la violencia armada en Colombia 1999 – 2003". *Archivos de economía* – 277-

Rubio, M. (1997), "Percepciones Ciudadanas sobre la Justicia - Informe final de Investigación". Bogotá, Ministerio de Justicia, Cijus - Universidad de Los Andes.

Rubio, M. (1999). "Crimen e impunidad: Precisiones sobre la violencia". TM Editores – CEDE, Bogotá.

Sah, R. (1991). "Social osmosis and patterns of crime". *Journal of Political Economy* 99, 1272-1295.

Sánchez, F. (2007). "Las Cuentas de la Violencia". Facultad de Economía, Universidad de los Andes – Norma, Bogotá.

Sánchez, F & Núñez, J. (2001) "Determinantes del crimen violento en un país altamente violento: el caso de Colombia". Bogotá. Universidad Nacional de Colombia.

Sánchez, F., Díaz, A. M. & Formisano, M. (2003). "Conflicto, Violencia y Actividad Criminal en Colombia: Un Análisis Espacial". Documento CEDE 002187. Universidad de los Andes – CEDE.

Sánchez, A., Díaz, A., Peláez, A., Castelbanco, O., Tautiva, J., González, C. & Ángel, L. (2012). "Evolución geográfica del homicidio en Colombia". Documentos de trabajo sobre economía regional. Banco de la República, Cartagena.

Sarmiento, A. (1999). "Violencia y equidad" en *Planeación y Desarrollo*, Vol. XXX, No. 3, julio – septiembre, Departamento Nacional de Planeación. Pg. 47-80.

Trujillo, E. & Badel, M. (1998), "Los costos económicos de la criminalidad y la violencia en Colombia: 1991-1996". Documento No 76, *Archivos de Macroeconomía*, Bogotá, DNP.

United Nation Office on Drugs and Crime – UNODC. (2006). "Violence, Crime and Illegal Arms Trafficking in Colombia".

United Nation Office on Drugs and Crime – UNODC. *Homicide Statistics* (2013). Available: <http://www.unodc.org/unodc/en/data-and-analysis/homicide.html>.

Villamarín, A. (2011). "Prevenir y calcular: Una estimación de los costos de la violencia homicida en Colombia". Documento CERAC N° 16.

## Appendix.

**Table 6. Descriptive statistics of the municipal populations by year. 1993 – 2013**

year	Mean	Std. Deviation	Min	Max	Obs
1993	32,386	186,847.83	170	5,413,484	1,122
1994	32,964	191603.777	182	5,559,851	1,122
1995	33,517	196157.513	190	5,699,655	1,122
1996	34,050	200387.599	196	5,828,528	1,122
1997	34,558	204460.611	201	5,952,563	1,122
1998	35,049	208389.103	203	6,072,489	1,122
1999	35,537	212183.389	205	6,189,030	1,122
2000	36,043	215861.31	206	6,302,881	1,122
2001	36,506	219419.042	207	6,412,400	1,122
2002	36,967	222928.586	208	6,520,473	1,122
2003	37,432	226408.795	211	6,627,568	1,122
2004	37,897	229867.408	216	6,734,041	1,122
2005	38,362	233308.601	225	6,840,116	1,122
2006	38,825	236709.172	236	6,945,216	1,122
2007	39,273	240124.796	247	7,050,228	1,122
2008	39,699	243533.898	259	7,155,052	1,122
2009	40,171	246938.93	271	7,259,597	1,122
2010	40,645	250335.113	284	7,363,782	1,122
2011	41,122	253726.509	298	7,467,804	1,122
2012	41,602	257102.913	312	7,571,345	1,122
2013	42,084	260,464.18	326	7,674,366	1,122

*Source: Author's calculations based on information from the National Police of Colombia*

Table 7. Descriptive statistics of the municipal homicide rate by year. 1993 - 2013

Year	Mean	Std. Deviation	Min	Max	Obs
1993	70.2087725	88.0284991	0	793.838863	1,122
1994	63.3731426	77.4638646	0	913.022585	1,122
1995	54.479052	67.2593385	0	765.06811	1,122
1996	59.4918063	74.3050522	0	732.536845	1,122
1997	63.2791589	76.6908736	0	704.857106	1,122
1998	57.0848198	73.9298553	0	1028.6554	1,122
1999	57.2311573	93.4673566	0	1433.6127	1,122
2000	59.7290865	83.6268023	0	1232.22749	1,122
2001	65.7779539	89.5163651	0	976.408515	1,122
2002	69.1799106	95.2262421	0	1186.08592	1,122
2003	60.5143496	85.8153084	0	1222.1117	1,122
2004	50.2438925	67.2736065	0	549.039181	1,122
2005	40.9175004	49.7325049	0	446.598252	1,122
2006	39.8371345	47.6600819	0	454.671987	1,122
2007	39.4917045	45.9887236	0	373.885534	1,122
2008	34.5753836	40.651891	0	413.040271	1,122
2009	29.8654106	33.9007644	0	241.400121	1,122
2010	27.1755921	33.8110533	0	233.359262	1,122
2011	25.8078093	37.9818078	0	359.24456	1,122
2012	26.4787193	32.9382555	0	276.019432	1,122
2013	27.343987	31.4718149	0	220.889871	1,122

*Source: Author's calculations based on information from the National Police of Colombia*

**Table 8. Percentage of municipalities with presence of illegal armed groups (FARC, ELN and AUC). 1993 - 2008**

<b>Year</b>	<b>Percentage.</b>
1993	40.29%
1994	42.78%
1995	37.34%
1996	36.72%
1997	40.64%
1998	42.16%
1999	45.81%
2000	51.96%
2001	54.55%
2002	60.96%
2003	57.84%
2004	52.32%
2005	51.07%
2006	51.52%
2007	56.51%
2008	69.61%

*Source: Author's calculations based on information from the National Police and the DAS.*

**Table 9. Percentage of municipalities with presence of coca crops. 1999 - 2008**

<b>Year</b>	<b>Percentage</b>
1999	8.32%
2000	16.88%
2001	14.14%
2002	14.80%
2003	16.32%
2004	16.68%
2005	16.68%
2006	17.49%
2007	17.04%
2008	18.12%

*Source: Author's calculations based on information from the SIMCI.*

Table 10. Regressions outputs.

VARIABLES	(1) Lnth2013	(2) Lnth2013	(3) Lnth2013	(4) Lnth2013
Lnth2012	0.568*** (0.0250)			
Lnth2008		0.510*** (0.0252)		
Lnth2003			0.316*** (0.0267)	
Lnth1993				0.313*** (0.0273)
Constant	1.080*** (0.0718)	1.078*** (0.0788)	1.438*** (0.0959)	1.394*** (0.103)
Observations	1,117	1,117	1,117	1,059
R-squared	0.316	0.269	0.112	0.111

Standard errors in parentheses  
 \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 11. Regressions outputs.

VARIABLES	(1) Lnth2012	(2) Lnth2012	(3) Lnth2012
Lnth2008	0.484*** (0.0253)		
Lnth2003		0.307*** (0.0265)	
Lnth1993			0.294*** (0.0268)
Constant	1.101*** (0.0791)	1.423*** (0.0952)	1.429*** (0.102)
Observations	1,117	1,117	1,059
R-squared	0.247	0.107	0.102

Standard errors in parentheses  
 \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 12. Regressions outputs.

	(1)	(2)
VARIABLES	Lnth2008	Lnth2008
Lnth2003	0.326*** (0.0271)	
Lnth1993		0.263*** (0.0281)
Constant	1.638*** (0.0972)	1.798*** (0.106)
Observations	1,118	1,060
R-squared	0.115	0.077

Standard errors in parentheses  
 \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 13. Regression output.

	(1)
VARIABLES	Lnth2003
Lnth1993	0.382*** (0.0268)
Constant	1.987*** (0.101)
Observations	1,060
R-squared	0.161

Standard errors in parentheses  
 \*\*\* p<0.01, \*\* p<0.05, \* p<0.1