The Hidden Cost of Violence, Infant Mortality in Colombia

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I. INTRODUCTION

> *"On Monday January 8, 2001 around 11:00 a.m. four guerrilla members were waiting for their next assignment near La Meseta, on the road leading to Anorí via Yarumal in [northwest Colombia]. 'That is the ambulance we've been waiting for', said one of them suddenly, while making signs to stop the vehicle. The driver, Rudy Montoya, obeyed and stepped out of the car. Inside the ambulance, meanwhile, the inevitable was occurring. Accompanied by her husband, Miguel Angel Arboleda, and the nurse Maria Antonia Arango; Ana Maria Montoya was about to give birth. An hour earlier Oscar Cardona, the M.D. on call at the San Juan de Dios Hospital at Anorí, had ordered her immediate transfer to the Yarumal Hospital, considering her labor high risk."* Indeed the inevitable did occur.

The narration of this incident continues in the article "Parto Armado" published on January 22, 2001 in the Colombian magazine *Cambio 16*. [1] The four guerrilla members burned the ambulance, leaving a message for the Hospital manager: "Tell her that we do not like the people they are attending". A generous neighbor offered her house for the baby's delivery when the back-up ambulance never arrived. However, when the baby was born he was not breathing. The nurse had to break her stethoscope to use one of its cables as an oxygen conductor to make him breathe. Meanwhile the mother became anemic because of over-bleeding. Ultimately, the couple arrived at the hospital thanks to the leadership of the medical director on call that found a man with a car big enough to carry them. Luckily for this mother of 19 other children, she and her youngest survived.[2] Episodes like this or similar violent conditions may be negatively affecting infant survival in Colombia.

Colombian twentieth century history has been marked by three civil conflicts, of which the current one is the longest and the most intense in terms of the number of armed actors involved and the total number of lives lost.[3] In a country with a fairly homogeneous population, both religiously and ethnically speaking, conflicts have erupted mainly as political confrontations with important effects on daily life. The causes and some direct effects of the conflict have been widely studied in Colombia, such as human lives lost in combat and the negative effects on economic performance (Ruiz and Rincon, 1996; Sanchez and Nunez, 2000; Montenegro and Posada, 2001; Rubio, 2002.)[4] However, the indirect effects are less well known, such as the effect on infant mortality.

[1] The title literally translates as "Armed Delivery". The word Antioquia was replaced with "northwest Colombia".
[2] Unluckily a very similar episode happened again to the same Hospital recently. May 11, 2003 Noticiero Caracol.
[3] The current armed conflict has persisted for more than 40 years, and has ranked the country as the first one in number and rates of homicides in the Americas for the last 15 years.
[4] All of these papers include extensive reviews of the literature for the Colombian case.

Despite the decline of the infant mortality rate (IMR) in Colombia, from 42.2 per thousand live births in 1985 to 30.6 in 2000, this change does not fully reflect the much faster decline in fertility levels, nor the improvement in all other socioeconomic conditions, such as the increase in female education or the aggressive health reform carried out in 1993.[5] These facts appear contradictory in light of the main findings of the infant mortality literature and make me believe that external factors, such as the persistent current civilian conflict, may be keeping Colombian IMR from a faster decline. This is the focus of this study.

Using fixed effects estimations, I found that during the 1990s as homicide rates increases by one per thousand habitants, IMR increases by at least 2 death infants per thousand live births. More importantly, infant mortality dramatically increases in municipalities attacked or with a high probability of being attacked (harassed), as well as in those road-isolated due to road control reflected in the hijacks perpetrated by any of the outlaw armed groups. I used Colombian data arranged at the municipality level on violence, natality, mortality, population and fiscal revenues and investments. Although, these statistics are equally important for the study of different demographic, violence or economic behavior, I am the first to collect and use this information for all Colombia, from 1990 to 2000. I propose alternative estimations of the effect of violence on IMR to cross-sectional estimations, which bias the estimators, by using a fixed effects model and a quasi-experimental design. I exploit the fact that some municipalities did not experience violence during any year in the last decade or suddenly experienced it during one year only. The results show positive, consistent and significant effects of violence on infant mortality.

It is virtually impossible, with these data, to determine certain causal paths. It is difficult to determine if infant survival is directly impacted by the disruption of armed conflict or if armed conflict deteriorates the health care system, and lowers survival rates, or indeed if it is just the circumstances of displaced status that impact survival. Nevertheless, while the causal links are obscure, the final effects are clear.

[5] Infant mortality refers to the number of death infants (less than 12 months of age) over total live births collected in a calendar year.

Furthermore, I provide evidence showing the existence of an excess adult mortality that mainly affects young males. For instance, the years lost in life expectancy due to external causes of death, homicides in particular, have more than overcome the years gained in life expectancy attained by the reduction of deaths due to intestinal infectious diseases. For the most part this is true for men, who lost 1.7 years of life expectancy due to homicide increases during 1985 and 2000. The burden of such loss is concentrated in males between 25 and 49 years old, who experienced 50% of those lost years (.86).

The combination of large numbers of young adult deaths, large waves of internally displaced populations (IDP) and the very nature of war, that mainly affects infrastructure, has clear implications in Colombian household income and health conditions that reflect in poorer performance in decreasing the IMR. First, there are increasing numbers of orphans. Second, family composition is changing leading to an impoverishment of the households, reinforced by the impoverishment of forced migrants. Third, disruption in infrastructure created by war reduces the quality and quantity of health services provided in Colombia. These issues, altogether, have been pointed out as factors that reduce the survival chances for infants. In future research I will incorporate individual analysis, which will allow me to control for several important confounders, such as mother's education, household characteristics, pre-natal care and after birth health care.

Research in this area is important in order to understand the full demographic consequences of an intense and persistent civilian conflict, and reveal hidden victims of war. The analysis may also provide insight into broader policy need, for instance by establishing which subpopulations are in greater need of support, or by suggesting which kinds of public health programs should be created or expanded to areas suffering from varying degrees of violence.

This study is also relevant for other situations, where violent deaths have become a public health problem, depleting the young adult male population. In particular, it is useful for understanding the channels through which adult mortality affects infant mortality. Awareness of such a process could help us asses the effects on child and infant mortality in other situations in which adults are dying in dramatic numbers, namely, wherever there is an excess of mortality.

The remainder of this paper is organized as follows: the next section includes a brief literature review on the Colombian conflict and the direct and indirect consequences of violence on demographic variables. Section III presents a description of the data. Section IV shows the empirical methodology and the last two sections present the findings and concluding remarks, respectively.

II. VIOLENCE AND INFANT MORTALITY, COLOMBIA IN CONTEXT

Colombia, the oldest democracy in Latin America, has had a steadily growing economy during the twentieth century despite three major civil conflicts. The first, known as the "One Thousand Days War" (1899-1902), resulted from confrontations between loyalists of the two main political parties, the Liberals and the Conservatives. Next came the seven-year period known as "La Violencia" (1946-53) marked by confrontations between liberal and conservative guerrillas primarily in rural areas. Finally, the current internal conflict began in the mid 1960s with the creation of socialist guerrillas in rural areas, and has been termed as the "Armed Internal Conflict" (1965-present.)[6] In contrast to similar processes elsewhere in Latin America, the Colombian case escalated both in intensity and number of actors involved since the late 1970s, including the expansion of illicit, but very profitable, activities such as drug trafficking. This latter factor has deepened the conflict in Colombia. On one hand, there are the effects of the war on drugs, which started in the late 1980s, such as terrorist attacks. On the other hand, it corrupted government institutions and economically fueled outlaw armed groups, such as guerrillas and paramilitaries.

Despite the prolonged presence of widespread violence, there has been little investigation of the consequences of internal wars on demographic variables other than methods to accurately enumerate casualties. It is only clear that the primary direct consequence on mortality, without regarding the motivations or actors involved in the process, is the rise in homicide rates. This effect is stronger for young males –between ages 15 and 30– who are typically active participants in these conflicts (Mesquida and Wiener, 1996). As a consequence, a country's overall life expectancy may be negatively affected by this loss in years of life.

[6] At least four large guerrillas groups have been active in the last twenty years (M-19, FARC, EPL and ELN), as well as several paramilitary groups, and drug cartels.

In Colombia external causes of death affect men more than women and young adults (15 to 45 years old) more than elders[7]. As a result, life expectancy for males is much lower than for females (Ruiz and Rincon, 1996, 1991; Florez and Mendez, 1997)[8]. This change in the mortality patterns of young males has also resulted in an important change in the mortality schedule for both sexes, altogether, since the early 1980s, as explained by several scholars (Florez, 2000; Ruiz and Rincon, 1996; Florez and Mendez, 1997). In addition, life tables constructed in these studies have always shown a much higher probability of dying for males between ages 15 and 45, than for females, but have excluded analysis using causes of death.[9]

I took a step further in the spirit of such studies, and estimated the years gained/lost in life expectancy (e_0) by age, sex and causes of death following Pollard's methodology (1982), between 1985 and 2000.[10] Adult mortality was corrected using the Hill method (2001), and infant and child mortality by using the Brass-Trussell method (United Nations, 1990; 1983.)[11]

Figures 1 and 2 show the differences in mortality rates across age groups and sexes. Even though e_0 increased during the period 1985-2000 for both males (1.87 years) and females (3.18 years), the gain was much smaller for males. This is mainly explained by the excess mortality of young males between ages 10 and 44 relative to females, which increases in the last 15 years as depicted in Figure 2. Moreover, the results in the changes in life expectancy shown in Figure 3 emphasize this loss in year of male life expectancy between ages 15 and 49, while women improved their life expectancy at all ages. Moreover, all the years lost in male life expectancy at those ages (25.5 years) account for half the years gained by reducing infant deaths.

Furthermore, in Table 1, we can see that the gain from reduction of deaths due to intestinal infectious diseases is similar for men and women: .399 and .279 years gained,

[7] Among external causes of death, homicide is by far the first cause of death in the country, for males and both sexes altogether. The second cause is motor vehicle accidents, followed by other accidents, and finally suicide.
[8] All of the studies correct for the under-registration of deaths. Florez (1997) also corrects for census report errors.
[9] The probability of dying for males is between 4 to 6 times higher than for females, depending on the sources and the adjustment for underreport in death counts.
[10] In order to avoid exaggerations produced by any mortality shock in a single year, I constructed the mortality patterns following an average of the deaths of three consecutive years (i.e. the average of 1984, 1985 and 1986 account for the death patter for 1985)
[11] This method is a combination of Brass' proposed method General Growth Balance –GGB and the Synthetic Extinct Generation Method SEG-proposed by Bennett and Horiuchi (UN, 1983), which uses the population age and sex distribution from 2 censuses and

respectively. As expected, the main effect is absorbed by the first age group, being slightly higher for males than females, and it declines as age increases. In contrast, for all other external causes of death women always gain years of life, while men always lose. This fact is more dramatic for homicides: men lose 1.655 years, while women gain .105 years. Moreover, the years lost due to homicides were almost six times the years gained by reductions of intestinal infectious diseases. When looking at the age decomposition, we can see that young males keep the highest loss among sexes and age groups. (1.31 years by males between 25 and 49 years old.)[12]

In short, although Colombia has experienced a typical mortality-reduction pattern during the past decades violence has provoked a loss in years of life expectancy, especially for young males, almost equivalent to the gain by the reduction of infant mortality.

Another direct demographic effect of violence is forced migration. Internal conflicts generate waves of internally displaced populations (IDP) who are exposed to extreme physical, emotional and economic conditions. Therefore, IDPs usually have higher mortality and morbidity rates than the rest of the population (NRC, 2001), as past studies have suggested using data sources from resettlements (Keely and Reed, 2001). However, these results are questionable. In order to control for potential undercounting bias, data should be collected not only from settlements of forced migrants, but also from complementary information sources such as censuses, random sample surveys applied to households or individuals, or specialized surveys on the topic.

For instance, Colombian Demographic and Health Survey (DHS) 2000 allows a decomposition of the female sample by cause of migration. That is, among those who internally migrated I differentiate between those who did it for economic reasons (better jobs, wages, or education), and those who escaped from their hometowns after violence or natural disasters (internally displaced women). Therefore, I was able to estimate mortality patterns indirectly by migration categories, using the Brass-Trussell method. Although, the DHS-2000 had a very small sample of forced migrants between ages 15

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the average distribution of deaths by age and sex from the collected vital records in the correspondent intercensal period, whenever available. I used the 1985 and 1993 census for that purpose.

and 24, which did not allow me to estimate the IMR or the probability of dying at age 2 for internally displaced population (IDP), I was able to estimate probabilities of dying for both sexes at ages 3, 5, 15 and 20 by migration categories. The results are plotted in Figure 4, where it is clear that the estimated probabilities of death are almost ten times higher for internally displaced population (IDP) than those for the entire population, or for those migrating by choice. As Figure 4 shows, the probabilities of dying for IDPs are still well above those for the rest of the population, although, mortality tends to diminish after age 5, as expected.

In summary, the IDP mortality schedule is radically different from the one followed by the rest of the country. The number of IDPs has grown to almost two million people. This population and its mortality level is now so high that although it does not dramatically affect the total levels, a closer look at migration categories shows that they are reshaping the results for total migrants.

The indirect effects of violence, such as the effect on infant and child mortality, are not so obvious. As a consequence, little has been written on the topic, and it is common to encounter different health outcomes in such studies, with no variables capturing the political turmoil. For instance, the World Health Organization-WHO (2002) shows the health outcomes in three countries under conflict. First, in Uganda during the mid-1980s measles, tetanus and diphtheria reached epidemic proportions. As a result, infant mortality rates more than doubled in the conflict areas. Second, in Zepa, a United Nations controlled area in Bosnia and Herzegovina, perinatal and childhood mortality rates doubled during the conflict. Lastly, in Sarajevo, the average birth weight fell by 20% in 1993 as a consequence of the doubling rates of premature births. Moreover, Ibrahim et. al. (1996), believe that the increase in IMR in two Somali villages during 1987-89 was due to the civilian conflict. However, the Cox model they use includes as explanatory variables baby/child's sex, household head's literacy, maternal occupation, and household size, which cannot fully reflect the political turmoil because of their limited focus.

[12] A similar analysis was carried out with the 1973 census and death counts information, finding very similar patterns, although a more marked (and expected) decline in infectious diseases.

Other relevant literature, for the purpose of this paper, is that which addresses health outcomes of surviving children who lack one or two parents, or infants born out of wedlock. Yet, neither literature is helpful in explaining the mechanism through which adult mortality affects child health or mortality. For instance, a preliminary version of Gertler et. al. (2003) shows that, in Indonesia from 1993 to 1997, bereaved children have higher child mortality, whenever the death of mother and child did not occur during the same year.[13] Further, paternal deaths have no effect on child anthropometric measurements, while maternal deaths have a big impact, mainly reflected in measures of weight.

Children born out of wedlock, as cited by Preston and Haines (1991), in Baltimore during 1923 had larger infant mortality rates than those born within marriage. According to the authors, the fact that single mothers became the main economic support for their babies pushed the mothers into the labor market, and in turn, these mothers placed their babies in day-care institutions. This behavior implied shorter breast-feeding periods, increasing the risk for infants to suffer gastro-intestinal diseases. In fact, the authors showed that infants born out of wedlock shared lower proportions of being fed exclusively breast milk, and experienced higher infant mortality rates when compared to those born in marriage. Although, this is the main claim of the authors, this study lacks an analysis of causes of death for infants.

A. Colombia in the Latin American Context

The IMR in Colombia for year 2000 was 30.6 per thousand live births.[14] Although this rate is high compared to developed countries such as the U.S. (6.9 per thousand) or Sweden (4 per thousand), in the Latin American context it is placed at a medium-low level next to Argentina, Panama, Costa Rica, Dominican Republic and Venezuela (Pan-American Health Organization-PAHO, 1999). The region overall has maintained a downward trend in the IMR since the 1960s. However, Latin America covers such a large and diverse region that, for comparison reasons, demographers have classified these

[13] This fact avoids the possibility of contagion from mother to child, or the occurrence of an accident.
[14] Author's estimation based on DHS-2000.

countries according to their stage at the demographic transition. Colombia, along with 10 other countries, is ranked as "transition in progress" with low overall mortality and moderate fertility levels (Chackiel and Plaut, 1996).

Following this distinction, some characteristics can be extracted from the PAHO compiled mortality statistics for Latin America countries from 1960 to 1995.[15] First, Colombia had the highest infant mortality rate of communicable diseases among the countries classified as "transition in progress" and those with similar socioeconomic characteristics. Second, Colombia next to Panama had the highest rates of perinatal illness during the 1960-95 period. Also, IMR by nutritional deficiencies were the highest until the early 1990s, when Colombia catches up with the rest of the countries. Third, from 1990 to 1996 Colombia held on average the largest proportion of babies born with low birth weight (14%) among all Latin American countries, even larger than the proportions in two least developed in the region: Bolivia and Haiti.[16] Finally, poor outcomes were also observed when analyzing morbidity rates. Colombia has continuously diminished the immunization rates, while kept high prevalence rates of communicable diseases such as poliomyelitis, neonatal and post neonatal tetanus, tuberculous-meningitis and diphtheria.

Finally, a brief cross-country exercise for the main IMR determinants from 1985 to 2000 for Colombia and countries that share very similar demographic and socio-economic conditions, but experienced low or none political violence incidence will test the idea of harmful effects of violence and infant survival. The selected countries are Argentina, Brazil, Chile, Colombia, Costa Rica, Dominican Republic, Mexico, Panama, Peru, Uruguay and Venezuela. The data includes: proportion of illiterate women over age 15, accounting for women's education, infant's immunization rates (for DPT and measles, separately) and proportion of total population living in rural areas. The IMR is taken from the PAHO reports. The other variables are taken from the International Monetary Fund (IMF) dataset and PAHO.

I estimated fixed effects and ordinary least squared (OLS) models using the variables both in levels and in first differences. The results are very similar in all cases, and the fit

[15] See PAHO, 1999.

has an explanatory power of 74% (adjusted R-squared). Following those estimators, I plot the observed and predicted IMR for Colombia in Figures 5a and 5b. We can see that if Colombia had socio-economically behaved as the rest of these Latin American countries, in average, by the end of the century the IMR would have been almost 5 deaths per thousand live births lower. With a current population of over 40 million, that would imply 200,000 less infant deaths.

Although the channels through which the civil conflict may influence these outcomes are not known yet, one possibility may be the increase of internally displaced populations, which tend to have a higher risk of dying by communicable diseases and suffer from nutritional deficiencies (NRC, 2001). Other possibility are the constant attacks to electrical infrastructure and connecting roads that may reduce the quality of hygienic practices both in households and hospitals, as well as lower the possibilities of parents to reach health centers or medical services, delay food transportation and medicines distribution. Also, there may be special conditions in Colombia, other than the increase of force migrants that have led to the fact that it has the highest proportion of babies with low birth weight in the region. For instance, an increase in mothers' malnutrition due to the economic collapse in households, due to the excess mortality of young males, the typical bread-winners in Colombia. These hypothesis are depicted in Figure 6.

[16] It is also remarkable that Haiti holds the highest IMR in Latin America and Bolivia the highest in South America.

III. DATA

All the information is annually collected and merged to the municipality level from 1990 to 2000. The dependent variable, infant mortality rate (IMR), is defined as the number of infants' deaths over total live births in each year. For this variable in the numerator I use the information of total deaths for ages zero to one collected by the governmental statistical office (*Departamento Administrativo Nacional de Estadisticas*, DANE). In the denominator I include total live births, collected by the National Registry Office (*Registraduria Nacional del Estado Civil*) and processed by DANE until 1997. From 1998 onwards, DANE has directly collected and arranged this data.

I am aware that the IMR suffers from under-registration in Colombia. Although I attempted to correct this measurement problem by indirectly estimating infant mortality rate using the Demographic and Health Surveys (DHS) carried out in Colombia (1986, 1990, 1995 and 2000); these estimates are accurate only at national levels due to small sample size (DHS reports, 1990 and 1995; Florez and Mendez, 1997). That is, such corrections cannot be applied at regional levels, such as departments or municipalities.

The results from such indirect estimations of the national IMR, using the Brass-Trussell method (U.N., 1990; 1983), are presented in Table 2. I also estimated the national IMR using the Palloni-Helligman version of the Brass method with practically equivalent results.[17] Table 2 presents the estimated IMR and the recorded IMR by the vital registration. Both series show a declining pattern for the years under study. Counter-intuitively, the quality of the vital registration system seems to slightly worsen in time. This fact is also pointed out by Medina and Martinez (1999), who explain it as a delay in data entering in the vital registration system.[18] Then, by using the IMR recorded by the vital registration system the overall changes over time will be captured. Besides, some demographic parameters will be inferred, such as age distribution at death and sex ratio at birth, as shown by Pabon (1993), Ruiz and Rincon (1993), and Florez (2000).

[17] The Palloni-Helligman method differs from the Trussell version by using additional information: births of the year for which the estimation is made. With such information the mean age at maternity is computed, and when the information on births is not available a proxy is used. See, U.N. 1990

[18] Personal conversations with experts at DANE, National Institute of Legal Medicine (INML) and Registraduria Nacional, have confirmed this idea.

More importantly, the under-registration problem is not correlated with violence, as shown in Figure 7. DHS in year 2000 asked women whether they registered their babies born since 1995 or not. From that information, I estimated the proportion of registered babies per municipality for each year between 1995 and 1999. One can assume that the registration of births and the registration of infant's deaths are highly correlated, and therefore, the relationship between birth registration and violence is close to the registration of IMR and violence. In fact, the average proportion of babies born and registered between 1995 and 1999 is 76%, very close to my estimates of infant mortality under-registration. Furthermore, Figure 7 shows a very flat pattern between registration and violence. In fact, the trend of registration seems not to be influenced by violence, except for the extreme levels of violence, which is consistent with the research strategy of this study.

A. Independent Variables

During the entire period, 1990-2000, I capture violence by two different ways. First, by using total homicide rates, as well as specific male, young and young male homicide rates. For the numerator, I use information from the external causes of death available by sex and big age groups and collected by DANE. The denominator is derived from population estimations by age and sex, calculated from the two latest available Colombian censuses, carried out in 1985 and 1993 by DANE. External causes of death are recognized as the most reliable records among the mortality statistics, for which this information does not need a special correction.[19]

The second set of variables that measure political violence in Colombia includes total number of armed actions carried out by outlaw active groups. From 1990 to 1994 the information of altogether active guerrilla groups in Colombia was collected by the National Police and processed by the Social Foundation (Fundacion Social, 1998), and includes all armed activities perpetrated by the four active guerrilla groups at the time:

[19] There is a consensus about the reliability of this data among researches, as expressed in WHO (2002), Londono and Guerrero (1999) and Fajnzylber et. al. (1998).

ELN, ELP, FARC, and M-19.[20] From 1995 to 2000 the information was collected by the National Police and processed by the National Planning Department and includes each of the armed activities perpetrated by the above listed guerrilla groups, altogether paramilitary groups and unorganized criminals. Those activities include: terrorist attacks, ambushes, attacks on rural and urban areas, harassment, attacks to infrastructure, attacks to aircrafts, weapon trafficking, confrontations with military or police forces, roads hijackings, homicides and massacres. Given these data constraints, and to be consistent, for the analyses that assess the effects of violence on infant mortality rates during the entire decade, I include as violence measures homicide rates and guerrillas' armed actions per capita.

Finally, in order to account for Colombia's economic performance some indicators will be included. Unluckily, there is no information on GDP per municipality, then, the best source for economic performance is taken from the fiscal yearly balance of each municipality, collected by *Contraloria General de la Republica*. This information includes the total revenues from direct and indirect taxation, which I use to construct the economic size of each municipality. That is, the proportion of total revenues of municipality *i* over the total Colombian revenues, which is a good proxy of GDP per capita, as shown in Annex 1.

The Contraloria's information also includes government investments on health and health-related sectors. More precisely, it contains the flow of public investment on: infrastructure of clean water supplies (construction and maintenance), garbage collection and treatment, construction and improvement of slaughterhouses, construction and maintenance of hospitals and health care centers, acquisition of technical health devices, medical and laboratory equipment, promotional health campaigns, subsidies to high risk population in the demand of health services, and operational expenditures of hospitals and health centers such as salary payments of medical doctors, nurses and the like. All these variables are used in constant Colombian pesos of year 1988, and as per capita measures. The descriptive statistics for all variables are shown in Table 3.

[20] ELN stands for the name in Spanish of National Army of Freedom, ELP for Patriotic Liberalization Army and FARC for Armed Revolutionary Forces of Colombia. The group M-19 (Movement April 19) signed a peace treaty and resigned the arms in 1992 after negotiations with the Colombian government.

IV. EMPIRICAL METHODOLOGY

The prototype cross-sectional models for infant mortality and violence are each described by

$$IMR_{it} = \beta\ x_{it} + \varepsilon_{it}, \qquad \varepsilon_{it} = \alpha_i + \upsilon_{it} \qquad (1)$$

$$v_{it} = \gamma x_{it} + \mu_{it}, \qquad \mu_{it} = \sigma_i + \varpi_{it} \qquad (2)$$

where IMR_{it} is the infant mortality rate in municipality i at exactly year t, v_{it} is the violence level, x_{it} is the vector of municipality characteristics (e.g. economic performance and fiscal investments) and ε_{it} and μ_{it} are the unobservable determinants of infant mortality and violence, respectively. Biases in the estimations of the parameters β and γ may arise due to covariance between the regressors and the unobservable characteristics. For that reason, an unbiased estimation requires no relation between the observable characteristics and the municipality-specific effects (α_i and σ_i), or the random errors (υ_{it} and ϖ_{it}).

To test for biases on the cross-sectional estimations of infant mortality, I checked the associations between violence measures and the *predicted* IMR from a regression of mortality on all other covariates, excluding violence. The results show a high and significant relation for any of the violence proxies, suggesting that cross-sectional models will produce highly biased results. Moreover, to test for the reliability of cross-sectional estimations, I checked for associations between violence and other covariates across municipalities. I found that both homicide rates and guerrillas' armed actions per capita covary with several observables, mainly with economic size, health investment and water supplies investment, at almost all years. Both results strongly suggest low reliability and biased parameters from cross-sectional estimations.

Therefore, exploiting the aggregated data, with repeated observations for the same municipality over a decade, and the large number of municipalities included in it, a fixed effects model better captures the effects of violence on IMR. Besides, the interest of this

paper is on the estimation of the effects of violence on infant mortality rates, which is best denoted by

$$IMR_{it} = \theta v_{it} + \beta x_{it} + \varepsilon_{it}, \quad \varepsilon_{it} = \alpha_i + \upsilon_{it} \qquad (3)$$

where θ is the parameter that measures the effect of violence on infant mortality rates and the main interest for the reminder of this paper. A fixed effects model will help to control for the unobserved invariant characteristics of the municipalities across time that have been found to be related to infant mortality, such as altitude, climate and humidity (Bloom et. al., 2000; Woodruff, et. al., 1997; Miller, 1993). Given this, within-municipality changes on infant mortality can be described as the difference of (3), which absorbs fixed municipality effects:

$$dIMR_{it} = IMR_{it} - IMR_{i(t-1)} = \theta v_{it} - \theta v_{i(t-1)} + \beta x_{it} - \beta x_{i(t-1)} + \upsilon_{it} - \upsilon_{i(t-1)} \qquad (4)$$

For the estimations based using data for the entire 1990s decade I use as violence measures (v) guerrillas' armed actions per capita and homicide rates. Given these are the consistent measures available during the period of analysis.

Furthermore, an ideal research design would randomly assign different degrees of violence across mothers and infants in the different municipalities. However, that is not what occurs in real life. For that reason, a "quasi-experimental" approach becomes useful. I will exploit the fact that there are some municipalities that never experienced any of the armed actions perpetrated by any of the outlaw-armed groups during the period of analysis. The peculiarities of the Colombian conflict allow to compare the results of such aggregation of municipalities, since violence seem to be the result of inequality distribution of the economic resources only in areas with very rapid economic growth (Rubio, 2002; Sanchez and Nunez, 2000; Penate, 1999; Rangel, 1999). Indeed, other covariates follow very much the same pattern, except for the violence levels as shown in Table 10. The following findings show similar results in the estimated parameter in the different specifications and insensibility of the estimated coefficient of violence to the inclusion of other controls, which validate this research strategy.

Additionally, I will use the sudden introduction of violence in a municipality, after years of peace, followed by the eradication of it. I will observe the effect of violence on

infant mortality rates in municipalities that did not have armed presence of any of the outlaw armed groups for the first half of the decade, but by any particular year after 1995 violence explodes for a year and is further controlled at the following year. I chose years after 1995 because, after then, I can control for the presence of *both* guerrilla and paramilitary groups.

V. EMPIRICAL FINDINGS

The following results are based on the IMR reported from vital records. Figure 8 shows that infant mortality rates tend to increase as homicide rate increases, up to an inflexion point where this pattern reverses. Although this may be due to under-registration linked to high violence levels, this problem seems not to be of great preoccupation. In fact, it is only at dire violence when this becomes an issue. Therefore, that is true only for extreme outliers, since the vast majority of the data points report homicide rates below 200 per hundred thousand inhabitants (92% of the data points), where the expected negative relationship between violence and infant mortality holds. The negative relation between violence and infant mortality is even clearer when violence is captured by Guerrillas' armed actions per capita as shown in Figure 9. For that reason, only extreme outliers have been removed. The following analysis is based on all data points where IMR is lower or equal to 150 deaths per thousand births and homicide rate is below or equal to 800 deaths per hundred thousand habitants. That is from 10,428 data points collected 1,199 were removed.

Table 4 contains "t-test" on the difference in means for IMR across municipalities arranged by quartiles of violence, captured by homicide rates. The quartiles are ordered from the least violent (Q1) to the most violent (Q4). Table 4 shows a significantly higher IMR for the most violent municipalities (Q4) when compared to the least violent municipalities (Q1) at all years. The same is true when comparing Q1 and Q2. However, differences were not statistically significant between Q2 and Q3 or Q3 and Q4. The trends are clear. Infant mortality tends to increase as violence increases, however at the highest levels of violence the differences shorten and are not longer significant. Similar results are achieved when violence is captured by other homicide rates, such as male homicide rates, young's' homicide rates and young male homicide rates.

Cross-sectional estimations for each year from 1990 to 2000 are shown in Table 5. The estimations use the two available measures of violence for the entire decade. That is, columns 1, 3 and 5 use as violence measure the total homicide rates per thousand inhabitants, while columns 2, 4 and 6 use guerrillas' armed actions per capita per ten

thousand habitants. Three different specifications are presented. First, a bivariate regression, second a regression including the squared of the violence term and economic size, and a third specification which additionally includes public investments on the health and health related sectors. Although the coefficients for violence are always positive and significant, they also show great variability depending on the year and the specification. For instance, as homicide rates increases by one per thousand, IMR increases from 9.3 infant deaths per thousand in a bivariate regression for 1991, to 3.2 infant deaths per thousand in 2000 when the squared violence term and economic size are included. Also, when guerrillas' armed actions per capita increase by one unit, IMR increases vary from .89 infant deaths per thousand in 1996 in a bivariate regression, to almost 10 infant deaths per thousand in 1990 when the squared violence term and economic size are included. This wide range in the estimated coefficients reflects problems of omitted variables bias.

A. Fixed Effects Results

By using a fixed effects model, exploiting the richness of the data and the large sample, helps correcting for such omitted variable bias, induced mainly by dimensionality problems. All the results are based on 10,428 observations correspondent of 944 municipalities out of 1,074 municipalities in Colombia, from 1990 to 2000. Since IMR collected the vital registration system suffer from under-registration on average by 25%, the estimates from this model would be better read as a lower bound, rather than the actual coefficients. Furthermore, regression analysis on mortality rates usually produce error terms that are first-order autoregressive. Therefore, all the results presented below account for a correction of autocorrelation whenever necessary.

For all estimations the dependent variable is the yearly infant mortality rate per thousand for each municipality. Table 6 shows the coefficients for the effects of bivariate regressions of violence on IMR, both using an ordinary least square (OLS), column 1, and a fixed effects model (FE), column 2. For each of these bivariate regressions the coefficients are always positive and significant for both homicide rate and male homicide rate. For instance, the fixed effects results imply an almost one to one relationship, since

an increase by a homicide per thousand would imply an increase by almost one infant death (.9) per thousand. In contrast, the OLS coefficients are much larger, showing a relationship by almost 8 infant deaths per increase in homicide rates, what exemplifies the bias problems of using this estimation. Since the results on the coefficients for all homicide rates are almost the same, the following results will only present the effects of total homicide rates on infant mortality.

When other controls are included the coefficients show similar trends for the effects of violence on IMR, as reported in Table 7. But, interestingly enough, the magnitude is larger both for OLS and FE models. The fist two columns in Table 7 show the OLS estimations and the last two columns the FE results. OLS estimators are about seven times larger than those from FE. Fixed effects estimators imply that as homicide rates increase in one per thousand, infant deaths would increase in over 2 deaths per thousand, while as guerrillas' armed actions per capita increase by 1 per ten thousand IMR increases by .17 deaths per thousand, being the former significantly different from zero.

For all cases, all other variables show the expected signs, being economic size the largest in magnitude, although it is not significantly different from zero, and the coefficient for fiscal investments in health and health related sector show an unexpected sign. It is important to remind the reader that the scope of this paper is on the effect of violence on infant mortality, rather than the effect of public investments on infant mortality. For that reason, the coefficients here presented for those covariates may not be the true parameters, since such variables are used here as controls. Indeed, several problems may arise when trying to identify the true effect of public investments in health and health related sectors on infant mortality, such as the fact that municipalities that experienced negative shocks in health (i.e. a contagious diseases outbreak) respond to them with higher public and/or private investments, as explained by Costa and Kahn (2003).

For all the above-presented estimations, and the following, several specification checks were tested. For instance, excluding the 20 largest metropolitan areas, according to the National Statistical Office (DANE), or the 31 cities that report the highest fiscal

revenues in Colombia. In all cases the results are very similar to those presented in Tables 6 and 7.

B. Which Part of Political Violence Matters the Most?

As mentioned in the data description, since 1995 violence data accounts not only for the total number of armed actions carried out by active guerrilla groups in Colombia, but also for each of the armed actions perpetrated by guerrillas, paramilitary groups and common delinquency (described in section III and Table 3). I believe some of such actions have a greater impact on infant mortality than others, and this detailed information will allow me to test for such beliefs. As stated before (see Figure 6), the channels through which political violence may be mostly affecting infant mortality are closely related to the depletion of breadwinners in Colombian households and the lower accessibility to food and proper health services, mainly caused by the destruction of infrastructure and/or the control of roads by any of the outlaw armed groups.

Having this in mind, any armed action such as attacks to infrastructure, massacres or homicides attributed to guerrillas are as harmful to infant survival as those attributed to paramilitaries. For that reason, I have pooled together each of the armed actions, disregarding the perpetrator. For instance, the total number of massacres that took place in municipality *i* at year *t* will be the number of massacres perpetrated by altogether guerrilla groups *plus* the total massacres perpetrated by altogether paramilitary groups. All variables are expressed in per capita measures. “Recognized homicide rates” now refer to homicides whose perpetrator was identified as either one of the guerilla or paramilitary groups, instead of being the total homicide rates recorded by the vital registration system.

The results of bivariate fixed effects regressions are reported in Table 8. Most coefficients are positive and half of them are statistically significant. Surprisingly, the effect of terrorism is negative on infant mortality, although non significant. Also, attacks to aircrafts showed a negative and no significant effect. It is clear that such actions are a very rare event (77 in total), and for which I did not expect an effect on infant mortality. On the other hand, highjack, weapon trafficking, harassment, attacks to populations,

recognized homicides and attacks to infrastructure have a positive and significant effects on the infant mortality rate.

These results present provoking evidence on what particular populations are being more affected in the war-like environments. In magnitude, the highest effect on infant mortality, among these armed actions, is reported by recognized homicides. A reduction by one of such violent deaths per thousand would reflect in a reduction by 74 infant deaths per thousand births. The following effects in magnitude are attacks (18.9) and harassments (12.8). In the Colombian context populations are usually first harassed and then attacked (there is a correlation of .85 between these two variable). In the first place, these actions reflect the intensity of war and are obviously linked to infrastructure destruction and lower effectiveness of State protection to civilians. Then, these actions translate into congestion of several public services, which in turn affect health outcomes.

Furthermore, by reducing the ground transportation hijacks in one per ten thousand, infant mortality rates would reduce in almost 2 infant deaths per thousand. This result is consistent with the hypothesis of increments to infant mortality via households' impoverishment and the roads' control by the outlaw armed groups. Hijacks have a partial effect on people's income, when people are simply being robbed, or a more permanent effect when people are kidnapped, a common practice in the roads' hijacks. But more importantly, I believe this effect captures the control of roads by the outlaw-armed groups. These groups control, at least partially, as many roads as in which they have perpetrated hijacks. Besides, it reflects the lack of State provided security. Therefore, knowing that in a particular road hijacks have taken place, the probabilities that people use such roads will reduce, aggravating situations relevant for mothers and infants' survival, such as food and medicines transportation, as well as patients' movements.

Finally, weapon trafficking have a negative effect on infant survival of almost one infant death per thousand live births. Weapon trafficking per se may not be affecting infant mortality. Instead, it may be capturing a zone control by outlaw-armed groups, similarly to hijacks. Whether all those trafficked weapons were intended to be used in the war, or were part of the financial sources of the outlaw armed groups remains a question.

But definitely, at least a fraction of those was going to be used in the conflict. Therefore, this partially captures the military power gained by either guerrillas or paramilitary groups, which ultimately reflects in violent actions affecting the entire population.

Table 9 shows the results adding other control variables to these particular armed actions. The effect of each of these armed actions are similar to those presented in the bivariate regressions. The negative and significant effect on infant survival remains for highjack, weapon trafficking, harassment, attacks to populations, recognized homicides and attacks to infrastructure. Moreover, the coefficients of these multivariate regressions are typically higher to those of bivariate regressions. For instance, as the number of hijacks increases by one per ten thousand habitants, infant deaths increase by 39 per thousand births. Harassments and attacks increases reflect in about 20 infant deaths per thousand, and attacks to infrastructure increase imply an increase by almost 70 infant deaths per thousand.

In summary, for the second half of the 1990s decade armed actions carried out by either paramilitary or guerrilla groups such as road hijacks, weapon trafficking, attack to infrastructure, harassment and attacks to populations had the largest and significant effects on infant mortality in Colombia. That is, if a policy was designed to reduce the harmful effects of war on infant survival, then it should first direct its efforts towards municipalities that lack State provided security, are more prone to suffer an attack (or have been harassed) or are currently under attack by any of the outlaw-armed groups. These policies should also provide especial attention to municipalities where outlaw armed groups hold illicit business such as weapon trafficking and hijacks, which road-isolate them.

C. Quasi-Experimental Results

Two approaches have been tried for this section. First, a comparison on infant mortality outcomes between municipalities that did not experience any armed action during the entire decade against those that did. The second experiment follows municipalities that had a short-term eruption of violence for a single year after 1996.

1.First Experiment: Violent vs. Nonviolent Municipalities

To validate the design of the first experiment, Table 10 shows the means and standard deviations of all independent variables for municipalities that have ("violent") and did not have any armed action ("non-violent") during the last decade. I exploit the fact that all variables but violence show similar patterns, regardless of the absence of violence, which is mainly explained by the expansionist guerrilla and paramilitary groups' movements. The largest and oldest guerrilla group in Colombia, FARC, during the 1990s set in areas that experienced economic booms mainly due to the exploration and transportation of petroleum oil, coal, or gold, production and transportation of bananas, and more recently coffee production zones (Rangel, 1999). The second largest guerrilla group, ELN, settles in municipalities where they can afford rents from the fiscal income, by threatening the local authorities or "electing" their majors, as well as in regions with high rents from petroleum oil exploitation (Peñate, 1999). Paramilitary groups during the 1990s have followed two main expansionist strategies. On one hand, paramilitaries react to every political attempt that would empower guerrilla groups, such as peace negotiations initiated by the Colombian government with guerrillas (Romero, 2003). On the other hand, paramilitary groups fight against guerrillas for the control of very productive territories, such as illicit crops (Echandia, 1999). In general, high homicide rates are related to regional economies with the most accelerated economic growth. This is particularly true in isolated regions with sudden increases in income, such as those produced by the discovery and exploitation of emeralds, gold, petroleum oil, bananas and coca leaf plantations and cocaine processing (Montenegro and Posada, 2001).

Following the above classification for Colombian municipalities, I estimated the difference in the mean infant mortality rate between these two types of municipalities. Violent municipalities have a significant higher IMR than non-violent municipalities.[21] A parametric estimation using fixed effects is presented in Table 11. Since non-violent municipalities record zero armed actions perpetrated by any of the outlaw groups, then, the consistent violence measure is the homicide rates. The first two columns report the results of bivariate regressions, while the other columns include additional control variables. For all specifications the effect of violence on IMR is larger and significant in

[21] Significant at 1%

all violent municipalities, while it is positive but smaller and not statistically significant for non-violent municipalities. The coefficients in violent municipalities show low variability across specifications and are very close to those using all data points, providing consistency in the results. That is, as homicide rates increase in one death per thousand, IMR increases by 2 to 3 infant deaths per thousand. These results reinforce the above-mentioned policy implications of directing efforts to municipalities that have been or are experiencing any kind of violence from any of the outlaw-armed groups.

2. Second Experiment: Sudden Eruption of Violence in 1996

I tracked on time the municipalities that never experienced an armed action by either of the perpetrators before 1996, but after that had at least an armed action for only one year and return to a non-violent state in the following year. A more desirable experiment would be a two-year violence eruption, so a fixed effects estimation could be tested for both the years in violence and those without violence. However, there are not enough municipalities experiencing this, only 5 municipalities in 1996-97 and 6 in 1999-2000.

Figure 10 shows non-parametric evidence for the impact of violence on infant mortality, given that for all years this condition of sudden violence covers few observations. Yet, for all cases the highest average infant mortality rate for such municipalities is the one that corresponds to the year when the violence outbreak took place, except for those that experienced the outbreak in 1997, which have a lagged effect. For instance, for the municipalities that did not experience any armed actions perpetrated neither by guerrillas or paramilitary groups before or after 1996, IMR increases by almost one infant death per thousand live births by 1996 and only until 2000 the IMR returns to the lower levels of 1990. Moreover, this difference is statistically significant at a 5% level of significance. Similar results are reported for all the following years, with even more dramatic differences for 1998 and 1999. This evidence suggests that municipalities that suffered a violent outbreak experienced larger infant mortality rates than would have otherwise occurred if they have kept a continuous peaceful state.

VI. CONCLUDING REMARKS AND FURTHER RESEARCH

To date, much attention has been devoted to study the causes of violent internal conflicts. Little research, however, has been devoted to understand the effects of such conflicts on the population. For the most part, economists, historians and political scientists have focused on the impacts on the economy and its institutions. However, a deep understanding of the consequences of such conflicts must also incorporate demographic variables. It is clear that the best solution to the problem would be the end of the conflict, but given the length and intensity of it, Colombian institutions must also adapt their policies in order to reach and help all victims of violence.

On one hand, my findings indicate that the direct effects of violence on mortality are as expected. Men, and particularly young males, are more negatively affected by violence than women. In fact, violence has generated a loss in years of life expectancy, especially for young males, almost equivalent to the gain attained by reducing infant mortality. Changes in infant mortality are mostly explained by attainments of higher levels of development, as well as targeting the control of specific illness, such as communicable diseases. For that reason, this reduction usually involves large efforts from the public sector. Efforts that in the Colombian case have been overcome by the civilian conflict.

On the other hand, internally displaced populations show higher mortality rates relative to the total population or recent migrants. Although these numbers are not large enough to set trends in Colombia, they do set trends in migratory populations. Both facts, then, could be incorporated in the design of health policies by targeting young males and internally displaced populations in Colombia, in order to reduce the direct harmful consequences of war on mortality.

The comparison of IMR trends and other health outcomes of Colombia with other Latin American countries provide valuable evidence on how negative can be violence to infant health in the recent years. In particular, in Colombia vaccination coverage has decreased, while morbidity of communicable diseases has increased and larger proportions of babies are being born with low birth weight. There is no direct evidence showing these facts were triggered by the current political turmoil. However, public

expenditures in the health sector have steadily increased during the last decade and, according to fiscal revenues and expenses data, the fraction of investment dedicated to health campaigns, which include vaccination, has more than doubled since 1990, and in per capita measures has increased by almost 80%. Therefore, this poor performance could be hardly linked to lower investments in the health sector. However, it may be the case that these programs need a re-design in order to reach the populations being left out.

Although the infant mortality rates recorded by the vital registration system are under-registered, this problem is not perversely affecting the results of this study. In fact, it is only true that under-registration aggravates with violence for the extreme violence levels, namely extreme outliers. For that reason, such data points have been removed, keeping consistent information for 944 out of 1,074 municipalities in Colombia.

Using such information I proved that cross-sectional estimates lead to biased estimators. For that reason, exploiting this data with repeated observations over time and by using fixed effects models such biases were reduced. The results prove a negative relation between violence and infant survival during the 1990s. The results are very consistent for different specifications presented in this paper and for those mentioned such as excluding the largest and richest Colombian municipalities. This added to the fact that the coefficient measuring the effect of violence on infant mortality is usually resistant to the inclusion of additional control variables, proves consistency in the estimates. In general, in Colombia the reduction of one homicide per thousand habitants would lead to a reduction by about 2 infant deaths per thousand live births, during the past decade.

Among the different armed activities perpetrated by both guerrilla and paramilitary groups several have been found to have a negative effect on infant survival during the second half of the 1990s. Namely, ground transportation highjack, weapon trafficking, harassment, attacks to populations, recognized homicides and attacks to infrastructure have a significant effect on infant mortality of at least one infant death per live births. In particular, municipalities being attacked, whose infrastructure has been destroyed, with high chances of being attacked (harassed) and those road-isolated should be the main

target to provide additional investments on the health and health related sector, other than to provide extra State security.

The parametric and non-parametric evidence using two quasi-experimental exercises, proves that municipalities that have suffer from a long or short term violence experience higher infant mortality rates, of at least one more infant death per thousand. This effect not only shows that non-violent conditions are desirable, but also expose the needs of entire communities that had been victims of the conflict in one way or another. Several actions are needed in order to counteract these negative effects, both in the search for more peaceful states, as well as in the expansion of health care services targeting municipalities under conflict. As stated before, these municipalities are not characterized by being the poorest ones. On the contrary, these regions are usually experiencing sudden economic growth, which in turn, need the proper design of public policies targeting both redistribution of such resources via progressive taxation and providing higher quality and quantity health care to the populations in need. Among such policies, immunization and malnutrition are lines that need more study and attention for the design of future policies.

Finally, as this was a first attempt to measure the negative impact of secondary effects of violence on human health more research and resources should be devoted to this area. In particular, the needs of the populations at higher risk should be accounted by medical services in the different municipalities in Colombia, in order to asses the real needs and dictate which are the channels through which secondary effects of violence affects human health.

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TABLES

Table 1. Contribution (years of life) of selected causes of death to improvement in expectation of life at birth, Colombia 1985-2000

Age Group	Intestinal Infectious Diseases	Accidents	Suicides	Homicides	All Other Causes
		Females			
0-4	0.191	0.006	0.000	-0.002	0.560
5-14	0.011	0.016	-0.002	0.000	0.218
15-24	0.008	0.065	0.030	0.060	0.843
25-49	0.039	0.107	0.012	0.066	3.474
50+	0.150	0.023	-0.003	-0.019	6.904
Total years	0.399	0.217	0.037	0.105	12.001
		Males			
0-4	0.214	0.006	0.000	-0.001	0.615
5-14	0.009	0.017	-0.001	-0.006	0.144
15-24	0.003	-0.034	-0.023	-0.453	0.241
25-49	0.009	-0.097	-0.055	-0.857	0.794
50+	0.044	-0.109	-0.039	-0.338	3.549
Total years	0.279	-0.218	-0.118	-1.655	5.344

Source: Author's calculation using census and death registry

Table 2. Estimated Infant Mortality Rates-IMR- in Colombia Using Brass-Trussell Method[22] (per thousand live births).

Source	Estimation Year	Estimated IMR	Vital Registration IMR
DHS 1986	1986	40.6	27.9
DHS 1990	1990	37.5	20.0
DHS 1995	1995	33.7	18.0
DHS 2000	2000	30.6	17.1

Source: Author's calculations using DHS and Vital Registration from DANE

[22] The curious reader can consult the United Nations "Step-by-step Guide to the Estimation of Child Mortality" where you can find all methods of indirect mortality estimation.

Table 3. Descriptive Statistics. Aggregated Data per Municipalities in Colombia, 1990-2000

Demographic Variables			*Economic Performance Proxies (in real Colombian pesos, 1988=100)*		
Variable	**Mean**	**S.D.**	**Variable**	**Mean**	**S.D.**
Infants' Deaths	12,613.64	87.30	Fiscal Income	548,720.80	5,686,028.00
Total Births	760,158.10	4922.40	Tax Revenue	236,095.50	3,595,704.00
Males' Births	388,863.00	2522.12	Fiscal Income Per-Capita	13.00	37.38
Females' Births	371,295.20	2400.39	Tax Incomes Per-Capita	1.97	4.75
IMR (per thousand live births)	32.12	203.10	Expenditures on Judicial System	0.05	0.85
Total Population	35,775.52	196,699.50			
Health Sector Performance (Per capita measures, in real Colombian pesos, 1988=100)					
Expenditures on the Health Sector	1.75	6.13	Expenditures on Garbage Collection	0.09	0.35
Expenditures on Water and Sewer Services	1.41	8.98	Expenditures on Health Facilities Construction and Equipment Acquisition.	0.24	1.15
Expenditures on Slaughterhouses	0.04	0.26	Expenditures on Health Facilities Maintenance and Laborers Pay.	0.44	1.52
Expenditures on Health Campaigns	0.08	0.35	Expenditures on Subsidies to Most Vulnerable Pop.	0.79	3.12
Homicide Rates (per 100,000)					
Homicide Rate	68.58	119.46	Male Homicide Rate Ages 15-44	214.81	385.73
Male Homicide Rate	124.16	218.80	Female Homicide Rate Ages 15-44	16.21	54.65
Female Homicide Rate	11.14	40.23	Homicide Rate Ages 15-44	116.20	197.76
Number of Armed Actions Perpetrated by Paramilitary Groups (1995-2000)					
Extortive Terrorism	0.0417	0.46	Attack to a Urban Area	0.0077	0.12
Non-Extortive Terrorism	0.0197	0.34	Weapon Trafficking	0.0158	0.36
Ambush	0.0005	0.02	Confrontations	0.0000	0.00
Attacks to Rural Areas	0.0005	0.02	Highjack	0.0004	0.02
Harassment	0.0164	0.26	Massacres	0.0011	0.03
Attack to Infrastructure	0.0009	0.03	Homicides	0.0545	0.56
Attack to Aircrafts	0.0002	0.01	Total Actions	0.1593	1.53
Number of Armed Actions Perpetrated by FARC (1995-2000)					
Extortive Terrorism	0.1020	0.54	Attack to a Urban Area	0.0448	0.25
Non-Extortive Terrorism	0.0983	0.45	Weapon Trafficking	0.4970	2.60
Ambush	0.0258	0.18	Confrontations	0.0021	0.05
Attacks to Rural Areas	0.0188	0.16	Highjack	0.0413	0.32
Harassment	0.1289	0.56	Massacres	0.0171	0.15
Attack to Infrastructure	0.0151	0.14	Homicides	0.7683	2.81
Attack to Aircrafts	0.0111	0.13	Total Actions	1.1599	4.08

Table 3 (continued). Descriptive Statistics. Aggregated Data per Municipalities in Colombia, 1990-2000

Variable	Mean	S.D.	Variable	Mean	S.D.
Number of Armed Actions Perpetrated by ELN (1995-2000)					
Extortive Terrorism	0.1748	1.17	Attack to a Urban Area	0.0213	0.18
Non-Extortive Terrorism	0.1013	0.67	Weapon Trafficking	0.2387	1.16
Ambush	0.0088	0.10	Confrontations	0.0005	0.02
Attacks to Rural Areas	0.0137	0.13	Highjack	0.0556	0.50
Harassment	0.0608	0.46	Massacres	0.0051	0.07
Attack to Infrastructure	0.0062	0.09	Homicides	0.2913	1.22
Attack to Aircrafts	0.0023	0.05	Total Actions	0.5885	2.91
Number of Armed Actions Perpetrated by EPL (1995-2000)					
Extortive Terrorism	0.0046	0.10	Attack to a Urban Area	0.0005	0.02
Non-Extortive Terrorism	0.0074	0.11	Weapon Trafficking	0.0236	0.28
Ambush	0.0002	0.01	Confrontations	0.0002	0.01
Attacks to Rural Areas	0.0007	0.03	Highjack	0.0044	0.08
Harassment	0.0018	0.04	Massacres	0.0005	0.02
Attack to Infrastructure	0.0005	0.03	Homicides	0.0171	0.25
Attack to Aircrafts	0.0000	0.00	Total Actions	0.0432	0.48
Number of Armed Actions Perpetrated by Common Delinquency (1995-2000)					
Extortive Terrorism	0.1946	1.5958	Attack to a Urban Area	0.0162	0.1868
Non-Extortive Terrorism	0.0647	0.5403	Weapon Trafficking	0.0192	0.1650
Ambush	0.0009	0.0296	Confrontations	0.0171	0.1726
Attacks to Rural Areas	0.0046	0.0675	Highjack	0.1737	0.8692
Harassment	0.0062	0.0907	Massacres	0.0810	0.4710
Attack to Infrastructure	0.0007	0.0325	Homicides	3.0067	11.4103
Attack to Aircrafts	0.0004	0.0187	Total Actions	3.5858	13.8081
Altogether Total Number of Armed Actions					
Guerrilla Groups	1.7919	5.5099	Guerrilla Groups Per Capita	0.0001	0.0012
All Perpetrators	3.8347	14.1131	All Perpetrators Per Capita	0.0002	0.0013
Number of Municipalities	950				
Number of Years	10				

Table 4. Yearly Differences in Infant Mortality by Violence Quartiles

Homicide Rates											
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Least Violent Munips. (Q1)	13.66	12.04	14.66	10.12	9.428	13.75	10.28	15	16.15	14.6	14.4
Low-Medium Viol. Munips. (Q2)	17.58	16.33	18.18	13.55	14.06	13.69	14.32	18.1	20.76	18.23	18.18
Medium-High Viol. Munips (Q3)	18.04	16.99	18.26	14.97	12.45	13.57	14.79	22.81	22.7	23.6	21.68
Most Violent Munips. (Q4)	19.79	16.77	18.17	17.73	16.94	17.24	15.85	21.17	23.03	23.86	23.77

Table 5. Effect of Violence on Infant Mortality in Colombia. Yearly Cross-Sectional Estimates. Dependent Variable: Infant Mortality Rate

	Homicide Rate (1)		Guerrillas' Per Capita Armed Actions (2)		Homicide Rate (3)		Guerrillas' Per Capita Armed Actions (4)		Homicide Rate (5)		Guerrillas' Per Capita Armed Actions (6)	
	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.
	N	*Adj.R-Squ.*	*N*	*Adj. R-Squ.*	*N*	*Adj. R-Squ.*	*N*	*Adj. R-Squ.*	*N*	*Adj. R-Squ.*	*N*	*Adj. R-Squ.*
1990	11.9	(0.8)**	4.05	(1.1)**	21.8	(1.7)**	9.94	(1.3)**	20	(1.6)**	7.86	(12.4)**
	818	*0.31*	*818*	*0.03*	*818*	*0.40*	*818*	*0.06*	*818*	*0.42*	*818*	*0.16*
1991	9.3	(0.7)**	3.08	(6.1)**	18.8	(1.8)**	8.12	(6.1)**	18.1	(1.3)**	6.82	(6.9)**
	861	*0.34*	*861*	*0.06*	*861*	*0.47*	*861*	*0.14*	*861*	*0.49*	*861*	*0.20*
1992	10.6	(0.6)**	3.22	(9.6)**	23.8	(1.1)**	8.26	(8.1)**	20.9	(1.2)**	6.26	(7.9)**
	866	*0.30*	*866*	*0.04*	*866*	*0.42*	*866*	*0.10*	*866*	*0.44*	*866*	*0.23*
1993	11.2	(0.7)**	4.44	(9.5)**	21.6	(1.3)**	9.91	(9.4)**	20.1	(1.3)**	7.70	(9.2)**
	843	*0.37*	*843*	*0.04*	*843*	*0.45*	*843*	*0.08*	*843*	*0.46*	*843*	*0.18*
1994	11.1	(0.7)**	5.44	(6.2)**	22.7	(1.3)**	12.18	(11.0)**	19.7	(1.4)**	8.79	(12.2)**
	842	*0.31*	*842*	*0.07*	*842*	*0.41*	*842*	*0.11*	*842*	*0.43*	*842*	*0.25*
1995	12.3	(0.8)**	1.60	(3.6)**	21.6	(2.3)**	3.46	(4.2)**	19.9	(2.4)**	2.77	(4.1)**
	837	*0.29*	*837*	*0.06*	*837*	*0.36*	*837*	*0.12*	*837*	*0.37*	*837*	*0.18*
1996	10	(0.9)**	0.89	(3.5)*	18.8	(1.6)**	2.10	(2.4)**	18	(1.8)**	1.75	(3.2)**
	834	*0.23*	*834*	*0.05*	*834*	*0.32*	*834*	*0.10*	*834*	*0.32*	*834*	*0.14*
1997	11.1	(1.0)**	1.63	(2.9)**	20.9	(1.4)**	3.69	(3.6)**	17.7	(1.8)**	2.53	(4.7)**
	823	*0.26*	*823*	*0.08*	*823*	*0.34*	*823*	*0.15*	*823*	*0.36*	*823*	*0.25*
1998	17.8	(1.3)**	3.95	(4.9)**	33.2	(2.0)**	7.77	(7.3)**	29.3	(2.3)**	6.14	(8.6)**
	849	*0.26*	*849*	*0.10*	*849*	*0.35*	*849*	*0.13*	*849*	*0.37*	*849*	*0.23*
1999	16.1	(1.3)**	2.42	(3.9)**	31.4	(2.2)**	5.86	(4.3)**	26.2	(2.3)**	4.08	(4.8)**
	866	*0.23*	*866*	*0.09*	*866*	*0.32*	*866*	*0.15*	*866*	*0.36*	*866*	*0.25*
2000	14.9	(1.1)**	1.46	(2.3)**	31.9	(1.6)**	2.90	(3.3)**	29.1	(1.7)**	2.20	(3.2)**
	790	*0.23*	*790*	*0.09*	*790*	*0.34*	*790*	*0.13*	*790*	*0.36*	*790*	*0.20*
Violence Squared	N		N		Y		Y		Y		Y	
Economic Size	N		N		Y		Y		Y		Y	
Expenditures on Health and Health Related Sector	N		N		N		N		Y		Y	

Robust standard errors in parentheses

Numbers in Italics are the number of municipalities and Adj. R-squared

* Significant at 5%; ** significant at 1%

Table 6. Effect of Violence on IMR, 1990-2000. Bivariate Regressions.

Ordinary Least Squared (OLS) and Fixed Effects (FE). Dependent Variable: Infant Mortality Rate (per thousand)

	OLS (1)		Fixed Effects (2)	
	Coefficient	N	Coefficient	N
	S.E.	*Adj. R-Squ.*	*S.E.*	*# of Munips*
Homicide Rate	7.7	8348	0.9	8281
	*(0.5)***	*0.45*	*(0.4)**	*944*
Male Homicide Rate	4.2	8348	0.5	8281
	*(0.3)***	*0.45*	*(0.2)**	*944*
Guerrillas' Armed Actions Per-Capita	0.91	8348	0.04	8281
	*(1,5)***	*0.38*	*(6.2)*	*944*

Standard Errors, Adjusted R-Squared and Total number of Municipalities in Italics.

**Significant at 1%, *significant at 5%

Table 7. Effect of Violence on IMR, 1990-2000.

Ordinary Least Squared (OLS) and Fixed Effects (FE). Dependent Variable: Infant Mortality Rate (per thousand)

	O.L.S		Fixed Effects	
	Homicide Rate (1)	**Guerrillas' Armed Actions Per Capita** (2)	**Homicide Rate** (3)	**Guerrillas' Armed Actions Per Capita** (4)
Violence	**14.00**	**1.32**	**2.30**	**0.17**
	(0.9)**	**(.18)****	**(0.8)****	**(.09)**
Violence Squared	-0.000	-183.11	-0.000	-31.78
	(0.0)**	(59.3)**	(0.0)*	(18.3)
Economic Size	13.068	70.945	-84.263	-84.2
	(4.278)**	(15.422)**	(153.063)	(153.13)
Expenditures on Health and Health Related Sectors	0.420	0.657	0.194	0.19
	(0.078)**	(0.106)**	(0.040)**	(0.04)**
Observations	8348	8348	8281	8281
Adj. R-Sq/ # of Municipalities	*0.49*	*0.42*	944	944

Standard errors in parentheses. *Adjusted R-squared in italics.* * Significant at 5%; ** significant at 1%

Table 8. Effect of Each of the Armed Activities on IMR, 1995-2000. Bivariate Fixed Effects Regressions. Dependent Variable: Infant Mortality Rate

	Coefficient *S.E.*	N *# of Munips.*
Terrorism	-0.167	4162
	(0.54)	942
Ambush	2.32	3220
	(2.23)	922
Massacres	7.55	3220
	(3.95)	922
Hijack	1.89	4056
	(.66)**	932
Confrontation	14.99	4056
	(8.33)	932
Weapon Trafficking	0.971	3220
	(.399)*	922
Aircraft Attack	-39.068	3220
	(29.648)	922
Harassment	12.84	3220
	(.4152)**	922
Attack	18.999	4162
	(.78)*	942
Recognized Homicides	74.112	3220
	(22.874)**	922
Infrastructure Attack	0.027	3220
	(0.010)**	922

Standard errors in parentheses

* Significant at 5%; ** significant at 1%

Table 9. Effect of Particular Armed Actions on IMR, 1995-2000. Fixed Effects Regressions.

Dependent Variable: Infant Mortality Rate

	Terrorism	Ambush	Massacres	Hijack	Confrontation	Weapon Trafficking	Aircraft attack	Harassment	Attack	Recognized homicides	Infrastructure attack
Violence	**-0.164**	**0.60**	**60.98**	**39.25**	**196.65**	**0.98**	**-64.97**	**20.53**	**20.57**	**0.028**	**69.57**
	(0.618)	**(23.83)**	**(40.52)**	**(1.101)****	**(388.9)**	**(.402)***	**(58.52)**	**(.94)***	**(.78)****	**(0.00)****	**(23.83)****
Violence Squared	-232.42	-22,805.33	-23,773.75	-1,584.38	-50,734.87	-25.37	10,388.63	-4,309.83	523.72	-0.00	-8,106.57
	(816.25)	(110.47)*	(15147.32)	(1061.84)	(4,113.33)	(32.22)	(19108.97)	(1,2546.77)**	(506.10)	(0.000)	(11620.6)
Economic Size	33.517	95.807	92.386	-222.542	35.214	96.154	-224.042	20.535	-182.884	77.876	105.921
	(404.455)	(459.856)	(459.655)	(329.410)	(404.157)	(459.638)	(330.136)	(403.732)	(457.660)	(459.721)	(459.598)
Expenditures on the Health and Health Related Sector	0.039	-0.001	-0.012	0.244	0.040	0.014	0.258	0.068	0.170	0.035	-0.005
	(0.062)	(0.072)	(0.072)	(0.056)**	(0.061)	(0.072)	(0.056)**	(0.062)	(0.063)**	(0.073)	(0.072)
Observations	4056	3220	3220	4999	4056	3220	4999	4056	4162	3220	3220
# of Munips.	932	922	922	943	932	922	943	932	942	922	922

Standard errors in parentheses. * Significant at 5%; ** significant at 1%

Table 10. Descriptive Statistics. Aggregated Data per Municipalities in Colombia, 1990-2000. Violent and Non Violent Municipalities

	Non-Violent Munips.		Violent Munips.	
Variable	**Mean**	**Std. Dev**	**Mean**	**Std. Dev**
IMR (per thousand live births)	20.44	32.28	23.48	46.39
Economic Performance Proxies (in real Colombian pesos, 1988=100)				
Fiscal Income Per-Capita	11.68	12.74	12.56	23.35
Tax Incomes Per-Capita	2.35	5.12	2.03	4.76
Health Sector Performance Proxies (Per capita measures, in real Colombian pesos, 1988=100)				
Expenditures on the Health Sector	1.74	3.50	1.62	3.41
Expenditures on Water and Sewer Services	1.39	3.54	1.25	3.52
Expenditures on Slaughterhouses	0.04	0.21	0.04	0.28
Expenditures on Health Campaigns	0.08	0.33	0.08	0.35
Expenditures on Garbage Collection	0.09	0.30	0.09	0.37
Expenditures on Health Facilities Construction and Equipment Adq.	0.22	0.81	0.22	1.08
Expenditures on Health Facilities Maintenance and Laborers Pay.	0.50	1.06	0.38	0.92
Expenditures on Subsidies to Most Vulnerable Pop.	0.74	1.73	0.74	2.24
Homicide Rates (per 100,000 habitants)				
Homicides Rates	**52.82**	**71.02**	**77.80**	**81.91**
Male Homicide Rates	**96.53**	**132.85**	**140.67**	**149.49**
Female Homicide Rates	**8.02**	**18.20**	**12.43**	**23.55**
Homicide Rates Ages 15-44	**87.55**	**124.60**	**132.88**	**144.38**
Male Homicide Rate Ages 15-44	**163.75**	**240.09**	**244.40**	**268.62**
Female Homicide Rates Ages 15-44	**11.64**	**30.59**	**18.60**	**40.45**

Non-violent municipalities are defined as those that did not experience any armed action during the entire 1990s decade.

Table 11. Effect of Violence on IMR, Violent and Non-Violent Municipalities, 1990-2000.

Fixed Effects Regressions. Dependent Variable: Infant Mortality Rate

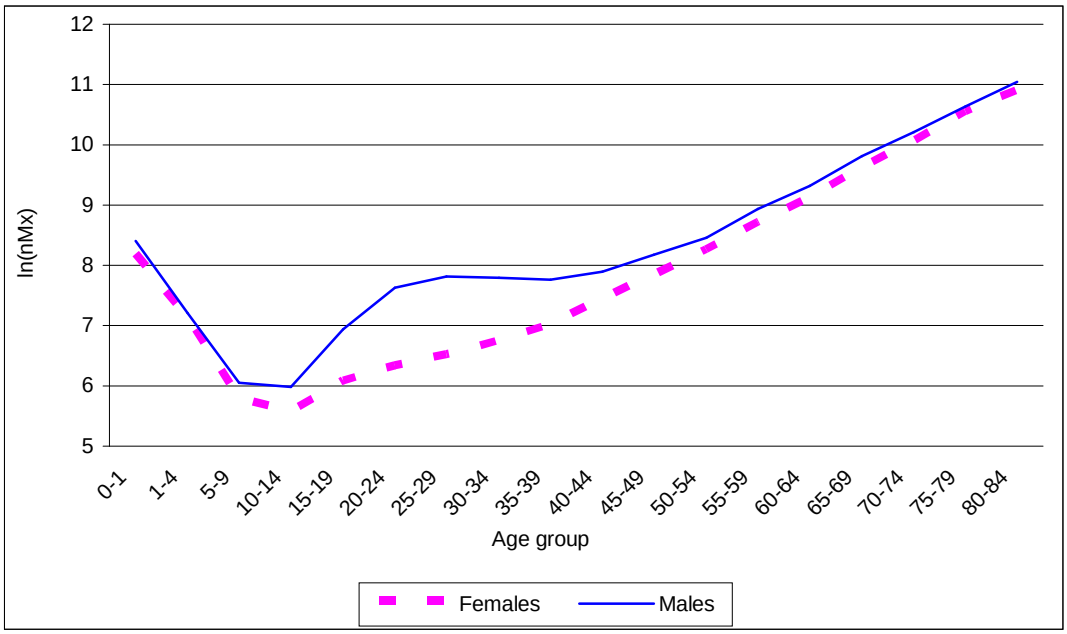
	Non-Violent Munips (1)	Violent Munips. (2)	Non-Violent Munips (3)	Violent Munips. (4)	Non-Violent Munips (5)	Violent Munips. (6)
Homicide Rate	**0.1**	**1.0**	**0.8**	**2.3**	**0.9**	**2.5**
	(1.6)	**(0.4)***	**(2.9)**	**(0.8)****	**(2.9)**	**(0.8)****
Homicide Squared			-0.000	-0.000	-0.000	-0.000
			(0.000)	(0.000)*	(0.000)	(0.000)*
Economic Size			3,305.859	-44.384	1,766.719	-90.101
			(3,051.425)	(147.471)	(3,172.130)	(147.059)
Expenditures on the Health and Health Related Sector					0.180	0.193
					(0.104)	(0.044)**
Observations	1388	6893	1388	6893	1388	6893
# of Munips.	178	766	178	766	178	766

Non-violent municipalities are defined as those that did not experience any armed action during the entire 1990s decade.

Standard errors in parentheses. * Significant at 5%; ** significant at 1%

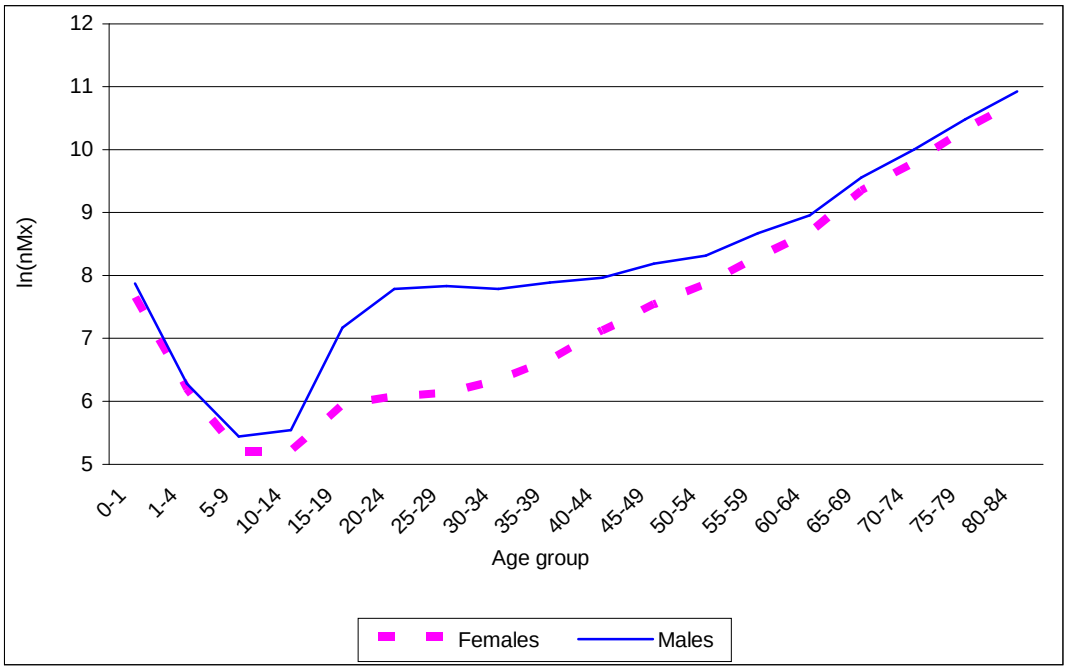
FIGURES

Figure 1. Logarithm of the Age Specific Mortality Rates (nMx) by Sex in Colombia, 1985



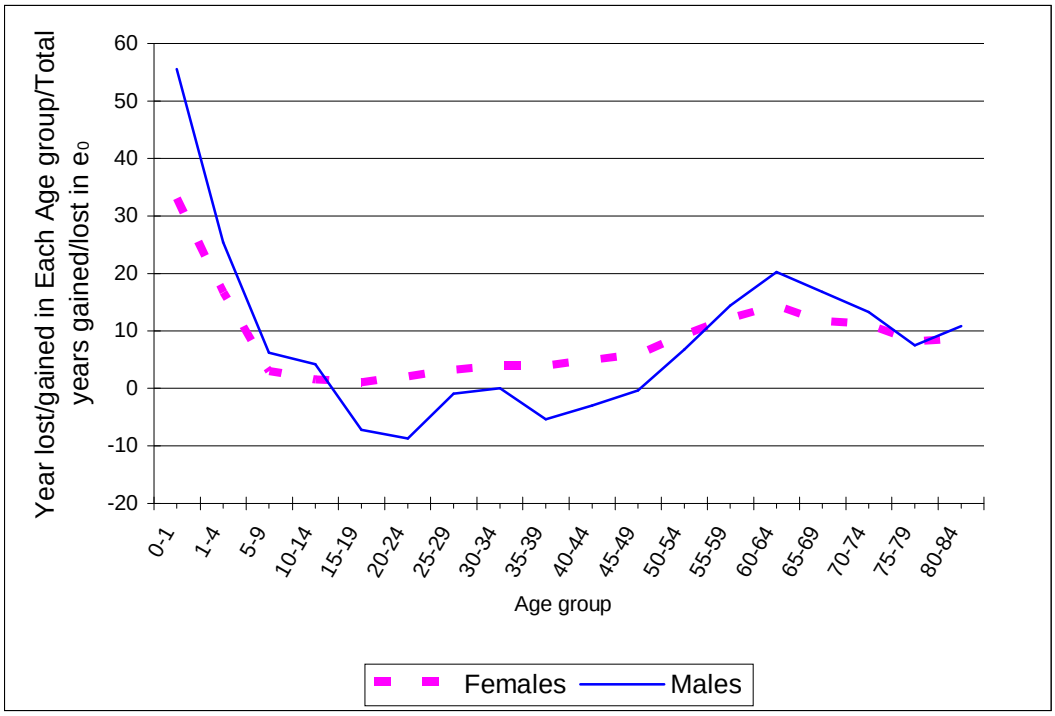
Source: Authors calculation from vital registration.

Figure 2. Logarithm of the Age Specific Mortality Rates (nMx) by Sex in Colombia, 2000



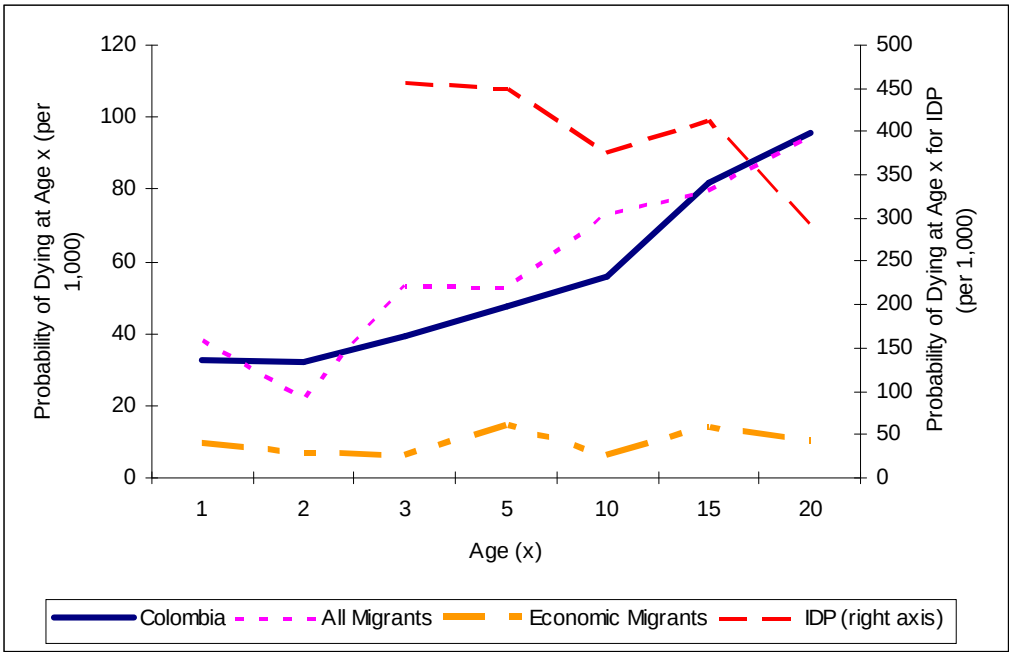
Source: Authors calculation from vital registration.

Figure 3. Change in Life Expectancy (e_0) by Sex and Age Group in Colombia, 1985-2000



Source: Authors calculation from vital registration.

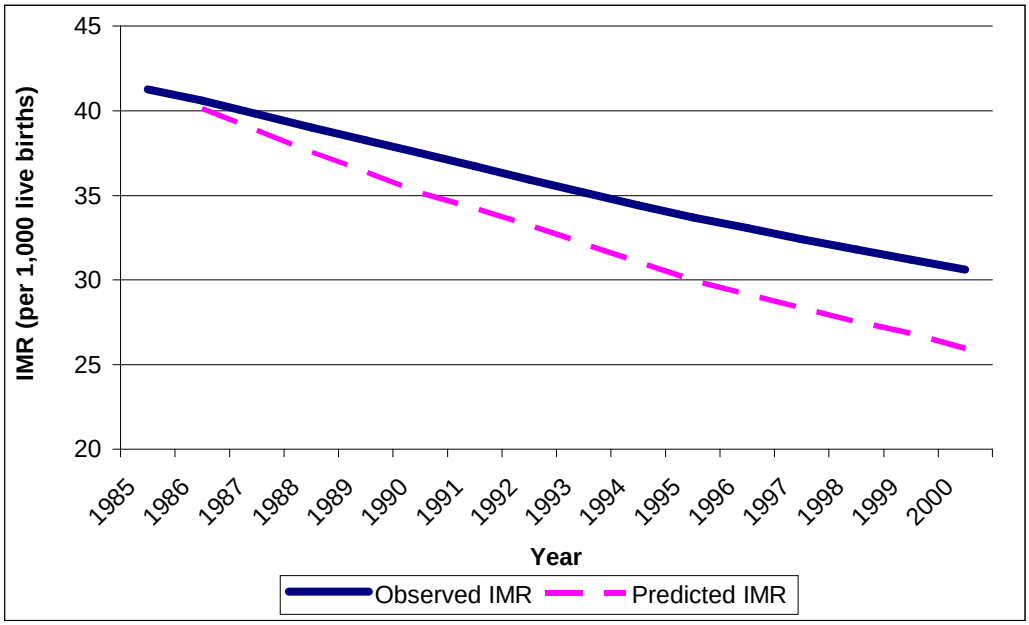
Figure 4. Estimated Probability of Dying by age x, q(x) by Migration Categories. Both Sexes in Colombia 2000 (per thousand)



Source: Authors calculations from DHS-2000

Figure 5a.Observed and Predicted Infant Mortality Rate (IMR) for Colombia, 1985-2000 from Cross-Country Regressions

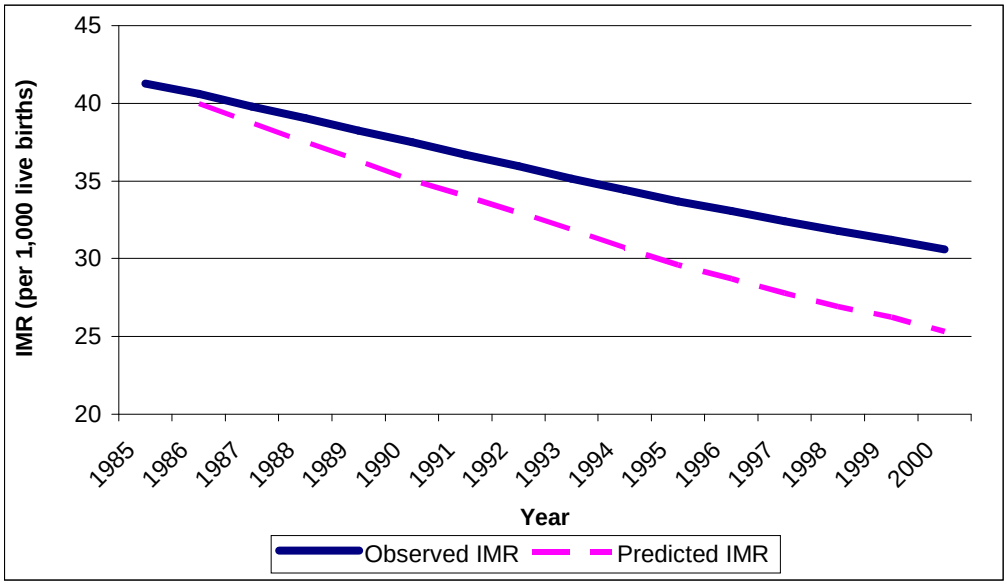
IMR=f(Female illiteracy, GDP, Immunization, Rural)



Source: Authors calculations

Figure 5b.Observed and Predicted Infant Mortality Rate (IMR) for Colombia, 1985-2000 from Cross-Country Regressions

IMR=f(Female illiteracy, GDP)



Source: Authors calculations

Figure 6. Channels Through which Political Violence Affect Infant Mortality

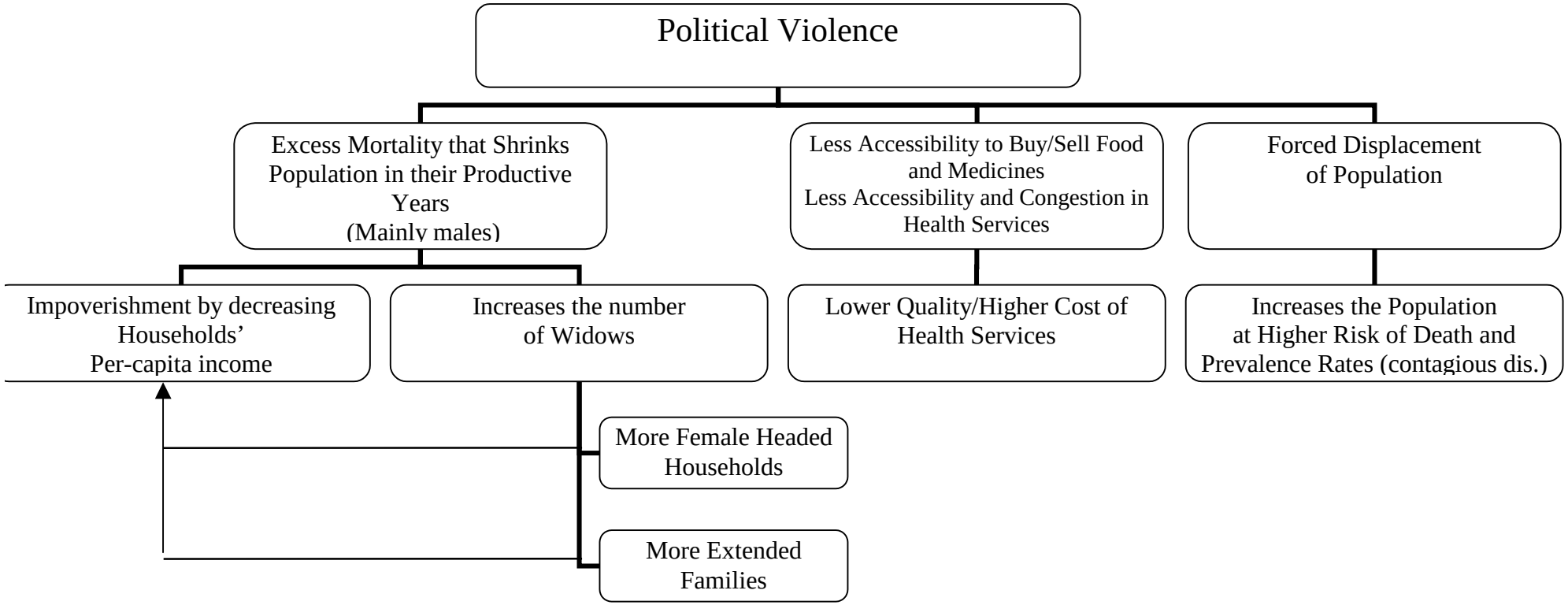
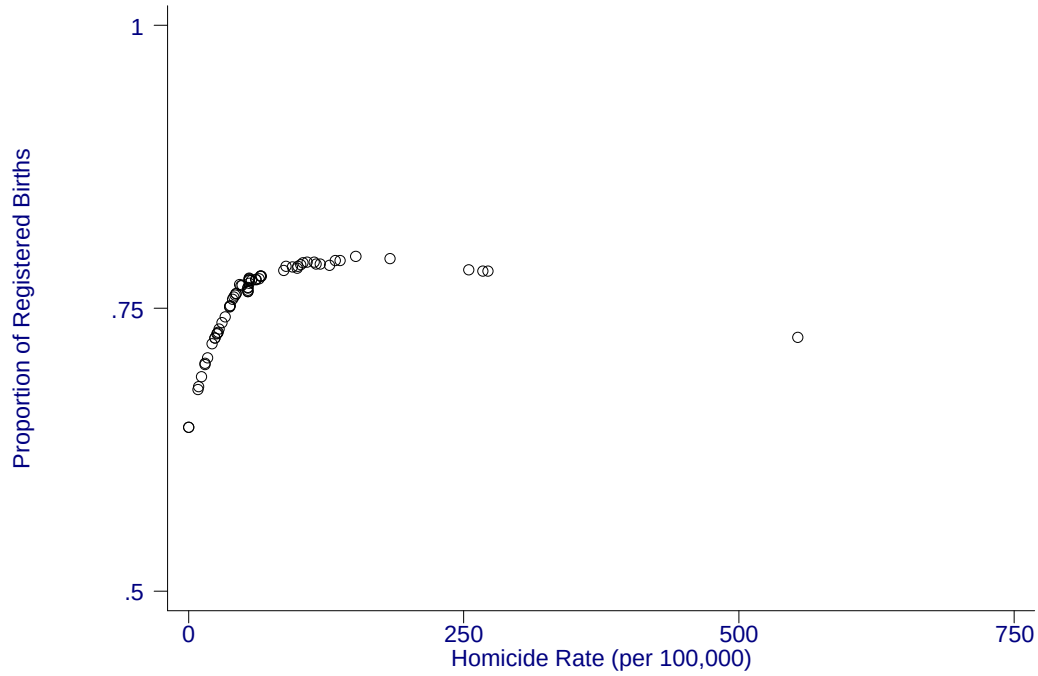
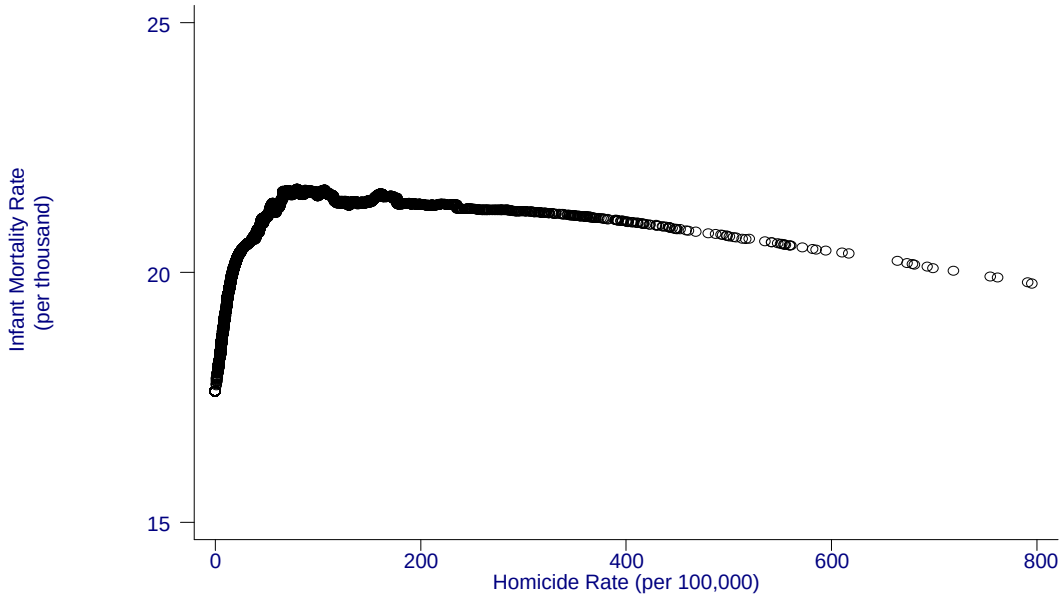


Figure 7. Proportion of Registered Births (%) and Homicide Rates (per 100,000), 1995-1999



Source: Demographic and Health Survey, 2000

Figure 8. Infant Mortality Rate (per 1,000 live births) and Homicide Rates (per 100,000), 1990-2000



All data points included, only shown those for which Homicide Rate falls below 800 per 100,000

Figure 9. Infant Mortality Rate (per 1,000 live births) and Guerrillas' Armed Actions Per Capita, 1990-2000

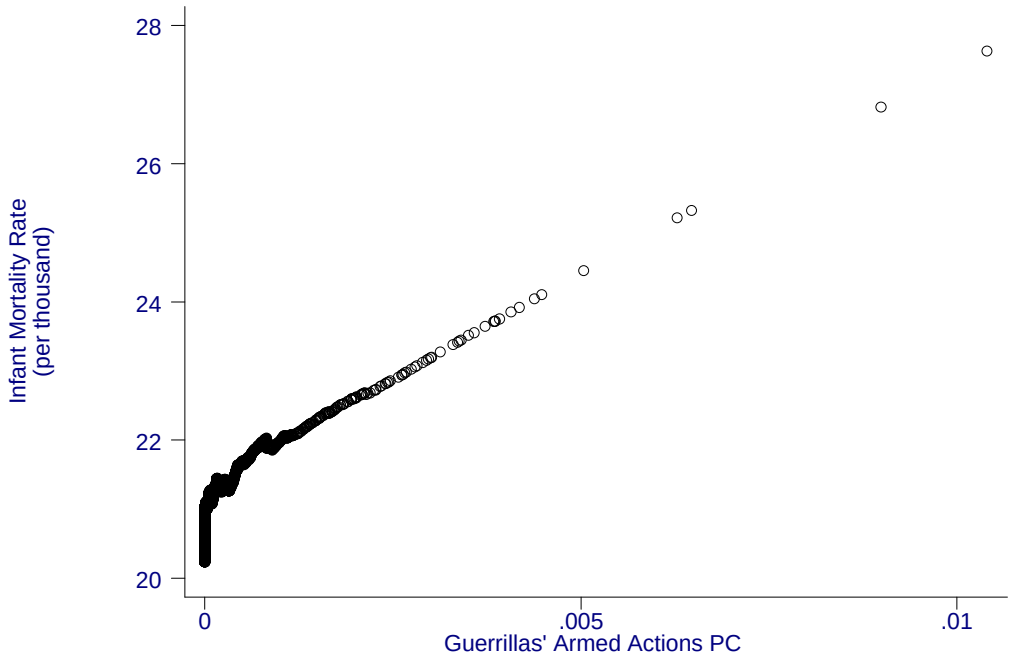
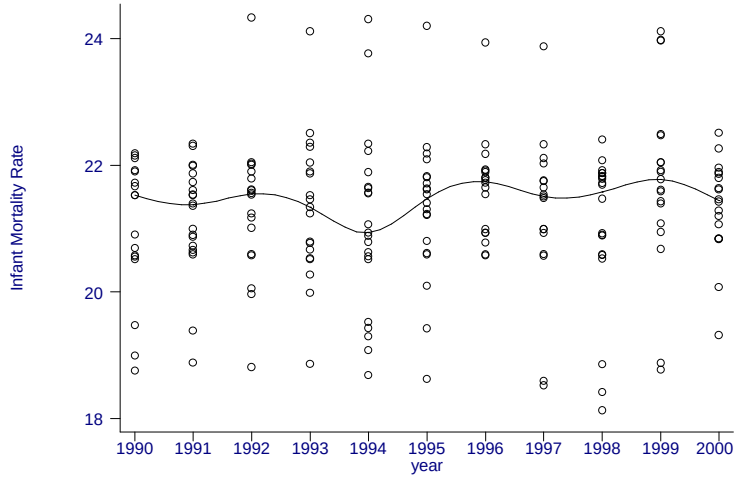
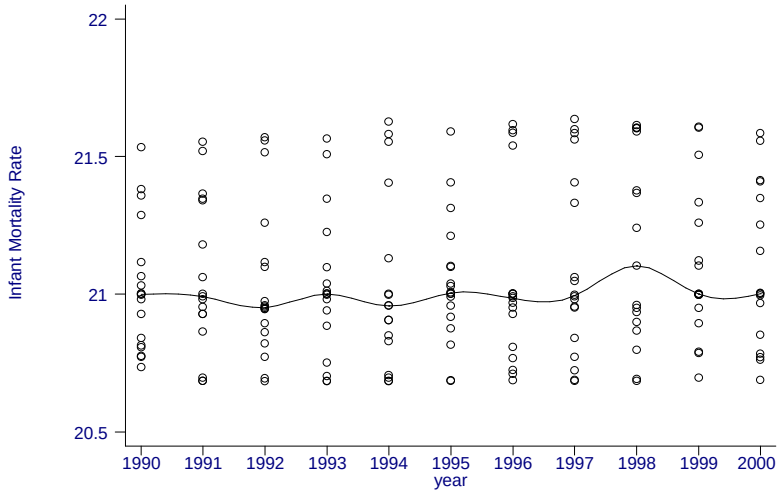


Figure 10. Infant Mortality Rate (per 1,000 live births) For Municipalities that Experienced a Violence Outbreak for a Sole Year after 1996. 1990-2000

A. Violence Outbreak in 1996:

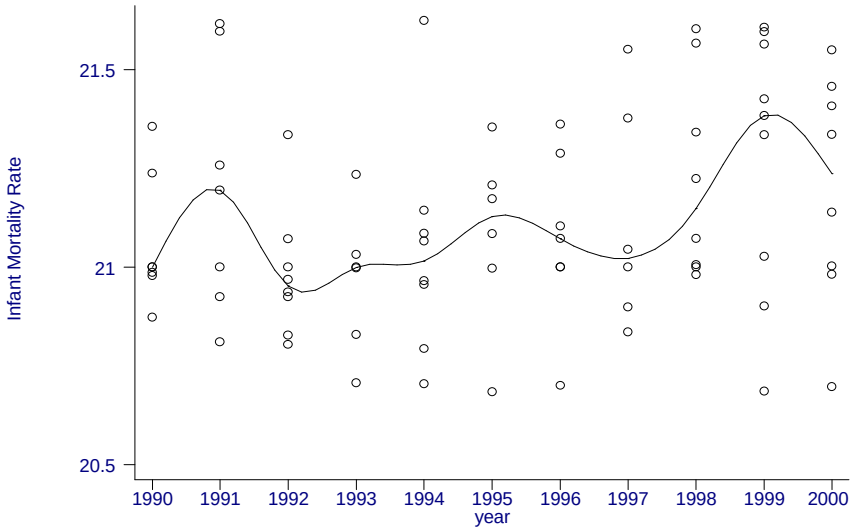


B. Violence Outbreak in 1997:



C. Violence Outbreak in 1998:

D. Violence Outbreak in 1999:



Annex 1

Table A1. Yearly Relationship Between GDP per Capita and Economic Size at the Departmental Level, 1990-2000

	Coefficient	(SE)	Observations	Adj.R-squared
1990	13.428	(4.430)**	33	0.00
1991	20.099	(5.240)**	33	0.01
1992	29.666	(6.157)**	33	0.02
1993	53.797	(11.463)**	33	0.01
1994	67.896	(15.241)**	33	0.02
1995	105.183	(24.145)**	33	0.01
1996	143.446	(41.732)**	33	0.02
1997	196.658	(55.422)**	33	0.01
1998	233.026	(74.832)**	33	0.02
1999	294.097	(88.716)**	33	0.02
2000	365.301	(133.818)*	33	0.02