

# **The Hidden Cost of Violence: Infant Mortality in Colombia\***

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Palabras Claves: Mortalidad Infantil, Conflictos, Colombia

Key Words: Infant Mortality, Conflict, Colombia

## **Abstract**

Colombia has experienced for over 60 years a severe internal conflict that has intensified during the last decade. Several demographic behaviors have been affected by such long and intense conflict, and not only male adult mortality. In this paper, I will test whether political violence could be affecting infant mortality rates in Colombia during the last decade. I will use demographic information as well as on violence for the period from 1990 to 2000, which along other covariates, will allow me to analyze the effect on yearly IMR changes of changes in violence per municipalities using a difference in differences model. In addition, I will explore a quasi-experimental approach that will support the previous findings.

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# The Hidden Cost of Violence: Infant Mortality in Colombia

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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.<sup>1</sup> In a country with a fairly homogeneous population, both in terms of religion and ethnicity, conflicts have erupted mainly as political confrontations, which have had 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).<sup>2</sup> However, the indirect effects are less well known, such as the effect on infant mortality the main interest of this document.

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.<sup>3</sup> 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 hindering Colombian IMR from a faster decline. This is the focus of this study.

Using fixed effects estimations across 966 Colombian municipalities during the 1990s, I found that as homicide rates increased by 1 per thousand habitants the IMR increased by over 3 infant deaths per thousand in the same year, plus 1.5 additional deaths due to lagged effects. That would translate in a reduction of about 3,150 infant deaths given a yearly average of 700,000 live births for the decade. I used Colombian data arranged at the municipality level on violence, natality, mortality, population fiscal revenues and public investments in the health and health related sectors. I am the first to collect and use this information for 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.

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.

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.

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<sup>1</sup> 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.

<sup>2</sup> All of these papers include extensive reviews of the literature for the Colombian case.

<sup>3</sup> Infant mortality refers to the number of death infants (less than 12 months of age) over total live births collected in a calendar year.

## 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).<sup>4</sup> 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. First, the war on drugs, which started in the late 1980s, contributed to the violent climate by provoking retaliatory responses, such as terrorist attacks. Secondly, the drug trade has corrupted government institutions and economically fueled outlaw armed groups, such as guerrillas and paramilitaries, all of which has added to the overall strife in Colombia.

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.

### A. Colombia in the Latin American Context

The IMR in Colombia for year 2000 was 30.6 per thousand live births.<sup>5</sup> 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). All countries characterized with low overall mortality and moderate fertility levels, know as with a “transition in progress” (Chackiel and Plaut, 1996).

However, a comparison within Latin America, using the PAHO compiled mortality statistics from 1960 to 1995, reveals interesting patterns.<sup>6</sup> First, Colombia had the highest infant mortality rate of communicable diseases among “transition in progress” countries. 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

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<sup>4</sup> 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.

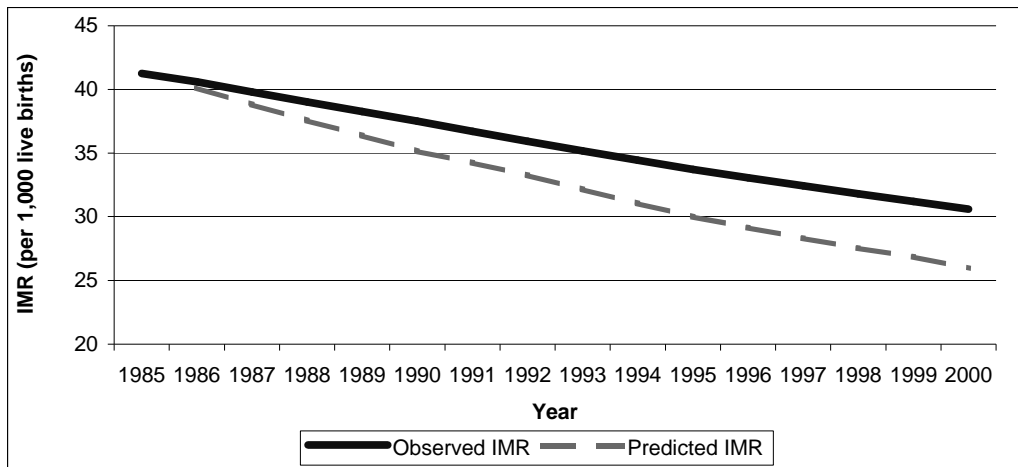
<sup>5</sup> Author’s estimation based on DHS-2000.

<sup>6</sup> See PAHO, 1999.

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 the two least developed in the region: Bolivia and Haiti.<sup>7</sup> 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.

**Figure 1.**

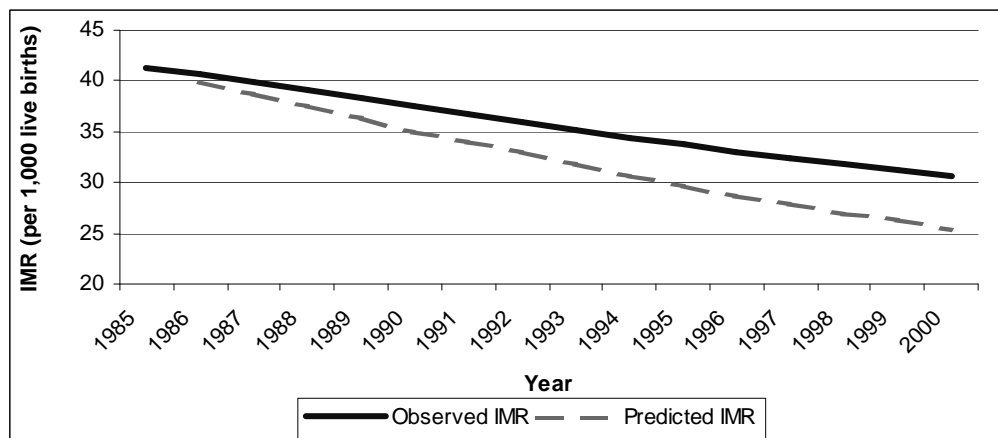
**Observed and Predicted Infant Mortality Rate (IMR) for Colombia, 1985-2000 from Cross-Country Regressions**



Source: Author's calculations

**Figure 2.**

**Observed and Predicted Infant Mortality Rate (IMR) for Colombia, 1985-2000 from Cross-Country Regressions**



Source: Author's calculations

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

<sup>7</sup> It is also remarkable that Haiti holds the highest IMR in Latin America and Bolivia the highest in South America.

experienced low or no political violence incidence will test the idea of harmful effects of violence on infant survival. The selected countries are Argentina, Brazil, Chile, Colombia, Costa Rica, Dominican Republic, Mexico, Panama, Peru, Uruguay and Venezuela. The data includes: GDP per capita, 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.

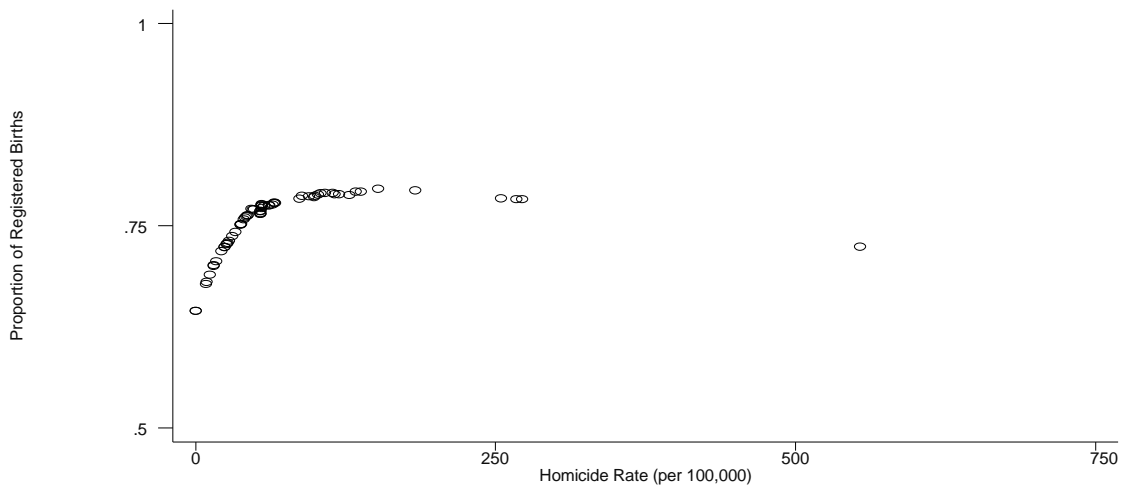
I estimated fixed effects using the above-described variables. The fit has an explanatory power of 74%. Figures 1 and 2 plot the observed and predicted IMR for Colombia. There, we can see that if Colombia had socio-economically behaved as the rest of these Latin America, on average, by the end of the century the IMR would have been almost 5 deaths per thousand live births lower. With a current average of 700,000 live births per year, that would imply 3,500 less infant deaths per year.

### III. DATA

This project required a large collection of data from different sources including National Police, National Statistical Office (*Departamento Administrativo Nacional de Estadísticas*, DANE), National Registry Office (*Registraduría Nacional del Estado Civil*), *Contraloría General de la República*, Net of Social Solidarity (*Red de Solidaridad Social*). All the information is annually collected and merged for 966 municipalities 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 Estadísticas*, DANE). In the denominator I include total live births, collected by the National Registry Office (*Registraduría Nacional del Estado Civil*) and processed by DANE until 1997. From 1998 onwards, DANE has directly collected and arranged this data.

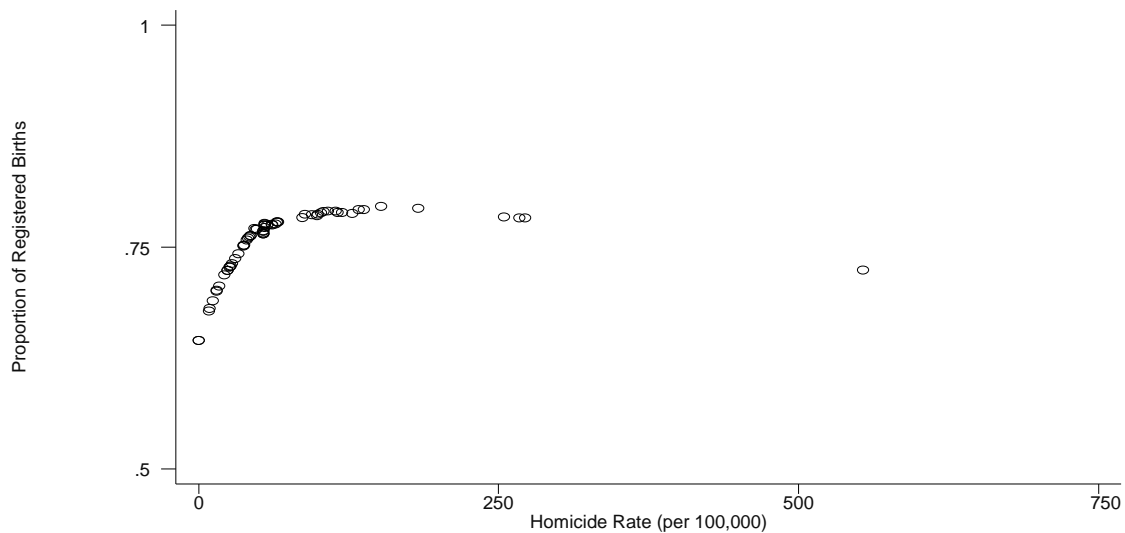
**Figure 3.**  
**Proportion of Registered Births and Homicide Rates (per 100,000),**  
**1995-1999**



In this particular analysis, under-registration is not correlated with violence, as shown in Figures 3 and 4. DHS in year 2000 asked women whether they registered their born babies or not. From there, I estimated the proportion of registered babies per municipality for each year between 1995 and 1999. In those two figures we can see that as violence increases registration does not fall. In contrast, at lower violence levels the relationship is counter-intuitive, and it is only at high violence levels that registration, as everything else, tends to fall apart.

During the entire period, 1990-2000, I capture violence in two sets of variables. The first one uses total homicide rates. The second set of variables that measure political violence in Colombia includes total number of armed actions carried out by outlawed active groups. From 1990 to 1994 the information of total 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: ELN, ELP, FARC, and M-19.8 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 not only for the first three guerrilla groups listed above, but also the activities of paramilitary armies (combined), 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 for consistency reasons, the analyses that assess the effects for all years in the decade, measures violence by using homicide rates.

**Figure 4.**  
**Proportion of Registered Births and Homicide Rates (per 100,000), 1995-1999**



Source: Author's Calculations from Demographic and Health Survey, 2000

In order to account for Colombia's economic performance I will use the information on fiscal revenues. In particular, total revenues per capita for each municipality as a proxy of GDP per capita, which has been tested as a good proxy. The Contraloria's information also includes public investments on health and health-related sectors. More precisely, it contains the flow of investment in: infrastructure of clean water supplies (construction and maintenance), garbage

<sup>8</sup> 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 signed a peace treaty and resigned the arms in 1992 after negotiations with the Colombian government.

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 (for 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 in per capita terms and expressed in constant Colombian pesos of year 1988.

#### IV. EMPIRICAL METHODOLOGY

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

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

$$v_{it} = \gamma x_{it} + \mu_{it}, \quad \mu_{it} = \sigma_i + \bar{w}_{it} \quad (2)$$

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. fiscal revenues, public investments on different sectors, etc), and  $\varepsilon_{it}$  and  $\mu_{it}$  are the unobservable determinants of infant mortality and violence, respectively. An unbiased estimation requires no relation between the observable characteristics and the municipality-specific effects ( $\alpha_i$  and  $\sigma_i$ ), or the random errors ( $v_{it}$  and  $\bar{w}_{it}$ ).

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 large and significant relation for each 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 confounders, 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, a fixed effects model better captures the effects of violence on IMR. In addition, the interest of this paper is on the estimation of the effects of violence on infant mortality rates, which is best denoted by

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

where  $\theta$  is the parameter that measures the effect of violence on infant mortality rates and will be the main interest for the remainder 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, changes on infant mortality within municipalities can be described as the difference of (3), which absorbs fixed municipality effects:

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

For the estimations using data for the entire 1990s decade, I use as violence measures ( $v$ ) homicide rates, given this is the only consistent measure available for the period of analysis.

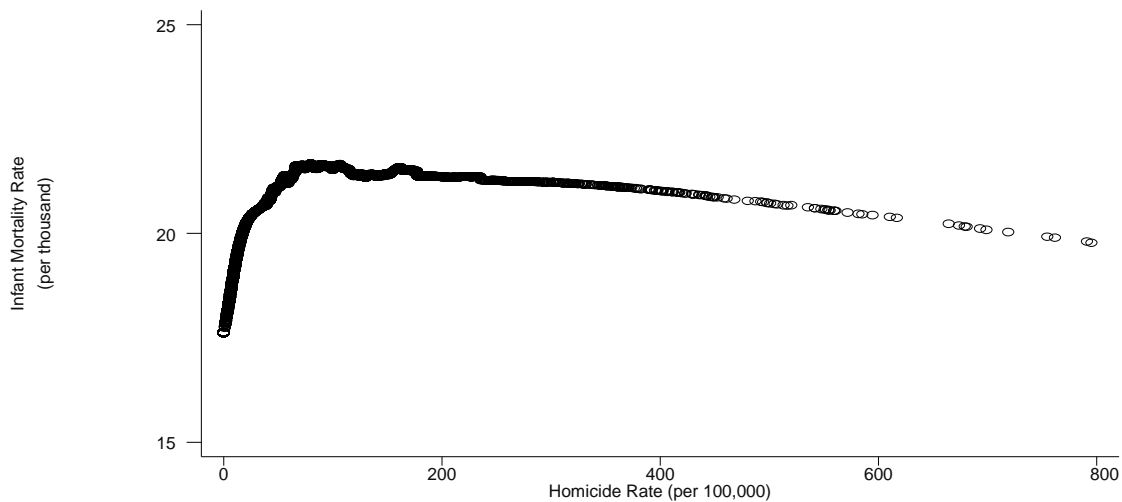
Furthermore, an ideal research design would randomly assign different degrees of violence across mothers and infants in the different municipalities. However, that is not what occurs in real life. For that reason, a "quasi-experimental" approach becomes useful. I will exploit the fact

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 a comparison of the results of such aggregation of municipalities, since violence seems to be the result of inequality distribution of the economic resources 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 6.

## V. EMPIRICAL FINDINGS

The following results are based on the IMR reported from vital records. Figure 5 is a smoothed trend (Lowess), that shows non-parametric evidence of the positive relationship between infant mortality and homicide rates from 1990 to 2000. In particular, this figure shows that infant mortality rates tend to increase as homicide rate increases, up to an inflexion point where this pattern reverses.

**Figure 5.**  
**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

Although this may be due to under-registration, this problem seems not to be of great preoccupation for this study. In fact, it is only at dire violence when it becomes an issue. Such high levels of violence are true only for a handful of data points. In contrast, the vast majority of municipalities in the decade have homicide rates below 200 per hundred thousand inhabitants (92% of the data points), where the expected negative relationship between violence and infant survival holds. For that reason, such outliers have been removed. That is, 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 11,550 data points for which numbers were collected, 1,081 were removed.



## A. Measuring the Effects of a Decade of Violence

All the results are based on 10,469 observations forming an unbalanced panel for 966 Colombian municipalities, from 1990 to 2000.<sup>9</sup> Since the infant mortality rates collected by the vital registration system suffer from under-registration, I must point out that the estimates from this model would be better read as a lower bound. 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 live births for each municipality. Homicide rates are expressed in terms of per thousand inhabitants, and all regressions include a time control.

Table 1 shows the coefficients for different specifications of the fixed effects model (FE) for the entire decade. In all cases the estimators are significantly different from zero. The results suggest that when the current homicide rate increases by one per thousand habitants, infant deaths would increase by at least 3 deaths per thousand live births. While the first lag of homicide rates would have half the effect.<sup>10</sup>

**Table 1.**  
**Effect of Violence on IMR, 1990-2000. Fixed Effects.**  
**Dependent Variable: Infant Mortality Rate (per thousand)**

	(1)	(2)	(3)	(4)
<b>Homicide Rate (per thousand)</b>	<b>3.274</b>	<b>3.085</b>	<b>3.159</b>	<b>3.155</b>
	<i>(0.702)**</i>	<i>(0.773)**</i>	<i>(0.772)**</i>	<i>(0.772)**</i>
Homicide Rate Squared (per thousand)	-0.547	-0.531	-0.540	-0.537
	<i>(0.150)**</i>	<i>(0.163)**</i>	<i>(0.162)**</i>	<i>(0.162)**</i>
Lag Homicide Rate (per thousand)		1.541	1.586	1.587
		<i>(0.451)**</i>	<i>(0.451)**</i>	<i>(0.451)**</i>
Lag Homicide Rate Squared (per thousand)		-0.010	-0.011	-0.011
		<i>(0.019)</i>	<i>(0.019)</i>	<i>(0.019)</i>
Fiscal Income per Capita			-0.002	0.003
			<i>(0.014)</i>	<i>(0.017)</i>
Public Investments in the Health and Health Related Sectors per Capita				-0.024
				<i>(0.049)</i>
Observations	9,503	8,544	8,506	8,506
# of Munips.	966	965	959	959

*Standard Errors in parenthesis.* \*\*Significant at 1%, \*significant at 5%

The squared term of homicide rates captures the fact presented in Figure 5, which suggest that infant mortality is most affected by low/medium violence levels rather than its extreme levels of violence when not only infant mortality registration falls, but also everything else tends to fall apart. More importantly, these coefficients of current and lagged violence are invariant when other controls are included, proving the validity of the results.<sup>11</sup>

<sup>9</sup> As for year 2000 Colombia had 1,096 municipalities.

<sup>10</sup> All other lags were not significant.

<sup>11</sup> The controls coefficients may not show the expected signs. However, it is important to remember that such coefficients 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).

## B. Which Part of Political Violence Matters the Most? 1995-2000

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 paramilitary groups and common delinquency. Some of such actions may have a greater impact on infant mortality than others, and this detailed information will allow a test for such beliefs. 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. All variables are expressed in per capita measures per 10,000 habitants and “Recognized homicide rates” 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 FE results are reported in Table 2. Unexpected results were shown by the coefficients of ground transportation highjack, harassments and attacks to populations. Yet, the rest of the coefficients are positive and the first lag of infrastructure attacks and weapon trafficking show estimators significantly different from zero.

**Table 2.**  
**Effect of Particular Armed Actions on IMR, 1995-2000. Fixed Effects Regressions.**  
**Dependent Variable: Infant Mortality Rate**

	Terrorism	Ambush	Recognized Homicides+	Massacres+	Hijack	Confrontation	Weapon Trafficking+	Infrastructure Attack+	Harassment	Attacks to Populations
<b>Violence</b>	<b>0.24</b>	<b>1.76</b>	<b>2.89</b>	<b>8.11</b>	<b>-2.14</b>	<b>28.67</b>	<b>1.43</b>	<b>12.02</b>	<b>-0.50</b>	<b>-1.39</b>
	(0.60)	(3.93)	(3.9)	(6.21)	(1.13)	(18.55)	(0.69)*	(5.32)*	(0.57)	(1.02)
Violence Squared	-1.15	-16.38	-1.123	-25.03	2.16	-1.67	-3.62	-2.57	1.40	1.43
	(7.57)	(13.93)	(1.872)	(2.63)	(1.1)*	(1.28)	(5.75)	(2.09)	(9.60)	(4.68)
Fiscal Income PC	-0.014	-0.014	-0.008	-0.010	-0.014	-0.015	0.003	-0.007	-0.020	-0.016
	(0.025)	(0.025)	(0.031)	(0.031)	(0.025)	(0.025)	(0.032)	(0.031)	(0.025)	(0.025)
Public Invest.in Health PC	0.003	0.006	0.029	0.034	0.003	0.004	0.021	0.030	0.003	-0.002
	(0.067)	(0.067)	(0.083)	(0.084)	(0.067)	(0.067)	(0.083)	(0.083)	(0.067)	(0.067)
Observations	4,688	4,688	3,673	3,673	4,688	4,688	3,673	3,673	4,688	4,688
Munips.	959	959	958	958	959	959	958	958	959	959

*Standard Errors in parenthesis. \*\*Significant at 1%, \*significant at 5% +Lagged Variables*

These results present provoking evidence on what particular populations are being more affected in the war-like environments, although more resources should be devoted to unravel the mechanisms through which these actions may affect infant mortality rates in Colombia. The results in Table 2 suggest that populations whose physical infrastructures is being depleted and not reconstructed are at higher risk of increasing their IMR by at least 12 infant deaths per thousand live births as these actions increase in one per ten thousand habitants. The destruction of physical infrastructure perpetrated by guerrillas or paramilitary groups reflects on itself the lack of State security. But, more importantly, the perpetuation of such condition implies also a lack of State’s presence at the economic and developmental level, which in turns reflects in poorer health outcomes.

Also, municipalities where weapon trafficking has escalated are more prone to reduce infant survival by over one infant death per thousand live births. Weapon trafficking per se may not be

affecting infant mortality. Instead, this fact may be capturing a zone control by outlaw-armed groups. 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 or the zone control, which may reduce the probability of people's mobility. This latter effect, as stated before, reduces the chances of food and medicines distribution and medical doctors and patients' mobility.

Similarly, particular attention in the public health area should be devoted to municipalities where confrontations between the military forces and the outlaw-armed groups are taking place. That is, not surprisingly, whenever there is a struggle for territory, the civilian population suffers the negative consequences of war, which in this case are measured as an increase of over 28 infant deaths. Finally, whenever massacres are taking place IMR grows by almost 3 more infant deaths, signaling the lack of control of human rights violations on such municipalities and how the intensity of the conflict takes lives both directly and indirectly.

In summary, for the second half of the 1990s decade armed actions carried out by paramilitary or guerrilla groups such as weapon trafficking, attack to infrastructure, confrontations and massacres had the largest 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 guaranteeing the enforcement of human rights, and to reconstruct the destroyed physical infrastructure. Similarly, it must pay particular attention to re-take the control of territories where the outlaw-armed groups have gained military control or hold illicit business.

### **C. Internal Reliability**

In moments of high economic stress there is a possibility that infanticide increases as a response. However, most of the channels here proposed may rather reflect in infants' health increasing their internal mortality rates rather than a drastic increase in external causes of death (homicides and accidents). For that reason, the following estimations discriminate between internal and external infant mortality rates. By doing so, I expect higher effects of violence on internal infant mortality rates and very low or none on external infant mortality rates.

Tables 3 and 4 corroborate this hypothesis, being the estimators for violence always positive and significantly different from zero. In Table 3, we can see that internal infant mortality rates increase by almost 3 more infant deaths as homicide rates increase by one per thousand inhabitants. As well as an increase of 1.5 infant deaths due to internal causes of death as the first lag of homicide rates increases in one more death per thousand, between 1990 and 2000. These results, as those present in Table 1, are very consistent and resistant to the inclusion of control variables, while there is no significant effect on external infant mortality rates. The violence coefficients for external infant mortality rates are just above 0 for all specifications and not significant, suggesting an effect of violence and human health rather than on parent's behavior.

Similarly, the coefficients found in Table 4 resemble the results of Table 2. That is, the effect of the specific armed actions between 1995 and 2000 have an effect on infants' internal causes of death rather than external causes of death. Not surprisingly, the coefficients are similar to those present above signaling the same higher and significant effects of infrastructure destruction and outlaw armed groups' territorial control on internal infant mortality rates.

**Table 3.****Effect of Violence on IMR, 1990-2000. Fixed Effects. Dependent Variables: Internal Infant Mortality Rate and External Infant Mortality Rate (per thousand)**

	Internal Infant Mortality Rate				External Infant Mortality Rate			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<b>Homicide Rate (per thousand)</b>	<b>3.148</b>	<b>2.962</b>	<b>2.994</b>	<b>2.992</b>	<b>0.233</b>	<b>0.203</b>	<b>0.208</b>	<b>0.206</b>
	<i>(0.704)**</i>	<i>(0.775)**</i>	<i>(0.775)**</i>	<i>(0.775)**</i>	<i>(0.165)</i>	<i>(0.179)</i>	<i>(0.180)</i>	<i>(0.180)</i>
Homicide Rate Squared (per thousand)	-0.524	-0.512	-0.513	-0.512	-0.038	-0.033	-0.035	-0.033
	<i>(0.150)**</i>	<i>(0.163)**</i>	<i>(0.163)**</i>	<i>(0.163)**</i>	<i>(0.035)</i>	<i>(0.038)</i>	<i>(0.038)</i>	<i>(0.038)</i>
Lag Homicide Rate (per thousand)		1.621	1.662	1.662		-0.038	-0.049	-0.049
		<i>(0.453)**</i>	<i>(0.453)**</i>	<i>(0.453)**</i>		<i>(0.105)</i>	<i>(0.105)</i>	<i>(0.105)</i>
Lag Homicide Rate Squared (per thousand)		-0.012	-0.015	-0.014		0.001	0.002	0.002
		<i>(0.019)</i>	<i>(0.019)</i>	<i>(0.019)</i>		<i>(0.004)</i>	<i>(0.004)</i>	<i>(0.004)</i>
Fiscal Income per Capita			-0.008	-0.006			0.006	0.009
			<i>(0.014)</i>	<i>(0.017)</i>			<i>(0.003)*</i>	<i>(0.004)*</i>
Public Investments in the Health and Health Related Sectors per Capita				-0.008				-0.014
				<i>(0.049)</i>				<i>(0.012)</i>
Observations	9488	8531	8502	8502	9488	8531	8502	8502
Munips.	966	965	959	959	966	965	959	959

*Standard Errors in parenthesis.* \*\*Significant at 1%, \*significant at 5%

**D. Quasi-Experimental Results**

This section makes a comparison on infant mortality outcomes between municipalities that did not experience any armed action during the entire decade against those that did.

To validate the design of this experiment, Table 5 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 react to every political attempt that would empower guerrilla groups, such as peace negotiations initiated by the Colombian government with guerrillas (Romero, 2003). Additionally, paramilitary groups fight against guerrillas for the control of very productive territories, such as illicit crops (Echandia, 1999).

**Table 4.**

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

**Dependent Variables: Internal Infant Mortality Rate and External Infant Mortality Rate (per thousand)**

Internal Infant Mortality Rate										
	Terrorism	Ambush	Homicide+	Massacres+	Hijacking	Confrontation	Weapon Trafficking+	Infrastructure Attack+	Harassment	Attack
Violence Rate	<b>-0.52</b> (0.54)	<b>1.19</b> (3.41)	<b>4.819</b> (3.889)	<b>8.98</b> (6.18)	<b>-2.42</b> (2.90)	<b>18.94</b> (180.65)	<b>1.86</b> (.688)**	<b>10.49</b> (53.00)*	<b>-0.82</b> (0.51)	<b>-0.51</b> (0.91)
Violence Rate Squared	167.55 (704.38)	-6735.95 (12511.72)	-1.736 (1.867)	-27596.24 (26.27)	2194.56 (962.18)*	-121367.18 (12569.40)	-633.07 (5,733.22)	-21050.45 (20919.45.)	31.56 (90.65)	-14.29 (415.83)
Fiscal Income per Capita	-0.007 (0.022)	-0.007 (0.022)	-0.022 (0.031)	-0.018 (0.034)	-0.013 (0.023)	-0.009 (0.022)	-0.021 (0.031)	-0.027 (0.032)	-0.008 (0.022)	-0.007 (0.022)
Public Investments in the Health and Health Related Sectors per Capita	-0.013 (0.060)	-0.014 (0.060)	0.056 (0.083)	0.056 (0.083)	-0.009 (0.060)	-0.002 (0.060)	0.056 (0.083)	0.055 (0.083)	-0.016 (0.060)	-0.014 (0.060)
Observations	5643	5643	3669	3669	5643	5643	3669	3669	5643	5643
Munips.	959	959	957	957	959	959	957	957	959	959
External Infant Mortality Rate										
	Terrorism	Ambush	Homicide+	Massacres+	Hijacking	Confrontation	Weapon Trafficking+	Infrastructure Attack+	Harassment	Attack
Violence Rate	<b>0.11</b> (0.12)	<b>1.50</b> (0.78)	<b>-1.362</b> (0.755)	<b>-0.94</b> (1.200)	<b>0.56</b> (.02)*	<b>0.81</b> (4.16)	<b>-0.22</b> (0.12)	<b>1.25</b> (1.11)	<b>0.15</b> (0.11)	<b>0.05</b> (0.21)
Violence Rate Squared	102.45 (162.46)	-9641.59 (288.17)**	0.444 (0.374)	2731.50 (5286.79)	-423.92 (221.98)	-5297.65 (29001.99)	146.84 (102.50)	-4298.63 (4446.12)	-15.67 (20.92)	-23.14 (95.94)
Fiscal Income per Capita	0.012 (0.005)*	0.012 (0.005)*	0.012 (0.006)*	0.013 (0.006)*	0.012 (0.005)*	0.012 (0.005)*	0.013 (0.006)*	0.013 (0.006)*	0.012 (0.005)*	0.012 (0.005)*
Public Investments in the Health and Health Related Sectors per Capita	-0.016 (0.014)	-0.015 (0.014)	-0.015 (0.015)	-0.017 (0.015)	-0.016 (0.014)	-0.017 (0.014)	-0.016 (0.015)	-0.016 (0.015)	-0.015 (0.014)	-0.016 (0.014)
Observations	5643	5643	4628	4628	5643	5643	4628	4628	5643	5643
Munips.	959	959	959	959	959	959	959	959	959	959

Standard Errors in parenthesis. \*\*Significant at 1%, \*significant at 5%

+Lagged Variables

**Table 5.**  
**Descriptive Statistics. Aggregated Data per Municipalities in Colombia, 1990-2000. Violent and Non Violent Municipalities**

Variable	Non-Violent Munips.		Violent Munips.	
	Mean	Std. Dev	Mean	Std. Dev
IMR (per thousand live births)	22.60	66.56	24.48	47.39
<b><i>Economic Performance (in real Colombian pesos, 1988=100)</i></b>				
Fiscal Income Per Capita	12.00	13.14	12.57	23.66
Tax Revenue Per Capita	2.06	4.67	1.91	4.62
<b><i>Public Investments on the Health and Health Related Sectors (Per capita measures, in real Colombian pesos, 1988=100)</i></b>				
Expenditures on the Health Sector	1.78	3.54	1.66	3.55
Expenditures on Water and Sewer Services	1.39	3.33	1.26	3.45
Expenditures on Slaughterhouses	0.04	0.19	0.04	0.27
Expenditures on Health Campaigns	0.08	0.34	0.08	0.36
Expenditures on Garbage Collection	0.08	0.29	0.09	0.36
Expenditures on Health Facilities Construction and Equipment Adq.	0.23	0.79	0.23	1.09
Expenditures on Health Facilities Maintenance and Laborers Pay.	0.52	1.09	0.40	1.06
Expenditures on Subsidies to Most Vulnerable P.	0.80	2.04	0.74	2.23
<b><i>Homicide Rates (per 100,000)</i></b>				
<b>Homicides Rates</b>	<b>42.61</b>	<b>67.11</b>	<b>70.70</b>	<b>81.38</b>
<b>Male Homicide Rates</b>	<b>77.86</b>	<b>125.26</b>	<b>127.69</b>	<b>148.25</b>
<b>Female Homicide Rates</b>	<b>6.47</b>	<b>16.65</b>	<b>11.37</b>	<b>23.50</b>
<b>Homicide Rates Ages 15-44</b>	<b>70.62</b>	<b>117.12</b>	<b>120.74</b>	<b>143.33</b>
<b>Male Homicide Rate Ages 15-44</b>	<b>132.08</b>	<b>225.11</b>	<b>221.82</b>	<b>266.02</b>
<b>Female Homicide Rates Ages 15-44</b>	<b>4.31</b>	<b>12.55</b>	<b>7.61</b>	<b>18.11</b>

**Table 6.**  
**Effect of Violence on IMR, Violent and Non-Violent Municipalities, 1990-2000. Fixed Effects. Dependent Variable: Infant Mortality Rate**

	Violent	Non-Violent	Violent	Non-Violent	Violent	Non-Violent
	Munips.	Munips	Munips.	Munips	Munips.	Munips
	(1)		(2)		(3)	
<b>Homicide Rate (per thousand)</b>	<b>2.789</b>	<b>5.513</b>	<b>2.876</b>	<b>5.682</b>	<b>2.873</b>	<b>5.692</b>
	<i>(0.785)**</i>	<i>(3.155)</i>	<i>(0.784)**</i>	<i>(3.162)</i>	<i>(0.784)**</i>	<i>(3.163)</i>
Homicide Rate Squared (per thousand)	-0.481	-1.103	-0.490	-1.157	-0.487	-1.157
	<i>(0.162)**</i>	<i>(0.993)</i>	<i>(0.161)**</i>	<i>(0.995)</i>	<i>(0.161)**</i>	<i>(0.996)</i>
Lag Homicide Rate (per thousand)	1.369	4.086	1.427	4.082	1.431	4.109
	<i>(0.455)**</i>	<i>(2.929)</i>	<i>(0.454)**</i>	<i>(2.929)</i>	<i>(0.454)**</i>	<i>(2.931)</i>
Lag Homicide Rate Squared (per thousand)	-0.004	-0.375	-0.007	-0.375	-0.007	-0.380
	<i>(0.018)</i>	<i>(0.804)</i>	<i>(0.018)</i>	<i>(0.804)</i>	<i>(0.018)</i>	<i>(0.805)</i>
Fiscal Income per Capita			-0.006	0.042	0.002	0.034
			<i>(0.014)</i>	<i>(0.052)</i>	<i>(0.018)</i>	<i>(0.058)</i>
Public Investments in the Health and Health Related Sectors per Capita					-0.042	0.033
					<i>(0.056)</i>	<i>(0.108)</i>
Observations	6,960	1,584	6,922	1,584	6,922	1,584
# of Munips.	785	180	779	180	779	180

*Standard Errors in parenthesis. \*\*Significant at 1%, \*significant at 5%*

Following the above classification for Colombian municipalities, Table 5 shows the descriptive statistics that validate this experiment and in the first row show non-parametric evidence that IMR is at least 2 infant deaths higher in violent municipalities. This difference in mean of infant mortality rates between these two types of municipalities is significant.<sup>12</sup>

A parametric estimation using fixed effects is presented in Table 6. Once again violence is measured by Homicide Rates per thousand inhabitants. For all specifications the effect of violence on IMR is larger and significant in all violent municipalities, while it is positive but not statistically significant for non-violent municipalities. The coefficients in violent municipalities show low variability across specifications and slightly lower than those using all data points presented in Table 1. These results suggest a negative impact of political violence on infant survival of about 3 more infant deaths per thousand live births, which is consistent with the previous results.

## VI. CONCLUDING REMARKS

Colombia, among other similar Latin American countries, has relatively decreased vaccination coverage, while morbidity of communicable diseases has increased and larger proportions of babies are being born with low birth weight. However, public expenditures in the health sector have increased during the last decade and the fraction of public investment dedicated to health campaigns has more than doubled since 1990. While per capita investment measures have increased by almost 80%. Therefore, these programs need a re-design in order to reach the populations being left out.

The results suggest a significant negative relation between violence and infant survival during the 1990s. The estimated coefficient measuring the effect of violence on infant mortality is usually resistant to the inclusion of additional control variables, proving consistency in the estimates. In general, in Colombia the reduction of one homicide per thousand inhabitants would lead to a reduction by about 3 infant deaths per thousand live births for the current year and an additional 1.5 infant deaths from the lagged effect of violence. These coefficients translate into an average of 3,150 yearly infant deaths due to violence during the past decade.

Among the different armed activities perpetrated by both guerrilla and paramilitary groups the first lags of weapon trafficking and attacks to infrastructure have a significant effect on infant mortality. Most of the remaining armed actions also have positive signs suggesting that municipalities where lack of State provided security or where human rights violations occur are at higher risk of increasing infant mortality. Therefore, a policy intended to reduce the harmful consequences of violence on infant mortality should target municipalities with the above-mentioned characteristics, re-take control in zones where armed groups are growing strong or hold illicit business and reconstruct the destroyed physical infrastructure.

The quasi-experimental approach suggest that municipalities that have suffer from a long-term violence experience higher infant mortality rates, of about three more infant deaths per thousand. Several actions are needed in order to counteract these negative

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<sup>12</sup>Significant at 1%

effects, such provision of State security and the expansion of health care services targeting municipalities under conflict. 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 definitely need more study and attention for the design of future policies.



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