UNIVERSITY OF CALIFORNIA
RIVERSIDE

Essays on Civil War and Welfare: Child Mortality, Learning Attainment and Access to Water and Sanitation Services

A Dissertation submitted in partial satisfaction
of the requirements for the degree of

Doctor of Philosophy

in

Economics

by

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March 2013

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They have the most beautiful and most impossible love story. She teaches me about faith and sensitivity and gives me the stories of a family that is still plenty of secrets. He teaches me more with his simple and candid smile, his discipline, his silence and the way he looks at the mountains during the sunset than all my classes and books. Because of them I am here and every effort in my life has been to please them and to make them happy. This has not been the exception.

ABSTRACT OF THE DISSERTATION

Essays on Civil War and Welfare:
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by

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University of California, Riverside, March 2013
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This dissertation deals with the effects of civil war on child and infant mortality, learning attainment and access to water and sanitation services. Household and individual level data (such as the Demographic and Health Surveys and the Colombian Standardized Saber test) are extensively used along with data on conflict intensity (such as Prio-Uppsala Battle Deaths and the Colombian Police Crime statistics). The first chapter explores how different intensity levels of civil war lead to changes in child and infant mortality in Latin American countries that have experienced lengthy civil wars (Colombia, El Salvador, Guatemala, Nicaragua and Peru). Econometric procedures indicate that civil war increases the risk of mortality during the first year of life. Using individual level test scores from Colombia, as the measure of learning attainment, the second chapter studies how exposure to civil war at birth and at the year of the test impacts math and language learning. Exposure to conflict at birth reduces the learning attainment of 5th grade students. Results seem to be not conclusive for 9th and 11 grade students due to sample attrition. The third chapter estimates how civil war modifies households' access to water and sanitation services and, in turn, the health of children in Colombia. Employing different methods to control for the civil war intensity, regressions found that civil war leads to contradictory effects on access to water and sanitation services. Overall, estimations throughout the three chapters provide strong evidence supporting the existence of negative effects of civil war on child and infant mortality, learning attainment and access to water and sanitation services. The techniques and the theoretical model used in the third chapter also open up the way for the existence of households' adaptive behavior while the conflict goes on. Results also suggest a role for government interventions in helping households cope with these negative effects.

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INTRODUCTION

The 20th century has been a century of war. From the World Wars that marked the end of the empires, to the wars that have come after the decolonization and the creation of new countries after the 1950's, as well as the ideological confrontations between capitalism and socialism. As the international order has made it more difficult and costly for countries to go to war among themselves, most wars have been waged within the countries. In these wars either rebel factions with new political ideas fight the state or different factions fight among themselves as a way to achieve superiority. These wars, called civil wars and also called internal armed conflicts or low intensity wars and their impact on various aspects of societal life, are the focus of this dissertation.

Civil wars, by themselves, are a topic that deserves economic research. They are costly to society as capital is destroyed and financial resources re-allocated to wage war. The incentives and motivations of the engaged factions and of individuals involved are also of economic interest since they pose questions to game theory models. Economics can explore, as has been done, what features of a country make it more prone to host a civil war. Finally, and the center of this dissertation, civil wars are an external shock to households and individuals not engaged in the war. When war begins, households have to deal with the uncertainties war entails and have to cope with the economic costs and the risks of being victimized. In the midst of conflict, a household is making decisions. This is the strand of the literature about civil war, how households react and what kind of costs they bear, where the contributions of this dissertation are aimed.

As it is presented throughout the chapters of this dissertation, civil wars are far from a simple phenomenon, which makes necessary to focus the scope of any study.

This dissertation does not deal with the causes of civil war. All the chapters assume that, regardless of the causes, a civil war is already happening and that households make decisions under this environment of uncertainties. This dissertation is not interested in the determinants of the duration of the civil war or in its macroeconomic consequences. Although it is true that a longer civil war is a more costly one, has more negative macroeconomic consequences and it is also more difficult for the household to make decisions. Macroeconomic consequences are acknowledged, but not explored.

Households and individuals still make decisions during the civil war and that is why this dissertation deals with some of the microeconomic impacts of such a conflict. While this dissertation explores the impacts on fertility, learning and access to water and sanitation services, there are many other microeconomic consequences of civil war. For instance, workers may end up losing their jobs because of the civil war or they may just resign as a way to reduce their exposure to violence. Men and women may alter their marriage decisions as the civil war may change the life expectation of young males. An increase in child and adult morbidity can be modified because of a reduced food intake or because of the destruction of health supporting infrastructure. Saving, consumption and investment decisions can be drastically altered as households are not sure about the possibility of reaping the benefits from their assets or because the markets do not properly function. These are some examples of the changes civil wars can impose on household and individual behaviors.

Fertility is explored through the study of changes in child and infant mortality due to civil war. If civil war increases the likelihood of children dying before turning 1 or 5 years of age, parents may need to have more children in order to replace the dying ones. On the contrary, parents can delay their fertility decisions while waiting for peaceful times. The accumulation of human capital can change during civil war because students learn less. Civil war may force the closure of schools, the

killings of teachers, and an increase in the number of missing days or, simply, it can prevent children from focusing on the contents of their classes. Finally, households may experience changes in the access to water and sanitation services because of the destruction of the infrastructure, higher pollution of water or because they just cannot afford to pay for water and sanitation. As access to water and sanitation are essential for health, the changes can translate into higher morbidity and poorer hygiene practices.

In researching these particular microeconomic effects of civil war, this research contributes to the literature in three ways. First, it uses data from Latin American countries that experienced civil war during the second half of the twentieth century to explore infant and child mortality. This cross country study is relevant as it helps to understand how civil war curtailed the gains from the overall declining trend of child and infant mortality in the continent. Second, it uses an outcome measure of education, scores in standardized tests, to estimate the impact of civil war on the accumulation of human capital. Although school attainment (measured as the completed number of years) has been a widely-used measure, this is an input of the education process. Third, and final, it explores changes in access to water and sanitation service at the household level. Civil war can modify the use and the accessibility to natural resources and, in the case of the paper, how households meet their demands of water and sanitation services. With this paper, the attention is called to the analysis of possible environmental effects of civil war at the household level. Moreover, the paper attempts at exploring how households react to changes in civil war intensity.

Specifically, the first paper explores how the civil war in Colombia, El Salvador, Guatemala, Nicaragua and Peru impacted child and infant mortality in these countries. Data from the Prio-Uppsala Battle deaths is used to measure the intensity of

conflict. The DHS provides the reproductive history records from women of reproductive age in those countries. The results indicate that the intensity of civil war matters. Higher intensity levels increase the probability of death before turning 1 year of age. It seems that the first year is the critical period for the survival of a child during a civil war. Other interesting results related to the gender of the children and the age of the mother at every birth are also discussed in Chapter 1.

The second paper focuses on Colombia. The Colombian government applies standardized tests for the 5th grade, 9th grade and 11th grade students as a way to assess the quality of education. These individual level scores are crossed with a data set containing the most relevant indicators of civil war for that country. By using 5 different measures of intensity (extortions, terrorist attacks, kidnappings, attacks against the police and mass murder victims), this paper studies how civil war can impact learning through different economic or psychological channels. Results confirmed the negative impacts on learning, but also called into attention how school desertion can bias the samples and reduce the significance of the estimates. More on this can be seen in Chapter 2.

Chapter 3 presents the third paper, also with data from Colombia. For this paper, the Demographic and Health Surveys (DHS) data on household level access to water and sanitation is used along with civil war intensity level information. The very same conflict indicators used in Chapter 2 are also employed here. Violence intensity is modeled in a novel way, by introducing a stock of violence computed as an aggregation or as a weighted average for different lengths. The econometric procedures come from a proposed theoretical model where civil war enters both as a tax on prices and as a tax on income. The econometric results show somehow contradictory effects pointing out the possibility that households adapt to conflict.

To close this introduction, it is important to note that the more is known about the effects of civil war, the more likely the reconstruction and pacification efforts are to be successful in healing the wounds of the society and preventing future conflicts. Working for peace involves knowing how civil war affects the livelihoods and welfare of households and the very fabric of the society, the social contract binding people together in a nation. It is hoped that this dissertation improves the awareness of how civil war can produce irreversible changes in the paths of human and physical capital accumulation.

CHAPTER I

Collateral Damage: Civil Conflict and Child Mortality

I. INTRODUCTION

Indirect victims of civil conflict are all those who do not die because of bullets or explosions. Vulnerable groups, like children, the elderly, the sick and the poor, are also likely to bear a disproportionate burden during armed conflicts and right after peace has been achieved. Those in vulnerable condition suffer from disruptions in the economy and the destruction of welfare services (health and education) and of social support networks. As market functioning is disrupted, lower levels of income, linked to higher levels of unemployment and uncertainty, lead to increased poverty, lower human capital accumulation and changes in household decisions or asset allocations.

This paper explores the impact of civil conflicts on infant and child mortality in 5 Latin American countries. During a civil conflict, a period of increased and widely spread violence, children die in the conflict and because of the conflict. They die in conflict when they are victims of the factions engaged in waging the war. They die because of conflict when their families cannot provide all the care, food and amenities children need to properly develop. Conflict creates hunger, destroys and relocates families, reduces sanitation and health. Certainly, these are not bullets nor explosions, but they also kill children. Conflict takes a toll on women when they are victims or mobilized into war, but also when it forces them to change their marriage and fertility decisions. Women may have children sooner if expecting further increases in violence or may delay pregnancies for more peaceful times. Both decisions represent different risks for the newborns: the risk of lower maternal body replenishment or the risk of pregnancies at an older age.

The literature suggests that civil conflict could impact child mortality through two possible channels. The first channel is through mother's health and fetal nutrition. Godfrey and Barker (2000), in their survey about fetal nutrition and diseases, pointed out that fetal nutrition is critical for the survival and development of the fetus, as well as for preventing diseases during youth and adulthood. Newborn children will suffer from the destruction of household assets, public infrastructure and family support networks (as in Akresh et. al. 2008, 2009), an overall environment of high disease levels (Ghobaragh et al., 2001, 2003) and a deterioration of the health care system (Urdinola, 2004), unless parents have the critical skills for their survival (Guo, 1997). In the second channel, civil wars increase child and infant mortality by increasing stress levels of pregnant women. For instance, Camacho (2007) reported stress during pregnancy created by the explosion of land mines in Colombia is negatively related to birth outcomes.

A direct consequence of conflict (battle deaths) is going to be used as an instrument to measure the effect of civil conflict on infant and child mortality. This paper fills a gap in the literature by exploring the behavior of child and infant mortality in 5 Latin American countries that experienced (or still experience) civil conflicts. Civil conflicts happened while Colombia, El Salvador, Guatemala, Nicaragua and Peru were changing their economic orientation (from protected to open economies) and when health care services and provision of infrastructure increased. Specifically, this paper explores, first, differences in mortality between children born during conflict to those born before or after the conflict. Second, it also analyzes how changes in armed conflict intensity lead to different mortality risks for children born during conflict. This paper also studies the differences in the effects between the peace before the conflict and the peace after the conflict.

The main goal is to provide evidence of the existence of a causal relationship between civil conflict intensity and child and infant mortality, after controlling for relevant features of the mother and the child. Estimations use the Prio Uppsala Battle Deaths data file (vol. 4, 2006), as well as available waves of the Demographic and Health Surveys (DHS) for Colombia, El Salvador, Guatemala, Nicaragua and Peru. The measure of civil conflict intensity, the battle deaths, is coded at the national level, which hides important local variation within the country. DHS registers the reproductive history of women between the age of 16 and 45 years, but does not control for changes of some relevant features of mothers during their reproductive history. The use of the DHS places this research in the strand of the literature that explores the microeconomic effects of civil wars. The micro level data allows for studying the impact of civil conflict on education and health outcomes at the level of communities and individuals, as Blattman and Miguel (2009, p.6) indicated.

The main finding of this chapter is that conflict intensity matters. Children born during peace years (before or after the conflict) exhibited a significantly lower level of infant and child mortality than those born during conflict years. The importance of this finding lies in the fact that conflicts could break the overall declining trend in child and infant mortality in the selected countries (Colombia, El Salvador, Guatemala, Nicaragua, Peru). Using household level fixed effects, mortality risk was reduced for female newborns and for those born in later stages of their mother's reproductive history. Intra-state armed conflicts are more harmful during the first year of life. Governments can reduce the impact of conflict by supporting younger mothers, reducing human capital gaps of mothers and having full provision of services (mainly health) for the newborns. Overall, the findings highlight the usefulness of household level surveys in exploring how armed conflict-induced market disruptions and uncertainty take a toll on the abilities of households to properly raise their children.

Finally, these findings draw attention to how violence-induced changes in mortality can have a long-lasting impact on fertility decisions and population dynamics.

After this introduction, a literature review on civil war, child mortality, health and nutrition is presented. The third section presents a description of the civil conflicts and the data sources. The fourth section deals with the econometric strategy and explains the rationale behind the expected relationship among variables and points out caveats or drawbacks. Results from the logit regressions are discussed in the fifth section. Finally, the sixth section presents the conclusions and the directions for further research.

II - LITERATURE REVIEW

This literature review begins with the description of possible causes and main macroeconomic effects of civil war. The behavior of households is explained by their vulnerability to poverty and violence as a way to approach the microeconomic impacts of civil war. Finally, the determinants of child mortality will introduce the main channels linking civil war to child and infant mortality: nutrition and stress.

a) Civil war definition and main features

Civil war[1] is the outcome of a disintegrated social contract (Murshed, 2002). They are also the outcome of greed or grievance in a society and reveal the preferences or

[1]The third Geneva Convention (1949 and Additional protocols -1977, 1993, 2005, reported by the ICRC), defines civil wars as conflicts not of international character, in which the government uses military forces against organized insurgents, who have sort of belligerent status recognition and control a portion of the national territory and exercise de facto power in it. They can also be described as: first, an internal conflict between the state and a insurgent-guerrilla group (Rupesinghe, 1992) with different and opposed political ideologies; second, a Low Intensity Conflict involving "... struggles of competing principles and ideologies... waged by a combination of means, employing political, economic, informational, and military instruments" (US Army, 1990); and third, the outcomes are mass killings and human rights violations, specially, of indigenous peasants. A more practical definition, one grounded on data and research purposes, is the one proposed by Collier and Hoeffler (2002), who define civil war as a conflict with more than 1,000 battle deaths a year. In the remaining of these pages the term civil conflict is going to be employed.

constraints a society has to deal with social conflict (Collier and Hoeffler, 2002). Once started, the duration of a civil war will depend on whether parties see civil war as an investment, are overly optimistic, or take the rebellion as a business (Collier, Hoeffler and Södemberg, 2004). Higher levels of ethnolinguistic fractionalization increase likelihood and duration of armed conflict, while democracy reduces both (Elbadawi and Sambanis, 2002). The spatial distribution of conflict is determined by whether the aim is independence or overthrowing an existing government (Mursheed, 2002). According to length of the civil war, peace can bring a dividend (gains to the society) or a war hangover effect (Collier, 1999).

Civil wars are harmful and destructive for the society and the economy. GDP per capita is lower, while GDP growth rate, investment rare and inflation are higher after the conflict (Chen, Loayza and Reynal-Querol, 2008). Civil war-ravaged countries experience high dependence on primary commodities since manufacturing and services are forced to shut down (Ross, 2004) Countries neighboring a civil war have lower GDP growth due to a shift in the growth model parameters (Murdoch and Sandler, 2002).

b) Towards the microeconomic impacts of civil war and household behavior

Justino (2009) poses that vulnerability to poverty and vulnerability to violence are the two axis of a four scenario model explaining how households and individuals cope with violent conflicts. This model of vulnerability opens up questions about social networks and insurance, besides the issue of displacement. Poor people are vulnerable to conflict and to natural disasters and do not have access to market-based or government-provided insurance mechanisms (Holzmann, 2001). Their only choice is to rely on family or community arrangements; however, these arrangements may not be enough in the event of a destructive war. Households relocate if participation in

the conflict is not in their set of preferences. Nonetheless, relocation may translate into deprivation, marginalization, discrimination, the destruction of assets and infrastructure left behind (making the return harder), the lack of kinship or traditions and no access to shelter, food and education (Cohen and Deng, 2009) and psychological problems (Garfield, 1985).

c) Households and Child Mortality

In a study using a household utility maximization and production function framework to explain child mortality, with data from Nicaragua, the number of siblings, mother's calorie intake and the quality of sewerage system, rather than family income, were the actual determinants of child mortality (Wolfe and Behrman, 1982). Another research, the determinants of child mortality in different survival intervals, highlights the importance of child spacing and that children born from young mothers face excess risks since teenage mothers are more likely to be socio-economic disadvantaged (Hobcraft, McDonald and Rutstein, 1985). There might be a U-shaped (or at least J-shaped) relationship between maternal age and child mortality. The first parity involves a considerable risk if women are completing their physical development, while the last parity is also risky because because of reproductive system depletion (Pebley and Stupp, 1987).

The survival of a newborn depends on genetic material, parental prenatal and neonatal care, economic status (amenities and welfare improving services), household's health-related knowledge (knowledge about prevention and disease coping) and, most relevant, parents' skills to raise and provide for a newborn (Guo, 1993). Specifically for prenatal and neonatal care, public spending on health and infrastructure only explains a very low share of child mortality, .since the impact of the health

supplied by the public sector works through the household level demand (Prichett, 1997).

d) The fetal nutrition and the maternal stress channels

One of the proposed channels linking child and infant mortality to armed conflict is through fetal nutrition and development. Intra-utero nutrition and development depend on the supply of oxygen and nutrients reaching the fetus. Following Paxon and Schady (2005), pregnant women have to reduce their food intake as a coping strategy in an environment of civil conflict and market disruptions. According to Godfrey and Barker (2000), variations in fetus nutrition are related to low birthweight, which, in turn, is related to neonatal and post neonatal mortality. Alderman and Behrman (2006) indicate that abnormally small or blocked placentas and the maternal environment (such as under nutrition and hard work) cause problems of placenta circulation and oxygen supply to the fetus. Even if children survive, society may end up facing a situation where the costs of low birthweight could be higher than the economic benefits of early childhood medical care (Petrou, Sach and Davidson, 2001).

The second channel is high stress levels. In an environment of constant violence and the threat of being harmed, pregnant women may experience high stress levels, which in turn activate the maternal sympathic nervous system, producing hormones (like epinephrine and norepinephrine) that reduce blood flow to the fetus. Moreover, stress increases the secretions of hormones (like corticotrophin releasing hormone) that can produce early delivery (Smits et al., 2006). Maternal stress seems to be more damaging during the early stages of pregnancy since this is the most influential time for the fetus development and for the birth outcomes (Camacho, 2007). Stress can also affect the conception mechanisms (Catalano et al., 2005) due to the reduction of sperm mobility and the frequency of coitus. Through changes in the frequency of

coitus, stress impacts the gender of the offspring and the born males to born females ratio.

In summary, the literature review indicates that, once started, civil war will becomes a burden to the pregnant mothers either because of indirect exposure to violence or economic disruptions that reduce food intake and access to health services. For the newborn children, civil war presents an environment of higher likelihood of disease, lower supply of medical services and, possibly, parents that have to cope with conflict by taking lower income and food intake and higher uncertainty about poverty and being targeted.

III - DATA SOURCES

a) Countries hosting civil wars

In this paper, the definition of a civil war deviates from what has been common in the literature: intra-state conflict with more than 1,000 battle related deaths per year (like in Collier, 2004). Instead, criteria of length (more than 1 year of civil war), continuity (continuous fighting over time) and overall intensity (indications of significant disruptions in the society) are preferred. Applying this criteria to the data in the Prio Uppsala Conflict Data Base Volume 4 1996, only 5 countries remain in the sample for the estimations[2]: Colombia, El Salvador, Guatemala, Nicaragua and Peru.

[2]The Latin American countries that have experienced some sort of civil conflict or armed unrest in the second part of the 20th century are: Argentina, Bolivia, Colombia, El Salvador, Guatemala, Mexico, Nicaragua, Paraguay, Peru, Uruguay. Some countries did not experience a continuous civil conflict or guerrilla war (Bolivia, Mexico, Uruguay). In other cases, best estimates of battle deaths are very low and do not indicate the existence of a conflict spreading throughout the territory and disrupting the normal functioning of the society (Bolivia, Mexico, Uruguay and 3 years of the Argentinean revolutionary terrorism). Argentina is a particular case because only one year (with a best estimate of battle deaths equal to 1200) could be considered in the sample following the standard definition of civil war.

The detailed explanation of the conflicts is well beyond the scope of this paper. Some military recounts (like the ones published on Global Security, like Serafino (2001), Olan (1984), Wilson (1984), Huston (1988) in particular) and the works collected by Arnson (1999) on peace processes in Latin America allow a minimal characterization of the conflicts (**Table I.1**). The chosen countries have different development levels and their conflicts are rooted in long-standing political, social and economic contradictions. Most of these contradictions are related to land concentration, lack of a functioning and stable political system, clash of ideologies during the Cold War era, and transformations during the urbanization process. While in Peru and Guatemala racial discrimination could have been a triggering factor, political contradictions during the Cold War were the main causes for the conflicts in El Salvador and Nicaragua. The Colombian conflict is the only one that still continues and it has evolved from a war against leftist guerrillas to a war against powerful terrorists groups funded by drug trafficking.

Conflicts in El Salvador and Guatemala ended through the mediation of the international community and the signing of peace and reconciliation agreements that were followed by political reforms. In Nicaragua, peace was reached when the government and the rebel forces agreed to hold internationally monitored presidential elections. In Peru, the main factions of the largest guerrilla group were defeated or disarticulated through military actions; however, some very low intensity guerrilla war still happens in Peru, although it is confined to remote jungle areas. The Colombian conflict has

not officially concluded and the country is now experiencing high levels of organized urban crime and terrorist activities in drug producing regions.

b) Demographic and Health Surveys - DHS

The DHS, the Demographic and Health Surveys, contain information about women of reproductive age (from 15 to 45 years old). The survey contains detailed information of each child born from the respondent. The main strength of the DHS is that it tracks the reproductive history of the respondents. This is supplemented by additional variables for the children born in the 5 years prior to the survey date. On the side of the weaknesses, the DHS is a snapshot of the mother as she was at the moment of the survey. The evolution of some of her features (like location and education) at the time of every single birth is not recorded. This is not a minor problem as the evolution path of education or labor market participation may be discontinuous at every single birth. Another weakness is that information related to fertility and pregnancies are based on recall data. Paxon and Schady (2005) argue that births and deaths are very important moments in the life of a woman and that she keeps track of significant events for every child. Nevertheless, it is likely that some error is introduced as time passes by and mothers either forget about some events or how and when some events unfolded. The final weakness is that DHS does not record the location at every birth. It is not possible to know if migration or forced relocation ever occurred, specially, during civil war.

Table I.2 characterizes the mothers in the selected countries[3]. In the sample, Colombia and Peru have the biggest shares of mothers living in a city or in a town during their childhood (some sort of suburban setting) and the largest percentage of women attaining primary, secondary and higher education and, in consequence, with abilities to read. Adding the percentages of women living with a partner to the married women, the percentages are around 80%. Interestingly, close to 70% of women in the sample have only had 1 union during their lives at the moment of the survey.

Infant mortality and child mortality are also presented in **Table I.2** as shares. Infant mortality (**Figure I.2**) is computed as the number of dead children before 1 year of age divided by the total number of born children in any given year. Child mortality (**Figure I.1**) is calculated as the ratio of dead children before 5 years of age to total born children in any given year. In the sample, the child mortality is mainly explained by children dying before 1 year of age: almost 80% of the dead children died before 1 year of age and the 20% remaining died mainly before turning 3 years old.

Child and infant mortality rates exhibit high variability before 1967 due to low sample sizes, but the variability falls as sample sizes increase. Steady reductions of child and infant mortality after the 1960's reveal that social and economic transformations (such as expanded health care provision, more women attending school and

[3]The sample of Colombia, 141,973 observations, comes from 5 waves of the DHS (1986, 1990, 1995, 2000 and 2005). El Salvador has the smallest sample, 6,383 observations, from the 1985 DHS. Data from Guatemala, 72,032 observations, come from three DHS surveys (1987, 1995 and 1998-1999). 77,977 observations from the 1998 and 2001 DHS correspond to the sample for Nicaragua. Finally, Peru is the country with the largest sample size, 217,275 observations, from 5 waves of the DHS (1986, 1991-1992, 1996, 2000 and 2008). The total sample size is 508,640 observations. About the number of households (equivalent, surveyed women), the sample is composed by a total of 150,702 households (surveyed women). the distribution by country is like follows: Colombia (50,574 households), El Salvador (3,653 households), Guatemala (16,804 households), Nicaragua (18,971 households) and Peru (60,700 households).

more availability of information about fertility and contraception) were taking place while civil wars were raging. Civil wars could have curtailed or reduced the benefits of those transformations on child and infant mortality. Bigger sample sizes are not necessarily good for infant or child mortality. Assuming that families forecast a low probability of survival for the newborns, families may engage in increasing the total number of children as a way to replace those who may eventually die. Another factor to consider is the composition of women giving birth (Paxon and Schady, 2005). Increases in births from older women can be a transitory phenomenon; however, increases in births from younger women can be a lasting phenomenon as younger women have a longer fertility window for the replacement of their dead newborns. By this pattern, indirect and direct effects of conflict can be more devastating to the fertility and reproductive decisions of older women.

c) Conflict Data - Battle Deaths

The Prio Uppsala-Battle Deaths is the generally accepted source on conflict intensity. In this paper, battle deaths figures have to be considered lower bounds of the actual conflict intensity and deaths. Conflict data may present some problems of measurement error, relevance and trends. In inter state wars most deaths take place in battles, but that is not the case in civil conflicts. Deaths in civil wars happen as a consequence of massacres, terrorist attacks, selective killings. Moreover, human rights violations, typical during a civil war, may suffer from underreporting. For all this, measurement error introduces attenuation bias in the regressions results and the results should be interpreted as lower bounds.

With respect to relevance, there is not one indicator that best describes conflict intensity, or that signals more negative externalities to the economy or that solely defines households' violence vulnerability. In an attempt to tackle this issue, Akresh

and de Walque (2008) employed several measures of violence intensity, trying to disentangle the real impacts of genocide on School attainment. Battle deaths might not be the most relevant indicator of intensity; however, this variable also permits a sample including countries that had different civil war dynamics.

The final point about the nature of conflict data is the existence of conflict trends. Trends can signal conflict evolution as strategies change and evolve, new and different types of violence or war technology are employed, or some armed factions join the conflict or are defeated. At the level of households, trends could even have a buffering effect on the society and on the economy if households react in lagged fashion to conflict information. For instance, if the battle deaths were high in year $t-1$, households may assume the groups will retaliate (tit-for-tat) and, therefore, battle deaths will be also high in year t. Trends are not an empirical problem for this paper since the focus is on the effects of conflicts more than in the data generating process of the conflict indicators.

The battle deaths are presented in **Figure I.3**. El Salvador had the most intense conflict of all the sample. Colombia and El Salvador have half of the conflict years classified as of low intensity (if battle deaths in a year are below the conflict median) and the other half as a high intensity (if deaths are equal to or above the conflict median). Guatemala has most of the years (27) classified as low intensity and the remaining years (4) are of high intensity. Nicaragua, the shortest conflict in the sample, has most of its years as years of high intensity, as is the same case for Peru.

IV. REGRESSION ANALYSIS

a) Identification Strategy

The identification strategy rests on the classification of the year of birth of each child in the sample. That year of birth has been classified either as: a year of peace before

conflict, year of high conflict intensity, year of low conflict intensity or, finally, as year of peace after conflict. A year is considered to be a year of high conflict intensity if battle deaths in that year were equal or above the median battle deaths throughout the conflict. A year is considered of low conflict intensity if battle deaths in that year were below the median battle deaths throughout the conflict. Years before conflict and after the conflict are not comparable. The peace lived before the conflict is different from the peace lived after the conflict because the last one includes the destruction of infrastructure, the reconstruction of the country, the loss of human lives and what Collier called a war hangover effect.

In the sample (**Table I.2**), most children were born in years of high levels of conflict; the only exception is Guatemala where more children were born after the conflict. The classification can be biased due to the timing between the survey and the conflict. For instance: there are not children born after the conflict in El Salvador and almost all Colombian children were born during the period of conflict (the majority in years of high intensity).

Table I.4 and **Table I.5** contain the mean values of child and infant mortality and of some other variables, according to the classification of the year of birth of the children (high conflict intensity, low conflict intensity, before conflict, after the conflict, all peace and all conflict). More children died before turning 5 years old during years of high conflict intensity. The same is true for infant mortality. When looking at the age at death (in months), children died younger during years of high conflict intensity. Nonetheless, children born after the conflict are underrepresented in the sample and care is needed to make further interpretations of this finding. (See **Table I.4**)

Table I.5 continues this analysis with relevant mothers' features. Children born in years of high conflict intensity were born from mothers who appear to have postponed their marriages and their first pregnancy. Also, these children were born from mothers who reported a significantly lower number of ideal children and that end up having a smaller number of offspring. Women giving birth during years of high intensity have longer child spacing, but are forced to have shorter periods of breastfeeding. Finally, more mothers of children born during high conflict intensity years reported not desiring their last child.

b) Econometric Strategy

The general form of the equation to be estimated is:

$$M_{ih} = \begin{array}{c} \beta_0 + \beta_1 highIntensity_{ih} + \beta_2 lowIntensity_{ih} + \beta_3 afterconflict_{ih} + \beta_4 birthorder_{ih} \\ +\beta_5 female_{ih} + \beta_6 motherage_{ih} + \beta_7 motherage_{ih}^2 + \theta_h + d_{ih} + \varepsilon_{ih} \end{array}$$

(Eq. I.1)

where i is the i-th child in the household h, and M_{ih} is the mortality indicator. The dependent variable can be either child mortality (equal to 1 if child died before turning 5 years old and 0 otherwise) or infant mortality (equal to 1 if child died before turning 1 year old and 0 otherwise). To control for conflict intensity, $highIntensity_{ih}$ is a dummy variable for children born in years of high conflict intensity; $lowIntensity_{ih}$ is a dummy for children born in years of low conflict intensity; and $afterconflict_{ih}$takes a value of 1 for children born after the conflict. The use of these conflict dummies implies that children born before the conflict are the excluded class and the comparison group.

The variable $birthorder_{ih}$ controls for the order of birth of each child in the mother's reproductive history. Birth order takes into account time changes in the household and any possible risk variation due to the mother's reproductive depletion. **Table I.6** presents the variation in the time of the birth (during conflict or

during peace) depending on the birth order. The table is constructed for children in households with 2 or more offspring since this will be the sample for the fixed effects estimation. Overall and regardless of the birth order, 70% of children were born in conflict, and 30% were born during peace. The gender variable, $female_{ih}$, is equal to one for female children. The final variables are $motherage_{ih}$ and $motherage_{ih}^2$, standing for the age of the mother at the birth of every child. The squared value controls for any non-linear change in the mortality risk. $\theta_h$is the household fixed effect and is d_{ih} the decade of birth fixed effect.

In general, it is expected that high and low levels of conflict intensity increase the mortality risk and that the risk is bigger at the higher intensity level ($\mid \beta_1 \mid > \mid \beta_2 \mid$). The comparison group is composed of the children born before the conflict started. Due to the potential existence of a war hangover effect, the persistence of conflict effects during the first years after the conflict could imply that children born during the early peace time have the same mortality risk as those born during the conflict. Being born after the conflict would only cause lower mortality levels if markets were restored to their normal functioning and infrastructure is easily reconstructed. The sign on the variable for birth order can be positive, if mortality increases with higher orders or negative if mortality decreases in the later pregnancies and deliveries. The cited studies on mortality mentioned an inverted J relationship between mother's age at birth of every child and the death risk; if so,the coefficient on the squared value of the mother's age at the birth of every offspring is negative.

A final important point about the sample composition is important before presenting the results. For example: the survey asks for the status (dead or alive) of all children, including those under one year (the same is true for children under 5 years). However, the survey does not record the future status when the child turns 1 year old or 5 years old. Ignoring what may happen in the future leads to underestimate the

effect of conflict. This is an underestimation, if children tend to die close to the 12th or 60th month (unlikely, but conflict may change the patterns of mortality and morbidity), which cannot be foreseen with the data available. To address this problem, an expected age of the children was computed as the difference between the date of the survey and the reported date of birth. Regressions were run for the 1 year old and older children (when estimating the effect on infant mortality) and for 5 years old and older children (when estimating the effect on child mortality), using the expected age in both cases.

c) Threats to the Identification Strategy

As every identification strategy, this one has its own nuisances. The first is the recall data errors, or errors in reporting the occurrence of events (births and deaths) and the year of their occurrence. The second, and more severe, has to do with the selection bias of mothers and births. The third is the relevance of battle deaths as the most accurate and relevant indicator to measure the conflict intensity.

Regarding recall error, there some common features: it is correlated to household size (Gibson and Kim, 2007), it is higher for the older children born from the same mother (Valadez and Wel, 1991) as it tends to increase with longer lengths of recall (Launer et. al., 1992), a with higher variability of what is reported (Tamakoshi, 2003). Paxson and Schady (2005), in a paper exploring the economic crisis impact on Peruvian child mortality, eliminated all birth records occurring more than 10 years before the survey. For this research, eliminating the records of children born 10 years before the survey does not permit the estimation of differences between peace and conflict periods and between different conflict intensity levels. If recall error is introduced in this way, keeping those records is justified as the main purpose is comparing children born in different stages of the conflict. Moreover, the effect of

recall data should be minimal given the relevance of births and deaths in a mother's history. Instead, birth records from before 1970 are not going to be considered for the regression analysis. On one hand, eliminating the records from before 1970 reduces the variability due to small sample sizes for those years; on the other hand, this procedure reduces the under representation of children born after the conflicts.

Additionally, armed hostilities may create selection bias of mothers and births through relocation decisions. Women of reproductive age can decide to leave their place of residence due to the intensity of armed operations; if this is so, samples can be biased and only those who do not leave are going to be surveyed. Perhaps women who could not leave their region of residence were the weaker ones, the poorer ones or, conversely, those who enjoyed the support from social networks or the protection of one of the armed factions. If the weaker and poorer, the mortality risk of their children is already high; if the ones with access to support and protection, the benefits of support and protection will diminish the negative impacts of civil war.

Internal displacement and problems with the coding of births could be a source of selection bias. Households can be constantly relocating within the boundaries of the country throughout the conflict, and then being exposed to different levels of violence in each place they settle. An example can demonstrate the real scale of this issue: in the case of Colombia, approximately 3.65 million people (or 0.85 million households) have relocated due to the civil conflict (Accion Social, 2001). International migration also poses a risk for the representativeness of the sample, if countries that host a conflict also received a large influx of immigrants. Incoming inhabitants have a higher propensity to diseases with negative impact on mortality (like Ghobara et. al. reported). Internal displacement is a problem when using regional level data (at state or municipality level); however, this research only uses

national aggregates and, therefore, internal relocation does not pose a problem for the results. Only international migration could be a source of bias.

The advantage of the DHS is that surveyors visit the mothers in each country and ask them about their birth history; mothers do not have to go to a specific place to fill out a form (like for the vital statistics records or other government documents). Underrecording of births is not an issue for the estimation procedures to be presented. Complications would only arise if women do not report all their births and deaths to the surveyors. Nevertheless, surveyors may not have reached some regions or some populations due to the fear of getting caught in the midst of fighting. In this case, women and children suffering very high conflict intensity levels would be underrepresented.

The figures on infant and child mortality exhibit a downward trend. What is true for the child and infant mortality is true for the evolution of conflict itself: trends and breaks. The nature of the conflict, the geography and resources of the hosting country and the decisions made by armed groups also give origin to trends or breaks in the battle deaths series. To tackle this issue, year or decade fixed effects are the most flexible strategy to control for time changes that cannot be measured by the explanatory variables.

In spite of the DHS richness, there are relevant variables that are not recorded or are not observed. If all those unobservables are correlated with mortality risks, the estimates are biased. Following Garces, Duncan and Thomas (2002), assuming that parents' preferences for the accumulation of human capital are the same among siblings (i.e. parents equally care about the survival of all their children), a fixed effects model absorbs and controls for all those not measurable variables. The fixed effects reduces the sample as it only considers women with two or more born children and exacerbates the effect of possible measurement errors. Another problem is when

unmeasurables change with every newborn due to spillovers. Using the fixed effects framework helps to compare the effects of conflict on the mortality risks for children born from the same mother.

V. ESTIMATION RESULTS

1) Simple regressions all sample

The first regression is of an exploratory nature (**Table I.7**). Instead of using the measures of intensity, this regression only compares the mortality risks for children born in periods of peace (either before or after conflict) to those born during conflict. The variable $peace_{ih}$ takes the value of 1 if a child was born during years of peace. The regression ignores the existence of household fixed effects. Although not statistically significant, the results show that children born in periods of peace have a lower infant mortality risk. This finding emphasizes the perverse effect of violence on the proper development and nutrition during the first months of life. Armed hostilities have a reduced impact once a child has survived the first year of life and has completed the critical phases of physical development. Females have a significantly lower mortality risk. Birth order, with a significant and positive coefficient, accounts for the reproductive depletion for higher ranks of pregnancies.

Positive effects of peace could incorporate the benefits from reduced violence, as well as from the reconstruction of infrastructure and the expansion of government-provided services. Gender differences in mortality are a topic beyond the scope of this paper, but this result demonstrates how changes in sex ratios can be significant in uncertain and violent environments and its repercussions in future population dynamics. Finally, summary statistics shows that conflict makes women postpone their marriage and pregnancy decisions. This regression provides evidence that a higher

infant and child mortality risk can be exacerbated by the mother's decision of delaying pregnancies.

2) The case for fixed effects

A dummy variable for mothers with two or more children is created and interacted with the dummy variable for being born during years of peace. The comparison between these two groups is important because of the use of household fixed effects in the following regressions. Women with only one child will be dropped out of the sample when using the fixed effects. It is important to see if there are significant differences among these women and the mothers of 2 or more children. Ignoring these differences may entail overlooking a more severe issue: the selection problem. Women may respond differently to violence and uncertainty. During armed conflict, some women may prefer to have one child and such a decision would not be a problem if it is random; however, it could be that mothers of only one child are essentially different from those having larger families. Differences can come from risk attitude, health status, genetic material, membership to support and kinship networks, among other non-measurable traits.

Regressions on **Table I.8** presents the effect of conflict on mortality for the aforementioned groups of women. Here, the focus is still on comparing peace and conflict periods. The coefficients on peace are significantly different from zero and negative; however, when interacted with the type of mother, note that the effect can be counteracted for children born from mothers with two or more children. This finding may imply that larger families, due to reduced resources and income, cannot properly cope with conflict as they may find it hard to provide food and care to the newborn.

Indeed, these two types of women are very different according to some observable characteristics (**Table I.9** and **Table I.10**). Women with one child have higher

levels of education and more educated husbands; their children presented lower rates of infant and child mortality. Certainly, the mortality rates differences are counter intuitive since women with only one child were those who gave birth, mainly, during conflict times. It could have been that higher levels of education allowed these women to take better care of their only child during the conflict (more nutrition, resources, disease prevention and treatment and parenting). If this is true, then, the strategic behavior would be to have smaller families during times of conflict or to postpone pregnancies. Also, it would imply that more educated women can counteract the impact of violence through better parenting or labor participation.

3) Fixed Effects estimation

The two previous estimations have the flaw of not controlling for household fixed effects. Mothers have critical features for the survival of the children that cannot be measured, like parental skills or genetic material. Assuming constant preferences regarding child survival, fixed effects will factor out all those unobservables and will change the comparison: now the focus is on comparing the mortality risks for children born from the same woman.

The results (**Table I.11**) also compare children born during conflict to those born during peace (before or after the conflict). Regressions using fixed effects show a negative, yet not significant, impact of conflict. Children born during peace had a lower mortality risk than their siblings born during conflict. It is revealing that the impact of conflict is relatively higher on infant mortality. The first year of life is critical for the survival and development of any child. Seemingly, this is the time when the consequences of the hostilities are amplified. The destruction of infrastructure and the shortage of food and services may pose serious threats to the lives of newborns; for

instance, they can die suffering diseases that are curable and not harmful if properly treated.

Interestingly, the fixed effects estimation show the typical J shaped pattern in mother's age at birth, but a reduction in mortality for children born in later pregnancies. The J shaped pattern in mother's age at birth might be an indication of reproductive depletion. This is exacerbated if a woman had her first pregnancy at a young age and did not have long enough intervals between pregnancies. Children of later pregnancies can be enjoying the benefits of more knowledgeable parents, assuming there is a learning curve on parenting.

4) Fixed effects and mother's period of birth

A possible spillover in mortality works through from mothers to the children. Women born during conflict experienced an environment of constraints, uncertainty and lack of resources that is detrimental to their physical development and their accumulation of human capital. Mortality of children could be a consequence of the risky environment the mother faced. Assuming that such a channel exists, it could be entirely possible that the most negative effects of conflict are those lived during the mother's childhood than those actually experienced (directly and indirectly) by the child. A mother growing up surrounded by violence may have health or education issues that cannot be addressed later on in her life.

A dummy variable is created for women born before the conflict and interacted with the dummy variable for children born during peace time. The results of this exercise have to be taken cautiously because the sample is mainly composed of mothers born before the conflict. As for the results (**Table I.12**), the estimates are not statistically significant, but the signs are as expected. Reading the signs on the coefficient

of the interaction variable, children may have further reductions in mortality risks if mothers were born during peace.

5) Conflict Intensity Levels (Fixed Effects)

Moving from the peace and conflict analysis, regressions in the next pages go back to **Equation I.1** and estimate the effect of conflict intensity on mortality (**Table I.13**). Children are classified in periods of high and low conflict intensity according to whether the number of battle deaths in their year of birth is above (high intensity) or below (low intensity) the median value throughout the conflict. Regressions also include a dummy variable for children born after the conflict. Therefore, children born before the conflict compose the comparison group. The idea behind this regression is that intensity matters for household behavior: households could act normally when intensity is low; however, the real strain from conflict comes when conflict reaches high intensity levels that make households more vulnerable to poverty and violence.

Indeed, the results support the idea that intensity does matter. Children born during high intensity periods experienced a higher infant mortality risk than children born before the conflict. The story is different for children born in low intensity years or after the conflict: there is not significant difference with respect to children born before the conflict. In particular, results denote a bigger effect of conflict on infant mortality. This finding indicates that policy interventions are needed during pregnancy and during the first year of life of newborns. Although not significant, the sign of the dummy for children born after the conflict is negative as expected.

The use of the national level conflict intensity data hides important spatial variation and assumes that all households experienced the same intensity. The former is not only false, but prevents us from knowing the differentiated reactions by households and their responses to the conflict-created shocks. Despite this drawback, the

results stand in proving that severe market, institutional and social network disruptions increase child and infant mortality by imposing extra costs on the households.

6) Conflict Intensity and Education Levels (Fixed Effects)

It is expected that more educated mothers are better in parenting. They can be involved in market activities (producing and exchanging goods) or earning a wage and, in consequence, can provide better care and nutrition. More educated mothers will know more about health and hygiene and can make better fertility decisions and better planning of pregnancies. To test this, three new dummy variables are created using the maximum education level attained by the mothers. The variables are: a dummy variable for children born from women with no education, another dummy variable for children born from women with primary education and, finally, a dummy for children born from women with secondary education. Due to low numbers in the sample, women with higher education are not considered in the regressions. These dummy variables are interacted with the conflict intensity level in the year children were born.

Intensity and education appear to matter for infant mortality rate (**Table I.14**). Children born from women with primary and secondary education had an increased mortality risk when born during low conflict intensity levels and after the conflict. Considering that women with education tend to engage in market or labor activities, it is presumed that their incomes could be reduced when armed conflict disrupts markets. Women without education or only primary education may be having equal economic hardship regardless of conflict level and violence intensity may not impose any extra burden.

There is a caveat. DHS does not report changes in education history during the mother's reproductive history. Assuming that mothers complete their desired or

achievable level of education before all their pregnancies can be misleading. If mothers are both studying and parenting, children may not receive the required care during their early years, which can be aggravated by any additional economic constraint due to conflict. Women could have changed their education attainment decisions and could have dropped out of school because conflict reduced the availability of education (destruction of schools or killings of teachers) or increased opportunity cost of education.

7) Conflict Intensity and Mother's Childhood Place of Residence (Fixed Effects)

Here, the goal is to test whether an environment of reduced infrastructure and services availability during mothers' childhood increases the effect of conflict on their offspring survival. Rural settings in Latin America featured lack of or inappropriate infrastructure, limited provision of services (education and health) and, in general, lower economic development when compared to cities. This channel could operate as follows: mothers who spent their childhood in rural areas did not have access to all the amenities and nutrition levels critical for their physical development; their children born during periods of high conflict intensity may experience an extra risk of mortality. Another factor can be that those women had their first pregnancies at a younger age, which seems to be a determinant for future offspring survival.

To check for the mortality risk of children born from mothers living in rural areas during their childhood, a dummy variable is created taking the value of 1 for women born in urban areas and 0 otherwise. When looking at the coefficients of the regressions **(Table I.15)**, an urban childhood of the mother does not matter for her offspring's survival; at most, it would only matter for children born after the conflict

(yet, the coefficient is not significant). Like in previous regressions, the sensitivity is higher for infant mortality **(Table I.15)**.

Migration could be contaminating this result. DHS does not track the migration pattern of the household. A mother could have migrated to urban areas and counteracted the consequences of the childhood environment. Migration can have positive effects (like enjoying a higher levels of services and amenities), but also negative outcomes (disconnection of social support networks or location in poor neighborhoods). Without a record of migration, it is hard to make further comments about this result. Meanwhile, it is worth saying that this finding supports the importance of geography and location for both mortality and conflict; also, that the gap between urban and rural settings can be aggravated when markets are disrupted due to violence.

VI. CONCLUSIONS

Civil conflicts have direct and indirect effects on households. Direct effects include the change in household composition due to killings, recruitment or household forced displacement. Indirect effects consist of those changes in the economic decisions and behaviors due to market disruptions and uncertainties. Mortality risks for newborns and children before the age of 5 increase during the time of an armed unrest either because of the direct violence (children that are killed due to the armed operations) or because of changes in mothers' health, destruction of household assets and crops, nutrition constraints during in utero development and high disease environment during the first months of life. These collateral casualties represent a cost for families and societies in terms of lost lives and resources.

The goal of this chapter was to study the impact of conflict on child and infant mortality for Latin American countries that experienced civil conflict over the last half of the 20th century: Colombia, El Salvador, Guatemala, Nicaragua and Peru.

The identification strategy was based on the conflict or peace classification and on the conflict intensity level of the year of birth of each child. Using the means of selected variables by the groups defined by the year of birth, it was found that women postpone their marriages and the birth of the first children, reduce the desired number of children and increase the spacing between pregnancies due to higher intensity of conflict. Regression analysis, using household fixed effects, provided evidence supporting the claim that conflict intensity matters. In all the findings, the effects of conflict were higher for infant mortality, while it was reduced for female newborns and for children born in later stages of their mother reproductive history. Regressions show that civil conflict reduced the pace of the overall declining trend of infant and child mortality in the selected countries.

These previous findings open the way for possible government interventions during conflicts. As a strategy to win minds and hearts during the armed conflict, governments could increase provision of services (education and health) and infrastructure (potable water and sanitation) in rural areas. Policies should target younger women with nutrition and health assistance in order to reduce the risks of their first pregnancies. Especially, governments should make sure that children before 1 year of age, the most vulnerable to conflict-induced mortality, have the assistance and care their survival requires. Military operations should be joined with extensive health and infrastructure programs for the population living in and nearby the main war theaters. Data revealed a difference between the ideal number of children and the total number of actual children, which draws attention to better planning and fertility decisions through more education. Nutritional support to pregnant women should pay special attention to women in the tails of the age distribution, for whom the risks associated with conflict may be even higher due to their physical development or reproductive depletion.

Are these interventions feasible during a civil war? Most likely, they are not. Governments may be in a situation where no service can be efficiently provided because they are budget constrained after funding the military operations or because it is not possible to staff such programs. Perhaps with help of the international organizations (such as the UN) and with the active participation of community organizations (cultural, social and faith-based organizations), governments can still reach the pregnant women and provide some assistance to the newborns.

Future work in this area requires a more diverse array of conflict intensity indicators (like massacres, kidnappings, terrorists attacks, forced displacement and human rights violations). To address the issue of relevance, indicators are needed at the municipality or state level to take into account any possible spatial variation. It is important to have information about the cause of death of children to identify those who are actual victims of conflict (by bullets or terrorist attacks). Data on household relocation decisions and mothers' education levels throughout their reproductive history will be needed for more comprehensive results. Finally, as data become available, similar research will need to explore the issue of the existence of a peace dividend or a war hangover for children born after the civil conflict. The possible existence of a war hangover will require special interventions during the early peace years.

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Tables and Figures Chapter I

Table I.1: Summary and Description of Selected Civil Conflicts[a]

Country	Start	End	Forces Fighting	Main reasons for conflict	Conflict development
Colombia	1964	N.A.	Ejército de Liberación Nacional. Fuerzas Armadas Revolucionarias de Colombia. Movimiento 19 de Abril. Ejército Popular de Liberación. Autodefensas Unidas de Colombia.	Land concentration and peasants expulsions. Partial collapse of the state in some regions. Foreign influences on the need and ways for a social change. Political violence throughout the country's history.	Minor guerrilla groups signed peace agreements with the government. Major Guerrilla groups evolved into organizations related to drug production and trafficking. United States backed government's offensive has reduced the military capabilities of the remaining groups.
El Salvador	1979	1992	Ejército Revolucionario del Pueblo. Fuerzas Populares de Liberación. Frente de Liberación Nacional Farabundo Martí.	Land concentration and peasants expulsions. Foreign influences on the need and ways for a social change. Political violence throughout the country's history.	United Nations brokered peace agreements between the government and the rebel forces. United States changed the focus from military defeat of the rebel groups to a peace process.
Guatemala	1965	1996	Ejército Guerrillero de los Pobres. Organización Armada Revolucionaria del Pueblo. Fuerzas Armadas Revolucionarias. Unidad Revolucionaria Nacional.	Racial discrimination against indigenous groups. Land concentration and peasants expulsions. Successive coup d'etat impeded functioning representative system. Foreign influences on the need and ways for a social change.	Government forces largely defeated the rebel groups. Transition to democracy, by drafting a new constitution, needed peace for consolidation. International isolation and peace in neighboring countries made possible the peace talks.
Nicaragua	1981	1990	Frente Sandinista de Liberación Nacional. Fuerza Democrática Nicaragüense. Contras.	Leftist guerrilla overthrew a dictatorship, but reduced political participation. Foreign influences on the need and ways for a social change.	United States reduced financial support to the rebel groups. Internationally monitored elections gave power to a democratic leader and allowed for demobilization.
Peru	1981	1999	Movimiento Revolucionario Túpac Amaru. Sendero Luminoso.	Racial discrimination against indigenous groups. Foreign influences on the need and ways for a social change.	Government offensives and captures of principal leaders represented an almost military defeat of the rebel forces.

[a] Sources: www.globalsecurity.com; Arnson (1999); Huston (1988); Olan (1984); Serafino (2001); Wilson (1984).

Table I.2: Main Variables (in proportions)[a]

Variable	Colombia	El Salvador	Guatemala	Nicaragua	Peru	All Countries
Respondent's urban childhood Residence	0.273	NA	0.066	0.401	0.198	0.229
Respondent's childhood Residence	0.265	NA	0.195	NA	0.252	0.208
Respondent's childhood Residence	0.286	NA	0.665	0.456	0.376	0.408
Respondent's no attained Education	0.079	0.289	0.464	0.288	0.147	0.194
Respondent attained Primary education	0.489	0.616	0.441	0.462	0.462	0.469
Respondent attained Secondary education	0.358	0.079	0.083	0.211	0.284	0.264
Respondent attained Higher education	0.074	0.016	0.013	0.039	0.108	0.074
Respondent is able to read	0.883	0.695	0.502	0.747	0.777	0.723
Respondent is married	0.391	0.352	0.595	0.391	0.568	0.492
Infant mortality	0.036	0.069	0.082	0.061	0.070	0.061
Child mortality	0.043	0.080	0.103	0.073	0.092	0.077
Children born during high conflict intensity level	0.560	0.469	0.659	0.225	0.400	0.459
Children born during low conflict intensity level	0.416	0.257	0.291	0.175	0.271	0.302
Children born before conflict	0.024	0.274	0.008	0.162	0.299	0.158
Children born after conflict	0.000	0.000	0.042	0.438	0.029	0.081

[a]Source: USAID- Demographic and Health Surveys.

Table I.3: Conflict indicators for the selected countries[a]

Conflict indicator	Colombia	El Salvador	Guatemala	Nicaragua	Peru
Average battle deaths	717.025	3950	1493.55	3636.36	1624.68
Median battle deaths	527	3500	1000	3600	1986
Standard deviation	657.76	3776.65	1775.33	2581.58	1217.70
Minimum number of deaths	2417	13001	9000	7000	3400
Maximum number of deaths	40	300	100	100	63
Years of conflict above the median	20	7	4	8	11
Years of conflict below the median	20	7	27	3	8
Years of conflict	40	14	31	11	19

[a]Source: Prio-Uppsala Conflict database Volume 4 2006. Author's calculations.

Table I.4: Year of Birth classification and mortality variables[a]

Variable	Peace			Conflict		
	All Peace	Before conflict	After Conflict	All Conflict	High Intensity	Low Intensity
Infant mortality (proportion)	0.080	0.100	0.038	0.054	0.057	0.051
	(0.0008)	(0.0011)	(0.0009)	(0.0004)	(0.0005)	(0.0006)
Child mortality (proportion)	0.104	0.135	0.044	0.068	0.071	0.063
	(0.0009)	(0.0012)	(0.0010)	(0.0004)	(0.0005)	(0.0006)
Age at death (months)	23.896	26.473	6.568	17.188	14.338	21.892
	(0.4250)	(0.4821)	(0.2946)	(0.2366)	(0.2250)	(0.5071)
Proportion of dead children	0.115	0.151	0.044	0.073	0.075	0.069
	(0.0009)	(0.0013)	(0.0010)	(0.0004)	(0.0005)	(0.0006)

[a]Source: USAID- Demographic and Health Survey for selected countries. Standard errors in parenthesis.

Table I.5: Mother's variables according to the children's year of birth classification[a]

Variable	Peace			Conflict		
	All Peace	Before conflict	After Conflict	All Conflict	High Intensity	Low Intensity
Age at First Birth (years)	18.652	18.568	18.812	19.661	19.739	19.542
	(0.010)	(0.012)	(0.018)	(0.006)	(0.008)	(0.010)
Age at first marriage (years)	17.846	18.019	17.503	18.891	18.967	18.777
	(0.011)	(0.014)	(0.019)	(0.007)	(0.009)	(0.011)
Total number of children	5.743	6.580	4.099	4.696	4.682	4.717
	(0.009)	(0.011)	(0.014)	(0.004)	(0.006)	(0.007)
Ideal number of children	3.110	3.155	3.021	2.991	2.971	3.021
	(0.004)	(0.005)	(0.007)	(0.002)	(0.003)	(0.004)
Preceding birth interval (months)	31.784	26.944	40.077	36.693	37.471	35.499
	(0.079)	(0.073)	(0.163)	(0.051)	(0.067)	(0.078)
Succeeding birth interval (months)	33.547	34.299	30.314	36.300	36.316	36.275
	(0.085)	(0.101)	(0.126)	(0.050)	(0.062)	(0.085)
Breastfeeding length (months)	11.213	NA	11.213	12.314	11.894	12.822
	(0.057)		(0.057)	(0.031)	(0.043)	(0.044)
Last child not wanted (proportion)	0.434	0.647	0.294	0.396	0.401	0.388
	(0.002)	(0.003)	(0.002)	(0.001)	(0.001)	(0.002)
Prenatal Care by a Doctor (proportion)	0.411	NA	0.411	0.528	0.626	0.400
	(0.003)		(0.003)	(0.002)	(0.002)	(0.003)
Prenatal Care by a Nurse (proportion)	0.310	NA	0.310	0.230	0.211	0.254
	(0.003)		(0.003)	(0.001)	(0.002)	(0.002)
Delivery assisted by a Doctor (proportion)	0.457	NA	0.457	0.495	0.602	0.357
	(0.003)		(0.003)	(0.002)	(0.002)	(0.002)
Delivery assisted by a Nurse (proportion)	0.342	NA	0.370	0.390	0.434	0.332
	(0.003)		(0.003)	(0.002)	(0.002)	(0.002)

[a]Source: USAID- Demographic and Health Survey for selected countries. Standard errors in parenthesis.

Table I.6: Order of birth by conflict or peace for children with one or more siblings[a]

Order of birth	Classification by year of birth	
	Born during Peace	Born during Conflict
1	0.27	0.73
2	0.24	0.76
3	0.24	0.76
4	0.23	0.77
5	0.23	0.77
6	0.22	0.78
7	0.21	0.79
8	0.21	0.79
9	0.20	0.80

[a]Source: USAID- Demographic and Health Survey for selected countries. Author's calculations.

Table I.7: Effect of Conflict on Mortality[a]

Variable	Child Mortality	Infant Mortality
Born during years of peace	0.015 (0.82)	-0.028 (1.47)
Birth order	0.198 (52.90)**	0.184 (48.38)**
Female	-0.150 (12.90)**	-0.201 (16.62)**
Mother's age at birth	-0.207 (29.22)**	-0.220 (32.51)**
Mother's age at birth squared	0.003 (18.55)**	0.003 (22.61)**
Constant	1.105 (12.16)**	-0.446 (4.01)**
Observations	384150	476100
Likelihood ratio Chi2(12)	10892.31	9138.4
Prob>Chi2(12)	0	0

[a]Logit Absolute value of z statistics in parentheses. +significant at a 10%* significant at 5%; ** significant at 1%. Logit reporting marginal effects.

Table I.8: Effect of Conflict on Mortality by number of children[a]

Variable	Child Mortality	Infant Mortality
Born during years of peace	-0.582 (4.62)**	-0.570 (6.16)**
Born during years of peace * Mother with 2 or more children	0.832 (6.60)**	0.734 (7.89)**
Birth order	0.202 (55.41)**	0.189 (50.94)**
Female	-0.149 (12.92)**	-0.201 (16.65)**
Mother's age at birth	-0.202 (28.63)**	-0.219 (32.38)**
Mother's age at birth squared	0.003 (18.52)**	0.003 (22.79)**
Constant	-0.093 (1.04)	-0.634 (6.48)**
Observations	384150	476100
Likelihood ratio Chi2(9)	7885.53	7326.28
Prob>Chi2(9)	0	0

[a]Logit Absolute value of z statistics in parentheses. +significant at a 10%* significant at 5%; ** significant at 1%. Logit reporting marginal effects.

Table I.9: Mothers' Features by number of children (in proportions)[a]

Variable	Households with only one Children	Households with two or more children	Statistically different
No Education attained	0.0442 (0.0420 − 0.0463)	0.2057 (0.2046 − 0.2069)	Yes
Primary education attained	0.2786 (0.2738 − 0.2833)	0.4837 (0.4822 − 0.4851)	Yes
Secondary education attained	0.4748 (0.4695 − 0.4801)	0.2471 (0.2459 − 0.2483)	Yes
Higher education attained	0.2024 (0.1982 − 0.2067)	0.0635 (0.0628 − 0.0642)	Yes
Able to read	0.9140 (0.9096 − 0.9183)	0.7107 (0.7090 − 0.7124)	Yes
Respondent is married	0.2752 (0.2704 − 0.2799)	0.5089 (0.5075 − 0.5103)	Yes
Husband has no education attainment	0.0414 (0.0391 − 0.0438)	0.1385 (0.1376 − 0.1395)	Yes
Husband attained primary education	0.2529 (0.2479 − 0.2580)	0.4690 (0.4676 − 0.4705)	Yes
Husband attained secondary education	0.4710 (0.4651 − 0.4768)	0.2827 (0.2814 − 0.2840)	Yes
Husband attained higher education	0.2223 (0.2174 − 0.2271)	0.0963 (0.0955 − 0.0971)	Yes

[a] 95% Confidence intervals reported under the proportion.

Table I.10: Mortality and Classification by number of children (in proportions)[a]

Variable	Households with only one Children	Household with two or more children	Statistically different
Infant mortality	0.0157	0.0641	Yes
	$(0.0144 - 0.0170)$	$(0.0634 - 0.0648)$	
Child mortality	0.0182	0.0812	Yes
	$(0.0168 - 0.0196)$	$(0.0804 - 0.0819)$	
Children born during high conflict intensity	0.5102	0.4550	Yes
	$(0.5049 - 0.5155)$	$(0.4536 - 0.4565)$	
Children born during low conflict intensity	0.2999	0.3025	No
	$(0.2950 - 0.3047)$	$(0.3012 - 0.3038)$	
Children born before conflict	0.0257	0.1685	Yes
	$(0.0240 - 0.0274)$	$(0.1674 - 0.1695)$	
Children born after conflict	0.1642	0.0740	Yes
	$(0.1603 - 0.1682)$	$(0.0732 - 0.0747)$	

[a] 95% Confidence intervals reported under the proportion.

Table I.11: Effect of conflict on Mortality (Household Fixed Effects)[a]

Variable	Child Mortality	Infant Mortality
Born during	-0.026	-0.042
years of peace	(1.03)	(1.63)
Birth order	-0.028	-0.046
	(2.81)**	(4.77)**
Female	-0.149	-0.193
	(10.73)**	(13.53)**
Mother's age at	-0.207	-0.220
birth	(18.99)**	(21.34)**
Mother's age	0.003	0.003
at birth squared	(16.35)**	(20.89)**
Observations	120015	121482
Households	22008	21315
Likelihood ratio	2286.66	2193.51
Chi2(8)		
Prob>Chi2(8)	0	0

[a]Logit Absolute value of z statistics in parentheses. +significant at a 10%* significant at 5%; ** significant at 1%. Decade of birth fixed effect Logit reporting marginal effects.

Table I.12: Effect of conflict on Mortality by Mother birth (Household Fixed Effects)[a]

Variable	Child Mortality	Infant Mortality
Born during	0.656	-0.020
years of peace	(1.12)	(0.14)
Born during	-0.682	-0.023
years of peace *	(1.16)	(0.15)
Mother born before the conflict		
Birth order	-0.028	-0.046
	(2.81)**	(4.77)**
Female	-0.149	-0.193
	(10.73)**	(13.53)**
Mother's age at	-0.207	-0.220
birth	(19.01)**	(21.32)**
Mother's age at	0.003	0.003
birth squared	(16.37)**	(20.88)**
Observations	120015	121482
Households	22008	21315
Likelihood ratio Chi2(9)	2287.98	2193.53
Prob>Chi2(9)	0	0

[a]Logit Absolute value of z statistics in parentheses. +significant at a 10%* significant at 5%; ** significant at 1%. Decade of birth fixed effect. Logit reporting marginal effects.

Table I.13: Conflict Intensity Effect on Mortality (Household Fixed Effects)[a]

Variable	Child Mortality	Infant Mortality
Born during High conflict intensity	0.031	0.058
	(1.08)	(1.89)+
Born during Low conflict intensity	-0.036	-0.007
	(1.08)	(0.19)
Born after the conflict	-0.057	-0.012
	(0.89)	(0.20)
Birth order	-0.026	-0.045
	(2.64)**	(4.65)**
Female	-0.149	-0.193
	(10.72)**	(13.52)**
Mother's age at birth	-0.207	-0.220
	(18.99)**	(21.35)**
Mother's age at birth squared	0.003	0.003
	(16.47)**	(21.02)**
Observations	120015	121482
Households	22008	21315
Likelihood ratio Chi2(10)	2297.61	2203.58
Prob>Chi2(10)	0	0

[a]Logit Absolute value of z statistics in parentheses. +significant at a 10%* significant at 5%; ** significant at 1%. Decade of birth fixed effect. Logit reporting marginal effects.

Table I.14: Conflict Intensity Effect on Mortality by Mother's education level (Household Fixed Effects)[a]

Variable	Child Mortality	Infant Mortality
Born during high conflict	-0.050	-0.136
intensity	(0.31)	(0.83)
Born during low conflict	-0.247	-0.375
intensity	(1.27)	(1.94)+
Born after the conflict	-0.494	-1.027
	(1.20)	(2.43)*
Born during high conflict	0.023	0.151
intensity * Mother	(0.14)	(0.90)
attained no education		
Born during low conflict	0.249	0.419
intensity * Mother	(1.27)	(2.14)*
attained primary		
education		
Born during low conflict	0.279	0.436
intensity * Mother	(1.34)	(2.09)*
attained secondary		
education		
Birth order	-0.026	-0.046
	(2.62)**	(4.73)**
Female	-0.149	-0.193
	(10.71)**	(13.52)**
Mother's age at birth	-0.208	-0.220
	(18.97)**	(21.23)**
Mother's age at birth	0.003	0.003
squared	(16.49)**	(20.98)**
Observations	120015	121482
Households	22008	21315
Likelihood ratio Chi2(19)	2306.55	2222.18
Prob>Chi2(19)	0	0

[a]Logit Absolute value of z statistics in parentheses. +significant at a 10%* significant at 5%; ** significant at 1%. Decade of birth fixed effect. Logit reporting marginal effects.

Table I.15: Conflict Intensity Effect on Mortality by Mother's place of childhood residence (Fixed Effects)[a]

Variable	Child Mortality	Infant Mortality
Born during High conflict intensity	0.016	0.052
	(0.44)	(1.37)
Born during Low conflict intensity	-0.056	-0.021
	(1.37)	(0.49)
Born after the conflict	-0.031	0.038
	(0.37)	(0.51)
Born High conflict intensity * Mother's Urban childhood	0.032	0.013
	(0.73)	(0.27)
Born Low conflict intensity * Mother's Urban childhood	0.044	0.033
	(0.85)	(0.60)
Born after the conflict * Mother's Urban childhood	-0.058	-0.122
	(0.54)	(1.23)
Birth order	-0.026	-0.045
	(2.64)**	(4.70)**
Female	-0.149	-0.193
	(10.71)**	(13.51)**
Mother's age at birth	-0.207	-0.220
	(18.96)**	(21.24)**
Mother's age at birth squared	0.003	0.003
	(16.46)**	(20.96)**
Observations	120015	121482
Households	22008	21315
Likelihood ratio Chi2(13)	2299.2	2206.46
Prob>Chi2(13)	0	0

[a]Logit Absolute value of z statistics in parentheses. +significant at a 10%* significant at 5%; ** significant at 1%. Decade of birth fixed effect. Logit reporting marginal effects.

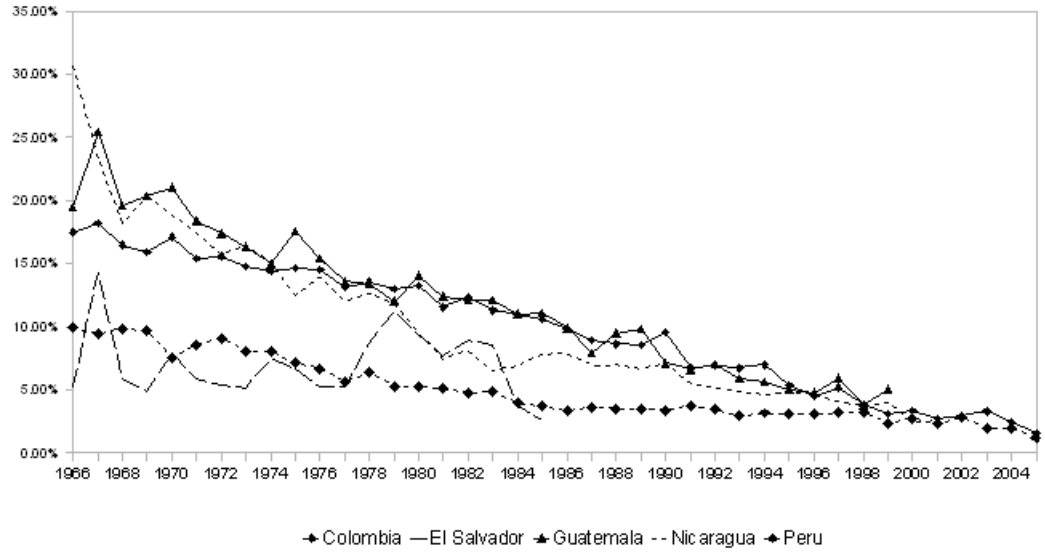

Figure I.1: Child Mortality rate (defined as percentage in the sample)[a]

[a]Source: USAID-Demographic and Health Survey for the selected countries. Author's calculations.

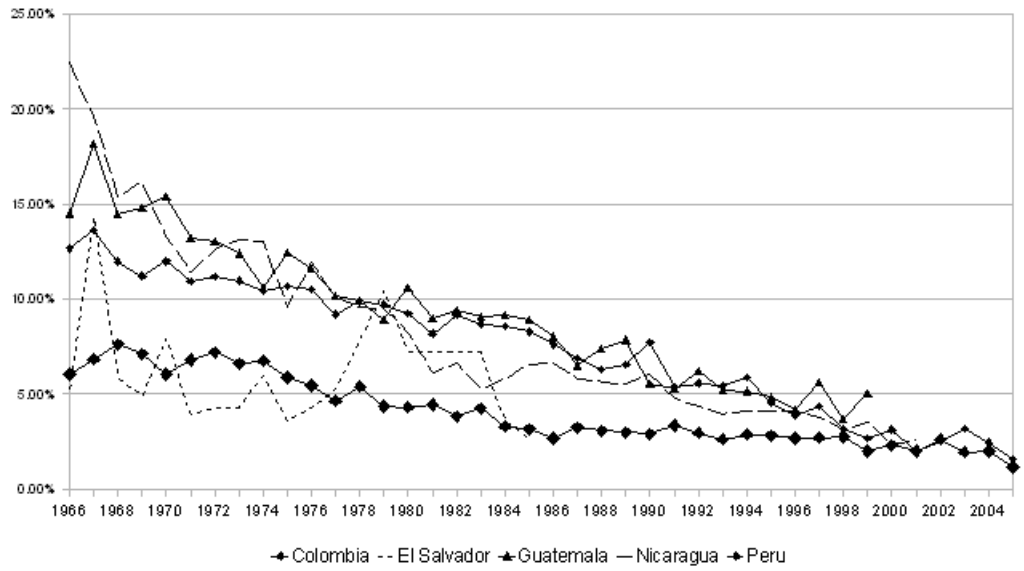

Figure I.2: Infant Mortality rates (defined as percentage in sample)[a]

[a]Source: USAID-Demographic and Health Survey for the selected countries. Author's calculations.

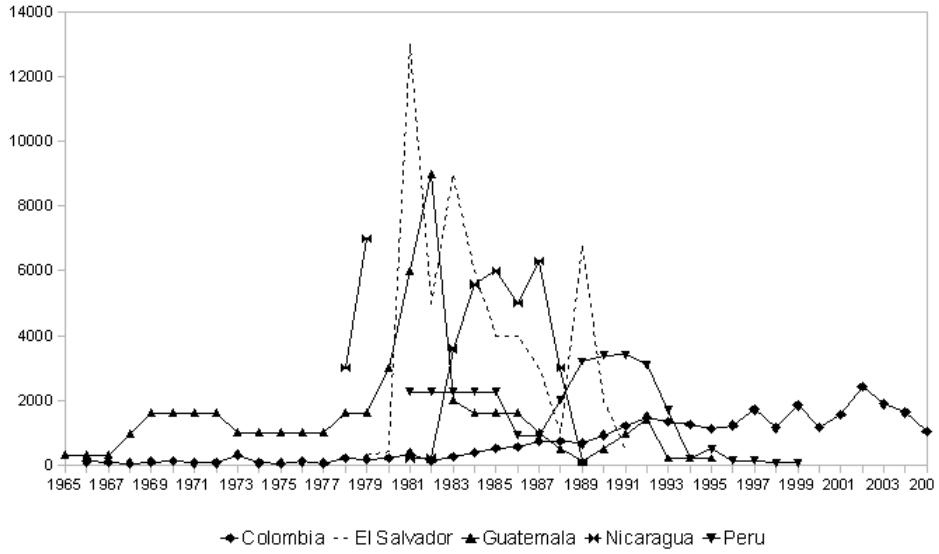

Figure I.3: Battle Deaths in Selected countries[a]

[a]Source: Prio-Uppsala Conflict database Volume 4 2006.

CHAPTER II

Math and Language at War: The effect of the Colombian armed conflict on math and language learning

I - INTRODUCTION

In many countries around the world, at least once a year, students are summoned to take tests that are a requisite to apply for college education or that are designed as an assessment of the education they receive. During a day or two, they answer questions on math, language and sciences. With the scores, educational institutions and governments assess the quality of the education they provide. Those very same tests are applied in countries that experience high levels of violence or civil war. This is the context where children's learning happens: learning in the midst of conflict. Taking the Colombian internal armed conflict as case study, it is this learning, measured as the scores in the Colombian government's standardized Saber Tests (Knowledge Tests) that is the focus of this paper. The goal is to estimate the effect of the Colombian armed conflict on the Saber test scores at 5th, 9th, and 11th grade.

On the macroeconomic level, previous research has found that after a civil war GDP per capita is lower and GDP growth is higher due to an increase in the investment rate when compared to pre-war levels; the aftermath is also marked by higher inflation since governments needed to emit money to finance their military campaigns (Chen et. al, 2008). There is evidence that Sub-Sahara African countries tended to have a GDP growth 2.2 percentage points higher during the peace years (Collier, 1999). Civil war can even reduce the growth of neighboring countries to the level of those hosting the conflict (Murdoch and Sandler, 2002). Macroeconomic research on

the impact of civil war still needs to sort out the existence of a peace dividend or of a "war hangover" as Collier (1999) pointed out.

This paper is placed in the strand of economics literature exploring the microeconomic-level effects of civil warfare. Worse health and education indicators at the individual and household levels are the main outcomes of civil war. Certainly, the availability of household and individual level data (as pointed out by Blattman and Miguel, 2010) has opened the path for better understanding of how individuals and families cope with conflict-related consequences (Justino, 2009). About health impacts, genocide and crop failure in Rwanda reduced the height-for-age of children exposed to these shocks in utero (Akresh et al., 2011). Likewise, children exposed to civil war in Burundi (Bundervoer et al., 2009) had a lower height-for-age. In regards to infant mortality, increases in homicides per 100,000 inhabitants translated into higher infant mortality rates in Colombia (Urdinola, 2004). Finally, in utero exposure to maternal stress due to violence is associated with early delivery (Smits et al., 2006), changes in gender ratios (born males to born females ratio) (Catalano et al., 2005) and, again in Colombia, with lower weight at birth and higher probability of miscarriage (Camacho, 2008).

The microeconomic exploration of the effects of civil war on education mainly deals with the effects on the schooling attained (measured by completed years of education). A shortcoming of this approach is that years of schooling are an input and not an outcome variable of the educational process. The present research aims at filling a gap in the literature by measuring the human capital effects of civil war using an outcome variable of the education process: cognitive achievement represented by scores in Colombian standardized tests at three different school grades (5th grade, 9th grade and 11th grade).

This research will use the number of extortions, terrorist attacks, kidnappings, mass murder victims and attacks against the police per year at the state level as the indicators of the armed conflict. The variables will be adjusted per 100,000 inhabitants to account for the heterogeneous population distribution in the country. The number of battle deaths is traditionally used as the variable measuring the intensity of a civil war. It is important to notice that open battles or battle engagements are a rare event in a guerrilla type of war, while terrorist attacks, ambushes, kidnappings and extortions tend to be more frequent. Also, it is not known, at least theoretically, which conflict intensity indicator households use to make decisions to cope with the negative externalities of the armed conflict. For all these reasons, several armed conflict indicators can lead to more representative results when considering that, in the midst of conflict, households make decisions.

The main contribution of this paper is the use of an outcome of education, represented by the test scores, as the measure of the human capital accumulation. Nonetheless, there is a caveat: the test scores may not be fully representative due to sample attrition. If all the children that are supposed to be enrolled at any chosen school grade take the test, the scores will give the complete picture of the cognitive achievement; nevertheless, when children drop out of school, the scores only give the information of those that do stay in school and, thus, the information is biased. Attrition can be more serious if conflict is the leading reason to drop out of school. The attrition is addressed in two different ways. First, estimations will use the scores from 3 grades with different net enrollment rates (5th grade, 9th grade and 11th grade). The enrollment for 5th grade is around 90%, while for 9th grade it goes down around 70% and, finally, it is around 50% for 11th grade. Second, the drop-outs are included in the regressions, by assigning them the average features and scores of the actual test takers.

The effects of conflict on learning are reduced: higher levels of conflict at birth may be more harmful for the learning achievement of the 5th grade students. Due to sample attrition or the reduction of the net enrollment rate throughout secondary education, the sample only shows a negative impact of conflict on learning up until 9th grade. The effect on the 11th grade scores appears very small or even positive. Adding up the exposure to conflict at birth and the exposure to conflict during the year of the test, higher levels of conflict lead to a reduction of language scores (5% of the standard deviation for 5th grade and 3% of the standard deviation for 9th grade) and of math scores (6.5% of the standard deviation for the 5th grade and 6% of the standard deviation for the 9th grade). Performance on the math tests seems to suffer more from higher levels of conflict. Robustness checks confirm the negative impact on the 9th grade scores and the unrepresentative results for the 11th grade scores; however, the inclusion of the dropouts eliminates any effect of the exposure to conflict at birth. The results call for policies aimed at promoting the completion of all primary and secondary years (like conditional cash transfer programs), as well as policies helping mothers and communities to support children to cope with the stress and trauma caused by violence.

Following this introduction, a literature review is presented. Then, a section discusses some background about the Colombian conflict, the educational system and the Saber Test. The data section addresses the selection of the conflict indicators and the processing and cleaning of the test scores samples. The empirical method section introduces the theoretical model and describes the identification strategy. Basically, the conflict indicator level is assigned according to the state of residence, the year of birth and the year of the test. The empirical method section also deals with the threats to this identification strategy. After discussing the results, the last section concludes and presents some policy recommendations.

II - LITERATURE REVIEW

During civil war, education and learning attainment deteriorate because families may withdraw children from school, children may not have access to the nutrition they need to succeed in school, or they just cannot get the education due to the destruction of facilities and killings of teachers. Lai and Thyne (2007) found that countries in civil war reduce educational expenditure even after the war is over and that there is a reduction in the balance of enrolled male to enrolled females. Akresh and de Walque (2008) argued that school age children exposed to genocide had fewer years of completed schooling. For Guatemala, Chamarbagwala and Moran (2011) concluded that rural Mayan males and females, born during the most violent years, had a lower probability of completing primary grades. In the case of Peru, Leon (2010) suggested that the younger children are exposed to violence, the higher the reductions in schooling attainment.

Psychology and psychiatry researchers have also explored how exposure to violence or war can affect the learning process. Food, water or shelter deprivation, and the loss of the family were related to the development of post-traumatic symptoms for children (Husain et al., 1998). Osofsky (1999) posits that school age children suffer from concentration issues (because of intrusive thoughts) and feelings of regret (as they can understand more about violence) and adolescents show higher levels of aggression, anxiety, behavioral and school problems and truancy. Good parenting, and specially mothering (Dybdahl, 2001), or the support of a significant adult, are the best strategies to foster children's learning in a violent environment. Nevertheless, parents with symptoms of post-traumatic disorder may be unable to offer support to their children (Curran and Miller, 2001).

This paper can be related to the work by Sharkey (2010), who estimated how homicides in students' neighborhood relate to their performance in vocabulary and reading tests, using neighborhood fixed effects regressions on data from Chicago. He argued that violence alters test performance through emotional and physiological responses to stress. He reported that experimental studies show that high levels of stress hormones impair cognitive performance and activities related to the declarative memory. His findings indicated that a homicide in the student's block within a week of the tests reduces the scores. He calls for a broader recognition of how violence can be an obstacle for human capital accumulation, whether or not students are directly exposed. If a negative neighborhood effect on cognitive development exists (a topic of extensive discussion, like in Burdwick-Will et. al, 2010), better and increased policing and the provision of safe community environments may result in cognitive development short term gains.

This paper is similar to the work by Sharkey (2010) since it also uses standardized test scores for students that are exogenously exposed to violence. Methodologically speaking, this research tries to follow closely the works by Leon (2010) and Chamarbagwala and Moran (2011). Following Leon (2010), this paper explores a long run effect by estimating of the impact of exposure to conflict at birth, while it explores the short run effect by estimating the impact of exposure to conflict during the year of the test. Contrary to Leon (2010), a linear state-specific trend is preferred over a cubic specific trend to avoid a drastic reduction in the data variability. Unlike Chamarbagwala and Moran (2011), no initial-level control variable is employed here since the effect of such a trended variable is expected to be absorbed by the linear state specific trend.

Another difference with these two works and the works previously done for Colombia (Urdinola, 2004; Camacho, 2008) is the use of 5 different armed conflict indicators.

Leon (2010) and Chamarbagwala and Moran (2011) used human rights violations, but this variable may suffer from underreporting. It can be that citizens fear to report or that those who report are different in unobservables to those who do not report. In a extreme case, it can be that events go unreported because victims are dead. Urdinola (2004) used the number of homicides per 100,000 inhabitants at the municipal level. That variable may contain homicides not related to the armed conflict and does not account for the number of combatants killed as a result of attacks on the armed forces. Camacho (2008) used land mine explosions at the municipal level. Even though the mine explosions are random, their location is not and terrorist groups choose the location depending on the features of the places they want to target.

III - COLOMBIAN BACKGROUND

a) The Colombian armed conflict[4]

Nahzri (1997) pointed at the land ownership concentration as the key factor to understand the roots and evolution of the Colombian conflict. There are two phases of the war system in Colombia(see **Figure II.1**): the low intensity phase, from the 1960's up until 1982, and, then, a more intense phase begins as the war system breaks due to the money of drug dealing. After 1982, guerrilla groups became involved with the drug dealing and, as a response, right wing paramilitary forces were created. The armed groups gained sophistication and action capabilities because of the money col-

[4]There has been a lot of controversy on how to classify the Colombian conflict. The Colombian Government has avoided calling it a civil war because it does not want the terrorist groups to claim the belligerent status. What happens in Colombia is, indeed, the fight between the State's armed forces against armed groups, in a type of guerrilla war (like the ones experienced in most of Latin America after the 1960's) and where the armed groups (right wing and left wing) use terrorist strategies. The issue of naming the Colombian conflict was solved in the first semester of 2011. In the process of passing a victims compensation law through congress, the government classified the conflict as an internal armed conflict (Law 1448 of 2011). According to the Human Rights Education Association (2010) an internal armed conflict is the conflict between two factions within one state. In international law, the 1977 Protocol II of the Geneva Convention defines this type of war as conflict of non international nature and aims at protecting the victims, while respecting the sovereign rights of national governments and delaying international intervention. When conflict or war are mentioned in this paper, it is meant the internal armed conflict and not civil war, according to the Protocol II of Geneva Convention and the Colombian laws.

lected by taxing the drug trafficking (Ortiz, 2002). The peak of violence coincided with another breaking point in the Colombian war system. President Andres Pastrana (1998-2002) offered a large demilitarized zone for peace talks. When the peace talks collapsed, the Colombian government asked for help from the US. The help materialized through the US-funded Plan Colombia, whose goals were to promote peace, increase security and end drug trafficking (Veillette, 2005). When in 2002, Alvaro Uribe was elected president, the state's military offensive took place. The results can be seen in **Figure II.2**. The Uribe government also pursued a more active social policy, increasing expenditure in areas like health and education (see **Figure II.3**), and extending the coverage of conditional cash transfer programs.

Not everything has gone well in this last phase of the conflict for the Colombian government. Since 2002, many allegations have been made about human right violations and the increased danger for some social groups, including public school teachers. As Noticolombia (2010) indicates, 927 teachers have been killed in Colombia (264 since 2002), more than 4,000 teachers have been threatened, 1,092 were forced to relocate, 70 looked for refuge in other countries and 60 disappeared. Moreover, the conflict seems to be mutating instead of reaching an end. Nowadays, the main priority for the government is to fight against the augmented and more powerful organized urban criminality.

b) Education system and the Saber Tests

Formal education in Colombia is divided into 3 levels after one year of pre-school education (Ministerio de Educacion, 2011): 5 years of primary education, 4 years of secondary education and 2 years of middle education. After completing these levels, students can apply for higher education, whether the 5 years of college education or the usually 2-3 years of vocational education. During the period of analysis, 2000-

2010, the Colombian education system was subject to a policy of improving enrollment rates, quality and accountability, as well as increasing public expenditure. Indeed, the government had increased the education expenditure since 2002 (**Figure II.3**). Supporting the coverage expansion, the government implemented conditional cash transfer programs for families to keep their children in school.

The policies still seem to be insufficient. Data from the 2005 Colombian Census (the latest census available) reveal that around 90% of children at age 10 are enrolled in any educational center, but the enrollment percentage drops to 56% when they are 17 years old (**Table II.1**). Children not enrolled in any educational institution mainly live in households with insufficient income and the share grows with age (**Table II.2**). Those who are not enrolled are mostly males regardless of age (**Table II.3**). The net enrollment rate in primary education has been around 90% and there were not substantial increases during the decade. The country did experience gains of 10 percentage points in net enrollment for secondary education and for middle education (**Figure II.4**). Note, however, that only 40% of children achieve the milestone of completing their secondary education.

The Ministry of Education designs and applies the standardized tests, Pruebas Saber (Knowledge Tests), at the different levels of education. The goal of the Saber tests for 5th and 9th grades is to assess the quality of the education through the evaluation of the cognitive achievement of the students. By law, these tests are mandatory for all students enrolled in 5th and 9th grade and the government has to apply them every 3 years (Ministerio de Educacion - ICFES, 2011). As for the 11th grade, the Saber tests serve as a quality assessment and as a requisite in the application and admission for higher education (Ministerio de Educacion - ICFES, 2008).

Other tests, like the UNESCO PERCE-SERCE tests and the OECD PISA (Programme for International Student Assessment), have been applied to samples of Colombian students to measure their cognitive achievements and skills in language, math and sciences. For instance, Colombia has participated in the 2006 and 2009 OECD-PISA. **Table II.4** presents the mean scores for the OECD countries and the Latin American participating countries. On average, Colombia only outperforms Brazil and Peru in both math and reading; more importantly, the country has improved the tests' means between 2006 and 2009. In the analysis of the 2006 tests, the Ibero American PISA Group indicates about Colombian students that: more than 50 % of students are below the basic level of scientific literacy; 72% of students cannot use basic formulae and procedures, and are not capable of direct reasoning and making literal interpretations of the results; finally, more than 50% of students cannot identify the main idea in a text (OECD-PISA, GIP 2010).

IV - DATA SOURCES

a) Armed Conflict Indicators

Extortions, terrorist attacks, kidnappings, mass murder victims and terrorist attacks against the police were selected as the most representative measures of the Colombian armed conflict. Values were taken on a yearly basis at the state level from Revista Criminalidad (2008). The Colombian Police records the number of events for each of these variables at the level of its regional commands or special jurisdictions[5]. Legal definitions of each of the selected variables are taken from the Colombian National Police website (2011) and can be found in **Table II.5**.

[5] For this paper, the figures of the major cities are going to be added to the states where they are located; for the public safety special regions, an educated guess was made with the information provided by army and police officers: for instance, if 10 extortion cases are reported for one of those regions and that region is formed by territory of 2 states (state X and state Y, for the purpose of illustration), following the army and police officers advice, it can be said that 80% of the cases correspond to state X and the remaining 20% to state Y.

The chosen indicators are not exempt from problems. Extortions suffer from underreporting because people being extorted may fear that reporting to the police can increase either their vulnerability or what they have to pay to criminals. Even though extortion can be more related to the common criminality, it is a perfect expression of the linkages between criminal activities and the internal armed conflict: common criminals may increase their own activities because the deterrence on them is reduced as the armed forces and the police fight the terrorist groups and the drug dealers. Mass murders, also known as massacres, were very common during the most violent years of the conflict. Usually, mass murders happened as a retaliation strategy of the drug-dealing gangs, but also as a part of the war between the right wing and the left wing narco-terrorists in order to bring terror to the population in conflict zones. As for kidnapping, civilians were kidnapped for a ransom, while politicians and members of the armed forces were kidnapped as a way to push society to demand peace talks.

Some variables that can be relevant in the Colombian case are not going to be used in the empirical exercises. Total number of homicides is a very appealing measure; however, this variable includes killings that happen due to factors not related to the internal armed conflict. The second variable not chosen here is the amount of cocaine seized by the armed and police forces; this may draw some criticism because of the preeminent role drug trafficking has played in the Colombian conflict. Nevertheless, most of the seizing takes places in production or shipping areas, which are only part of the drug production, distribution and commercialization chain.

Table II.6 and **Table II.7** exhibit the average values of the conflict indicators for the sample of the students taking the tests. For the 5th grade and 9th grade students taking the test in 2002-2003, 2005-2006, the average values are reported at the birth year (an assumed two years state average is taken as it is going to be explained) and

at the test year (for the 2002-2003 and 2005-2006 a state level two years average was taken since no specific date of the test is provided). For the 11th grade students taking the tests from 2000 to 2007, the figures are also reported at the birth year and at the year of the test. Note that the closer the students were born to the years the conflict intensified (1994-2002), the higher the level of conflict experienced at birth; that is exactly why the 5th grade students tend to have higher averages of conflict indicators at birth than the 9th grade students (who are 4 years older).

b) Saber Tests Datasets

Of all the array of subjects in the tests, only the scores for math and language are going to be employed and discussed throughout this paper since these fields are also included in international based tests. For 5th and 9th grade, the datasets lack information on the student gender and family background related variables. The main drawback is that the year of birth is not reported; this poses a serious problem for the estimation of the effects of conflict at birth. To overcome this problem, it is going to be assumed that all the students in the 5th and 9th grades sample are of the expected ages (11 and 15 years old, respectively). Data from the 3 waves of the tests suggest that more students at 9th grade have been evaluated (see **Table II.8** for details). The increase in number of students taking the tests may be correlated with an increase in the enrollment and in the tests coverage.

No additional assumptions were needed for the 11th grade data since the files recorded the information about the year of birth, level of education of the parents (although the categories change for every wave and are not always recorded), the plans (if any) to go to college and all the detailed scores for the mandatory and the optional fields in the test. The 11th grade sample of test takers does not include all those graduating before 1990 and those with coding errors in the variables for age,

birthyear and the identifying code of the school. Although the data is available from 2000 to 2009, only the years from 2000 to 2004 are considered for estimations since these provide the identification code for the schools. After all the cleaning process, it can be seen than more women than men take the 11th grade tests from 2000 to 2007. Finally, the percentage of father and mothers of the students with high school or more education also increases (see **Table II.9** for details).

The main statistics of the math and language scores for each of the selected grades are presented in **Table II.10** and **Table II.11**. Some salient features about the scores are as follows. First, the scores variability (represented by the standard deviation) increases. Second, math and language average scores tend to go decline over time for the 5th and 9th grades sample, grades that may have a higher heterogeneity of students than the 11th grade. Third, the 11th grade math average seems to be stable, but the 11th grade language average actually improves. It may be entirely possible that only the relatively better students remain in school: their families can cope better with the economic constraints and the negative impacts of the internal armed conflict.

V - EMPIRICAL METHOD

a) Theoretical Background

Cognitive achievement should be understood as the outcome of the learning at the level of the student. Education has many individual and social outcomes (UNESCO, 2008), but this paper focuses only on math and language learning. Most of the discussion on cognitive achievement is centered around the relevance of school inputs and family background; however, relevant for this paper is the use of the Saber Tests scores as a measure of the cognitive achievement in language and math, which is the best approximation for assessing learning. Other applied papers in the context of

a developing country (like Behrman et al., 1997) have also used test scores as the cognitive achievement indicators.

Following Todd and Wolpin (2003), cognitive achievement can be described in the context of a production function (g). In the function (g), the level of achievement at the entrance of first grade (A_1) depends on family inputs during the preschool time (F_0) and and the child's endowment of ability (μ), or: $A_1 = g(F_0, \mu)$. Family inputs are defined by the family's permanent resources (W). The family's choices about where to live and to send offspring either to private or public education defines the level of school inputs (S) in the function. Families do not have complete information about the school inputs and, even with complete information, the inputs applied to each child may deviate from the school aggregate. For the beginning of the second year, the achievement production function is $A_2 = g(S_1, F_1, F_0, \mu)$. As children go through their education, the function will contain the history of family inputs, the school inputs and children's ability.

Civil conflict can affect the history of cognitive achievements in several ways. Armed conflict may reduce family resources through the destruction of family assets, drops of income due to decreased labor opportunities or due to the killing of household members. Because of economic effects, families are exposed to lower food intake during the time of conception and gestation of children, resulting in lower birthweight and learning difficulties during the school years. Armed conflict forces the most vulnerable families to relocate into places without access to proper sanitation services or housing; in these unhealthy new settings, the increased morbidity in children may harm their academic performance and achievement. Armed conflict possibly brings the destruction of school buildings and the killing or displacement of teachers, which altogether diminishes the quantity and the quality of the education that children

can attain. Children could be forced to to leave school for prolonged periods during war, decreasing the probability of future academic achievement. Direct and indirect exposure to violence and conflict may generate post-traumatic stress and learning disorders if children do not have adequate family and community support. With post-traumatic stress, the efficiency of the family and school inputs is reduced since children are not able to focus on learning and might experience behavioral or memory problems.

The variables being considered in this paper can affect children's learning through economic or psychological channels. Extortions work primarily through the economic channel. When a household is extorted, income is reduced and parents have less money available to spend on children's education. The risk of post-traumatic disorders due to extortion would only materialize if a household refuses to pay and criminals attack household members. Terrorist attacks have a negative consequence on learning causing post-traumatic disorders in children. Children can witness a terrorist attack or may suffer from the chaos and the forced changes in daily routines those attacks bring. Similarly, attacks against the police act through the psychological channel. The only way terrorist attacks may act through the economic channel is when terrorism leads to severe market disruptions or when the uncertainty created translates into reduced economic activity. Finally, exposure to mass murder victims has a psychological impact.

b) Identification Strategy

Based on the cognitive achievement production function, the net effect on the test scores of the economic and psychological channels will be estimated as follows:

$$Score_{ijt} = \alpha + \beta_1 Conflict_{jt} + \pi_j Statetrend_t + \gamma X_i + \delta_t + \eta_j + \varepsilon_{ijt} \quad \textbf{Eq. II.1}$$

Where $Score_{ijt}$ is the score (either math or language) of student i born or residing in state j and taking the test in year t. $Conflict_{jt}$ is the value of the chosen violence indicator (extortion, terrorism, kidnapping, mass murder victims and terrorist attacks against the police) per 100,000 inhabitants in state j during the test year t. δ_t is test year fixed effect. The test year fixed effects stand in the equation to take into account events during the year of the test that are not controlled with the selected variables and are common to all test takers regardless of the state they live. The $Statetrend_t$ variable is created in order to control for state specific linear trends; this linear trend aims at controlling for linear variations in economic development or conflict intensity in each state during the period of analysis. η_j represents the state fixed effects to control for state features, that affect both violence and learning outcomes, that are time invariant. Finally, X_i, contains the control variables: gender and parental education for the 11th grade sample estimations, and location of the school (rural or urban) and type of school (public or private) for the 5th grade and 9th grade samples. The coefficient of interest is the coefficient on the armed conflict indicator (β_1).

Equation II.1 estimates the effect of exposure to the armed conflict during the year of the test. It could be expected that increased armed conflict during the test year impairs the concentration and memory of students and generates additional stress during the test sessions[6]. It could also be expected that households may take some time to adjust to economic shocks due to the conflict; if so, student scores may

[6]The separate regressions for the identification of the effect of exposure at birth and the effect of exposure in the year of the test are preferred to one regression including the two effects. Basically, states that were very violent during the year of the birth of the test-takers are also the states that were very violent during the year of the test. Even though there is an overall decline in violence throughout the country, the ranking of violent states does not change over time. Using a single regression, including the two measures of exposure, will not allow for the separate identification.

be harmed by all the transitions happening at home. This is, nonetheless, only one side of the story.

The other side of the story acknowledges that exposure to conflict at birth may reduce the birthweight and may hinder child development. For instance, the gestation and development of children suffers from the increased stress hormones of mothers during pregnancy (like in Camacho, 2008); moreover, conflict early in life may force children permanently into trajectories of lower income and lower education (both in years and quality of education) due to changes in household resources and innate level of ability. If $Conflict_{jb}$ is the level of conflict in the state j during year of birth b and with year of birth fixed effects δ_t , the equation, **Equation II.2**, for the effect of exposure to conflict at birth is:

$$Score_{ijt} = \alpha + \beta_1 Conflict_{jb} + \pi_j Statetrend_t + \gamma X_i + \delta_t + \eta_j + \varepsilon_{ijt} \quad \textbf{Eq. II.2}$$

Causality will exist as long as the state fixed effects remove all observed and unobserved features that are constant over time and common to all the individuals born and residing in each state. If there is any variable explaining armed conflict levels and the scores at the state level, and it stays constant during the period of analysis (like whether or not the state is a cocaine producing area, the presence of mineral rents that attract terrorist groups, or geography and infrastructure), the state level fix effects will cancel it out. Additionally, year fixed effects control for shocks that are common to all test takers whether during their birthyear or the year of the test. And state specific trends capture changes for each state through time. With all these fixed effects, the results will not be the effect of the armed conflict on learning attainment at a national level, but rather the average effect with respect to the state average and year average, after factoring out state trends. Causality will also imply that the error

term is not correlated with the armed conflict levels. If states with higher conflict levels are also those with lower learning attainment (lower scores on the test), this assumption would be violated. The case of Colombia is quite unique since there is not a relationship between poverty and conflict: relatively wealthy states have the same, and even higher, levels of conflict than the poorest states. More interestingly, there is not a geographical pattern of how the conflict has spread through the territory. With all this, the estimates can be read as causal.

c) Threats to Identification

For the 5th grade and 9th grade scores, t takes values of 2002-2003, 2005-2006 and 2009, corresponding to the years when the tests were applied. The datasets do not provide the specific date of the test for each school, which makes the year identification difficult. To overcome this, the average level of conflict (for each of the 5 chosen indicators) at the state level was taken for the periods 2002-2003 and 2005-2006. Unfortunately, the yearly state variation is reduced by this averaging, but it is the only way to carry out the estimations. This procedure will bias down, towards zero, the possible impact of conflict on learning.

Another difficulty with the dataset for 5th grade and 9th grade is the lack of the test takers' birthdate. The year of birth was calculated by assuming that the students in the sample were of the expected age in each grade: 5th grade students are expected to be 11 years old and 9th grade students are expected to be 15 years old. For instance, 5th grade students taking the tests in 2002 are assumed to be born in 1991 and and they are assumed to be born in 1992 if they took the test in 2003; for the level of conflict at birth, the state average between 1991 and 1992 is calculated. The Ministry of Education reports that from 2002 to 2008, the percentage of students who passed their grades went up from 82% to 90% (with the related drops in those who left

school and in those who failed their grades). Moreover, the net enrollment rates are high for 5th grade (around 90%), but not that high for 9th grade (70%), as discussed before. The net enrollment rate is computed as the ratio of enrolled students at the expected age in a particular grade to the total population at the expected age.

None of the datasets report the state of birth of the test takers. If internal migration is high and it is mainly caused by conflict, assuming that students still live in the state of birth would bias downwards the estimations. This bias happens because students could be living, at the time of the test, in a safer state, rather than in a more violent state; if so, the sample is no longer representative since observations from more violent states at birth may be underrepresented. In **Table II.1**2, the 2005 Colombian census reveals that around 90% of the students at the expected age for each of the grades still lives in the same state (departamento) of birth. It seems that there is no direct relationship between conflict intensity and across state migration as the most violent states exhibit both high migration rates (Putumayo and Guaviare) and low migration rates (Antioquia, Santander, Valle). Most of internal migration happens within the state and that is why state level violence is more appropriate than municipal level violence.

Another threat deals with school mobility. The student is observed only at the moment of the test and nothing is known about his or her academic history. It is entirely possible that a student changes of school several times during primary and secondary education. This mobility can be important in explaining test scores. For instance, a student can move from a lower quality school to a higher quality school (or in the terms of the cognitive achievement model, a school with higher and better inputs) in which, despite the level of violence, the student is going to achieve higher test scores. The contrary is also true. Mobility can become even worse if parents

decide to change schools as a way to protect their children from the direct threat of conflict. Data currently available do not allow for controlling school mobility.

Earlier, when describing Colombian education (**Tables II.1, II.2** and **II.3**), a reduction in net enrollment rates from basic to middle education was mentioned. Those who dropped out of school may have done it for economic reasons and/or due to the civil conflict. The datasets only contain data about the students enrolled at the moment of the test and no information is available on the cognitive achievement of all those who dropped out of school. Nothing can be said about them[7]. A full understanding of how and why Colombian children drop out of school goes beyond the scope of this paper. Specifically for the years considered in this research, the unemployment rates around 10% and the increase in the self employment (employment without benefits), may signal that educational gains are slim regardless of the conflict level. Another issue to consider is that profits from criminal activities (like drug trafficking) may tempt some children to drop out of school. For the purposes of this paper, following Akresh et al., (2009), the impacts of civil conflict on the Saber scores are conditional on being enrolled in school at the year of the test.

Even though Colombia suffers from a lot of underreporting of criminal activity due to the inefficiency of the judiciary system (Nazih, 1997), this is not a major

[7] A preliminary exploration of the mechanics of attrition was approached by using the state level net enrollment rates per year and the 11th Saber tests. Firstly, regressions on the net enrollment rates were run, with the state GDP growth and conflict indicators as independent variables (with year and state fixed effects). Not reported here, those regressions indicate that the effect of conflict is likely insignificant and only GDP growth may have a positive effect. Secondly, with the 11th grade datasets, the following proportions were constructed at the school level: females enrolled, students reporting that her family has a mortgage on their house, students living in a house owned by the family, students whose parents attained some or more than secondary education. Again, GDP growth and conflict indicators were chosen as independent variables. The school and test year fixed effects, and state specific trend regressions (not reported here) give a very diverse picture: conflict seems not to have an impact on the proportion of enrolled females; not highly significant (only at 10%), extortion and kidnapping reduce all proportions, while terrorism, mass murder victims and attacks against the police do not show a consistent pattern of effects on the proportions (regressions not reported here). The proportion tests may indicate that the armed conflict changes the composition of those staying until 11th grade, with respect to parental education and dwelling (economic issues), but varying the composition of those staying in school is not necessarily an explanation of why other dropped out of school. If these tests reveal something it is that economic factors are key in explaining why children leave school.

source of concern for the estimation results. Certainly, victims do not report all extortion, but this is not the case for terrorist attacks, mass murders, kidnappings and attacks against the police, which are very difficult to hide from the authorities and the general media. A very valid point is about the endogeneity between policing and crime figures (like in Levitt, 1997). In Colombia, the rise in the armed conflict indicators is explained by the growing terrorist involvement in drug dealing and the demilitarized zone the government created for the failed peace talks. According to this timing of events, it is reasonable to expect that no endogeneity exists between policing and the conflict figures.

With all the turmoil the left wing and right wing narco-terrorists caused, individual criminals and other criminal organizations may take advantage of the reduced costs of carrying out their activities. As the number of criminals increases, the average police effort to chase each of them decreases. That a share of kidnappings, extortion, attacks against the police, mass murder victims and terrorist attacks come from other sources than the right wing or left wing terrorist groups cannot be ignored. Only extortions and kidnappings may suffer from this sort of pollution.

State level measures of conflict intensity are useful to incorporate most of the space-level variation of conflict throughout the country. Nevertheless, conflict is not homogeneous even at the state level and it is entirely possible that only some regions within the state receive the bulk of conflict, while others remain relatively peaceful. If so, this leads to issues of measurement error because the regressions cannot capture the different intensity at the state level. With measurement error, attenuation bias will take the estimates of the effects of exposure to conflict towards zero. Most likely the effect of conflict on learning (both at birth and the year of the test) is higher than what is estimated.

As it was discussed in the model of cognitive achievement, learning depends on school inputs and students' characteristics and innate levels of skills. The data available does not provide the variables to control for school-level inputs or student's features (like gender, in the case of the 5th and 9th grade estimations). Depending on their correlation with the chosen measures of civil war, the omitted variables can bias estimates of the impact of civil war upwards or downwards.

VI - ESTIMATION RESULTS

This section presents the results of estimating **Equation II.1** and **Equation II.2**. The effects of exposure to conflict at birth on language and math scores are discussed first and, afterwards, the estimates of exposure during the year of the test. This section closes with a discussion of robustness checks. The main results include different regression specifications: estimations without state nor year fixed effects and without state specific trends (**Specification 1**); estimations with only state and year fixed effects (**Specification 2**); estimations with state and year fixed effects and state specific trend (**Specification 3**); and estimations with school and year fixed effects and state specific trend (**Specification 4**). Errors are clustered at the state level (**Specification 2**, **Specification 3** and **Specification 4**). Regressions for the 11th grade scores include gender and two indicator variables controlling for fathers and mothers having some or more than high school education. Given the information available in the datasets, no individual level controls are included in the regressions for 5th and 9th grades, but rather controls for the location of the school and the type of school are included. Conflict variables per 100,000 inhabitants per state per year are used. Additionally, assuming that all variables are criminal events and that those criminal events can be added up, some estimations include a variable called total

conflict. Since aggregation can be an issue, a principal component factor analysis of total conflict is also employed.

Overall, regressions indicate the following. First, fixed effects, either at the state level or at the school level, matter. Second, the main difference between state level and school level fixed effects is that the latter results in more significant estimates; using the school fixed effects reduces the variability (which mainly happens at the state level) and gives smaller standard errors. Third, for 5th and 9th grades, exposure to conflict at birth is more deleterious on the scores than the exposure to conflict during the year of the test; besides, math scores are more sensitive to conflict than language scores. Fourth, due to reduced net enrollment rates, there seems not to be a relationship between the scores and conflict for the 11th grade sample. Fifth, when adding the exposure during the year of the test to the effects of the exposure at birth, higher levels of armed conflict lead to a 3-4 points drop in the math and language scores for 5th grade students, and a reduction of nearly 2-3 points for the 9th grade students. Sixth, 5th and 9th grade students attending rural and public schools received lower scores (almost 30 points lower) than the students attending urban and private schools. Seventh, the 11th grade students with parents with some or more than high school education achieved scores 3 points higher than those students whose parents have less than secondary education; gender difference is around 1 point in favor of males in the math scores.

a) Effect of Exposure to Armed Conflict At birth

The impact of exposure to armed conflict at birth on the 5th grade and 9th grade language and math scores are presented in **Table II.13** (5th grade) and **Table II.14** (9th grade). For the language scores, the point estimate for extortion is negative and significant, but larger for 5th grade than for 9th grade; any possible reduction

can be caused by the attrition effect or by school desertion for secondary education. The estimate for the number of mass murder victims is of the correct sign in 5th grade, but it is not significant. It is noticeable that attacks against the police, an event that creates a lot of turmoil in any community, is significant and positive for the 5th graders' language scores; perhaps, the military and police response after an attack may increase the feeling of safety and reverse the initial negative effects of such an attack. Even though of negative sign, none of the estimates are significant for the 9th grade scores; again, the reduction in the heterogeneity of the sample, due to the attrition, may be behind this finding. Total conflict is only negatively significant, but marginal, for the 9th grade scores on language. Going to the math scores estimates, extortion and kidnapping have a significant and negative effect for the 5th grade scores. For the 9th grade scores, attacks against the police and the main factor from the principal component analysis have a negative and significant impact. As previously mentioned, attacks against the police could have a positive impact; here, in the case of the 9th grade scores, the same argument is valid for the negative impact: conflict intensifies with the augmented police and military activity after a previous attack on the troops.

Estimates of the exposure to conflict at birth for the 11th grade students' scores are in **Table II.15**. On the language scores, extortion and kidnapping are negative and highly significant, but their point estimates are very small (less than one point). The relative reduction in point estimates, and even the sign switch (as in the case of terrorist attacks) can be fully explained by the reduction in heterogeneity in the sample as only 40% of the population supposed to be enrolled at 11th grade is actually enrolled.

b) Effect of Exposure to Conflict during the Year of the Test

As it will be seen, these point estimates are smaller than those of the exposure to conflict at birth. Estimations for 5th grade (**Table II.16**) and 9th grade scores (**Table II.17**) suggest that extortion and terrorism are both significant and negative for the 5th grade language scores, while extortion is the only significant conflict indicator, but of positive sign, for the 9th grade language scores. This sign shift may be related to schooling desertion. Extortion may affect schooling by imposing an extra cost on households that, under the strain of conflict, may already be cutting down their expenditure on education; extortion can also lead to forced displacement, changing the access and the quality of the education available. Interestingly, the main factor of the principal component analysis has a negative and significant effect on language scores for both grades (around 1 point).

The results for the 5th and 9th grades math scores indicate that: terrorism and kidnapping have negative and significant coefficients; surprisingly, the coefficient on extortion is positive and relatively large and significant for both grades. The switched sign on extortion may be pointing at the environment of higher economic activity after 2000, with more money circulating, more profit from extortion for the criminals and, maybe, less impact on the households' budget. Specifically for 5th grade, attacks against the police reduce the math scores, but the point estimate is small; on the contrary, the main factor of the principal component analysis has a very large and negatively significant effect.

Lastly, the effect of exposure during the year of the test on 11th grade language and math scores is evaluated. **Table II.18** shows how deleterious desertion, throughout high school, can be on biasing the sample and the results: point estimates of the significant coefficients on extortion, terrorism, kidnapping and attacks against the

police (only for math scores) are positive. Only attacks against the police have a negative, but not large and not very significant effect, reducing the math scores.

c) Robustness checks

From the previous results, it was seen that the effect of the internal armed conflict gets smaller from 5th grade to 11th grade and that, even in some cases, the sign on the coefficients of conflict indicators switches from negative to positive. That extortions or kidnappings have a positive sign is not necessarily worrisome since more available income leads to potentially higher criminal gains by extorting and kidnapping. Nevertheless, positive sign on the coefficients for terrorist attacks, mass murder victims and attacks against the police may point to a different problem. School desertion biases the results by biasing the sample. According to auxiliary regressions (not reported here), desertion does seem to be sensitive to annual GDP growth. Poor households may not find it profitable to keep their children at school either because of high opportunity costs (foregone wages) or just because low gains from education. Gains from education could be low in a country with unemployment around 10%, high levels of self employment or employment without benefits and lack of upward social mobility. Therefore, children who remain in school are substantially different from those who drop out. Those staying in school may come from families that can cope better with economic shocks or that place a higher value on educational achievement.

Given the available data, it is not possible to know who the dropouts are. As a way to handle this attrition problem, the technique Bharadwaj et al., (2012) used for estimating the effect of early interventions on Chilean children with low birthweight is adapted for the purposes of this paper. Bharadwaj et al. had information on children at birth and their performance in language and math scores when they are at school. They could not observe the scores of children who died and they assigned to the dead

children an artificial score ranging from the 55th percentile to the 80th percentile of the scores of those who did survive. Here, the procedure is adapted as follows: first the number of the dropouts is found and, second, the mean value of the test takers scores and most relevant variables are imputed to the dropouts.

The net enrollment rate can be defined as: $NetEnrollment_{jt} = \frac{DO_{jt}+TT_{jt}}{Agepopulation_{jt}}$. Where, $NetEnrollment_{jt}$ is the net enrollment rate for grade j at the year of the test t; DO_{jt} is the variable for the dropouts (not observed in the Saber tests samples) or those who are not enrolled in grade j at the year of the test t; TT_{jt} stands for those who are observed, the test takers, and for whom scores are reported. Finally, $Agepopulation_{jt}$ is the reference age group or the total number of people aged 15 for 9th grade or aged 17 for 11th grade at the year of the test t, j =9th grade, 11th grade and t is the year of the test for 9th grade (2002-2003, 2005-2006 and 2009) and for 11th grade (from 2000 to 2004). Assuming that net enrollment rate stays constant throughout all grades of primary and secondary education, that is 90% for 9th and 11th grades during each year of the test, the number of dropouts can be found as:

$$NetEnrollment_{jt} = \frac{DO_{jt}+TT_{jt}}{Agepopulation_{jt}} = 0.9 \Rightarrow DO_{jt} = 0.9\,(Agepopulation_{jt}) - TT_{jt}$$

For each of the mentioned years, the total age reference population was taken from the Colombian statistic bureau (DANE, 2011) population series. Acknowledging that sticking to the criteria of 15 years old for 9th grade and 17 years old for 11th grade may not be very representative for Colombia, a weighted age reference was computed as follows: 80% of the reference population of the expected age, 10% of the population one year younger and 10% of the population one year older. The samples of dropouts were constructed in such a way that they have on average the same values of the control variables used in the regressions with the real samples: same proportion of

students attending private schools and of students attending rural schools (for the 9th grade sample) and the same proportion of female students and of students with mother and/or father with some or more than high school education (for the 11th grade sample). The dropouts were assigned the mean score in math and the mean score in language, as well as the 95%, 90%, 85% and 80% of those means. They were also given the same armed conflict indicators levels (by place of residence and year of birth and year of the test) as the real test takers.

The inclusion of the artificially created dropouts in the 9th grade and 11th grade sample leads to different results. Overall, it would seem that armed conflict is no longer deleterious for learning achievement if students stay in school until 11th grade. Negative effects of exposure to conflict at birth may disappear for students enrolled in 9th grade and 11th grade. The estimations do not indicate what should be the imputed scores to the dropouts in order to find a negative impact of armed conflict. Assuming very low scores would be indicative of extremely poor learning attainment, for which no negative impact of conflict would be needed. Finally, the coefficient on some of the conflict indicators remain positive even after including the artificially created dropouts.

Specifically, results for effects of exposure to armed conflict at birth on the 9th grade scores including the dropouts (**Table II.19**) reveal that no variable is significant. For the 11th grade sample (**Table II.20**), exposure to conflict at birth would lead to positive and significant effects of extortion and kidnapping, but the point estimates are smaller than 0.5. It may be that the education system in Colombia, ensuring that parents keep their children in school, eliminates the negative impact of the armed conflict.

Results are perhaps more interesting for the exposure to armed conflict during the year of the test. For the 9th grade sample including the dropouts (**Table II.21**),

there is a reduction in the language scores (until using the 95% of the mean as the imputed scores for the dropouts) as consequence of higher number of mass murder victims, but the coefficient is significant only at 10% level. When the 9th grade dropouts are imputed only 80% of the scores in math, kidnappings, terrorist attacks and attacks against the police lead to a reduction of around 1 point; again, the coefficient is only significant at 10%. The final table (**Table II.22**) shows the effects of exposure to conflict during the year of the tests for the 11th grade sample including dropouts. Kidnapping translates into very small and not very significant reduction in language scores for all the 5 specifications; the same is true for terrorist attacks. Math scores are negatively impacted by the number of mass murder victims throughout the 5 specifications; only when the imputed score is 80% of the mean to the dropouts, math scores are also negatively impacted by kidnappings, terrorist attacks and attacks against the police.

Another robustness check is motivated by what previous works describe as the existence of non-linearities in understanding the effects of conflict and violence on school achievement. Sharkey (2010) found the impact of homicides in the neighborhood fades away as the time between the test day and the day of the killings gets longer. From the intervention perspective, Burdwick-Will, et al. (2010) indicate the possible existence of non-linear effects of violence on children. Is this the case for the Colombian armed conflict? Not reported here, Equation (2) was re-estimated with a squared term for each conflict indicator and without the state-specific trend, leaving only state and year of the test fixed effects. Although results should be taken with care and more theoretical discussion may be needed in order to draw an ultimate conclusion, it can be said that there are non-linear effects: extortion has negative and significant non-linear impact on the 5th and 9 grades language scores; terrorist attacks only have a negative non-linear effect on the performance of 5th grade language

scores. For the math scores, only extortion and terrorist attacks have non-linear negative impact on the 5th grade students; 9th grade math scores are also negatively impacted by extortion, kidnapping and attacks against the police. The results of non-linear effects on 11th grade language and math scores remain insignificant.

The final robustness check deals with the timing of the exposure to conflict. Up until now, the contemporaneous exposure to conflict at birth and in the year of the test has been chosen as the timing for measuring the impact. Nonetheless, this approach has its weaknesses. For instance, exposure to conflict in utero can be more pervasive for the physical and cognitive development of the children (Camacho, 2008; Doyle et al., 2009). Following this line of thought, instead of the exposure to conflict at birth, the exposure to conflict during the gestation months is going to diminish the learning outcomes of children in the future. Additionally, the exposure to conflict in the year of the test might not be the right procedure because exams do not take place at the end of the year and, so, the conflict of that year has not been fully realized. It could be that conflict levels experienced in the year before the test are the ones that harm the performance of the students. Not reported here, but available upon request, regressions using the indicators of conflict in the year before the birth year and the year before the year of the test were estimated. The results indicate that only extortion has a negative impact on the math and language scores for 5th grade. In the case of 9th grade only mass murder victims reduce the scores on both math and language tests. No significant coefficient was found for the 11th grade regressions. These results highlight how the economic and the psyschological channel can interact at different stages of the student's life to impair the learning outcomes: economic channel early in life (represented by extortions) and psychological channel later in life (represented by mass murder victims).

VII - CONCLUSIONS

Previous research indicates that exposure to civil war and violence reduces the number of completed school years and test scores. This type of war imposes economic costs on families due to the destruction of assets or reduction of revenues. As a way to smooth consumption, households may take their children out of school either to reduce expenditure or to have them available for work. Governments may reduce their expenditure on education to make more funds available for the military effort. In the heat of the confrontation, schools are destroyed and teachers killed. Households may be forced to relocate and settle in places where education is insufficient or of a lower quality. Children, directly or indirectly exposed to violence, may suffer from post traumatic disorder, reducing their learning abilities; furthermore, their environment may not be learning-conducive due to the violence concerns at home and the economic constraints. Taken as a whole, these mechanisms create obstacles to the accumulation of human capital.

Using data collected by the Colombian Police, this paper estimates the effect of the Colombian armed conflict on math and language learning. Estimations are carried out via models in which the score in the Colombian Saber test is the dependent variable and one of the conflict indicators (Extortion, Kidnapping, Terrorist Attacks, Mass Murder Victims and Terrorist Attacks against the Police) is the main independent variable. The regressions also include state fixed effects and year of the test fixed effects, besides a state-specific linear trend. The identification strategy is based on the level of violence to which the student was exposed at the year of birth at the state of birth or at the year of the test in the state of residence.

The results indicate that the exposure to conflict at birth has a bigger impact on scores than the exposure to conflict at the year of the test. The reduction in the

scores is bigger in point estimates for the 5th than for the 9th grade students. Due to attrition, as students drop out of school, the results are not conclusive for the 11th grade sample. In the cases of the 5th and 9th grades samples, the effects seem to be bigger for the math scores than for the language scores and the total effect (exposure at birth plus exposure at the year of the test) is a reduction about 3-4 points. The combined effect of the exposure at birth and the exposure during the year of the test produces a small reduction of language scores (5% SD for 5th grade and 3% SD for 9th grade) and of the math scores (6.5% SD for the 5th grade and 6% SD for the 9th grade). When tackling attrition by including artificially created dropouts, it seems that there is no effect of the exposure to conflict at birth, implying that the education system cancels out any pervasive effect of the violent conflict environment in which children grew up. This finding would also suggest that cash transfer programs, conditional on keeping children in school, may alleviate the effects of the armed conflict on the human capital accumulation. Overall, the variables leading these results are Extortion, Kidnapping and Terrorist attacks.

Small effects? On average. Some regions may deviate from the average and have suffered from high levels of conflict intertwined with poverty and forced displacement over long periods. These results may highlight the relevance of special interventions in these regions. Such interventions would need to target, in particular, children and mothers to help them overcome the trauma and stress generated by conflict. Furthermore, these regions need to be put back on the track of human capital accumulation with programs targeting adults who could not complete their schooling due to economic constraints and the burden of violence.

The results emphasize the importance of cash transfer programs conditional on keeping children in school (like Colombian scheme of Familias en Accion). They also highlight the importance of fighting the crimes that have more negative incidence

on the population because of the economic cost or post-traumatic stress disorders in children and adults. In particular for Colombia, as the recent developments indicate, authorities should focus their efforts on fighting all different types of extortions that are taking place in poor city areas. While fighting civil wars, government should also promote programs to offer support to families and communities, giving them the resources they need to help children to cope with the stress and trauma. Police forces should also help school administrators in providing the best climate for teaching and learning (as Osofsky, 2010, mentions) both inside the school and in the surrounding areas. Support networks can be built on the role of churches, community organizations and other grassroots groups (social and cultural groups) to provide a network of support for families and children, offering activities like mental counseling to mothers of children exposed to the violent conflict. Programs like Colombian Schools for Peace funded by the World Bank (2011) should be expanded in coverage and community involvement.

Future research in this area should address the dynamics of the attrition problem. The more is known about why students drop out of school after primary education, the better will be the assessment of the impacts of civil conflict on human capital accumulation. Solving the attrition problem would allow researchers to sort out the issue of the peace dividend or war hangover (Collier, 1999), at least, for the human capital accumulation process. Improvement in test scores due to lower violence, which could appear as a peace dividend, may ignore all those who dropped or are dropping out of school with a lower human capital. Education inequalities can be the worst war hangover during the expected years of peace. Data should allow the tracking of the same student throughout primary and secondary education to explore the evolution of the effect of conflict, controlling for individual level fixed effects.

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Tables and Figures Chapter II

Table II.1: Children enrolled in an education center by selected ages (in proportion)[a]

State	Enrolled at age 10	Enrolled at age 15	Enrolled at age 17
Antioquia	0.914	0.748	0.567
Atlántico	0.917	0.837	0.631
Bogotá	0.944	0.852	0.672
Bolívar	0.919	0.789	0.590
Boyacá	0.943	0.728	0.539
Caldas	0.958	0.740	0.567
Caquetá	0.856	0.641	0.421
Cauca	0.905	0.633	0.425
Cesar	0.884	0.742	0.508
Córdoba	0.930	0.794	0.546
Cundinamarca	0.951	0.807	0.581
Chocó	0.664	0.619	0.467
Huila	0.921	0.666	0.468
La Guajira	0.651	0.587	0.468
Magdalena	0.901	0.770	0.561
Meta	0.946	0.803	0.534
Nariño	0.867	0.614	0.431
Norte Santander	0.924	0.705	0.506
Quindío	0.931	0.803	0.632
Risaralda	0.930	0.771	0.546
Santander	0.950	0.756	0.573
Sucre	0.940	0.840	0.600
Tolima	0.903	0.737	0.526
Valle	0.954	0.827	0.543
Arauca	0.953	0.791	0.465
Casanare	0.928	0.744	0.485
Putumayo	0.821	0.628	0.390
San Andrés	0.972	0.829	0.696
Amazonas	0.852	0.780	0.563
Guainía	0.826	0.731	0.597
Guaviare	0.862	0.628	0.270
Vaupés	0.873	0.726	0.558
Vichada	0.701	0.528	0.370
Total	0.918	0.767	0.561

[a]Source: DANE, 2005 Census

Table II.2: Enrollment by relationship between household income and expenditure (in proportion)[a]

Age	Enrollment	Income covers expenditure			
		Enough	More than Enough	Not Enough	Not Reporting
10 years	Enrolled	0.955	0.937	0.917	0.596
	Not enrolled	0.039	0.052	0.070	0.097
	Not reporting	0.007	0.011	0.013	0.307
15 years	Enrolled	0.841	0.835	0.756	0.395
	Not enrolled	0.153	0.159	0.235	0.193
	Not reporting	0.006	0.006	0.009	0.412
17 years	Enrolled	0.659	0.657	0.547	0.267
	Not enrolled	0.336	0.337	0.444	0.251
	Not reporting	0.004	0.005	0.009	0.483

[a]Source: DANE, 2005 Census

Table II.3: Enrollment by age and selected ages (in proportion)[a]

Enrollment	Gender	10 years	15 years	17 years
Enrolled	Male	0.505	0.494	0.493
	Female	0.495	0.506	0.507
Not Enrolled	Male	0.575	0.558	0.516
	Female	0.425	0.442	0.484
Not Reporting	Male	0.522	0.514	0.496
	Female	0.478	0.486	0.504

[a]Source: DANE, 2005 Census

Table II.4: OECD PISA National Mean Scores 2006 and 2009[a]

Country	Reading Mean		Math Mean	
	2006	2009	2006	2009
Brazil	373.72	412	369.52	386
Colombia	385.31	413	369.98	381
Argentina	392.89	398	381.25	388
Mexico	410.5	425	405.65	419
Chile	412.52	449	411.35	421
Uruguay	442.09	426	426.8	427
Peru		370		365
OECD Average	491.79	493	497.68	496

[a]Source: OECD PISA Tests.

Table II.5: Legal definitions of selected internal armed conflict variables[a]

Variable	Description
Extortion	When someone threatens to use force or harm another person unless a payment is made; threats can be made by members of the narco-terrorists groups, organized criminal gangs or common criminality to entrepreneurs, business people, government officers or citizens.
Terrorist attacks	Attacks carried out using explosive devices or any other form of destruction, bringing terror or uncertainty to the population and endangering lives, buildings, communication means and infrastructure.
Kidnappings	Seizing a person against her/his will in return of a ransom or for propaganda gains. The kidnapping can be simple, for less than three people kidnapped at the same time by the same criminal, or collective, for three or more people.
Mass murders	When 4 or more people are killed at the same time and place and by the same perpetrators. This variable does not include the military personnel killed in action or when a group of 4 or more criminals are killed during police or military operations.
Terrorist attacks against the police	Attacks against the police units and officers. These attacks can be ambushes, open combats, attacks against police stations or patrols or when the attacker retreats without engaging in combat.

[a] Colombian National Police Website, 2011.

Table II.6: Average of conflict indicators (per 100,000 inhabitants) for 5th grade and 9th grade students[a]

Conflict Indicator	Year	5th Grade			9th Grade		
		2002-2003	2005-2006	2009	2002-2003	2005-2006	2009
Extortion	Birth year	2.59	1.50	1.72	1.50	2.62	1.60
	Test year	5.99	4.11	3.19	5.71	4.00	3.09
Terrorist attacks	Birth year	2.97	3.27	4.39	1.51	2.28	3.54
	Test year	4.10	1.53	0.68	4.38	1.34	0.61
Kidnappings	Birth year	4.61	3.48	6.56	1.88	4.26	3.44
	Test year	6.92	1.73	0.49	7.83	1.61	0.45
Mass murder victims	Birth year	NA	1.25	1.75	NA	NA	1.19
	Test year	1.50	0.38	0.36	1.66	0.33	0.33
Attacks against the police	Birth year	1.09	0.74	0.92	0.09	0.80	0.65
	Test year	1.12	0.48	0.37	1.21	0.38	0.29

[a]Source: Colombian National Police, 2009.

Table II.7: Average of conflict indicators (per 100,000 inhabitants) for 11th grade students[a]

Conflict Indicator	Year	11th Grade				
		2000	2001	2002	2003	2004
Extortion	Birth year	0.97	0.98	1.10	1.30	1.59
	Test year	3.97	4.74	9.02	7.86	7.86
Terrorist Attacks	Birth year	0.99	1.32	1.51	1.38	1.42
	Test year	5.36	4.01	5.47	3.86	2.15
Kidnappings	Birth year	0.49	0.63	0.64	0.67	1.02
	Test year	12.43	9.80	9.39	6.70	4.51
Mass murder victims	Birth year	NA	NA	NA	NA	NA
	Test year	4.62	3.21	2.05	1.65	0.82
Attacks against the police	Birth year	0.18	0.04	0.04	0.05	0.07
	Test year	1.36	0.98	1.08	1.22	0.56

[a]Source: Colombian National Police, 2009.

Table II.8: Statistics for 5th grade and 9th grade sample (in proportions)[a]

Variable	5th Grade			9th Grade		
	2002-2003	2005-2006	2009	2002-2003	2005-2006	2009
Rural School	0.23	0.21	0.25	0.14	0.11	0.15
Private School	0.18	0.15	0.18	0.18	0.18	0.20
Observations	465706	521421	512137	242362	357632	401038

[a]Source: Pruebas Saber, ICFES-Ministerio de Educacion nacional, 2010.

Table II.9: Statistics for the 11th grade sample (in proportion)[a]

Variable	11th Grade				
	2000	2001	2002	2003	2004
Female	0.54	0.54	0.54	0.54	0.54
Age at test	18.66	18.43	18.60	18.32	18.15
Graduating at the test year	0.95	0.95	0.89	0.94	0.93
Mother with high school or more education	0.47	0.50	0.51	0.52	0.55
Mother with high school or more education	0.47	0.49	0.50	0.50	0.55
Number of siblings	2.94	NA	2.82	2.74	2.72
Observations	432488	398846	433673	424432	431322

[a]Source: Pruebas Saber, ICFES-Ministerio de Educacion Nacional, 2010

Table II.10: Math and Language scores statistics for the 5th grade and 9th grade sample[a]

Variable	Test year	5th Grade				9th Grade			
		Mean	S.D.	Min	Max	Mean	S.D.	Min	Max
Math Score	2002-2003	294.88	72.79	80.91	476.14	296.97	71.57	88.84	569.18
	2005-2006	290.22	58.83	149.88	448.35	295.27	47.97	211.54	487.09
	2009	284.31	73.07	35.47	524.47	290.49	75.49	31.40	575.35
Language Score	2002-2003	297.83	68.13	57.59	483.26	296.38	68.65	44.68	519.49
	2005-2006	293.03	61.50	118.59	420.80	299.96	55.97	131.29	426.46
	2009	292.35	71.54	63.31	518.04	293.74	74.71	18.41	539.73

[a]Source: Pruebas Saber, ICFES-Ministerio de Educacion Nacional, 2010.

Table II.11: Math and Language Scores Statistics for the 11th grade sample[a]

Variable	Test year	11th Grade			
		Mean	S.D.	Min	Max
Math Score	2000	42.99	5.44	0	87
	2001	41.15	5.38	0	100
	2002	42.68	6.35	0	102
	2003	41.77	5.34	0	103
	2004	41.04	6.16	0	98.2
Language Score	2000	46.39	6.40	0	77
	2001	46.36	6.00	0	75
	2002	48.20	6.76	0	83
	2003	48.69	7.80	0	103
	2004	52.19	8.33	0	104.6

[a]Source: Pruebas Saber, ICFES-Ministerio de Educacion Nacional, 2010.

Table II.12: Living in the same department of birth by expected age at 5th, 9th and 11th grade[a]

State	11 years old	15 years old	17 years old
Amazonas	0.918	0.920	0.913
Antioquia	0.945	0.944	0.940
Arauca	0.909	0.878	0.839
Atlántico	0.967	0.967	0.965
Bogotá	0.938	0.941	0.942
Bolívar	0.964	0.961	0.954
Boyacá	0.932	0.926	0.905
Caldas	0.884	0.878	0.866
Caquetá	0.831	0.819	0.795
Casanare	0.908	0.925	0.892
Cauca	0.942	0.929	0.918
Cesar	0.935	0.926	0.912
Chocó	0.654	0.670	0.680
Córdoba	0.959	0.953	0.943
Cundinamarca	0.923	0.918	0.903
Guainía	0.929	0.932	0.890
Guaviare	0.779	0.762	0.775
Huila	0.927	0.919	0.908
La Guajira	0.923	0.924	0.902
Magdalena	0.956	0.954	0.944
Meta	0.884	0.880	0.861
Nariño	0.918	0.925	0.911
Norte Santander	0.943	0.944	0.935
Putumayo	0.646	0.640	0.650
Quindio	0.874	0.865	0.862
Risaralda	0.876	0.879	0.876
San Andrés	0.942	0.941	0.916
Santander	0.926	0.927	0.917
Sucre	0.958	0.957	0.943
Tolima	0.910	0.902	0.883
Valle	0.920	0.924	0.922
Vaupés	0.880	0.869	0.837
Vichada	0.898	0.883	0.873
Total	0.909	0.908	0.899

[a]Source: DANE, 2005 Census

Table II.13: Effect of exposure to conflict at birth on the 5th grade Language and Math Scores[a]

Conflict Indicators	Specification 1 Language	Specification 1 Math	Specification 2 Language	Specification 2 Math	Specification 3 Language	Specification 3 Math	Specification 4 Language	Specification 4 Math
Extortion	1.554 (46.56)***	2.208 (64.46)***	0.179 (0.39)	1.862 (2.70)**	-2.404 (2.60)**	-0.489 (0.24)	-2.494 (11.92)***	-0.573 (2.31)**
Terrorism	-0.569 (37.41)***	-0.553 (35.42)***	-0.278 (0.66)	0.433 (0.65)	-0.124 (0.22)	-0.34 (0.37)	0.155 (0.64)	0.022 (0.07)
Kidnapping	-0.533 (56.59)***	-0.663 (68.87)***	0.02 (0.23)	0.025 (0.16)	-0.008 (0.05)	-0.261 (0.71)	0.027 (0.40)	-0.279 (3.73)***
Mass murder victims	-0.38 (10.42)***	-1.015 (27.69)***	-0.018 (0.05)	0.252 (0.35)	-1.23 (11.52)***	-3.13 (27.84)***	-1.568 (1.06)	-2.161 (1.42)
Attacks against police	-0.808 (18.01)***	-0.624 (13.58)***	0.749 (0.99)	0.326 (0.30)	0.818 (0.68)	-0.394 (0.28)	1.134 (3.60)***	-0.128 (0.39)
Total conflict					0.023 (5.51)***	-0.119 (27.30)***	0.005 (0.08)	-0.093 (1.47)
Total conflict factorial					1.68 (5.1)***	-1.685 (27.30)***	0.071 (0.08)	-1.32 (1.47)
Clustered Errors	NO		State Level		State Level		School level	
Fixed effects	NO		State Level		State Level		School level	
Year of test fixed effects	NO		YES		YES		YES	
State specific linear trend	NO		NO		YES		YES	

[a] Absolute value of t statistics in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. Errors clustered at the school level. Conflict variables in per 100,000 inhabitants per state per year. Factor Eigenvalue 2.52; Proportion 0.47; KMO 0.70. Coefficients from separate regressions (controls for private and rural schools where appropriate).

Table II.14: Effect of exposure to conflict at birth on the 9th grade Language and Math Scores[a]

Conflict Indicators	Specification 1		Specification 2		Specification 3		Specification 4	
	Language	Math	Language	Math	Language	Math	Language	Math
Extortion	1.118	-0.031	-2.681	-0.003	-1.978	-0.769	-1.130	0.285
	(26.15)***	(0.73)	(1.76)*	(0.01)	(1.32)	(0.38)	(3.68)***	(0.64)
Terrorism	-0.257	-0.512	0.521	-1.133	-0.179	0.175	-0.020	0.394
	(10.54)***	(21.33)***	(0.54)	(1.99)*	(0.39)	(0.20)	(0.08)	(1.07)
Kidnapping	-0.097	-0.365	0.795	-0.475	0.416	0.55	-0.223	-0.244
	(4.45)***	(17.07)***	(1.05)	(0.81)	(0.69)	(0.70)	(1.48)	(1.07)
Attacks against Police	1.402	0.011	3.02	-0.431	1.276	-1.16	-0.130	-2.984
	(16.70)***	(0.13)	(1.36)	(0.20)	(0.79)	(0.53)	(0.34)	(5.40)***
Total conflict					-0.014	0.084	-0.172	-0.130
					(0.01)	(0.26)	(2.21)**	(1.14)
Total conflict factorial					0.521	-0.128	-0.745	-1.733
					(0.37)	(0.07)	(1.77)	(2.81)***
Clustered Errors	NO		State Level		State Level		School level	
Fixed effects	NO		State Level		State Level		School level	
Year of test fixed effects	NO		YES		YES		YES	
State specific linear trend	NO		NO		YES		YES	

[a] Absolute value of t statistics in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. Errors clustered at the school level. Conflict variables in per 100,000 inhabitants per state per year. Factor: Eigenvalue 2.41; Proportion 0.60; OKM 0.66. Coefficients from separate regressions (controls for private and rural schools where appropriate).

Table II.15: Effect of exposure to conflict at birth on the 11th grade Language and Math Scores[a]

Conflict Indicators	Specification 1		Specification 2		Specification 3		Specification 4	
	Language	Math	Language	Math	Language	Math	Language	Math
Extortion	0.405 (113.74)***	0.547 (156.49)***	-0.181 (1.81)*	0.254 (2.87)***	0.565 (5.40)***	0.159 (2.99)***	-0.018 (1.56)	-0.065 (6.06)***
Terrorism	0.152 (60.72)***	0.289 (113.25)***	0.091 (1.11)	0.153 (1.87)*	0.231 (1.91)*	0.131 (2.00)*	0.017 (1.90)*	-0.048 (5.44)***
Kidnapping	0.032 (15.97)***	0.169 (93.93)**	0.130 (3.33)***	0.052 (0.92)	0.439 (3.79)***	0.151 (3.65)***	-0.052 (4.52)***	-0.036 (3.66)***
Attacks against Police	-0.041 (5.94)***	0.282 (36.57)***	0.226 (1.94)*	0.222 (2.05)**	-0.02 (0.04)	0.073 (0.64)	0.055 (0.45)	0.019 (0.21)
Total Conflict					0.3 (8.18)***	0.18 (7.56)***	0.192 (52.51)***	0.118 (35.13)***
Total conflict factorial					0.505 (1.50)	-0.002 (0.03)	0.967 (9.49)***	0.283 (3.81)***
Clustered Errors	NO		State Level		State Level		School level	
Fixed effects	NO		State Level		State Level		School level	
Year of test fixed effects	NO		YES		YES		YES	
State specific linear trend	NO		NO		YES		YES	

[a] Absolute value of t statistics in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. Errors clustered at the school level. Conflict variables in per 100,000 inhabitants per state per year. Factor: Eigenvalue 2.47; Proportion 0.61; KMO 0.72.Coefficients from separate regressions (controls for female, education of mother and education of father).

Table II.16: Effect of exposure to conflict during the year of the test on the 5th grade Language and Math Scores[a]

Conflict Indicators	Specification 1		Specification 2		Specification 3		Specification 4	
	Language	Math	Language	Math	Language	Math	Language	Math
Extortion	0.046 (3.20)***	0.351 (23.80)***	-0.559 (1.27)	0.192 (0.26)	-0.431 (0.67)	1.596 (1.16)	-0.579 (3.55)***	1.505 (7.85)***
Terrorism	-0.201 (15.57)***	-0.085 (6.36)***	-0.679 (2.04)**	-1.3 (2.59)**	-0.857 (1.66)	-1.019 (1.84)*	-0.892 (5.40)***	-1.100 (5.95)***
Kidnapping	0.042 (3.40)***	0.058 (4.62)***	0.024 (0.07)	-0.613 (1.09)	-0.045 (0.09)	-1.238 (1.17)	0.024 (0.12)	-1.325 (6.04)***
Mass murder victims	0.439 (9.94)***	1.153 (25.42)***	-0.47 (0.21)	-0.529 (0.20)	-0.497 (0.40)	-0.529 (0.31)	-0.334 (0.77)	-0.351 (0.66)
Attacks against Police	-0.274 (10.12)***	-0.003 (0.11)	-0.925 (2.79)***	-1.905 (4.33)***	-0.402 (1.22)	-0.741 (1.00)	-0.297 (1.37)	-0.384 (7.25)***
Total Conflict					-0.282 (1.16)	-0.18 (0.76)	-0.288 (4.16)***	-0.224 (2.85)***
Total conflict factorial					-1.76 (1.55)	-4.845 (1.31)	-1.34 (2.71)**	-4.819 (7.00)**
Clustered Errors	NO		State Level		State Level		School level	
Fixed effects	NO		State Level		State Level		School level	
Year of test fixed effects	NO		YES		YES		YES	
State specific linear trend	NO		NO		YES		YES	

[a]Absolute value of t statistics in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. Errors clustered at the school level. Conflict variables in per 100,000 inhabitants per state per year. Factor: Eigenvalue 2.66, Proportion 0.47, KMO 0.6421. Coefficients from separate regressions (controls for private and rural schools where appropriate).

Table II.17: Effect of exposure to conflict during the year of the test on the 9th grade Language and Math Scores[a]

Conflict Indicators	Specification 1		Specification 2		Specification 3		Specification 4	
	Language	Math	Language	Math	Language	Math	Language	Math
Extortion	0.316 (17.67)***	0.193 (10.96)***	-0.006 (0.01)	-0.003 (0.01)	1.722 (1.90)*	1.951 (1.70)*	0.898 (5.86)***	1.028 (3.96)***
Terrorism	0.129 (7.32)***	0.134 (7.77)***	-0.537 (1.89)*	-1.133 (1.99)*	-0.216 (0.55)	-0.721 (1.03)	-0.065 (0.36)	-0.576 (2.17)**
Kidnapping	0.058 (3.76)***	0.148 (9.74)***	-0.026 (0.07)	-0.475 (0.81)	-0.729 (1.06)	-1.581 (1.59)	-0.218 (1.32)	-0.948 (3.57)***
Mass Murder victims	-0.268 (4.81)***	0.814 (14.87)***	-0.955 (0.57)	-0.431 (0.20)	-1.513 (1.36)	-1.265 (0.68)	-0.247 (0.41)	0.409 (0.48)
Attacks against Police	0.241 (6.38)***	0.275 (7.40)***	-0.493 (1.89)*	-1.324 (3.58)***	-0.645 (1.32)	-0.206 (0.35)	-0.286 (1.13)	0.191 (0.61)
Total Conflict					0.191 (1.02)	0.028 (0.10)	0.161 (2.21)**	-0.008 (0.07)
Total conflict factorial					-3.257 (1.38)	-3.539 (1.04)	-1.10 (2.04)**	-1.18 (1.46)
Clustered Errors	NO		State Level		State Level		School level	
Fixed effects	NO		State Level		State Level		School level	
Year of test fixed effects	NO		YES		YES		YES	
State specific linear trend	NO		NO		YES		YES	

[a]Absolute value of t statistics in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. Errors clustered at the school level. Conflict variables in per 100,000 inhabitants per state per year. Factor: Eigenvalue 2.68; Proportion 0.53; KMO 0.645. Coefficients from separate regressions (controls for private and rural schools where appropriate).

Table II.18: Effect of exposure to conflict during the year of the test on the 11th grade Language and Math Scores[a]

Conflict Indicators	Specification 1		Specification 2		Specification 3		Specification 4	
	Language	Math	Language	Math	Language	Math	Language	Math
Extortion	0.051 (85.05)***	0.017 (33.81)***	-0.006 (1.45)	0.005 (1.13)	-0.008 (1.29)	0.001 (0.34)	0.006 (3.26)***	0.013 (2.81)***
Terrorism	-0.012 (24.92)***	0.001 (1.56)	-0.014 (2.10)**	0.001 (0.21)	-0.014 (1.95)*	-0.002 (0.85)	0.008 (4.17)***	0.019 (4.12)***
Kidnapping	-0.041 (87.74)***	-0.008 (19.09)***	-0.009 (1.88)*	-0.004 (1.98)*	-0.014 (2.31)**	-0.007 (1.98)*	0.007 (4.28)***	0.004 (2.50)**
Mass Murder victims	-0.136 (99.88)***	-0.008 (7.29)***	-0.011 (1.03)	-0.007 (0.65)	-0.026 (1.85)*	-0.016 (1.65)	0.001 (0.28)	-0.005 (2.00)**
Attacks against Police	-0.031 (25.85)***	-0.007 (6.62)***	-0.034 (1.89)*	-0.007 (1.06)	-0.035 (1.65)	-0.004 (1.20)	-0.003 (0.90)	0.021 (3.91)***
Total Conflict					-0.005 (2.27)**	-0.001 (1.97)*	-0.001 (1.87)*	0 (0.09)
Total conflict factorial					-0.104 (1.60)	-0.028 (1.21)	-0.036 (1.74)*	-0.01 (0.97)
Clustered Errors	NO		State Level		State Level		School level	
Fixed effects	NO		State Level		State Level		School level	
Year of test fixed effects	NO		YES		YES		YES	
State specific linear trend	NO		NO		YES		YES	

[a] Absolute value of t statistics in parentheses.* significant at 10%; ** significant at 5%; *** significant at 1%. Errors clustered at the school level. Conflict variables in per 100,000 inhabitants per state per year. Factor: Eigenvalue 2.61; Proportion 2.51; KMO 0.57. Coefficients from separate regressions (controls for female, education of mother and education of father).

Table II.19: Effect of exposure to conflict at birth on the 9th grade Language and Math Scores including Dropouts[a]

Conflict Indicators	Assigning mean		Assigning 95% of mean		Assigning 90% of mean		Assigning 85% of mean		Assigning 80% of mean	
	Language	Math	Language	Math	Language	Math	Language	Math	Language	Math
Extortion	-6.16	-5.635	-5.436	-4.935	-4.711	-4.236	-3.987	-3.536	2.257	1.828
	(1.10)	(0.87)	(1.14)	(0.87)	(1.19)	(0.88)	(1.26)	(0.89)	(1.15)	(0.80)
Terrorism	0.093	0.343	-0.151	0.098	-0.396	-0.148	-0.64	-0.394	0.604	0.135
	(0.08)	(0.28)	(0.14)	(0.09)	(0.40)	(0.15)	(0.65)	(0.40)	(0.37)	(0.08)
Kidnapping	2.397	2.676	2.121	2.394	1.845	2.111	1.569	1.829	0.494	0.434
	(1.34)	(1.33)	(1.37)	(1.37)	(1.39)	(1.39)	(1.37)	(1.39)	(0.94)	(0.57)
Attacks against Police	6.629	5.072	4.891	3.407	3.153	1.741	1.415	0.076	0.354	0.292
	(1.19)	(0.81)	(1.02)	(0.63)	(0.74)	(0.36)	(0.36)	(0.02)	(0.11)	(0.08)
Clustered Errors	State Level		State Level		State Level		State Level		State Level	
Fixed effects	State Level		State Level		State Level		State Level		State Level	
Year of test fixed effects	YES		YES		YES		YES		YES	
State specific linear trend	YES		YES		YES		YES		YES	

[a] Absolute value of t statistics in parentheses.* significant at 10%; ** significant at 5%; *** significant at 1%. Errors clustered at the school level. Conflict variables in per 100,000 inhabitants per state per year. Coefficients from separate regressions (controls for private school and rural school).

Table II.20: Effect of exposure to conflict at birth on the 11th grade Language and Math Scores including Dropouts[a]

Conflict Indicators	Assigning mean		Assigning 95% of mean		Assigning 90% of mean		Assigning 85% of mean		Assigning 80% of mean	
	Language	Math	Language	Math	Language	Math	Language	Math	Language	Math
Extortion	0.529	0.087	0.517	0.081	0.504	0.074	0.492	0.067	0.266	0.075
	(5.73)***	(1.24)	(6.42)***	(0.92)	(6.57)***	(0.70)	(5.96)***	(0.54)	(1.22)	(0.41)
Terrorism	0.165	0.073	0.176	0.081	0.188	0.088	0.2	0.095	0.495	0.384
	(1.53)	(0.71)	(1.59)	(0.76)	(1.64)	(0.80)	(1.68)	(0.84)	(1.54)	(3.19)***
Kidnapping	0.306	0.104	0.33	0.124	0.354	0.143	0.377	0.163	0.632	0.287
	(3.80)***	(2.91)***	(3.69)***	(2.88)***	(3.50)***	(2.65)**	(3.30)***	(2.42)**	(2.02)*	(1.71)*
Attacks Against	0.013	0.192	0.218	0.348	0.423	0.504	0.628	0.66	0.501	0.524
Police	(0.04)	(1.73)*	(0.56)	(2.09)**	(0.95)	(2.15)**	(1.23)	(2.15)**	(0.74)	(1.53)
Clustered Errors	State Level		State Level		State Level		State Level		State Level	
Fixed effects	State Level		State Level		State Level		State Level		State Level	
Year of test fixed effects	YES		YES		YES		YES		YES	
State specific linear trend	YES		YES		YES		YES		YES	

[a] Absolute value of t statistics in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. Errors clustered at the school level. Conflict variables in per 100,000 inhabitants per state per year. Coefficients from separate regressions (controls for female, mother and father levels of education).

Table II.21: Effect of exposure to conflict during the year of the test on the 9th grade Language and Math Scores including Dropouts[a]

Conflict Indicators	Assigning mean		Assigning 95% of mean		Assigning 90% of mean		Assigning 85% of mean		Assigning 80% of mean	
	Language	Math	Language	Math	Language	Math	Language	Math	Language	Math
Extortion	3.594	4.027	2.809	3.241	2.024	2.455	1.239	1.669	0.104	-0.021
	(1.30)	(1.36)	(1.13)	(1.22)	(0.92)	(1.03)	(0.63)	(0.78)	(0.12)	(0.03)
Terrorism	-0.92	-1.321	-0.671	-1.06	-0.421	-0.8	-0.172	-0.539	-0.575	-1.052
	(1.17)	(1.43)	(0.97)	(1.33)	(0.69)	(1.17)	(0.31)	(0.94)	(1.47)	(1.94)*
Kidnapping	-2.881	-3.882	-2.581	-3.554	-2.281	-3.225	-1.981	-2.897	-0.88	-1.321
	(1.39)	(1.63)	(1.42)	(1.67)	(1.43)	(1.70)*	(1.43)	(1.71)*	(1.32)	(1.89)*
Mass murder victims	-4.213	-4.53	-3.581	-3.884	-2.949	-3.238	-2.318	-2.592	-2.005	-2.099
	(1.80)*	(1.68)	(1.74)*	(1.62)	(1.65)	(1.52)	(1.48)	(1.36)	(1.36)	(0.88)
Attacks against Police	-0.862	-0.417	-0.772	-0.344	-0.682	-0.271	-0.592	-0.199	-0.861	-1.464
	(0.60)	(0.29)	(0.57)	(0.25)	(0.52)	(0.20)	(0.46)	(0.15)	(1.33)	(1.98)*
Clustered Errors	State Level		State Level		State Level		State Level		State Level	
Fixed effects	State Level		State Level		State Level		State Level		State Level	
Year of test fixed effects	YES		YES		YES		YES		YES	
State specific linear trend	YES		YES		YES		YES		YES	

[a] Absolute value of t statistics in parentheses. Errors clustered at the school level. * significant at 10%; ** significant at 5%; *** significant at 1%. Conflict variables in per 100,000 inhabitants per state per year. Coefficients from separate regressions (controls for private school and rural school).

Table II.22: Effect of exposure to conflict during the year of the test on the 11th grade Language and Math Scores including Dropouts[a]

Conflict Indicators	Assigning mean		Assigning 95% of mean		Assigning 90% of mean		Assigning 85% of mean		Assigning 80% of mean	
	Language	Math	Language	Math	Language	Math	Language	Math	Language	Math
Extortion	-0.008	0.002	-0.007	0.003	-0.006	0.004	-0.005	0.004	-0.01	0.002
	(1.26)	(0.63)	(1.20)	(0.69)	(1.09)	(0.74)	(0.96)	(0.77)	(1.40)	(0.41)
Terrorism	-0.015	0	-0.015	0	-0.015	0	-0.015	-0.001	-0.018	-0.009
	(1.82)*	(0.03)	(1.87)*	(0.02)	(1.84)*	(0.06)	(1.76)*	(0.09)	(2.30)**	(2.77)***
Kidnapping	-0.016	-0.006	-0.017	-0.007	-0.018	-0.008	-0.018	-0.009	-0.025	-0.016
	(2.54)**	(1.46)	(2.61)**	(1.49)	(2.62)**	(1.49)	(2.58)**	(1.48)	(2.02)*	(2.34)**
Mass murder victims	-0.01	-0.017	-0.013	-0.019	-0.015	-0.02	-0.017	-0.022	-0.063	-0.041
	(1.03)	(1.75)*	(1.19)	(1.95)*	(1.31)	(2.11)**	(1.40)	(2.23)**	(2.34)**	(3.31)***
Attacks against Police	-0.025	0.001	-0.027	-0.001	-0.029	-0.003	-0.03	-0.005	-0.05	-0.031
	(1.29)	(0.23)	(1.39)	(0.11)	(1.45)	(0.35)	(1.49)	(0.50)	(2.09)**	(2.82)***
Clustered Errors	State Level		State Level		State Level		State Level		State Level	
Fixed effects	State Level		State Level		State Level		State Level		State Level	
Year of test fixed effects	YES		YES		YES		YES		YES	
State specific linear trend	YES		YES		YES		YES		YES	

[a] Absolute value of t statistics in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. Errors clustered at the school level. Conflict variables in per 100,000 inhabitants per state per year. Coefficients from separate regressions (controls for female, mother and father levels of education).

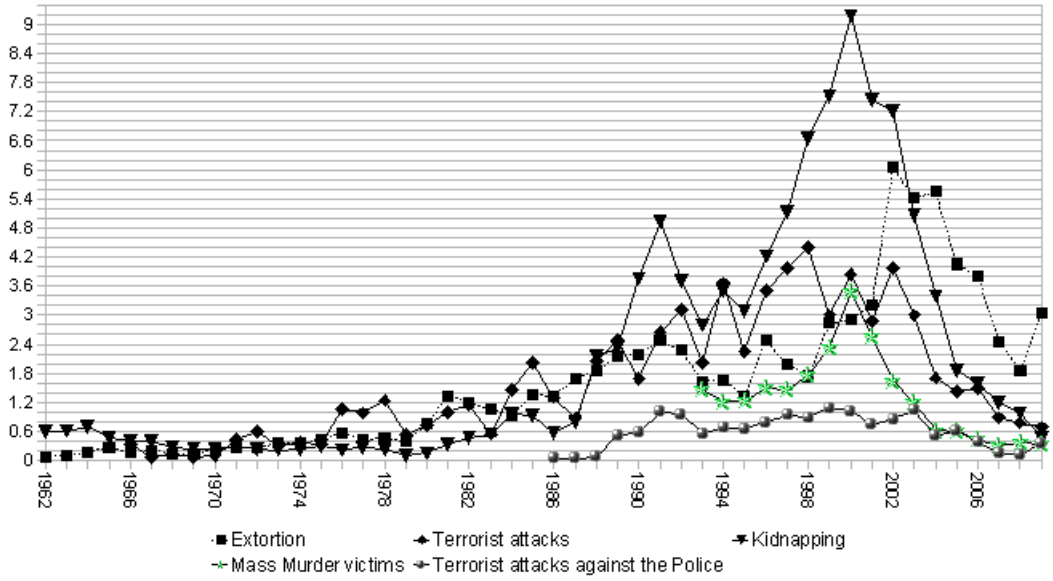

Figure II.1: Internal Armed Conflict indicators (per 100,000 inhabitants) 1960-2009[a]

[a]Source: Colombian National Police, 2009; DANE population Series, 2011.

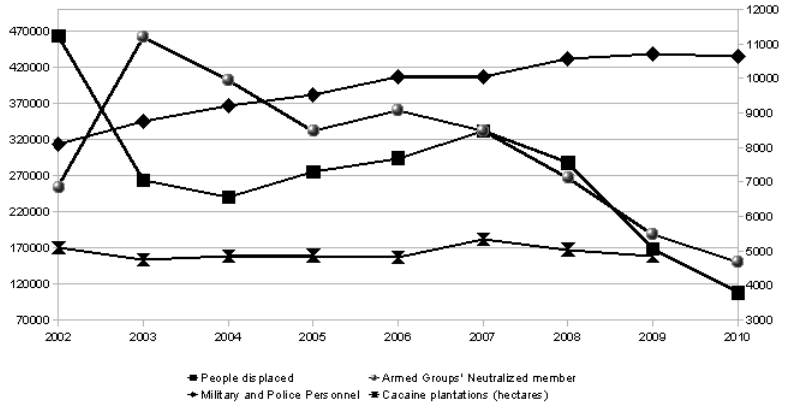

Figure II.2: Colombian Internal Conflict Main indicators, 2002 - 2010[a]

[a]Source: Ministry of Defense, March 2011. Right axis for people displaced and military and police personnel. Left Axis: People displaced, Military and Police Personnel

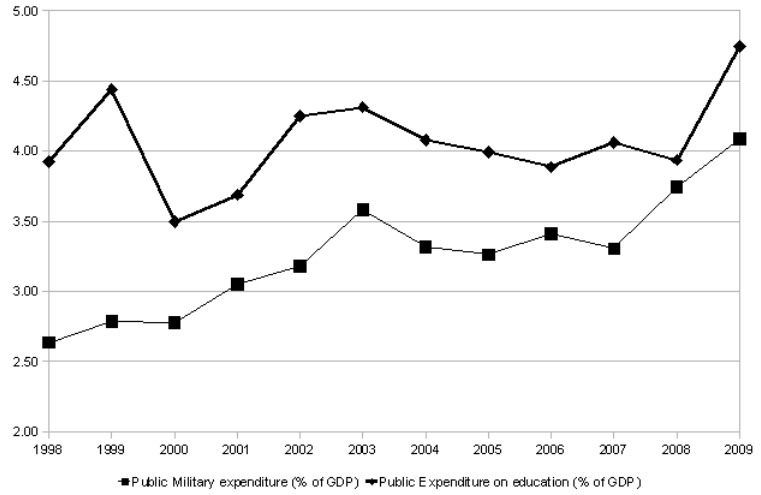

Figure II.3: Public Expenditure on Defense and Education as percentage of GDP, 1998 - 2009[a]

[a]Source: World Bank, World Development Indicators; UNESCO Data Center.

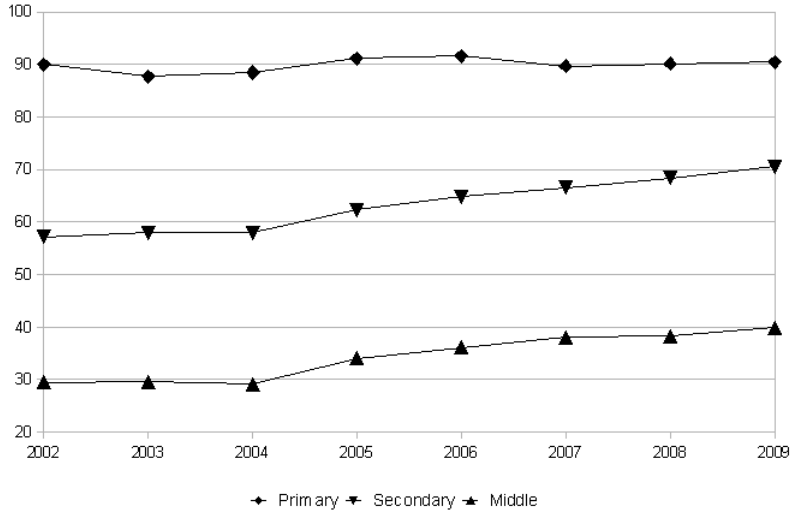

Figure II.4: Net Enrollment rates (percentage) by education level, 2002-2009[a]

[a]Source: Ministry of Education, 2011

CHAPTER III

War in the tap: Civil War's Impact on Access to Water and Sanitation Services

(Coauthored with Ariel Dinar)

I. INTRODUCTION

According to Prio (Armed Conflict version 4-2009) around 90 countries in the developing world experienced an intra-state armed conflict, an armed conflict between the government and opposition groups, between 1950 and 2009. Twenty percent of the nations have experienced at least 10 years of civil war since 1960 (Miguel and Blattman, 2010). Civil wars are rooted in longstanding ethnic or religious grievances, as well as in political differences that escalate to armed confrontation. While the armed groups engage in fighting, the consequences impact the population, the economy, and the environment. The fighting translates into deaths of combatants and the civilian population. It also impacts the economy by disrupting the markets, and the exchange of goods and services. As war develops, the environment is affected by the attacks on infrastructure (water canals, dams, roads, pipelines) and by deforestation, pollution, and stress on the natural resources in the regions the displaced population resettles. The deleterious impact on health outcomes will be additionally aggravated if civil war imposes changes to access to water and sanitation services.

Previous research indicates that civil war changes the trajectories of growth, inflation, and investment (Chen, Loayza and Reynal-Querol 2008) and the level of gross domestic product (GDP) of countries involved in civil war (Murdoch and Sandler 2002); governments may be forced to cut social expenditure (e.g., health, education) to face the military challenges (Lai and Thyne 2007). As for the educational impact, children born during civil conflict attain less schooling than those born before or after

the conflict (Akresh and de Walque 2008; Chamarbagwala and Moran 2010; Leon 2010). In terms of health consequences, civil conflict reduces the height of children born during the fighting period (Akresh, Verwimp and Bundervoet 2009), increases child and infant mortality (Urdinola, 2004), increases the probability of miscarriage in pregnant women (Camacho 2007), reduces the ratios of male to female births (Catalano et al. 2005), and reduces the length of pregnancies and birth weights (Smits et al. 2006).

By focusing on the environmental consequences of civil war, this paper explores the impacts of civil war on access to water and sanitation services. Access to water is defined here as the ease by which households can obtain the water they need for their survival and economic activities. Civil war may reduce access to water because of the destruction of infrastructure, deforestation, pollution of water bodies, or higher use of water resources, which altogether lead to costs related to water scarcity. Civil war limits access to water, while also impacting the health and productivity of the society that is bearing the burden of violence. Civil war can destroy sewerage systems and prevent families from using proper sanitation facilities. War can also force its victims to adopt unhealthy practices that increase their contact with excreta and pollute water sources.

Most of the literature on environmental effects of military operations focuses on the study of conventional war (usually, interstate war). In a broad sense, the effects of interstate wars are similar to those of civil wars[8]. Even though this paper explores the effects of civil war on access to water and sanitation services, it references literature

[8]Two different concepts of war are used throughout this paper: war and civil war (also called internal armed conflict, civil conflict, or armed strife). In a war, two armies are engaged in military operations to try to achieve victory; those armies, usually, follow international conventions of humanitarian law and are the armies of different states (and therefore, internationally recognized). In a civil war, rebel groups fight the army of the state; civil wars are featured by violation of human rights use of the guerrilla war tactics by the rebels and groups with different ideologies. In a civil war, the rebels seek to overthrow the government.

on the environmental effects of interstate wars. The commonalities do not exclude the fact that environmental effects may be different (in scope or nature) between interstate and civil wars.

This paper contributes to the literature on the environmental impact of civil war in four ways. The first, contribution is the use of the household as the unit of analysis. Previous studies (Raleigh and Urdal 2007; Reuveny et al. 2010) only explored the national or regional ecological burden of civil war, ignoring that families residing in those places are obliged to make rational decisions in times of war and ecological stress. Household reactions and behavioral changes may increase or, on the contrary, decrease the environmental consequences of any civil war. A household utility maximization model is proposed to explain how the family bears the burden of civil war through modified behavior to various water-access levels.

The second contribution is attributed to the results of the theoretical model. We found that is possible that conflict has contradicting effects on households. By having civil war impact presented as a tax on prices and income, unless certain conditions are met, it is entirely possible that civil wars end up having a positive effect on the access to water and sanitation services. Additionally, our modeling of the civil war intensity, as a stock of violence, following the likes of an habit stock, reinforces this finding. Contradictory effects may indicate that households learn about the intensity of the civil war, adapt appropriately and cope with conflict to maximize their utility.

Third, it develops variables that measure violence intensity. Taking the Colombian internal armed conflict as a case study, conflict is measured by yearly state-level data of leading conflict indicators (extortions, kidnapping, terrorist attacks, mass-murder victims and attacks against the police, per 100,000 inhabitants). Our variables deviate from what has been previously used by Urdinola (2004) and Camacho (2007) as measures of the Colombian conflict. Urdinola (2004) uses the homicide rate per

100,000 inhabitants to estimate the impact of violence on infant mortality. Camacho (2007) uses the explosions of land mines as a measure of the impact of violence on birth outcomes. Our variables follow the arguments by Raleigh and Urdal (2007) about the spatial heterogeneity of both conflict and environmental degradation throughout a country. Conflict intensity calculations are incorporated in the estimations following Biswas (2000) and his statements about the relevance of duration and intensity as determinants of the ultimate environmental footprint of civil war.

The fourth contribution is the use of the household level Demographic and Health Survey (DHS) dataset to explore how access to water changes throughout a civil war. DHS captures location, demographic, and socioeconomic features of a household's head and mother; it contains a detailed registry of children morbidity and mortality; it reports features of the inhabited dwelling; and it records household health-related behaviors and expenses. DHS datasets have been used in fertility, health, and education research, and now, for the first time, they are used in this exploration of changes to water access and sanitation services due to civil war. The theoretical model assumes that households care about water and its related effects on children health. DHS is preferred over other household-level surveys since its main source of data are women in reproductive age. It is for these women that the health of the children under their supervision is the most relevant[9].

II. LITERATURE REVIEW: The interactions between war, the environment, and households.

The relationship between war and the environment has been addressed in previous research. The deleterious footprint of war on the environment can be extended to armed conflict, in which the engaged factions are rebel groups and the state. The

[9]For full discussion of literature review, threats of identification and full set of tables of results, please, consult full working paper by Ortiz and Dinar (2012) available at <http://goo.gl/s9Nco>.

households are caught between the factions, and have to cope with the negative externalities and market disruptions due to increased violence.

a) Civil war and the environment

It may be appropriate to mention the institutional and the environmental strands of the literature in the civil war discipline. The first, championed by Collier (1999, 2002), interprets civil conflict as the outcome of an institutional failure, as institutions are unable to resolve the grievances or the greed of societal segments. The second strand of the literature addresses the role of environmental factors in civil conflicts. Gledistch (1998) argues that higher population growth rates lead to deteriorated environmental conditions, which in turn result in increased resource scarcity and competition that altogether translate into higher risk of violence. Gledistch (1998) extends this mechanism of environmental degradation leading conflict to a more complex process in which war leads to further environmental degradation, in a sort of feedback process. It is this final feedback – the effects of war on the environment – that is analyzed in this paper.

Two studies involving the environmental causes of civil war are worth mentioning. Raleigh and Urdal (2007) posit that the likelihood of war increases with medium to high levels of land degradation and very high levels of water scarcity. Miguel et al. (2004) show how environmental shocks that lead to severe income variability increase the probability of civil war. In exploring strengths and weaknesses of environmental origins of war, it has to be noted that there is an institutional mediation stage (Raleigh and Urdal 2007). Institutions act either to prevent war, when tackling its structural causes (Baird 2010), or institutions are changed as a consequence of war, when armed conflict alters access to common pool resources, (Kurf and Funfgeld 2006).

The effects of war on the environment depend on the type of war (conventional, biological, or nuclear), the kind of weapons and strategies being used, duration and intensity among others (Biswas 2000). There might be an increase in environmental consequences of armed conflict due to increased technological level (Westing 1980) and the process of preparedness for war (Singer and Keating 1999). However, war (and preparedness for it) could have a positive impact on the environment by reducing access to nature reserves, thus, allowing the recovery of species (Tucker and Russell 2004). Overall, negative effects will occur after massive and extended military disruptions and destruction, or by frequent small disruptions (McNeely 2010). For instance, desert surfaces were disturbed after the first Gulf War (El-Shobokshy and Al-Saedi 1993); moreover, Reuveny et al. (2010) estimated that a country hosting an armed conflict may experience an intensified deforestation.

b) Household behavior under civil war

Households cope with armed conflicts and, therefore, engage in coping strategies that also take a toll on the natural setting. In general, the coping strategies will be defined according to the risk of being targeted by the armed groups in the conflict and by the risk of poverty due to the conflict[10] (Justino 2009). Given a high risk of being targeted by armed groups or an equally high risk of facing poverty, households may decide to relocate in order to improve their welfare. The increased population in the receiving sites brings more stress to the environment. Refugee's impact on the environment could be explained by their short-sighted decisions and ignorance of the local environmental and resource management institutions (Jacobsen 1997).

[10]Unlike Justino (2009), who envisions circumstances in which households may actively participate in the civil war (by joining one of the fighting factions), it is assumed in this paper that households are victimized since civil wars are devastating for life, health, living standards, and for human and physical capital (Miguel and Blattman, 2010).

When conflict destroys water sources and infrastructure, or implies their pollution, households may be forced to modify the way they obtain water, and are forced to reduce water usage. This situation may increase the opportunity costs of collecting water (Nauges and Van Den Berg 2009). Access to improperly treated or polluted water is linked with infectious diseases, and blamed for high infant mortality rates worldwide (Montgomery and Elimelech 2007). Nevertheless, the actual effect of better water quality on children's health, ultimately, depends on how the household spending on their children's health enters into the parental utility function (Jalana and Ravallion 2003).

III. THE COLOMBIAN CONTEXT

The Colombian internal armed conflict has evolved over phases of low intensity, building up, and, currently, a phase of state offensive and rebel's reorganization. Surprisingly, and despite the economic costs the conflict has inflicted on the country, Colombia scores well on access to water and sanitation services (World Bank, 2012).

a) Colombian internal conflict

In Colombia, the high concentration of land property and various institutional failures lead to armed conflict as the only outlet (Nahzri 1997). Three main groups have been engaged in the fighting: the state army, the left-wing terrorist (LWT) and the right-wing terrorist (RWT) groups. Conflict intensified after the 1980s, as the RWT and LWT groups became involved in drug production and drug trafficking (Ortiz 2002). After the collapse of peace talks conducted during 1999-2002, the state's army was finally ready to take on an offensive with the help of the United States, the "Plan Colombia" (Veillette 2005). **Figure III.1** displays the yearly value of the five leading indicators of the conflict (that were mentioned earlier). All indicators are very low from the early 1960s to the early 1980s. However, all indicators increase throughout

the 1980s, reaching a peak in early 2000s, corresponding to the period of maximum strength of the terrorists and the peace talks. After 2002-2004, the first years of President Uribe's government, the indicators showed a sharp decrease.

b) Access to water and sanitation services in Colombia

Colombian legislation on water and sanitation is primarily based on the national constitution (Articles 361 and 366) that obliges the national government to invest in water and sanitation as fundamental for the rights of life and health (Constitutional Court, T-232, 1993). Besides, the national government established state-level water plans (planes departamentales de agua) as tools for designing and coordinating with local municipalities investments aimed at increasing access to drinkable water and improved sanitation services. According to the World Development Indicators (World Bank 2012), Colombia has increased the percentage of population with access to improved sanitation facilities (from 68 percent in 1990, to 74 percent in 2008) and with access to improved water sources (from 88 percent in 1990, to 92 percent in 2008). Water scarcity is not an issue in Colombia, since the total withdrawal of freshwater only accounts for 0.59 percent of the total internal resources (Ministerio del Medio Ambiente y Desarrollo Sostenible 2010). However, figures from the 2005 Colombian Census (DANE 2011) indicate a great level of variation across states. Despite the disparity in access to piped water and access to improved sanitation services, the incidence of diarrhea was responsible for only 4 percent of the child mortality in the country (WHO 2012).

IV. HOUSEHOLD UTILITY MAXIMIZATION MODEL: Estimation the effects of civil war

We define first some key concepts. According to the World Health Organization (WHO), access to water is defined as the availability of at least 20 liters per person per day from a source within one kilometer of the dwelling (WHO, 2011a). In

the Guidelines for Drinking Water Quality (WHO, 2011b), water quality is defined in terms of microbial water quality (pollution levels from fecal microorganisms) and chemical water quality (pollution originating from the additives, the materials used in the potabilization and distribution of water). WHO also categorizes the sanitation facilities into: improved sanitation (connection to a public sewers, connection to septic systems, pour-flush latrines, simple pit latrines and ventilated improved pit latrines) and unimproved sanitation (service or bucket latrines where excreta is manually removed, public latrines and open latrines).

a) The household maximization problem

We assume that households maximize a utility $U(.)$ that is a function of a composite good X, a quality-adjusted amount of water $\overline{q}w$, the health of children in the household H_c, and leisure time ℓ. The composite good is priced in the market at a price p_X, and households act as price takers. The quality-adjusted amount of water is used for household consumption. Children's health is assumed to be a direct function of water consumption because the better the water quality and its availability, the more likely households are to engage in health-improving practices. Households act as price takers. The price of water p_w is also given and affects the household through the budget constraint. The utility function can be expressed as:

$$U\left(X, \overline{q}w, H_c\left(\overline{q}w\right), \ell\right) \qquad \textbf{Eq. III.1}$$

Water quality $\overline{q}$, observed by the household, captures both the quality of the drinking water and the level of sanitation available. It is assumed that $0 < \overline{q} < 1$, such that $\overline{q} < \widetilde{q}$ (with $\widetilde{q}$ representing the WHO standards) represents unimproved sanitation and microbial water pollution, and $\overline{q} \geq \widetilde{q}$ represents the appropriate sanitation technologies and levels of water quality (as described above). War may affect

sanitation infrastructure, which creates a source of water pollution. Any effect of civil war on sanitation will be captured by the value of the quality parameter. Households will not consume water, $w = 0$, if $\overline{q} < \widetilde{q}$, and the marginal utility of children's health will be negative.

Income originates from a monetary endowment Y that may be provided by family savings or from other types of assets the family owns, and wages r from participation in the labor market. Households observe the level of the wages in the market, and decide to allocate their total time between work, L, and leisure, ℓ (such that $L+\ell = 1$). The total budget constraint can be expressed as:

$$Y + (1 - \ell)\, r = p_X X + p_w w \qquad \textbf{Eq. III. 2}$$

Regardless of its causes (whether institutional failure or environmental degradation, as mentioned in the literature review), civil war is introduced into this model as a taxing mechanism that impacts both the total income, the prices of water, and of the composite good. For instance, Chen et al. (2008) mentioned that prices increase during civil war because of loose government monetary policy in need to fund the military campaigns. Justino (2008) points out changes in the prices of goods sold and purchased as one of the channels by which civil war reduces welfare of households. Another type of tax is on income. This tax might be the result of the actual destruction of assets and infrastructure, or it might be levied indirectly by the reduction of government expenditure on education (Lai and Thyne 2007), health, or other social/welfare services. Governments may also impose extra taxes on firms and wealthy citizens. It is relevant to mention that extortions and kidnappings act as a tax, reducing the available income of households. Perhaps, by increasing uncertainty and risks, war acts as a tax by reducing the overall level of economic activity (lower GDP growth), and by disrupting the smooth functioning of markets.

b) The civil war taxes

The civil war taxes and the overall environmental footprint of civil war will be defined by the intensity of the conflict itself. Following Gleditsch (1998, p. 393), war acts as an echo and the effects of violence weakens as time passes by. According to Mcneely (2010), the environmental effects can be created from massive disruptions or from small disruptions that are self-regenerated. It could be expected that the environmental impact of civil war at time t depends on the criminal or war events at time t, plus the echo or regeneration of violent and war events that occurred in time $t-1, t-2, \ldots, t-\tau$.

This paper deviates from the time series modeling of conflict, because the focus is not on the data generated process of the conflict data series, nor on the prediction of future conflict levels (as in Odhuno 2012). Time series motivates the need to incorporate some sort of lag structure for the representation of the medium-term and long-term conflict dynamics. Because the conflict data will be used in the framework of a household utility maximization model, we adapt and apply the concept of "habit formation" to the case of civil war. According to Carroll et al. (2000), individuals make their consumption decisions based on a habit stock, which is the weighted average of past consumption. The habit stock is, in this case, a stock of conflict-related events that impact a household's decisions by changing prices and income, acting as a tax. The stock is computed as an aggregation or weighted average for different lengths of time (1, 5, 10, and 20 years.). When using the weighted average, it is proposed that weights grow either at 10 percent or at 20 percent per year. Lower growth rates occur in values closer to a simple aggregation. Higher weights occur when the impact of conflict is mainly in the year prior to the survey. Therefore, households

cope with conflict depending on the length of the violent period they consider and the level of the stock of violence they would face.

Therefore, at any year t, the environment deteriorates due to a stock of violence SV_t, which households need to consider when coping with civil war. In computing this stock of violence, weights are given in such a way that the closer the civil war event is to year t, the more important the impact will be. The stock of violence is defined as $SV_t = \sum_{t-\tau}^{t} \beta_t V_t$, where β_t stands for the weight assigned to year t and V_t is the civil war intensity in year t, $t-1, t-2, \ldots, t-\tau$. τ is the length in years for which the individual calculates the stock of violence and that can be $\tau = \tau_1, \ldots, \tau_n$ years. To account for a higher weight in years closer to t, the weights are proposed to grow at a fixed rate such that $\beta_0 + (1+\eta)^{t-\tau} \beta_0 + \ldots + (1+\eta)^{t} \beta_0 = 1$ and $\eta = \eta_0, \eta_1, \ldots, \eta_n$.

Keeping the assumption that civil war taxes incomes and prices, it is expected that the income tax of civil war can be defined as a function $g(.)$ increasing in the stock of violence (SV_t) and decreasing in the quality of state and local/family institutions (QI_t). Better government and social institutions can support households in coping with civil war: governments can provide assistance in time of distress; households can support each other through kinship or social networks.

The income tax is bounded between 0 and 1, such that

$$T_\theta = g(QI_t, SV_t) \in \{[0 \ldots 1]\} \qquad \textbf{Eq. III.3}$$

The price tax of civil war is a function $h(.)$ decreasing in the quality of institutions and increasing in the stock of violence and, like the income tax, will be bounded between 0 and 1, such that

$$\pi_\alpha = h(QI_t, SV_t) \in \{[0 \ldots 1]\} \qquad \textbf{Eq. III.4}$$

Subscripts α and θ are used to simplify the notation for the derivation of comparative statics. These taxes are independent from each other ($Cov\left(T_\theta, \pi_\alpha\right) = 0$)

The utility maximization problem for the household during civil war is

$$\underset{X,\, w,\, \ell}{Max} \; U\left(X, \overline{q}w, H_c\left(\overline{q}w\right), \ell\right) \qquad \textbf{Eq. III.5}$$

$$s.t.\; \left(1 - T_\theta\right) Y + \left(1 - T_\theta\right)\left(1 - \ell\right) r - \left(1 + \pi_\alpha\right) p_X X + \left(1 + t_\alpha\right) p_w w = 0$$

The budget constraint reflects the effect of civil war on reducing income and its effect on increasing the prices of water and the composite consumption good.

c) Theoretical Results

After setting up the Lagrangian and deriving the First Order and Second Order Conditions, the comparative statics are calculated (for detailed derivation see Ortiz-Correa and Dinar, 2012).

The Second Order Conditions involve three terms. First, $\frac{r(1-T_\theta)}{p_X(1+\pi_\alpha)}$ stands for the net real income from labor of the household. It is a real income, because it is adjusted by the price of the composite good and it is net, since the civil war taxes are applied. Note that the household monetary endowment does not enter into this income term. This is a very interesting result, indicating that civil war impacts the household through its participation in the labor and goods markets. It also indicates that civil war acts by modifying the labor participation of the household and, therefore, the allocation of time. By changing the time allocation, civil war modifies the availability of household members to haul water or to supervise the children.

The second term, $\frac{U_{\ell w}+U_{\ell H_c}H_c'}{U_{Xw}+U_{XH_c}H_c'}$, has two components. The numerator is the gains in leisure from children's health and from quality-adjusted water availability; the denominator includes the changes in the marginal utility of the composite good from

changes in quality-adjusted water availability and from children's health. More availability of water can enhance leisure through more hygienic habits and/or spending less leisure time on hauling water ($U_{\ell w} > 0$). The positive effect of children's health on a household's marginal utility from leisure is represented by $U_{\ell H_c}$. A positive U_{Xw} indicates a complementarity between water and the composite good. Finally, U_{XH_c} captures changes in the marginal utility of the consumption of the composite good through changes in children's health. Note that the effects of children's health on leisure, and the consumption of the composite good, are amplified by H_c', and supposed to be directly dependent on the quality-adjusted quantity of water.

Finally, the third term is $\frac{U_{w\ell}+U_{H_c\ell}}{U_{wX}+U_{H_cX}}$. The positive effect of leisure on the marginal utility of water is captured by $U_{w\ell}$; leisure time helps families get water (if the water source is not on the premises) or to treat the water to make it drinkable, if necessary. A positive $U_{H_c\ell}$ indicates how leisure time can be used to enhance the health of the children in the household through more hygiene or healthier practices (more exercise and more supervision). More consumption of the composite good has a positive effect on the marginal utility of water, a positive U_{wX}, in so far some elements of the composite good are necessary for the consumption of water, such as treating, storing or hauling water. U_{H_cX} stands for the variations in the marginal utility of the children's health, as the consumption of the composite good is increased or reduced. Altogether, $\frac{U_{w\ell}+U_{H_c\ell}}{U_{wX}+U_{H_cX}}$ is the ratio of the changes in the marginal utility of water and children's health, resulting from changes in the amount of leisure and level of consumption of the composite good.

In order to fulfill the second order condition one of two results has to hold. Either $\frac{U_{\ell w}+U_{\ell H_c}H_c'}{U_{Xw}+U_{XH_c}H_c'} < \frac{r(1-T_\theta)}{p_X(1+\pi_\alpha)}$ or $\frac{r(1-T_\theta)}{p_X(1+\pi_\alpha)} < \frac{U_{w\ell}+U_{H_c\ell}}{U_{wX}+U_{H_cX}}$. The first result is $\frac{U_{\ell w}+U_{\ell H_c}H_c'}{U_{Xw}+U_{XH_c}H_c'} < \frac{r(1-T_\theta)}{p_X(1+\pi_\alpha)}$ or, in other words, the ratio of the gains in leisure to the gains in the composite good consumption derived from children's health, and water consumption is

smaller than the net real income. Three possible interpretations of this result can be offered. The first is that households require sufficient income to afford the water needed for healthy children in order to enjoy their leisure time and the consumption of the composite good, after adjusting for the effects of the civil war through reduced income and increased prices. The second interpretation is that household members cannot fully capture the benefits of healthy children at home (and that is why the effect only happens through leisure and composite good consumption). The third interpretation is that the household does not value the consumption of water by itself, even though it is a choice variable in its utility function. But, rather, it values water through its impact on leisure and consumption of the composite good.

The second possible result of the comparative statics is $\frac{r(1-T_\theta)}{p_X(1+\pi_\alpha)} < \frac{U_{w\ell}+U_{H_c\ell}}{U_{wX}+U_{H_cX}}$. This is the mathematical representation of the fact that it is impossible for all household members (not the children) to fully capture the benefits from healthier children and water availability. It is through decisions on tradeoff between leisure time and level of consumption of the composite good – both of which allow households to cope with the negative externalities of war. This term means that the changes in the marginal utilities of water and health of the children as a result of the variations in the consumption of leisure and composite good have a higher value than the net real income. This result implies that it is through the leisure time and the consumption of the composite good that households cope with the civil war.

Together, the first and second results of the second order conditions imply that $\frac{U_{\ell w}+U_{\ell H_c}H_c'}{U_{Xw}+U_{XH_c}H_c'} < \frac{r(1-T_\theta)}{p_X(1+\pi_\alpha)} < \frac{U_{w\ell}+U_{H_c\ell}}{U_{wX}+U_{H_cX}}$. That is, the lower bound of the net real income is the ratio of the gains in leisure and composite good consumption, originating from changes in the health of children and the quality-adjusted quantity of water. The upper bound is the ratio of changes in the marginal utility of water and children's health, resulting from leisure and the consumption of the composite good. Since

the effects of civil war are experienced through market mechanisms, lower wages and higher prices, households value more their leisure and the consumption of the composite good. Households, even with a strong altruistic motive, value the health of children and access to water as long as these are critical in defining participation in the labor market and consumption.

An increase in the price of water will decrease the amount of water consumed, $\frac{\partial w}{\partial p_w} < 0$, if $U_{XX}U_{\ell\ell} > U_{X\ell}U_{\ell X}$ (the product of the second derivatives is larger than the product of the cross derivatives of leisure and the composite good). This results from the convexities of preferences: since leisure and the composite good are needed for the consumption of water, households prefer more balanced bundles than having all the utility coming from only one of the two. Higher civil war tax on prices of goods or on income leads to less water consumed, $\frac{\partial w}{\partial \pi_\alpha} < 0$ and $\frac{\partial w}{\partial T_\theta} < 0$, if, first, the product of the second derivatives is larger than the one of the crossed derivatives ($U_{XX}U_{\ell\ell} > U_{X\ell}U_{\ell X}$); and, second, the ratio of gains in marginal utilities of water to health of children from leisure plus the composite good is greater than the net real income ($\frac{U_{w\ell}+U_{H_c\ell}}{U_{wX}+U_{H_cX}} > \frac{r(1-T_\theta)}{p_X(1+\pi_\alpha)}$).

The final comparative static indicates a positive relationship between water consumed and water quality ($\frac{\partial w}{\partial \overline{q}} > 0$). This relationship holds if one of two conditions is met. Either the net real income is larger than the ratio of changes in the marginal utility of leisure to the marginal utility of consumption of the composite good, both resulting from changes in the health of children and the quantity of water ($\frac{U_{\ell w}+U_{\ell H_c}H'_c}{U_{Xw}+U_{XH_c}H'_c} < \frac{r(1-T_\theta)}{p_X(1+\pi_\alpha)}$); or that the gains in water consumption and health produced by changes in leisure and the composite good are higher than the net real income ($\frac{r(1-T_\theta)}{p_X(1+\pi_\alpha)} < \frac{U_{w\ell}+U_{H_c\ell}}{U_{wX}+U_{H_cX}}$). Water quality influences through leisure and the consumption of the composite good. With a lower level of water quality, households may

be forced to spend more of their leisure time trying to get better quality water or to improve their sanitation facilities.

The children's health is defined as a function of the quality-adjusted water quantity ($H_c(\bar{q}w)$), any impact of either the civil war tax on income or on prices works through changes in the quantity of water. Another source of change in the children's health is the water quality ($\bar{q}$) as households consume different quantities of water when a new water quality is observed. Deterioration of children's health occurs when the household faces higher prices and lower income, and cannot afford purchasing what is required for the proper nutrition and wellbeing (like medicine and visits to the doctor) of the children. Low water quality is a source of infections for the children, due to the destruction of potable systems or sanitary services. Even if the quality is not reduced, less water consumed may imply that households cannot undertake proper hygiene practices and, therefore, children are more prone to infectious diseases. In practical terms, it may happen that households find themselves better off by facing the changes in access to water and sanitation that civil war brings about. For instance, by finding new remote source of water, households may actually have access to water with higher quality. This implies that households do learn to cope with civil war.

d) The hypotheses

The following hypotheses are formulated based on the interpretation of the comparative statics and are tested using the DHS sample and the internal armed conflict indicators for Colombia:

Hypothesis 1: The civil war tax on prices of goods and the civil war tax on income reduce the quantity and the quality of water consumed by households.

Hypothesis 2: An increase in any of the civil war taxes reduces the access to improved sanitation facilities and further reduces the quality of water[11].

Hypothesis 3: Children's health deteriorates when the civil war taxes increase.

Hypothesis 4: The quality of institutions counteracts with increases in the conflict intensity (i.e., its effect, in absolute value, is larger than the effect of the stock of violence).

V. DATA SOURCES

Two main sources of data were used for the empirical verification. First, the state-level yearly values of the selected conflict indicators, as reported by the Colombian national police. Second, the six waves of the DHS for Colombia. Conflict data was processed, as explained, by constructing a stock of violence (total, or per indicator) by the year each survey data was collected. These sources of data were supplemented for proxies of institutional quality with data reported by the Colombian Statistical Bureau (DANE).

a) Internal armed conflict data

[11]Even though water quality level is not directly addressed in the empirical section since such measure at the state level is not available, any negative impact of civil war on access to sanitation services, like lack of toilet connection to the sewerage, will reduce the quality of water. For example, reductions in the percentage of toilet connected to the sewerage system increases the probability of contact between the excreta and water sources (as defined by WHO).

The conflict data is reported by the Colombian national police[12]. The variables elected for our analysis are the most representative of the Colombian internal armed conflict (extortion, kidnappings, terrorist attacks, mass-murder victims, and attacks against the police per state per 100,000 inhabitants). For each conflict indicator, the stock of violence was computed as explained in the previous section. The stock was computed per state and, according to the DHS survey year, either as an aggregated or as a weighted average value for the entire period with a 10 percent growing weight ($\eta = 0.1$) or a 20 percent growing weight ($\eta = 0.2$), over different lengths ($\tau = 1, 5, 10, 20$ years). Higher weights assign higher importance to violence events closer to the survey year and smooths out time trends. Environmentally speaking, putting higher weight on recent violent events accelerates the decay of the environmental impact of violence from previous years. Such a decay can be explained by the recuperation of natural systems or because households learn to react or to cope with conflict in the long run. A stock of violence was also computed by applying principal component analysis to all the conflict variables at the state level, after using the proposed aggregation or averaging procedure.

b) Demographic and Health Surveys

The second source of data is the DHS (Demographic and Health Surveys). We use all six waves of surveys of the DHS that correspond to different stages of the Colombian

[12]The Police codes the criminal events per year and per police units. Most of the police units are of state-level jurisdiction. The police units with national jurisdiction were discarded for the purpose of this paper. Data from police units with jurisdiction in the capital city of a state was added to the data of the state in which the city is located. Far more difficult to handle is the data reported for some police units with jurisdiction in more than one state; these units are usually located in violent regions covering bordering regions of two or more states. As the identification of the environmental effect of the internal armed conflict on access to water and sanitation services is intended to be estimated at the state level, information was gathered from Colombian police and military personnel to assign a weight for each of the states that have a share of its territory covered by one of these special police units. For instance a special police unit has jurisdiction over some municipalities of state X, and over some of state Y; the educated guess is that 60 percent of the criminal incidents happened in state X, and the remaining in state Y; then 60 percent of the conflict indicators reported in that unit go to the data of state X, and 40 percent to the data of state Y.

internal armed conflict. The wave of 1986 was collected during the last years of the low-intensity conflict period. The wave of 1990 has data gathered during the peak years of the drug-cartels terrorist offensive. By 1995 (the third wave), LWT were fully involved in drug trafficking and the RWT were rapidly expanding. The highest levels of LWT- and RWT-committed crimes took place around the fourth wave of 2000. The last two waves, in 2005 and 2010, were collected during the years of the government offensive on all terrorist groups.

DHS offers a full picture of the households sampled, its location and its composition, some physical features of the dwelling, and very detailed information about the reproductive. Nonetheless, DHS is not a panel data and does not track households over time; moreover, it does not record changes in mother's and father's features as every child was born. DHS only asks for details about health of the children born during the five years prior to the survey. Another weakness, and perhaps the most important when considering the impacts of armed conflict, is that DHS does not report any path of migration or relocation. This last weakness is not a major obstacle, since the focus of this paper is on the access to water and sanitation services at the time of the survey and not over time. A final point is that the newer (2005 and 2010) survey waves covered more states and, as a consequence, the number of households drastically increased.

The following variables were used or created, based on the DHS reported variables. First, water on premise is a dummy for all households whose main source of water is piped water, a well in the residence, the yard or the plot, rainwater, or bottled water. When the water source is not on premise, the DHS asks for the time spent going back and forth from the water source. The time to water source is used as an opportunity cost of water, because that is a time the household cannot allocate to

the labor market or leisure activities. The last variable measuring access to water is having piped water to the premise as the main source. This variable takes the value of 1 for households that use the publicly operated or private (rural) aqueducts, and 0 otherwise. Piped water is presumed to supply water of higher quality. Only one variable is related to the sanitary services – the type of toilet at the household. We devised a dummy variable that takes the value of 1 for households that have their toilets connected to the sewerage system, and the value 0 otherwise.

Households are classified as urban, when living in major cities or in what DHS considers urban areas (not towns, villages, or countryside). Living in an urban area is likely to translate into a higher probability of access to piped water and sanitation services connected to the sewerage system. The mother in the household is classified as married, if she is actually married or is living with her partner. This marriage variable is an indication of income and access to family related support networks. Education variables for the mother of the household are also constructed given the highest schooling level completed: no education, primary, secondary, or higher education. The last two variables are the children's health indicators. DHS asks whether the children born during the five years prior to the survey had diarrhea in the last 24 hours or within the last two weeks, and whether or not they had fever during the last two weeks.

Table III.1 presents the summary statistics (proportion and averages) of all variables. With respect to water on premises, there is an overall increase since 1986. Interestingly, the time to water source has risen for those households that do not have their water sources on the premises. We tested, empirically, if the conflict-driven effects were behind this hike. Piped water seems to be the main source of water for most Colombian households. Most households have electricity and their toilet connected to the sewerage system. Certainly the high values for the access to

water-related variables are explained by the large proportion of households located in urban areas.

Larger proportions of women have secondary and higher education. More women are head of households (the proportion of male head of household has been on the decline) and less of them are married or living with their partners. Perhaps, as more women are head of households and are not bonded by marriage, they prefer to stay living in the same place they were born in order to enjoy the support of the extended family or kinship networks. As for the two indicators of children's health related to water, diarrhea and fever, there seems to be an abatement when comparing the proportion of children with diarrhea or fever in 1986 to the proportion in 2010. This overall reduction is intertwined with variability in the years in between. This irregular pattern might be caused, as it will be tested, by the variation in conflict intensity.

c) Institutional quality variables

The last source of data is composed from the Colombian bureau of statistics (DANE) figures to create what we define as "quality of institutions." This term would include all government-level or social-level variables than support households in coping with conflict or, in terms of our theoretical model, reduce the effect of the war taxes on price and income. The choice of these variables was based only on data availability. The only data available, covering most of the period of analysis, is on education and growth of GDP per capita[13]. Education indicators at the state level can be a proxy for a better government effort in providing services that households need during conflict. Better education can also signal higher social capital and, therefore, stronger social networks supporting and helping the households (Holzmann 2001). A state with a more educated population can be one in which citizens tend to cooperate with the

[13]Auxiliary regressions that are not reported in this paper but available upon request indicate that the education data does not seem to be impacted by any of the measures of the stock violence.

authorities and, by doing so, help fighting against the criminals and the terrorists (by reducing underreporting, as in Fajnzylber et al. 1998) . Better-educated citizens make better decisions about sanitation, hygiene, and about the use of water and natural resources. Finally, a state with higher GDP growth per capita is a state in which households have more job opportunities and more income available. Furthermore, higher GDP growth may indicate that the state can provide better services to its citizens, helping them cope with the violence.

The variables chosen for primary and secondary education were: gross enrollment rate, students-to-teacher ratio, the students-to-school ratio, and the teachers-to-school ratio. The value of each of these variables is for the year before the survey. Summary statistics of these variables are presented in **Table III.2**. There is a reduction in the average GDP growth per capita after 1990, which ended in the economic crisis of 1990-2000, but there is a sustained growth after 2002. As for gross enrollment, almost all children are enrolled in primary education. Some values are larger than 1, due to grade repetition and because some children may start older than expected. Secondary education is problematic, although the enrollment figures show an overall increase in the period under analysis. Student-to-teacher ratios show increase until 2002, but they have declined in recent years.

VI. IDENTIFICATION STRATEGY

a) Econometric model

We developed the following model to test the validity of the hypothesis about the effect of armed conflict on the access to water and sanitation services, as well as on children's health, using the data from Colombia.

$$Indicator_{hst} = \beta_0 + \beta_1 SV_{st} + \beta_2 PrimStudTeach_{st-1} + \beta_3 SecStudTeach_{st-1} + \beta_4 Growth_{st-1} + \gamma X_{hst} + \theta_s + \delta_t + Statetrend_{st} + \varepsilon_{hst} \qquad \textbf{Eq. III.6}$$

where the dependent variable, $Indicator_{hst}$, is a dummy variable taking into account whether household h in state s surveyed in year t has access either to water on the premise (Hypothesis 1), to piped water (Hypothesis 1), or to a toilet connected to the sewerage system (Hypothesis 2). SV_{st} is the stock of violence aggregated over 1, 5, 10, or 20 years, as a 1, 5, 10, or 20 years weighted average as described in the previous sections. As for the institutional level variables, the quality of institution is proxied by $PrimStudTeach_{st-1}$ and by $SecStudTeach_{st-1}$, namely the primary and secondary education students-to-teacher ratio in the year before the survey in state s; and by, $Growth_{st-1}$, which is the GDP growth per capita, also in the year before the survey in state s. X_{hst} represents household level controls (related to the location). θ_s are the state fixed effects to control for the state level invariant features; δ_t stand for the survey year fixed effects to control for shocks in the year of the survey that are common to all the households. Since there might be other time-variant variables correlated with access to water and sanitation services, state-specific trends, $Statetrend_{st}$, are included in the estimations, allowing each state to have a different trend in terms of access to water and sanitation services. The equation will change when testing the impact of conflict on the price of water. The impact on the price of water is going to be tested by using as a dependent variable the time to and from the water source, for those households with no access to water on the premise.

It is expected that the coefficient of the stock of violence is of a negative sign, whether using each conflict indicator or an aggregate measure of conflict (by adding the criminal events per year per state or by principal components analysis). Terrorist attacks may delay the construction of water systems. Even worse, the destruction

can result in the pollution of water sources as an indirect effect. Attacks against the police are a proxy of the vulnerability of the government to provide services. If the police forces are attacked, they cannot assure the safety the government institutions need, for instance, to build or to maintain water and sewerage systems. There is a random element in mass-murder or massacre cases because many of the victims could not be directly related to the main assassination target. The risk of being a mass-murder victim may prevent households from going to places where there is a high risk of a massacre occurring, restricting their access to the water sources or to purchase of items needed for sanitation and hygiene.

Access to water and sanitation services is affected from increases in kidnapping, due to the reduction in the overall economic activity as uncertainty increases. It could be possible that utility companies can no longer perform maintenance of water and sanitation services out of fear for their staff being kidnapped; even households can no longer approach their traditional sources of water as they also fear of being apprehended by the terrorist groups. Mainly in urban areas (particularly poor neighborhoods), but still common in rural areas (especially those with agribusiness or mining), terrorist groups may extort business owners and residents through a tax on the price of goods or demanding frequent payments. With the higher prices and frequent payments, households may not afford to get better quality water or to build better sanitary services at their dwellings.

Testing Hypothesis 4 is not straight forward. When GDP growth per capita is higher, the government and households spend more on water and sanitation, and other supporting services. The situation is more complicated when it comes to the education variables. The students-to-teacher ratios are better measures of the quality of institutions, since they provide information about the resources the government spends on providing higher quality education. Enrollment figures, although relevant,

are not as indicative of the resources the state allocates to provide and to enhance the educational services. Nevertheless, the armed conflict may force the government to face a tradeoff – in order to fund the military campaigns or due to the reduced income brought about by the conflict, the government may not have sufficient funds to improve education and access to water and sanitation services all together. In this case, an improvement in education (a reduction in teacher-to-student ratio) can only be feasible by worsening access to water and sanitation services indicators. Then, the coefficients of the students-to-teacher ratios are of a positive sign. On the contrary, improved education ratios enhance access to water, either because it signals more government expenditure or because more educated people care more about water and sanitation; thus, the coefficients will be negative.

As for children's health (Hypothesis 3), the equation is:

$$Health_{ihst} = \beta_0 + \beta_1 SV_{st} + \beta_2 PrimStudTeach_{st-1} + \beta_3 PrimStudTeach_{st-1} + \beta_4 Growth_{st-1} + \gamma X_{hst} + \alpha \Pi_{ihst} + \theta_s + \delta_t + Statetrend_{st} + \varepsilon_{ihst} \quad \textbf{Eq. III.7}$$

The dependent variable, $Health_{ihst}$, takes two forms – an indicator variable for children that had diarrhea in the last 24 hours or within the last two weeks prior to the survey day, or an indicator for children who had fever in the last two weeks prior to the survey day, as in the DHS questionnaire. Notice that this regression is at the individual level, namely, child i in household h in state s surveyed in year t. For that reason, individual level control variables, in vector Π_{ihst}, are included in Equation 7. Signs switch for the coefficients of interest in this equation. For example, higher conflict intensity leads to more children with fever or diarrhea (a positive sign of the stock of violence coefficient). Positive signs are also expected for the coefficients of the education variable, because improvements in education could indicate that the government spends more in social services, which may reduce the incidence of fever and diarrhea. Finally, higher GDP per capita growth rates reduce the number of

children having water-related illnesses through better nutrition or access to higher quality water.

b) Threats to validity

Differences in access to water and sanitation services across states may also be explained by unobserved variables. As long as those unobserved variables are time invariant at the state level, for instance geography or political institutions, those differences are taken care of by introducing state-fixed effects. Additionally, any invariant factor that might be related to both the internal armed conflict and the delivery of services is controlled by using the state-fixed effects. If differences arise from changes that are common to all households, regardless of their state of residence in the year of the survey, those differences are purged by using survey-year fixed effects.

Access to water and sanitation involves a demand and a supply side. Regarding the demand side, it is assumed that households have the same preferences over water and sanitation services: households would prefer higher quality water and, in consequence, better sanitation facilities, as well as having the water sources as close as possible to their dwellings. Given the Colombian water market legislation, the construction and development of water and sanitation infrastructure can take different paths across states and, more importantly, subject to political cycles. For instance, local governments might be unable to provide water and sanitation services as civil war may constraint their budgets or may destroy water infrastructure that remains unrepared. All of these differences will be controlled by allowing state-specific paths of access to water and sanitation services, assuming that households' preferences over water and sanitation remain the same regardless of conflict intensity.

This paper focuses on access to water and sanitation services at the moment of the survey and not on the pattern over time. This is not to say that such a pattern

does not exist, and it is entirely possible that households experienced changes in the access to water throughout time due to civil war. Furthermore, it is possible that civil war could have forced the relocation of the household in a different state. Relocation can pose a problem for the estimation and biased the results. Households that are observed with lower access to water and sanitation services in more violent states, may end up being observed in less violent states and with a higher access to water and sanitation services.

Another threat to identification refers to the regression at the individual level – those for the health of children. Parents may have different preferences over the investments needed for their children's development, or their health. A strategy in this case would be to include a household fixed effect, assuming that those preferences are time invariant at the household level. Instead, the strategy chosen is to include as controls the maternal level of education and the location of the household.

DHS surveys households with women in reproductive age. Other households, with women in older age, are not included in the sample. The main concern is the exclusion of the households with older women (45 years and older) because it is reasonable to assume that women of younger age (from 0 to 14 years) are included as offspring in the households of women of reproductive age. With figures from the Colombian bureau of statistics (DANE 2012, Population series 1985-2020) for the years DHS were collected, women of reproductive age are roughly 46% of the total women population. By including this group, DHS allows to focus on the groups of women for whom access to water really make a difference in their fertility decisions.

The final threat to the identification strategy comes from a measurement error in the conflict data. It is possible that the conflict indicators may suffer from underreporting. This would be true in the case of extortions (not all households may have incentives to report of being extorted), but not the rest of the indicators, when the

whole society and the news media keep track of terrorist incidents and kidnappings. It is also possible that violence is not homogenous throughout the state. However, the theoretical model is not based on direct exposure to conflict, but on how conflict impacts a household's income and the prices that exist in the markets. As some measurement of error can still be possible, the results to be presented have to be considered a lower bound[14].

Finally, standard errors could be correlated at the state level, since the stock of violence is computed for each state. More precise standard errors are obtained by clustering the standard errors at the state level.

VII. ESTIMATION RESULTS

This section presents the results of the estimations at the household level (for access measures), and the individual level (for the health variables). The baseline models presented in equations 6 and 7 were estimated using Logit for the categorical-dependent variables (access to water on premise, access to piped water, access to toilet connected to the sewerage, and incidence of fever and diarrhea). Regular panel data estimation was employed for the regression on the time spent to and from the water source (measured in minutes). Those equations were modified to account for possible nonlinearities. If civil war leaves its impact on the environment and the water systems, having an echo tail, then a nonlinear relationship is needed. We employed a quadratic term for the stock of violence.

The results from the Logit estimations report the marginal effects, which represent a net state average effect of conflict on the access to water and sanitation services. It is the net effect after purging out some institutional, economic, and household

[14]The estimation does not distinguish between direct or indirect target of the violent events, whether the targets are households (or even foreign visitors) where the attacks took place or in neighboring places within the state. The impact through the stock of violence affecting the Colombian households in the sample is assumed the same on all households.

features variables, because the data does not allow capturing independently all the income and price effects that take place while households make decisions. It is an average effect, due to the inclusion of state-fixed effects. The coefficient of the stock of conflict should be read as the average effect of civil conflict on access to water and sanitation services, as well as on children's health indicators across states, after controlling for time and state-fixed effects, and for state-specific trends.

The following tables contain only the marginal effects of the coefficients on the conflict indicators[15]. The discussion of the results is based on the total probability change (linear plus quadratic terms of the stock of conflict).

a) Household-level regressions

These regressions estimate how civil conflict affects a household's access to water on the premise, piped water, toilet connected to the sewerage, and time spent to and from the water source. Here only the most relevant tables of results are presented.

Household's access to water on premise (**Table III.3**)

Among the control variables, only the dummy variable for urban households is significant and indicates higher probability (7 percent) of urban households having water on premises than their rural counterparts. As for the conflict indicators, kidnapping, aggregated or averaged over five years, increases the probability of water on premises by 0.4 percent. Another positive relation, only around 0.6 percent, exists between the attacks against the police and the access to water on the premises. When the risk of being kidnapped is higher and the police are under attack and cannot provide safety to the citizens, households will invest in getting the water inside their dwellings to avoid being targeted by violence while searching for water outside their premises.

[15]Tables with full results are available in Appendix 2 (Ortiz-Correa and Dinar, 2012)

Household's access to pipped water (**Table III.4**)

As can be expected, urban households have a higher probability (32 percent) of having piped water, compared with rural households. Another interesting finding is that an increase in the students-to-teacher ratio leads to an increase in piped water of around 0.1 percent. There might be, at some level, a tradeoff between government spending on education and in water systems, which is reasonable in a country with a budget under the pressure of military expenditure. On the conflict variables side, the aggregation of extortions over 20 years reduces the probability of access to piped water by 7.7 percent (significant at a 5 percent level). Another negative relationship is found with the number of mass-murder victims. Aggregating or averaging mass murder victims over 5 and 10 years reduces access to piped water by 2 percent and 9 percent, respectively. By increasing prices or reducing the households' incomes, extortion makes it difficult for the households to afford having access to piped water. The effect through the number of mass-murder victims may indicate that massacres bring such a disruption in the functioning of the society that the government and the water utilities cannot provide water services or cannot extend the water systems coverage.

Household's access to toilet connected to the sewerage system

Households dwelling in urban areas have a 71 percent higher probability of getting the toilet connected to the sewerage system. The number of terrorist attacks aggregated over 20 years before the survey increases by 10 percent the probability of connection to the sewerage system, but reduces it by 20 percent when using the 10 percent weighted average procedure. When attacks against the police are aggregated for 10 years, there is a 16 percent higher probability of connection. Surprisingly, there is a sign switch in the case of mass-murder victims aggregated for 10 years before the survey: the aggregation leads to a 68 percent increase in the probability, but the 10

and 20 percent averaging result, respectively, led to a 14 and 38 percent reduction in the probability. It has to be noted that the series for the mass-murder victims is relatively shorter, when compared to the other series of conflict indicators, and the coefficients may respond to a change in the sample. This result is surprising, since it would be reasonable to assume that mass murders and attacks against the police disrupt the delivery of essential services. One explanation is that the government and the households have internalized the effect of terrorism: governments rebuild the sewerage network or expand the service, and households adopt by moving to a different service. The sign switch calls attention to the relevance of the kind of conflict information households use in order to make their decisions.

Households' time spent to and from the water source

Kidnapping events one year before the survey reduce the time spent by 1.5 minutes, and increase the time spent by 1.6 minutes and up to 4.3 minutes, when the figures of kidnappings are aggregated for 10 and 20 years, respectively. Households may react by changing the water sources to closer ones, but may resort again to further water sources after processing the information about the likelihood of being kidnapped by terrorist groups. Paradoxically, the attacks against the police increase the time spent by 5 minutes, in the case of the 5 years aggregation, and reduce it to 4 minutes, in the case of the 10 years aggregation. Families may be forced to substitute water sources, when they do not have access to water on premise, or piped water, and they may go to sources that are away from locations police are clashing with the terrorist groups. The coefficients skyrocket for the 10 years aggregation and averaging of mass-murder victims, with reductions taking values of 95 minutes (10 years aggregation), 44 minutes (10 percent averaging for 10 years), or 32 minutes (20 percent averaging for 10 years). With the same reasoning, households may prefer to spend less time in getting the water they need rather than being around water sources where they

can be victims of massacres. This is particularly relevant, if women and children are responsible to haul the water from the water source, as forced recruitment and sexual abuses are common during civil war.

b) Individual level regressions (children's health)

The following results use the individual level data on incidence of diarrhea and fever occurring in children during the last two weeks before the survey. DHS only asks for detailed information of children born during the five years prior to the date of the survey. The structure of the DHS may act as strength for the estimation, since this group (aged 5 years or younger) is the most vulnerable to diarrhea and infectious diseases. Nonetheless, the structure of the DHS also acts as a weakness, since the proposed theoretical model focuses on all the children of the household. As a consequence, this section of the results has to be taken with caution, and as a sort of a lower bound due to the sample restriction.

Incidence of diarrhea in children (**Table III.5**)

Children living in urban settings have a 1.8 percent less probability of developing fever. Higher GDP per capita growth during the previous year increases the probability of diarrhea, with values that range between 25 and 28 percent. Since coefficients represent net average effects, it may be that the gains in nutrition explained by a higher income are offset by the increased labor opportunities for the parents that, in turn, reduce the time they spend taking care of the children. As for the conflict indicators, the number of the extortions in the year before the survey increases the likelihood of diarrhea by 7.4 percent; however, when aggregating the number of extortions over 10 years, the probability is reduced by 10 percent. It seems that the immediate threat of extortion, through its price and income effects, reduces the welfare and worsens the health of children; on the contrary, in the long run, households may adapt to the threat of being extorted, and that explains the sign switch. The terrorist attacks in

the year before the survey reduced the probability of diarrhea by 1 percent. The 10 years averaging of attacks against the police also reduced the probability by 11 percent (for the 10 percent averaging) and 8 percent (for the 20 percent averaging). This reduction could be caused by the fact that parents may take precautionary measures (such as increasing the leisure time they spend with children, which translates into more parental supervision and better health).

Incidence of fever in children (**Table III.6**)

The control variables suggest that children living in urban areas face a 2.1 percent higher risk of experiencing fever over the two weeks prior to the survey. It is possible that more agglomeration makes easier the contagion of the infectious processes causing fever. In this line, larger secondary students-to-teacher ratios raise the likelihood of fever by values ranging from 1 to 2 percent. The aggregation or averaging of the terrorist attacks for five and 10 years reports an increase of the fever probability around 2 percent. It may be that the terrorist attacks cause pollution (due to the debris and the destruction of infrastructure), but also that children experience the post-traumatic stress disorder that weakens their health. Finally, the number of mass-murder victims in the year before the survey reduces the probability of fever (close to 3 percent), but the aggregation for five and 10 years consistently increases up to 19 percent. Using the 10 percent and 20 percent weighted average for five and 10 years raises the probability around 6.5 percent. Again, the post-traumatic stress disorder may explain this result.

c) Robustness checks

Total conflict and total conflict factorial

The first robustness check deviates from the use of the leading conflict indicators for Colombia and creates a measure of total conflict. This strategy takes into consideration that the environment and the population may suffer from the overall violent

climate created by the civil war. It assumes that the whole process of violent conflict, operating jointly through the different types of crimes, is the one causing the negative externalities for the environment and the households. A variable named "total conflict" was computed by adding all the criminal incidents per state per year, assuming equal impact for each. It then applies the proposed one, five, 10, and 20 years aggregation or weighted average (10 percent and 20 percent growing weights). Since it is not clear how the aggregation process works, and since the five measures of conflict are correlated, a principal component analysis was applied. The first factor of a factorial analysis over the chosen five measures of conflict per state and per year was then computed. This factorial measure was also aggregated or averaged as described in the data section.

The coefficients suggest that total conflict and total conflict factorial increase the probability of having water on premise by 0.5 percent. A sign switch occurs during time spent traveling to and from the water source: the total conflict measures during the previous year translates into a 1.4-minute reduction in the time the household spends, but the total conflict during the previous 20 years increases the time by 2.8 minutes. The factorial measure of the conflict aggregation results in a 9-minute increase, but a 16-minute and 42-minute reduction in time spent when the aggregation is made for 10 and 20 years before the survey. All these values may hide a tradeoff between quantity and quality, with households preferring closer water sources with low quality. The lower the quality, the more the households have to spend on treating the water at home (boiling the water or using bleach), but this might be the only option when the civil war level is high.

As for the individual level regressions, total conflict during the year before the survey increases the probability of children having fever by 0.5 percent, while total

conflict factorial over the same period reduces the probability by 5 percent. The difference in sign and in magnitude between these two measures can be an indication of how households may react to different conflict intensity information and, moreover, how they can help their children to cope with the post-traumatic stress disorder (Nersisyan, 2006).

Difference in difference procedure (**Table III.7**)

In 2002, the government of President Alvaro Uribe took office and launched an offensive against the LWT and RWT groups throughout the country. Although the offensive had a national reach, it was specially focused on the territories in which the terrorist groups carried out most of their criminal activities. The offensive went on until the end of Uribe's government in 2010, a period that has seen the most drastic reduction in the conflict indicators. Using this quasi-natural experiment, a difference-in-difference estimation is carried out as a robustness check of the results. The year of the beginning of the offensive, 2002, will divide the surveys into two groups: surveys that took place before the offensive (1986, 1990, 1995, and 2000) and surveys that took place after the offensive started (2005 and 2010). The treatment group contains the states that received the main burden of the offensive, while the control group includes those states in which the offensive was not as intense. States were classified within these groups according to two criteria: first, whether the state was traditionally a place for the high intensity of the terrorist activities; and second, whether the state had a total conflict indicator per year that was above the national average in more than 50 percent of the years up until the offensive. Not presented here, but available upon request, is a summary of statistics indicating that there are no observable differences (from the DHS and quality institutional variables) between the treatment and the control groups before the offensive.

The regression equations for the difference-in-difference include the institutional quality variables (GDP growth per capita and the students-to-teacher ratios for primary and secondary education), and state-specific trends. The results indicate that the offensive during the Uribe government led to an increase of nearly 9 percent in the incidence of fever. Such an increase in fever could be explained by the possible post-traumatic disorder that children living in the offensive states could have experienced. It seems that intensity, measured in the civil war events per 100,000 inhabitants per state and per year, does matter in order to measure the impact of conflict on access to water and sanitation services. Besides, it can be that the government offensive may have, at most, offset the negative impact of conflict on access to water and sanitation.

VIII. CONCLUSION

Civil war takes a toll on the environment through the destruction of infrastructure and the pollution generated from combats, sabotage, and preparedness for war. Additionally, civil war forces the relocation of populations, thus abandoning natural resources and infrastructure, or conversely, leading to massive inflows of refugees that places extra pressure on the resources in the receiving communities. Water sources and systems, as well as sanitation services, suffer directly from the destruction and pollution, and indirectly through the changes in the expenditure of government and households. Governments relocate their expenditure to fund the military efforts, leading households to suffer from increased prices and reduced incomes, due to war. Because of the changes in access to water and sanitation, children may experience water-borne diseases, as well as diseases caused by poor nutrition and post-traumatic stress disorder.

This research proposed a household utility maximization model to understand how households cope with civil war impacts on access to water and sanitation services. It is

assumed that households' decisions are aimed at coping with the negative externalities of war violence and that the environmental effect of the civil war stays as an echo in the natural systems. Another assumption is that daring civil war acts, simultaneously, as a price tax and income tax on the households. Four hypotheses are tested out of the theoretical model with the econometric models. In summary, higher civil war intensity reduces the access and the quality of water; access to toilets connected to the sewerage system is reduced by higher conflict intensity; civil war leads to deterioration of the health of children; and, the quality of institutions can counteract the negative effects of civil war on access to water and sanitation services.

Using the Colombian civil war as case study and using six waves of the DHS for that country, the effect of civil war is estimated on the access and sanitation services at the household level and on the health-related variables at the individual level. The main results indicate that the effect of civil war is significant and its sign, whether negative or positive, depends on the length of the aggregation or averaging of conflict (or violence) indicators. Furthermore, the relationship is not linear, as significant squared terms are found for most of the estimations. With respect to the hypotheses, it can be said that civil war does reduce the access to water and sanitation services and worsens the health of children; however, there is evidence of some positive effects that ought to be interpreted as the result of households' strategic behavior and adaptation to the reality imposed by conflict. The up to 9-minute increase in the time households have to spend to and from the water sources points out an increase in an opportunity cost. With a back of the envelope calculation, using the monthly $317 minimum monthly wage (Portafolio, 2011) and assuming that households may need to get water at least three times a week, the effect of conflict represents 27 more minutes per week or 108 minutes a month, which has a labor equivalent value of $3.56, nearly 1 percent of the monthly wage. Given that the change in the quality of water is not

directly controlled, it can only be assumed that the exposure to lower-quality water forces the household to reallocate additional financial resources for potabilization and purification. Finally, it seems that the institutions, or at least the institutional variables considered in the empirical part of this paper, have no significant effect on the access and health measures and, therefore, cannot counteract the negative effect of conflict.

Possible interventions are necessary during any war, but war itself makes it difficult for any government to solve the trade-off between military expenditure and investment in health, education, water, and other social needs. Nevertheless, as part of the strategy to win minds and hearts during civil war, governments could invest in granting access to water and sanitation services to households – especially for those who were forced to relocate – and to increase the health services for children. Feasible interventions can be of the sort of investing in the maintenance of water systems in pacified areas or in areas that can be receiving refugees. To avoid shortages or to reduce the time households spend on getting water, government could deliver tank trucks that distribute water where needed. Finally, governments could design programs, such as health brigades or the distribution of nutrition supplements, targeting children and their caretakers.

Further research needs to use panel data at the household level, where available, from countries under war or civil war, as well as other methods for aggregations or averaging various conflict indicators. Panel data will allow researchers to track the access to water and sanitation services of a household over time, offering a more complete picture of the household's strategic behavior. The use of several conflict indicators can help find the measure households use as a basis for making their decisions and to account for the environmental effect of war. Additional research may also explore the differential impact according to the household composition, the ages

of the children and the age of parents in order to assess the relevance of fertility as a reason to have access to improved water sources and improved sanitation services. Further research should address the problem of the institutional variables at the community or extended-family level to control for the support networks households rely upon when living under civil war conditions.

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Tables and Figures Chapter III

Table III.1: DHS Variables of Interest summary statistics (proportion)[a]

Variable	1986	1990	1995	2000	2005	2010
	Household level					
Pipped water main source of water	0.742	0.879	0.801	0.853	0.758	0.714
Water on the premise	0.809	0.952	0.912	0.952	0.938	0.946
Time to water source (minutes)	13.461	19.756	16.737	18.990	17.649	17.800
Sanitary services connected to sewerage system	0.625	0.786	0.674	0.693	0.690	0.652
Electricity in the household	0.849	0.942	0.919	0.957	0.963	0.950
Household located in urban area	0.694	0.859	0.719	0.734	0.751	0.705
Respondent always living in the sample place	0.328	0.387	0.377	0.420	0.438	0.431
Respondent with no education	0.081	0.045	0.053	0.047	0.041	0.030
Respondent with primary education	0.586	0.448	0.448	0.407	0.353	0.329
Respondent with secondary education	0.302	0.429	0.427	0.449	0.467	0.472
Respondent with higher education	0.030	0.077	0.072	0.096	0.139	0.168
Respondent currently married	0.800	0.776	0.755	0.715	0.697	0.716
Male head of household	NA	0.801	0.791	0.737	0.705	0.677
Number of households	3043	5086	7109	7825	24241	35126
	Individual level					
Children with diarrhea	0.188	0.121	0.168	0.142	0.151	0.143
Children with fever	0.299	0.197	0.273	0.254	0.256	0.270

[a]Source: DHS. Authors' computations

Table III2: Summary statistics of quality of institutional proxy variables (averages)[a]

Variable	Year of the survey					
	1986	1990	1995	2000	2005	2010
GDP percapita growth	0.037	0.045	0.019	-0.039	0.013	0.014
Primary gross enrollment rate	0.933	1.044	1.059	1.145	1.163	1.103
Secondary gross enrollment rate		0.387	0.544	0.668	0.816	0.730
Primary students-to-teachers ratio	27.713	25.225	23.546	21.900	26.368	24.857
Secondary students-to-teachers ratio		18.301	19.179	16.863	24.363	20.159
Primary teachers-to-school ratio	3.604	4.057	3.724	3.586	3.311	3.226
Secondary teachers-to-school ratio		17.803	17.304	14.604	7.244	10.321
Primary students-to-school ratio	100.121	102.801	88.015	78.690	87.616	81.464
Secondary students-to-school ratio		326.635	326.365	246.704	185.738	209.031

[a]Source: DANE. All variables computed in the year before the survey to be consistent with the armed conflict intensity data

Table III.3: Effect of conflict on household's access to water on premises[a]

Conflict Indicator	Regression Information	Aggregation 1 year	Aggregation 5 years	Aggregation 10 years	Aggregation 20 years	Averaging $\eta = 0.1$ 5 years	Averaging $\eta = 0.1$ 10 years	Averaging $\eta = 0.1$ 20 years	Averaging $\eta = 0.2$ 5 years	Averaging $\eta = 0.2$ 10 years	Averaging $\eta = 0.2$ 20 years
Kidnappings	Linear	0.001	0.003	-0.001	0.000	0.004	-0.001	0.002	0.003	-0.001	0.002
		(0.001)	(0.001)**	(0.001)	(0.002)	(0.001)***	(0.001)	(0.003)	(0.001)***	(0.002)	(0.002)
	Quadratic	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		(0.000)	(0.000)**	(0.000)	(0.000)	(0.000)***	(0.000)	(0.000)	(0.000)**	(0.000)	(0.000)
	Observations	77464	77464	77464	77464	77464	77464	77464	77464	77464	77464
	R-Squared	0.305	0.3120	0.3060	0.3038	0.3125	0.3046	0.3041	0.3117	0.3038	0.3044
Attacks against the Police	Linear	0.006	-0.002	0.045		-0.003	-0.005		-0.003	-0.006	
		(0.002)***	(0.003)	(0.022)*		(0.004)	(0.003)		(0.004)	(0.003)*	
	Quadratic	0.000	6.97e-06	-0.011		4.97e-06	0.000		0.000	0.000	
		(0.000)***	(0.000)	(0.005)*		(0.000)	(0.000)		(0.000)	(0.000)	
	Observations	77464	73225	66116		73225	66116		73225	66116	
	R-Squared	0.3124	0.2998	0.3196		0.3006	0.2857		0.3014	0.2867	
Total Conflict	Linear	0.002	0.001	0.000	0.000	0.002	0.000	0.001	0.002	0.000	0.001
		(0.001)*	(0.001)*	(0.001)	(0.002)	(0.001)**	(0.001)	(0.001)	(0.001)*	(0.001)	(0.001)
	Quadratic	0.000	0.000	0.000	-8.68e-06	0.000	-5.09e-06	0.000	0.000	-5.42e-06	0.000
		(0.000)	(0.000)**	(0.000)	(0.000)	(0.000)**	(0.000)**	(0.000)	(0.000)**	(0.000)	(0.000)
	Observations	77464	77464	77464	77464	77464	77464	77464	77464	77464	77464
	R-Squared	0.3089	0.3081	0.3055	0.3038	0.3082	0.3042	0.3041	0.3079	0.3039	0.3044
Total Conflict (Factorial)	Linear	0.008	0.011	-0.004	0.004	0.012	-0.002	0.007	0.012	0.001	0.007
		(0.004)*	(0.005)**	(0.004)	(0.006)	(0.006)**	(0.006)	(0.008)	(0.005)**	(0.007)	(0.008)
	Quadratic	-0.003	-0.001	-0.001	0.000	-0.001	0.000	-0.001	-0.001	0.000	-0.001
		(0.001)*	(0.001)**	(0.001)	(0.002)	(0.001)**	(0.001)	(0.001)	(0.001)**	(0.001)	(0.001)
	Observations	77464	77464	77464	77464	77464	77464	77464	77464	77464	77464
	R-Squared	0.3087	0.3086	0.3057	0.3041	0.3088	0.3044	0.3043	0.3085	0.3039	0.3045

[a]Robust standard errors in parentheses clustered at the state level. * significant at 10%; ** significant at 5%; *** significant at 1%. Regressions include state specific trend and survey year fixed effects. Conflict indicators per 100,000 inhabitants averaged or aggregated as explained in the data sources section.

Table III.4: Effect of conflict on household's access to pipped water[a]

Conflict Indicator	Regression Information	Aggregation 1 year	Aggregation 5 years	Aggregation 10 years	Aggregation 20 years	Averaging $\eta = 0.1$ 5 years	Averaging $\eta = 0.1$ 10 years	Averaging $\eta = 0.1$ 20 years	Averaging $\eta = 0.2$ 5 years	Averaging $\eta = 0.2$ 10 years	Averaging $\eta = 0.2$ 20 years
Extortion	Linear	-0.127	-0.153	0.002	-0.775	-0.168	-0.066	-0.390	-0.178	-0.121	-0.238
		(0.122)	(0.169)	(0.159)	(0.370)**	(0.172)	(0.158)	(0.245)	(0.173)	(0.172)	(0.210)
	Quadratic	0.141	0.199	-0.092	0.560	0.214	0.024	0.191	0.222	0.117	0.181
		(0.118)	(0.209)	(0.142)	(0.408)	(0.204)	(0.163)	(0.239)	(0.197)	(0.203)	(0.235)
	Observations	81470	81470	81470	81470	81470	81470	81470	81470	81470	81470
	R-Squared	0.3342	0.3342	0.3340	0.3357	0.3342	0.3340	0.3347	0.3343	0.3340	0.3342
Attacks against the Police	Linear	0.031	-0.015	0.265		-0.017	-0.023		-0.016	-0.032	
		(0.011)***	(0.016)	(0.154)*		(0.018)	(0.028)		(0.019)	(0.026)	
	Quadratic	-0.002	0.001	-0.045		0.001	0.001		0.001	0.001	
		(0.001)***	(0.001)	(0.041)		(0.001)	(0.001)		(0.001)	(0.001)	
	Observations	81470	77000	69513		77000	69513		77000	69513	
	R-Squared	0.3372	0.3309	0.3239		0.3309	0.3266		0.3309	0.3267	
Mass murder victims	Linear	0.026	-0.046	-0.090		-0.048	-0.113		-0.049	-0.118	
		(0.025)	(0.019)***	(0.058)		(0.019)**	(0.039)***		(0.020)**	(0.032)***	
	Quadratic	-0.004	0.007	0.011		0.007	0.014		0.008	0.015	
		(0.004)	(0.002)***	(0.006)*		(0.003)***	(0.004)***		(0.003)***	(0.004)***	
	Observations	77000	69513	61685		69513	61685		69513	61685	
	R-Squared	0.3311	0.3277	0.3253		0.3278	0.3263		0.3278	0.3269	

[a]Notes: Robust standard errors in parentheses clustered at the state level. * significant at 10%; ** significant at 5%; *** significant at 1%. Regressions include state specific trend and survey year fixed effects. Conflict indicators per 100,000 inhabitants averaged or aggregated as explained in the data sources section.

Table III.5: Effect of conflict on incidence of diarrhea in children[a]

Conflict Indicator	Regression Information	Aggregation				Averaging $\eta = 0.1$			Averaging $\eta = 0.2$		
		1 year	5 years	10 years	20 years	5 years	10 years	20 years	5 years	10 years	20 years
Extortion	Linear	0.098	-0.016	-0.151	-0.142	0.004	-0.100	-0.099	0.021	-0.040	-0.040
		(0.037)***	(0.081)	(0.088)*	(0.160)	(0.080)	(0.089)	(0.115)	(0.077)	(0.102)	(0.114)
	Quadratic	-0.127	0.036	0.323	0.328	0.003	0.219	0.295	-0.022	0.093	0.112
		(0.043)***	(0.162)	(0.099)***	(0.231)	(0.152)	(0.160)	(0.198)	(0.140)	(0.209)	(0.255)
	Observations	44324	44324	44324	44324	44324	44324	44324	44324	44324	44324
	R-Squared	0.0134	0.0132	0.0134	0.0133	0.0132	0.0133	0.0133	0.0132	0.0132	0.0132
Terrorist attacks	Linear	-0.013	-0.006	-0.011	-0.022	-0.007	-0.010	-0.031	-0.008	-0.010	-0.018
		(0.004)***	(0.006)	(0.007)	(0.019)	(0.006)	(0.007)	(0.013)**	(0.007)	(0.007)	(0.009)**
	Quadratic	0.001	0.000	0.001	0.004	0.000	0.001	0.003	0.000	0.001	0.002
		(0.000)**	(0.000)	(0.001)*	(0.002)*	(0.001)	(0.001)*	(0.001)**	(0.001)	(0.001)	(0.001)**
	Observations	44324	44324	44324	44324	44324	44324	44324	44324	44324	44324
	R-Squared	0.0135	0.0132	0.0132	0.0133	0.0132	0.0132	0.0133	0.0133	0.0132	0.0133
Attacks against the Police	Linear	-0.010	-0.046	0.306		-0.046	-0.144		-0.045	-0.114	
		(0.009)	(0.025)*	(0.029)		(0.025)*	(0.057)**		(0.024)*	(0.046)**	
	Quadratic	0.001	0.011	-0.320		0.010	0.029		0.010	0.024	
		(0.001)	(0.006)*	(0.016)**		(0.006)*	(0.013)**		(0.006)*	(0.011)**	
	Observations	44324	41251	36289		41251	36289		41251	36289	
	R-Squared	0.0132	0.0136	0.0171		0.0136	0.0147		0.0136	0.0147	
Mass murder victims	Linear	0.000	0.013	0.561		0.018	0.296		0.022	0.214	
		(0.009)	(0.016)	(0.021)***		(0.017)	(0.009)***		(0.018)	(0.006)***	
	Quadratic	-0.001	0.001	-0.209		0.000	-0.126		0.000	-0.103	
		(0.001)	(0.002)	(0.006)***		(0.002)	(0.003)***		(0.002)	(0.002)***	
	Observations	41251	36289	31732		36289	31732		36289	31732	
	R-Squared	0.0135	0.0148	0.0162		0.0148	0.0162		0.0148	0.0162	

[a] Notes: Robust standard errors in parentheses clustered at the state level. * significant at 10%; ** significant at 5%; *** significant at 1%. Regressions include state specific trend and survey year fixed effects. Conflict indicators per 100,000 inhabitants averaged or aggregated as explained in the data sources section.

Table III.6: Effect of conflict on incidence of fever in children[a]

Conflict Indicator	Regression Information	Aggregation				Averaging $\eta = 0.1$			Averaging $\eta = 0.2$		
		1 year	5 years	10 years	20 years	5 years	10 years	20 years	5 years	10 years	20 years
Terrorist attacks	Linear	-0.003	0.023	0.021	-0.046	0.020	0.028	0.005	0.017	0.029	0.028
		(0.005)	(0.011)**	(0.010)**	(0.042)	(0.011)*	(0.013)**	(0.024)	(0.011)	(0.013)**	(0.016)*
	Quadratic	0.000	-0.002	-0.001	0.010	-0.002	-0.002	0.001	-0.002	-0.003	-0.002
		(0.000)	(0.001)**	(0.001)	(0.006)*	(0.001)**	(0.001)*	(0.002)	(0.001)*	(0.001)**	(0.002)*
	Observations	44324	44324	44324	44324	44324	44324	44324	44324	44324	44324
	R- Squared	0.0109	0.0110	0.0109	0.0112	0.0110	0.0109	0.0109	0.0109	0.0110	0.0109
Kidnappings	Linear	0.003	-0.001	-0.003	0.001	0.000	-0.002	-0.003	-0.001	-0.002	-0.002
		(0.003)	(0.003)	(0.005)	(0.009)	(0.004)	(0.006)	(0.009)	(0.005)	(0.006)	(0.007)
	Quadratic	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000
		(0.000)**	(0.000)	(0.000)***	(0.000)***	(0.000)**	(0.000)*	(0.000)	(0.000)	(0.000)	(0.000)
	Observations	44324	44324	44324	44324	44324	44324	44324	44324	44324	44324
	R- Squared	0.0109	0.0111	0.0112	0.0113	0.0111	0.0111	0.0112	0.0110	0.0111	0.0111
Attacks against the Police	Linear	-0.010	-0.024	0.068		-0.024	-0.008		-0.025	-0.022	
		(0.013)	(0.034)	(0.042)		(0.033)	(0.096)		(0.032)	(0.067)	
	Quadratic	0.001	0.008	-0.206		0.008	0.006		0.008	0.008	
		(0.001)	(0.007)	(0.024)***		(0.007)	(0.018)		(0.006)	(0.013)	
	Observations	44324	41251	36289		41251	36289		41251	36289	
	R- Squared	0.0108	0.0098	0.0104		0.0098	0.0107		0.0098	0.0107	
Mass murder victims	Linear	-0.033	0.060	0.260		0.068	0.067		0.072	0.047	
		(0.010)***	(0.016)***	(0.028)***		(0.022)***	(0.012)		(0.028)**	(0.008)***	
	Quadratic	0.003	-0.004	-0.043		-0.005	-0.004		-0.006	0.013	
		(0.001)**	(0.002)**	(0.008)***		(0.003)**	(0.008)		(0.004)*	(0.002)***	
	Observations	41251	36289	31732		36289	31732		36289	31732	
	R- Squared	0.0103	0.0112	0.0123		0.0111	0.0123		0.0110	0.0123	
Total Conflict	Linear	0.005	0.000	-0.003	-0.005	0.002	-0.002	-0.004	0.003	-0.001	-0.002
		(0.003)***	(0.003)	(0.004)	(0.007)	(0.004)	(0.005)	(0.007)	(0.004)	(0.005)	(0.006)
	Quadratic	0.000	0.000	0.000	0.001	5.35e-06	0.000	0.000	0.000	0.000	0.000
		(0.000)	(0.000)	(0.000)***	(0.000)***	(0.000)	(0.000)	(0.000)*	(0.000)	(0.000)	(0.000)
	Observations	44324	44324	44324	44324	44324	44324	44324	44324	44324	44324
	R- Squared	0.0111	0.0110	0.0111	0.0113	0.0109	0.0110	0.0111	0.0109	0.0110	0.0110
Total Conflict (Factorial)	Linear	0.011	0.002	0.009	0.093	0.006	0.003	0.012	0.009	0.001	0.000
		(0.012)	(0.015)	(0.022)	(0.039)	(0.018)	(0.023)	(0.033)	(0.017)	(0.021)	(0.024)
	Quadratic	-0.010	0.007	0.012	0.021	0.005	0.010	0.013	0.003	0.009	0.010
		(0.004)**	(0.005)	(0.006)**	(0.012)*	(0.006)	(0.006)*	(0.008)*	(0.006)	(0.006)	(0.006)*
	Observations	44324	44324	44324	44324	44324	44324	44324	44324	44324	44324
	R- Squared	0.0111	0.0110	0.0111	0.0113	0.0109	0.0111	0.0111	0.0109	0.0110	0.0110

[a]Notes: Robust standard errors in parentheses clustered at the state level. * significant at 10%; ** significant at 5%; *** significant at 1%. Regressions include state specific trend and survey year fixed effects. Conflict indicators per 100,000 inhabitants averaged or aggregated as explained in the data sources section.

Table III.7: Difference-in-Difference using additional controls[a]

Variables	Diarrhea	Fever	Pipped Water	Water on Premises	Sewerage	Time to water
Violent State	0.018	0.038	-0.016	-0.027	0.002	-7.159
	(0.028)	(0.042)	(0.078)	(0.049)	(0.097)	(7.767)
After Uribe	-0.021	-0.097	-0.016	-0.014	0.029	1.026
Government	(0.021)	(0.021)***	(0.059)	(0.030)	(0.066)	(3.173)
Violent State after	0.022	0.090	-0.037	-0.045	-0.044	0.397
Uribe Government	(0.023)	(0.027)***	(0.054)	(0.031)	(0.064)	(5.808)
Observations	44352	44352	81470	78540	81491	4674
R-squared	0.01	0.01	0.36	0.14	0.49	0.09

[a]Robust standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

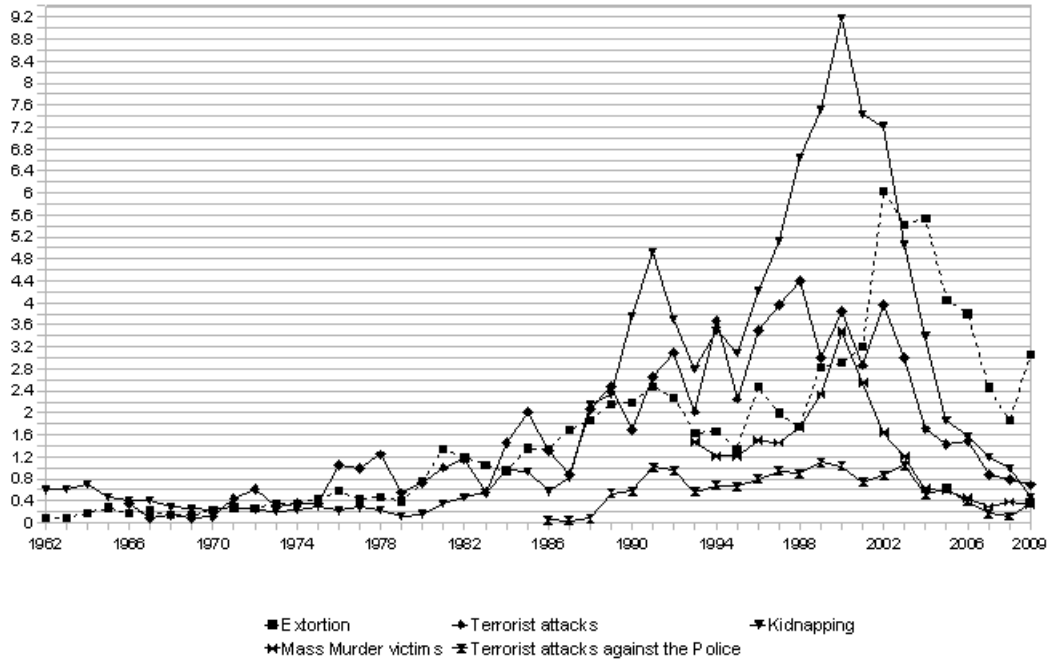

Figure III.1: Main conflict indicators 1962-2010 (per 100,000 inhabitants)[a]

[a]Source: Policia Nacional de Colombia, Revista Criminalidad, 2008-2010

CONCLUSIONS

All in all, these 3 chapters conveyed results showing the negative effects of civil war. Civil war increases the risk of, in particular, infant mortality, and is harmful for human capital accumulation by reducing learning. Unless households adapt to cope with civil war, it can decrease the access to water and sanitation services, harming the health of children. These results come from estimations that control for the appropriate level of fixed effects (household or state level fixed effects), as well as including other control variables.

The negative microeconomic impacts of civil war may be related to its negative macroeconomic consequences of civil war. It is entirely possible that the macroeconomic effects cause the microeconomic consequences. For instance, the disruptions in the market and in the institutions translate into hardship for households and individuals. As households and individuals struggle, their reduced welfare will reinforce the negative macroeconomic consequences of civil war. This sort of feedback relationship was not explored in this dissertation, but it is reasonable to assume that it exists.

Also relevant is that the negative effects found in this dissertation took place regardless of the causes of civil war. It is true that the causes of a civil war may define its nature in scope and persistence (both in space and time). It is also true that society and households may react differently whether the civil war is caused by an institutional failure or by scarcity of resources. It is possible that the actual extent of the impacts is defined by the nature of war itself, but civil war may bring changes that will end up changing the behavior of households and individuals and reducing their welfare. Here, an assumption is crucial: households suffer from conflict and do not benefit from it. Anecdotal evidence may show that some groups of the society actually benefit from civil war, but that case was ruled out in this dissertation; more

investigation in this area, however, would be beneficial to an understanding of the multifaceted consequences of civil war.

Negative effects of civil war call for government interventions to ease the burden of households. Nonetheless, it is questionable whether governments can provide any kind of support while spending considerable financial resources on waging a war. Despite these budget constraints, governments have to find a way to support households. One way, for instance, is assuring that the kinship and social support networks stay in place during a period of civil war. If households and individuals cannot find support in the government, they may still find some sort of help from neighbors and extended family members. The existence of such moral insurance mechanisms is also an interesting phenomenon for future research.

Since households and individuals may adapt to civil war and learn to cope with it, this dissertation highlights the importance of studying the effects of civil war at the household and individual level. Cross country or regional level analysis hide the variability of the effects as they do not lead to an understanding of how households and individual reacts. The space and time variability of civil war is very important. Civil war rarely spreads homogeneously across the territory and, therefore, individuals may bear different costs at different stages of the conflict. The increasing availability of household and individual level surveys from civil-war-torn countries will allow researchers to study how people respond to internal armed conflict.

At this point, it is important to highlight the relevance of studies tracking individuals and households throughout the periods of conflict. One period surveys are useful to provide a snapshot, but research should focus on the patterns of households' behaviors and decisions during a civil war. Households adapt, learn, and form expectations about future war intensity levels and about the risks of victimization. Taking

all into account, households can still maximize their welfare by shifting the allocation of resources and by changing their consumption, saving and investment decisions.

Finally, this dissertation moved from the traditional measure of intensity, battle deaths, then used a wider set of leading intensity indicators to end by proposing a measure of stock of violence that attempts at capturing how households interpret the civil war information. The use of multiple indicators is explained by several reasons. First, open battle engagements are rare in a civil war. In a civil war, factions may employ unconventional tactics and avoid open pitch battles as a way to keep the war ongoing. Second, depending on the households' wealth, location and composition, some civil war indicators are going to be more important than others in signaling the intensity. For instance, wealthier households may be more responsive to changes in kidnappings or extortions, while households depending on government services would be more sensitive to attacks on government infrastructure. A third point is related to the war technology. As war equipment and tactics evolve, new measures of civil war intensity will be needed.