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ABSTRACT

Persistent Impact of Natural Disasters on Child Nutrition and Schooling: Evidence from the 1999 Colombian Earthquake*

This paper studies the impact of the 1999 Colombian Earthquake on child nutrition and schooling. The identification strategy combines household survey data with event data on the timing and location of the earthquake, exploiting the exogenous exposure of children to the shock. The paper uniquely identifies both the short- and medium-term impacts of the earthquake, combining two cross-sectional household surveys collected before the earthquake and two cross-sectional household surveys collected one and six years after the earthquake. Colombia provides a unique setting for our study because the government launched a very successful reconstruction program after the earthquake. Findings report a strong negative impact of the earthquake on child nutrition and schooling in the short-term. Relevantly, amid the aid received by the affected area, the negative consequences of the earthquake persist with a lesser degree in the medium-term, particularly for boys.

JEL Classification: J22, I25, Q54

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1. Introduction

Natural disasters are unfortunate recurring events that happen worldwide. A great deal of evidence reveals that exposure of lives and property to disasters has increased in the last decades, with earthquakes and storms causing the most damage (CRED 2010, World Bank 2010).[1] Because risk of natural disasters is likely to become more significant in the years to come, increased attention has focused on the challenges that these events pose for economic development and poverty reduction.

Natural disasters may contribute to poverty and its intergenerational transmission if they force families to decrease their investment in children's human capital, inducing children to fail to reach their growth and educational potential (Ferreira and Shady 2009, Skoufias 2003). Investments in children's health and education establish the foundation for their lifelong welfare. An extensive body of economic literature on child development indicates that failure of children to fulfill their growth potential influences their life span, affecting morbidity, cognitive performance, educational attainment, and adult productivity (see Strauss and Thomas 2008, Schultz 2010 for a detailed review). More schooling is related to higher wages, lower probabilities of being unemployed, more prestigious jobs, and higher job satisfaction (Card 1999).

There is a nascent, but still limited literature that rigorously documents the impact of specific large-scale natural disasters on children's human capital in developing countries. These studies show negative impacts on children's nutrition (Baez and Santos 2007, Hoddinott and Kinsey 2001, Jensen 2000) and in general, on schooling outcomes (Bustelo 2011, Cuaresma 2010, Santos 2010, Baez and Santos 2007). However, considerably less is known about the

[1] The increasing trend of natural dissasters is related to a combination of the availability of more information, an increase in population and urbanization, and global climate change (CRED 2010, World Bank and United Nations 2010).

degree to which these negative effects on human capital formation persist over time across child cohorts.[2] Documenting the degree of persistence of these effects is critical to designing well-targeted, effective, and timely interventions that protect children's welfare. Information that enhances policies to improve household resilience to natural disasters is of immediate value.

The present paper contributes to the existing literature on natural disasters in three ways. First, it reports on new evidence from the earthquake that devastated the west-central part of Colombia's Coffee Belt in 1999 to identify the consequences of an extreme geologic event on child nutrition and schooling. Second, this paper uniquely identifies both the short- and medium-term impact of the earthquake, combining two cross-sectional household surveys collected before the earthquake and two cross-sectional household surveys collected one and six years after the earthquake. Third, this paper provides evidence from a unique context in that the earthquake in Colombia prompted what the country has termed a model of reconstruction, involving the creation of a public entity called the Fund for the Reconstruction and Social Development of the Coffee-Growing Region (Fondo para la Reconstrucción y Desarrollo Social del Eje Cafetero [FOREC]) to better coordinate and channel international, state, and private reconstruction and donation efforts. Indeed, the Colombian FOREC model won a United Nations prize for its effectiveness in reconstruction. By focusing on both the short- and medium-run impacts, we are able to pin down how persistent the impact of the shock is on child nutrition and schooling amid the successful relief aid received, something that has not yet been explored in the existing literature.

[2] A growing body of research explores whether natural disasters lead to poverty persistence. For instance, Rosemberg, Fort, and Glave (2010) find that the probability of staying in chronic poverty between 2002 and 2006 in Peru is higher for those households that experience a natural disaster. Premand and Vakis (2010) report that exposure to natural disasters in Nicaragua between 1998 and 2005 increase the probability that households suffer downward mobility and poverty (see de la Fuente 2010 for a review).

Results suggest that the 1999 Colombian earthquake forces households to decrease their investment in children's human capital. Findings report a strong negative impact of the earthquake on child nutrition and schooling in the short-term. Results from children living in Quindio, the most affected department, are the main driving force of these results. More importantly, amid the aid received by the affected area, the negative consequences of the earthquake persist with a lesser degree in the medium-term, particularly for boys. Our results are robust to a set of additional checks, including tests for pre-earthquake trends, differences in survey's sample design, and migration.

2. Aggregate Shocks and Human Capital

Some of the most important household choices refer to the human capital investments in children (Strauss and Thomas 1995). A large body of research has been quite concerned with household's responses to the impact of aggregate shocks on children's nutritional and schooling investments. This paper is broadly related to this literature, providing new evidence on the consequences of a natural hazard shock caused by an earthquake in a developing country.

A considerably large number of studies focus on adverse shocks caused by macroeconomic crises in developing countries, finding mixed results on schooling outcomes and negative effects on child nutritional status. For instance, studies performed in poor countries of Africa and Asia reported evidence that educational outcomes are pro-cyclical – i.e., school enrollment falls during recessions. Conversely, studies performed in middle-income countries of Latin America found that educational outcomes are generally counter-cyclical – i.e., school enrollment rises during recessions. The evidence of economic shocks on child health seems more homogenous in developing countries: existing evidence indicates that child nutritional status is pro-cyclical – i.e., malnutrition increases during recessions (Duryea and Arends-Kuenning 2003; see Ferreira and Shady 2009 for a detailed review).

Earlier studies have used weather variability to identify the effects of adverse income shocks on child investment in low-income settings. Foster (1995) examined the impact of a major flood on children's weight in Bangladesh, finding negative effects on nutritional status for children in credit-constrained households. Jensen (2000) used historical rainfall data to construct a measure of shock for areas in the Cote d'Ivore between 1986 and 1987, finding that exposure to negative rainfall shocks increases children's malnutrition and decreases school enrollment rates.

Several studies have used weather shocks to identify the effects of health shocks early in life on subsequent health and schooling outcomes. Hoddinott and Kinsey (2001) estimated the impact of a severe drought in 1994-1995 in Zimbabwe on children's growth in height to find a reduction in linear growth among the youngest children (aged 12-24 months in 1993). Alderman, Hoddinott, and Kinsey (2006) exploited weather variation and a civil war in Zimbabwe to identify the impact of preschool height on later health and schooling outcomes. The authors found that exposed children become shorter adolescents, start school later, and attain fewer years of schooling. Alderman, Hoogeveen, and Rosi (2009) found similar results exploring weather shocks in early childhood among Tanzanian adolescents. Maccini and Yang (2009) examined the effect of rainfall shocks at about the time of birth on adult education to find that Indonesian women exposed to 20 percent higher rainfall (relative to normal local rainfall) attained more schooling, have better self-reported health status, and are taller.

In recent years, a growing, but still limited, body of economic literature explores the impact of aggregate economic shocks caused by specific large-scale natural disasters in developing countries. Almost all the evidence comes from Latin American countries. Baez and Santos (2007) studied the medium-term impact of Hurricane Mitch in Nicaragua to report a negative impact on child nutritional status (measured by weight-for-age Z-scores) for children aged 0 to 5 and a null impact on school enrollment for children aged 6 to 15 living in affected areas.[3] Santos (2010) explored the short-term impact in rural areas of the two 2001 earthquakes in El Salvador. The author found that rural children aged 6 to 15 who were highly exposed to the shocks became less likely to attend school. Bustelo (2011) examined the short-term impact of Tropical Storm Stan, which devastated Guatemala in 2005. Results in this study emphasize a great deal of heterogeneity by age and gender in terms of how children's time allocation was affected by the storm. Evidence shows that school participation decreased only for male children aged 13 to 15 who were more likely to be engaged in market work that directly contributes to family income. The study finds no effect on children below 13 years old.

Alternative to studying the impact of a specific natural disaster, Cuaresma (2010) explored the impact of disaster risks on educational attainments to report a strong negative impact across several countries, between the propensity to suffer geologic disasters and secondary school enrollment rates. Lastly, while a number of studies examined the impact of exogenous negative shocks on child growth, Yamano, Alderman, and Christiansen (2005) studied the impact of the food aid received by Ethiopian households to counter the effects of price or weather variability. The authors report evidence that food aid is positively related to child growth (in height).

[3] Weight-for-age Z-scores are short-term measures of current health and nutritional status and physical work capacity. This paper uses height-for-age Z-scores, which are considered long-term measures of health that reflect fetal and childhood nutritional limitations and disease environment (Schultz 2010).

3. The 1999 Colombia Coffee Belt Region Earthquake

3.1 Earthquake's Destruction

On January 25, 1999, a severe earthquake measuring 6.2 on the Richter scale struck the west-central part of Colombia's Coffee Belt Region, with unprecedented effects in the country. The area affected covered 6,772 km^2 in five departments: Caldas, Quindío, Risaralda, Tolima, and Valle de Cauca (see figure 1). The epicenter was located in the Quindío department, 16 kilometers southwest of the department capital Armenia, and had a depth of 10 kilometers. Experts conclude that its short distance from the surface was what caused the shaking to be so strong (Restrepo 2000). An aftershock of 5.8 on the Richter scale that followed brought down numerous houses and buildings that had been partially damaged by the first shock. More than 300 aftershocks occurred in the days following the initial earthquake, generating more destruction.

The 1999 earthquake is considered to be one of the most destructive in the history of Colombia. According to the Economic Commission for Latin America (ECLAC 1999), this event caused damages estimated at $1.6 billion dollars, close to 35 percent of the region's gross internal product and 1.4 percent of the country's 1998 GDP. More than 400,000 individuals in the affected departments suffered direct earthquake losses in terms of housing, family members, and/or employment. There were 1,185 deaths, about 9,000 injured individuals, and more than 160,000 people left homeless. Nonetheless, the severe earthquake also indirectly affected more than 1.5 million individuals living in the five affected departments and the departments of Bogota and Antioquia.[4]

[4] "Population Indirectly Affected" denotes the population who suffered indirect losses, such as disruption in the commercial relations (ECLAC 1999).

The earthquake devastated the affected region with differential intensity. Quindio was both directly and indirectly the most affected department; approximately 60 percent of the establishments suffered damages and around 90 percent of the population suffered from consequences caused by the disaster (World Bank 2003, ECLAC 1999). The departments of Caldas, Risaralda, Tolima, and Valle de Cauca were directly affected to a lesser extent. These four departments, together with Bogota and Antioquia, mainly experienced indirect consequences of the shock with great variability (see table A.1 in the appendix). For instance, the earthquake indirectly affected 27.2 percent of the population in Risalda, while 0.4 percent of the population in Caldas was indirectly impacted.

Housing was the sector most affected by the shock, which constituted about 70 percent of the total loss. The high number of families that lost their dwellings was a burden for the provision of basic sanitary services, water supplies, food, counseling, health care to prevent disease and epidemics, and psychosocial care. Temporary housing camps were built under the supervision of non-governmental organizations. For instance, some transitory camps in Quindio remained two years after the disaster (Lora-Suarez et al. 2002). The region’s infrastructure also suffered considerable damage, including schools and health centers, primary and secondary roads, electricity networks, telephone systems, water and sewerage systems, markets, public offices, and the airport in Armenia (World Bank 2003).

One of the most affected infrastructure sectors was education, not only because of the number of schools affected, but also in the extent of the damage, largely attributable to non-compliance with construction norms (International Federation of the Red Cross and Red Crescent Societies 1999). After the earthquake, 509 schools in rural and urban areas needed to be repaired and 142 had to be rebuilt (World Bank 2003). This situation affected teachers and students at various levels in both public and private schools. Given the magnitude of the destruction, temporary facilities were provided so that children could complete the school year (ECLAC 1999).

The health sector suffered to a lesser degree. Seventy-four (63 urban and 11 rural) health care institutions, including hospitals, health care centers, and nutrition centers, were damaged by the earthquake (World Bank 2003). Fear of epidemics was high, but no outbreaks of infectious diseases, including diarrhea, dengue, or malaria occurred. Despite the lack of a real epidemic of diarrhea, there were increasing diarrheal events attributable mostly to alimentary problems, rather than infectious agents (Restrepo 2000).

3.2 Post-earthquake Reconstruction

Given the magnitude of the catastrophe, recovery of the areas affected by the earthquake was identified as one of the most critical concerns. The President of Colombia declared an economic and social state of emergency and five days after the earthquake created the Fund for Reconstruction and Social Development of the Coffee Region (FOREC), whose objective was to achieve the economic, social, and ecological reconstruction of the zone affected by the earthquake. To accomplish this it would provide assistance to the most vulnerable population, rebuild the affected dwellings (including the relocations of housing units located in high-risk zones), and reconstruct the social and public infrastructure, while trying to minimize potential negative effects on the environment. FOREC received resources from the national government, bilateral donors, and external credits to finance the reconstruction effort (World Bank 2003).

FOREC decentralized the reconstruction process by distributing responsibility among 32 NGOs, putting each one in charge of a small town or sector of an affected city. NGOs were responsible for identifying recovery projects and families that needed relocation and new homes.

They were also in charge of applying proper administrative practices, mechanisms to include the affected population in the reconstruction process, and environmental safeguards (World Bank 2003). The effective system of coordination of information, financial control, and quality management allowed the reconstruction process to be accomplished in just three-and-a half years.

Homes belonging to about 130,000 individuals were repaired or rebuilt. Another 16,700 new homes were built for people who had previously rented property in areas at high risk of seismic damage. These families were relocated and given permanent titles to new homes, creating a new class of low-income homeowners. Approximately 649 schools and 52 health centers were repaired or rebuilt in the five departments affected. Although the official goal of reconstruction was to rebuild infrastructure that was damaged or destroyed, in some instances the region was better off after then earthquake than before. For instance, the capital city of Quindio ended up with a gleaming new skyline, a new airport, a new police station, a new administrative center, and new hotels (Inter-American Development Bank 2003).

According to the National Coffee Survey conducted in 1997, the five departments affected in the Coffee Region accounted for 47 percent of the national coffee production. The 1999 earthquake exacerbated an existing economic recession in the area caused by low coffee prices. FOREC enhanced the economic revival and job creation in the region, considerably lowering its unemployment rate (e.g., from 52 percent in February of 1999 to 19 percent in 2000). FOREC generated a large number of temporary jobs through its various components of reconstruction. Other externalities were the increase of capital and activity in the financial and commercial sector and the access to loans for small and mid-size enterprises (World Bank 2003).

This post-disaster experience (one of the first in Latin America) was internationally recognized and received the United Nation's Sasakawa Award on October 2000 in Switzerland. The liquidation of FOREC was carried out on July 2002, when its work was considered complete (World Bank 2003).

4. Data

4.1 Colombian Demographic Households Survey

This paper uses the 1990, 1995, 2000, and 2005 Colombian Demographic Household Surveys (DHS) developed by the ProFamilia Institute in Colombia. The DHS is a repeated cross-sectional survey with national coverage. There are some differences in survey design between the first three surveys and the 2005 survey. Nonetheless, the survey sampling-weights include factors of adjustment to account for changes in subsampling. Following the approach in Angrist and Kugler (2008), results in this study are weighted using survey sampling-weights to account for differences in survey design.[5] Additionally, in 1990, 1995, and 2000, the DHS surveys excluded large areas with relatively low population (3 percent) from their sample for budgetary reasons (DHS Final Reports for 1990, 1995, 2000, and 2005). To maintain a consistent sample throughout our analysis, we exclude these large territories in the DHS sample of 2005. The map in figure 1 reports the departments included in our analysis.

The DHS dataset is a comprehensive health survey that includes information on fertility for all women aged 15 to 49, child mortality, child and maternal health service utilization, and the nutritional status of children under five and their mothers. The Colombian DHS surveys also collect information related to the education of all members in the household. The 2000 and 2005 surveys were collected 12 to 17 months and 69 to 77 months respectively after the geological

[5] The four samples - i.e. 1990, 1995, 2000, and 2005 - were drawn from the 1985 National Census. However, the sample size increased in 2005 compared to previous years. The Colombian data used by Angrist and Kugler (2008) presented the same sampling differences. The authors used sampling weights to account for these differences.

disaster. Taking advantage of the timing of the Colombian DHS datasets, we combine the four datasets to identify the short- and the medium-term impacts of the 1999 earthquake.

4.2 Preliminary Descriptive Statistics

The outputs of interest are the nutritional status of children under five and the schooling participation of children aged 6 to 15. Height is widely considered to be the best indicator of nutritional conditions and disease environments of childhood (Schultz 2010), hence we used height-for-age Z-scores as a measure of child nutrition. To perform our analysis, we computed height-for-age Z-scores for each child under five, where the Z-score is defined as the difference between the child's height and the mean height of the same-aged international reference population, divided by the standard deviation of the reference population.[6] Because information about height for children aged 0 to five was not collected in the 1990 DHS survey, we limited the nutritional analysis to data from 1995 through 2005.

We used school enrollment as a measure of schooling participation. To perform our analysis, we focused on two groups of children who differ in terms of the educational level they would normally be enrolled at for their age: (i) children aged 6 to 10 who should be enrolled in primary school and (ii) children aged 11 to 15 who should be enrolled in middle school. The emphasis on differential impacts by child age is important in understanding human capital investment, particularly in Latin America where schooling dropout rates increase significantly at the transition between primary and secondary education (Bustelo 2011).

Table 1 reports descriptive statistics at the national level by survey year for the three samples of children analyzed in our study. Child nutrition shows a moderately increasing trend at the national level. On average, children were 0.9 and 0.7 standard deviations below the average height-for-age of a reference child in 1995 and 2005 respectively. Educational outcomes also

[6] Height-for-Age Z-score estimates are based on WHO Child Growth Standards for children age 0-60 months.

show a persistent increasing trend. For all children, school enrollment improved between 1990 and 2005. School enrollment of children aged 6 to 10 increased from 78.6 to 94.2 percent, while school enrollment of children aged 11 to 15 increased from 73.2 to 88.4 percent. Not surprisingly, enrollment rates for older children are lower, meaning that schooling dropout rates increase significantly after the age of 11. Concurrent with improvements in school enrollment for children, adults' cohorts have persistently reached higher educational attainment. Household heads or maternal average years of schooling increased by more than one year.

The percentage of people living in the urban areas increased almost four percentage points between 1990 and 2005, accounting for nearly 68 percent of the total population of children in 2005. Interestingly, the proportion of male-headed households dropped between 1990 and 2005, favoring an increase in female-headed ones. Roughly one percent of Colombian children aged 0 to 15 lived in Quindio, which was the department most affected by the 1999 earthquake, both directly and indirectly. Children living in the rest of the affected departments – i.e., Caldas, Risaralda, Tolima, and Valle de Cauca - represented around 17 percent of the child population.

5. Empirical Identification Strategy

Identification comes from comparing, before and after the 1999 earthquake, the nutritional status and schooling participation of similar children living in affected and non-affected departments. The department-level panel dimension of the DHS Colombian data generates the variation used to identify the effects of the earthquake on schooling and child nutrition.

The baseline specification is:

(1) $$Y_{ijdt} = \lambda_t + \lambda_{0d} + \lambda_{1d} t + \sum_q \beta_q \left(Affected\ Departments_d * \ Year_{qt} \right) + X'_{ijdt} \delta + \varepsilon_{ijdt}$$

where Y_{ijdt} denotes the outcome of interest (height-for-age Z-score or school enrollment) for individual *i* in household *j* and department *d* at period *t*; λ_t are year fixed effects that control for the average changes in the outcome of interest across all departments between 1990, 1995, 2000, and 2005; λ_{0d} are department fixed effects that control for time-invariant department characteristics, such as endowments, schooling facilities, and geography; $Affected\ Departments_d$ is a binary variable indicating a child living in one of the five department most affected by the earthquake – i.e., Caldas, Quindío, Risalda, Tolima, and Valle del Cauca; and $Year_{qt}$ is a binary variable that indicates year *t* equal to *q*, where *q* is 1990, 2000, and 2005. All specifications separate the impact of the earthquake from any region-specific linear trend in outcomes.[7] This is done by including $\lambda_{1d}t$, where λ_{1d} is a region-specific time trend coefficient multiplied by a time trend *t*. All regressions also control for a vector of individual characteristics X_{ijdt} that are not affected by the shock but are likely to affect child investment decisions, such as a child's gender; age; area of residence; gender of the household head; and mother's or household head's age and education. ε_{ijdt} is a random, idiosyncratic error term. Standard errors are clustered at the department level to allow for correlation across households within a department. The parameter of interest β_q, where *q* is 1990, 2000 and 2005, measures the impact of the 1999 earthquake on child nutrition and schooling and is identified under the assumption that trends in child nutrition or schooling are uncorrelated with the interaction of interest.

One concern about the validity of this strategy is the potential existence of omitted variables that may change differently in affected and non-affected departments – e.g., a macroeconomic recession may have a different effect on one area compared to another area. As

[7] Regions in the survey are: (i) Atlantica, (ii) Oriental, (iii) Central, (iv) Pacifica, and (v) Bogota.

Meyer (1995) emphasizes the above concern is reduced when characteristics in the affected and the non-affected departments are similar before the shock. Table 2 formally tests this point, comparing affected and non-affected departments along a number of dimensions in year 1995, a pre-earthquake year. Before the earthquake, the outcomes of interest and child, household head, and maternal demographic characteristics are statistically indistinguishable between affected and non-affected departments.

Equation 1 assumes that the earthquake is the only event that affected child nutrition or schooling during the period considered in this analysis. However, remaining concerns exist about other events that might have coincided with the earthquake that might also have affected child nutrition and schooling. We address this concern in two ways. First, we acknowledge that Quindio was the most affected department, both directly and indirectly. The Caldas, Risalda, Tolima, and Valle del Cauca departments were mainly indirectly affected (see table A.1 in the appendix). In order to account for this difference in the intensity of the earthquake, we consider several affected groups to account for differential impact of the earthquake on the outcomes of interest. We estimate the following regression:

(2)

$$Y_{ijdt} = \lambda_t + \lambda_{0d} + \lambda_{1d}t + \sum_q \beta_{1q}\left(Quindio\ Department_d * Year_{qt}\right) + \sum_q \beta_{2q}\left(Less\ Affected\ \ Departments_d * Year_{qt}\right) + X'_{ijdt}\delta + \varepsilon_{ijdt}$$

where $Quindio\ Department_d$ is a binary variable indicating a child living in Quindio, while $Less\ Affected\ Departments_d$ is a binary variable indicating a child living in one of the other four affected department – i.e., Caldas, Risalda, Tolima, and Valle del Cauca. The impact of the earthquake is better identified when using several treatments; the identification strategy relies on the fact that the Quindio department was affected significantly more than the rest of the departments.

Secondly, we acknowledge that there exists large variability in terms of the intensity of the earthquake's impact on the less affected departments. Therefore, we use the proportion of the population indirectly affected by the earthquake, taken from Appendix Table A1, as a proxy for the earthquake's intensity.[8] $Less\ Affected\ Departments_d$ is replaced by $Intensity_d$, which refers to the proportion of the population indirectly affected by the shock in departments other than Quindio. The nutritional status and schooling participation of children living in areas highly indirectly affected by the earthquake are compared with the nutritional status and schooling participation of children living in areas less indirectly affected by the shock.

6. Empirical Results

Tables 3, 4, and 5 report the main results of the paper; table 3 presents the results of child nutrition for the group of children aged 0 to 5, while tables 4 and 5 show the results of child schooling for the group of children aged 7 to 10 and 11 to 15, respectively.[9]

6.1 Main findings

For the nutritional study, we have two groups of children that were exposed differently to the earthquake. Children aged 0 to 5 in 2000 were mostly born before the 1999 earthquake and consequently might have been highly affected by the shock. On the contrary, children aged 0 to 5 in 2005 were all born after the earthquake and consequently might have been affected by the shock to some extent, particularly the oldest children among this group. Previous evidence

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[8] Observe that this intensity measure includes Antoquia and Bogota D.C. as affected departments. Results are similar if these two departments are not considered as affected.

[9] All regressions in this paper control for a child's gender; age and age squared; area of residence; gender of the household head; and mother's or household head's education, age, and age squared. All coefficients of these controls have the expected sign. Table A.2 in the appendix reports coefficients of these controls using specification 3 of tables 3, 4, and 5. Results are similar when using specifications 1 and 2 (results not reported).

indicates that adverse environmental conditions that occur during both the prenatal period and between birth and age five have profound and persistent impacts on children's development (Almond and Currie 2011, Center on the Developing Child 2010, Schultz 2010, Strauss and Thomas 2008, Engle et. al 2007).

Column 1 of table 3 presents the baseline specification as outlined in equation 1. We find that the height-for-age Z-score is significantly lower by 0.182 standard deviations for children residing in affected departments right after the earthquake in 2000. Interestingly, this negative result seems to vanish in 2005, suggesting that the post-earthquake relief and improvement of living conditions might help mitigate the shock's negative effect on nutrition in the medium-term. Column 2 explores, as outlined in equation 2, the differential impact of the disaster depending on whether a child resides in Quindio, the department most affected by the earthquake both directly and indirectly, and the rest of the affected departments, which were mainly indirectly hit by the earthquake. In Quindio, children experience 0.296 standard deviations lower Z-scores in 2000, one year after the earthquake. Effects of lower magnitude, 0.175 standard deviations, are found for children residing in the less affected departments. We do not find any evidence of a significant impact of the earthquake in 2005. To test whether children living in Quindio experience a significantly different impact than children living in the less affected departments, Column 2 presents the p-values for the test of the null hypothesis that $\beta_1 = \beta_2$ in equation 2. In 2000, we are able to reject the null hypothesis of equality of these coefficients (p = 0.035). However, the opposite is observed in 2005, where we are not able to reject the null hypothesis (p = 0.118).

Column 2 of table 3 weights less affected departments equally. However, table A.1 in the appendix shows that there exists large variability in terms of the indirect impact of the earthquake – i.e., 27.2 percent of the population in Risalda was indirectly affected by the shock, while the earthquake indirectly affected only 0.4 percent of the population in Caldas. Column 3 of table 3 exploits the geographical variation in the intensity of the shock among the less affected departments. We compare, before and after the earthquake, the height-for-age Z-scores of children in departments that experienced high indirect effects as a result of the shock with the height-for-age Z-scores of children in departments that experienced low indirect effects of the earthquake. Results confirm that children living in Quindio have lower height-for-age Z-scores only in 2000. However, when exploiting the great variability of the shock on the less affected departments, estimates show no significant impact on child nutrition both in 2000 and 2005.

Table 4 explores the impact of the 1999 earthquake on the schooling participation of children aged 6 to 10. Columns 1 through 3 show the same specifications as the corresponding columns of table 3. In the case of education, we are able to compare pre-earthquake trends between affected and non-affected departments. Columns 1 through 3 show no statistically significant differences across departments in the pre-earthquake estimates under the three specifications proposed in our analysis. These results give further support to the empirical identification strategy used in this paper, since no differential trend is observed prior to the shock. Column 1 in table 4 indeed shows no statistically significant reduction in school enrollment for children living in affected departments one year after the earthquake, although the point estimate is negative. On the contrary, the estimated coefficient for year 2005 is negative and statistically significant at the 10 percent level.

Note that the cohort of children aged 6 to 10 in 2005 was 4 years old or younger when the earthquake occurred. The persistent impact in 2005 might reflect two issues. First, the negative effect in the medium-term may reflect the adverse earthquake shock that they experienced early in life. Previous evidence in child developmental literature showed that inadequate nutrition in early years could have persistent consequences in later childhood on children schooling – e.g. late entry, early dropout, inattention, and poor learning (Almond and Currie 2011, Center on the Developing Child 2010, Schultz 2010, Strauss and Thomas 2008, Orazen and King 2008, Engle et. al 2007, Grantham-McGregor et. al 2007).[10] Second, there could have been other events that happen together with the earthquake and that might have also affected school attendance for children aged 6 to 10. Consequently we might incorrectly attribute any variation of school attendance to the earthquake. Columns 2 and 3 in table 4 address this potential source of bias by introducing variables that capture the earthquake's intensity, exploiting the variation of the impact of the shock across departments.

Column 2 in table 4 reports the differential effect of the earthquake by department of residence, weighting less affected departments equally. Children residing in Quindio are 7 percent less likely to be enrolled in school in 2000. However, no significant impact is observed in 2005. In addition, although negative, there is no significant impact of the earthquake in the least affected departments in 2000, while there is an indication that the impact of the shock is significant in 2005. Column 3 in table 4 shows our preferred specification; it explores the differential impact of the earthquake exploiting the variability in the indirect damages caused by the disaster in less affected departments. This specification provides suggestive evidence that the earthquake only reduces, by 7 percent, the schooling participation of children aged 6 to 11 residing in Quindio in 2000. Note that the negative impact in 2005 observed in column 2 is no longer statistically significant when we exploit the variability of the shock in less affected departments.

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[10] Table 3 shows that children aged 0 to 5 living in affected areas in 2000 have 0.182 height-for-age Z-score standard deviations lower than their peers residing in non-affected areas.

Table 5 explores the impact of the earthquake on schooling participation of children aged 11 to 15. In line with the results found for the youngest group of children in table 4, no trend is observed prior to the shock (columns 1 through 3). Nonetheless, a different story is observed after the earthquake. Column 1 shows a negative and significant impact of the shock for children residing in affected departments both in the short term, in 2000, and the medium term, in 2005. Note that results for 2000 and 2005 refer to two different cohorts of children – i.e., in 2000 we measure the impact of the shock on children who were 10 to 14 years old when the 1999 earthquake struck, while in 2005 we measure the medium term impact of the earthquake on children who were 5 to 9 years old in 1999.

When considering the differential impact of the earthquake by department of residence, these impacts are large and meaningful. As column 2 reports, the probability of being enrolled in school for children residing in Quindio or the least affected departments falls both in 2000 and 2005. Column 3 presents our preferred specification, which exploits the great variability of the shock on the less affected departments. Results also confirm that the negative impact of the earthquake on schooling for children residing in Quindio persists in the medium term. The shock decreases the likelihood of being enrolled in school for children living in Quindio by 6.5 and 5.3 percent in 2000 and 2005, respectively. For children residing in the least affected departments, the coefficient is negative and statistically significant only in 2000, meaning that an increment of one percent of the proportion of the population indirectly affected by the earthquake reduces school attendance by 0.714 percent in 2000. For instance, the probability of being enrolled decreases by 3.9 (0.714*5.6) percent in 2000 in a department having the average value of the population indirectly affected by the earthquake (see table A.1 in the appendix).

6.2 Robustness Check

As described in the previous section, we constructed a panel dataset at the department level employing the DHS for the years 1990, 1995, 2000, and 2005. The four samples were drawn from the 1985 National Census. However, the sample size increased considerably in 2005 compared to previous years and, with the exception of the years 1995 and 2000, the municipalities where the data is collected differ between some surveys. Therefore, in tables 6 and 7, we examine the role of the sample design of the surveys.

In column 1 of the tables, we estimate our third specification, restricting the sample to the years 1995 and 2000, which are surveys that collect data on a representative sample from the 61 municipalities available in the 23 departments in 1995 and 2000. The magnitude of the impact and its level of statistical significance are consistent with the non-restricted sample (columns 3 of tables 3, 4, and 5), providing evidence the main results are unlikely to be influenced by the sample design.

In column 2 of tables 6 and 7, we perform a detailed exploration of whether unobserved heterogeneity at the municipality level, instead of at the department level, matters. The estimation of the results using municipality fixed effects and restricting the sample to years 1995 and 2000 leaves the main findings of our analysis unchanged. Lastly, and for the case of education, column 3 of table 7 compares pre-earthquake trends between affected and non-affected departments, restricting the sample to years 1990 and 1995. In line with our main results, there is no a differential trend before the earthquake.

An additional concern for our main findings is the existence of migration across departments, which could bias our results. First, shock exposure is based on the child’s current department of residence. Therefore, if a child resided in a different department during the earthquake, we would incorrectly determine child exposure to the shock (Akresh, Lucchetti, and Thirumurthy 2011). Second, migration across departments might not be random. For instance, we could overestimate the impact of the earthquake if households with higher preferences for children's health and education are more likely to migrate from departments devastated by the earthquake to departments not affected by the shock. In this regard, we also explore whether migration across departments is a significant concern for our results. Table 8 compares the proportion of migrant children after the earthquake by Quindio, less affected, and non-affected departments. We define migrant children as those children: (1) living for one year or less in the current place of residence in 2000 or (2) living for six years or less in the current municipality in 2005.[11]

Results in table 8 suggest that in general migration after the earthquake is slightly higher in Quindio compared to less affected and non-affected departments. This result suggests that people are mostly moving within or returning to Quindio department; it is unlikely that people residing in less affected or non-affected departments before the earthquake move to Quindio after the shock. In line with this evidence, Unicef (2004) and Restrepo (2000) mention that migration was mainly observed between cities within affected areas. Indeed, Restrepo (2000) highlights that after the earthquake, around 30,000 individuals in the capital of Quindio left to neighboring areas. However, most of them returned in the short-term to receive governmental aid.

To further check the robustness of our previous findings, table 9 restricts the sample to children whose current place of residence is the same as the one during the earthquake. If migrant children are systematically different than non-migrant children, then excluding these

[11] The 2000 survey asks about the number of years women have been living in their current place of residence, while the 2005 survey asks about the number of years women have been living in their current municipality of residence.

migrant children from the regressions should change the estimated impact of the earthquake (Akresh, Lucchetti, and Thirumurthy 2011). Results in the table show that the magnitude of the impact and its level of statistical significance are consistent with the non-restricted sample, providing evidence of no bias due to migration.[12]

6.3 Heterogeneous impact by gender

Table 10 examines whether the impact of the earthquake differed by gender. Exploring the impact of the shock on child nutrition (columns 1 and 2), both boys and girls aged 0 to 5 residing in Quindio appear to be affected in 2000 by the earthquake. On the contrary, height-for-age improves in 2005 for girls residing in Quindio when compared with peers residing in non-affected departments, while boys residing in Quindio are worse-off in 2005 compared to non-affected peers.[13] The effects in 2005 are particularly noteworthy; results suggest that the existing gap in 2000 between Quindio and non-affected departments tends to be small and reverses sign in 2005 for boys and girls, respectively. These gap changes favor girls and the effect observed for boys and girls in 2005 seems to balance the impact when we analyze the full sample of children in column 3 of table 3. In contrast with our findings, other studies in developing countries in Asia and Africa have found that the gender imbalance in the short-term impact of negative shocks favors boys over girls (World Bank 2011, Maccini and Yan 2009, Ferreira and Shady 2009).

Columns 3 and 4 of table 10, explore the differential impact on schooling participation by gender for children aged 6 to 10. Consistent with the findings for the full sample of children in table 4, the probability of not being enrolled in school is higher for both boys and girls residing in Quindio in 2000. The magnitude of the negative impact is larger for boys; indeed in a fully

[12] A more accurate approach will classify children's exposure according to the place of residence right before the earthquake. Unfortunately, this information is not available in the DHS Colombian survey.
[13] The equality of coefficients between boys and girls is rejected in a fully interacted model (results not shown).

interacted model, we are able to reject the equality of coefficients for boys and girls (results not shown).

Columns 5 and 6 report the findings for children aged 11 to 15. For children living in Quindio in 2000, the magnitude of the negative impact is slightly larger for boys, although we cannot reject the equality of coefficients for boys and girls in a fully interacted model (results not shown). On the contrary, boys living in Quindio are mainly driving the negative impact of the earthquake on schooling participation in 2005. For children residing in the least affected departments, both boys and girls in 2000 and boys in 2005 experience a significant decrease in schooling participation, although we cannot reject the equality of coefficients for boys and girls in a fully interacted model (results not shown).

Summarizing, the evidence shown in columns 3 to 6 suggests that boys tend to be slightly more affected by the earthquake than girls. Gender differences may reflect different opportunity cost of schooling for boys and girls, stemming from forgone wages (World Bank 2012). For instance, Bustelo (2011) finds that schooling participation decreases after Tropical Storm Stan in Guatemala only for exposed boys aged 13 to 15, who are more likely to be engaged in market work that directly contributes to family income. On the contrary, the storm increases the probability that older girls are enrolled in school and engaged in unpaid agricultural family work.

7. Conclusion

Natural disasters can have severe consequences for child welfare. An important question related to these negative impacts is the degree to which their effects persist over time across child cohorts. In this paper, we uniquely assess the short- and medium-term impact of the 1999 Colombian earthquake on child nutrition and schooling, combining two cross-sectional household surveys collected before the earthquake and two cross-sectional household surveys collected one and six years after the earthquake. Colombia provides a unique setting for our study because the government launched a very successful reconstruction program after the earthquake. In this regard, we are able to explore how persistent the impact of the shock is amid the successful relief aid received.

Findings report a strong negative impact of the earthquake on child nutrition and schooling in the short-term. The adverse effects are mainly observed in Quindio, the department most affected by the shock, although schooling also decreases one year after the earthquake in less affected departments. More importantly, amid the aid received by the affected area, the negative consequences of the earthquake persist to a lesser degree in the medium-term, especially for boys. Boy's nutrition is particularly vulnerable in Quindio after six years of the disaster, while boys aged 11 to 15 in both Quindio and less affected departments are more likely than girls to decrease their school participation.

While our data do not allow us to definitively conclude the mechanisms by which the earthquake might have affected child nutrition and schooling, evidence seems to indicate that the massive housing and infrastructure destruction caused by the geological shock might be a key pathway. Many families lost their homes and were internally displaced to temporary shelters, which caused difficulties in access to basic sanitary services, water supplies, and food. Additionally, the massive economic losses may have affected parent's mental health, impacting children's development. For instance, the child development literature indicates a positive relationship between child growth failure and maternal depression (see Wachs et al. 2009 for a review).

On the other hand, the sharp declines in living standards and destruction of educational infrastructure might have forced households to take children out of schools. Indeed, a schooling assessment study conducted by Unicef (2004) in the capital city of Quindio listed the 1999 earthquake as one of the causes for school desertion. The evidence for the children aged 11 to 15 in 2005 suggests that children whose schooling was affected by the earthquake when they were aged 5 to 9 were not able to overcome the shock to their school enrollment that occurred in 1999 and 2000. Schooling participation might have also decreased due to higher earnings opportunities for children triggered by FOREC reconstruction plan. Children's employment is related to lower educational attainment (Edmonds 2007, Duryea and Arends-Kuenning 2003, Psacharopoulos 1997). For instance, Duryea and Arends-Kuenning (2003) found that labor participation for children aged 14 to16 in urban Brazil increased as labor markets improved and children were more likely to leave school as local labor market conditions became more favorable. Lastly, indirect effects might also have played a role in the schooling of children aged 11 to 15 in less affected departments.

How substantive are the observed changes for child welfare? A body of empirical evidence established that (1) poorer child nutritional status is associated with subsequent lower educational attainments and adult earnings and (2) lower levels of education are associated with lower wages. To put our results in context, we can roughly estimate the long-term consequences that follow from our estimates and findings from previous studies for Zimbabwe and Peru. Alderman, Hoddinott and Kinsey (2006) reported that a one standard deviation decrease in height for preschoolers children correlates with 0.678 lower school grades completed in Zimbabwe. The World Bank (2005) estimated for Peru that the return to an extra year of education in 2003 is 11 percent. If the earthquake were associated with lower height-for-age Z-scores by 0.296 standard deviations for children residing in Quindío one year after the earthquake and a decline of at least 0.2 (0.678*0.296) years of schooling in the long term, wages in adulthood would be 2 percent lower for children younger than five in 2000. In addition, if affected children aged 7 to 15 in 2000 did not enroll in school after the earthquake and there is a decline of at least one year of schooling, the economic costs of the earthquake would be at least a 11 percent reduction in lifetime earnings.

The findings in this paper highlight three points for setting priorities of public programs. First, the destructive geological event forces households to adjust to the shock by reducing child nutrition or withdrawing children from school. Second, the successful remedial action plan that took place right after the disaster mitigates, but does not eradicate, the adverse effects in child human capital formation. The decrease of investment in children's human capital persists, to a lesser degree, across child cohorts many years after the shock. Third, the damage to human capital formation will have lasting impacts on children's welfare. This negative impact deserves serious policy attention and needs to be addressed with further economic interventions.

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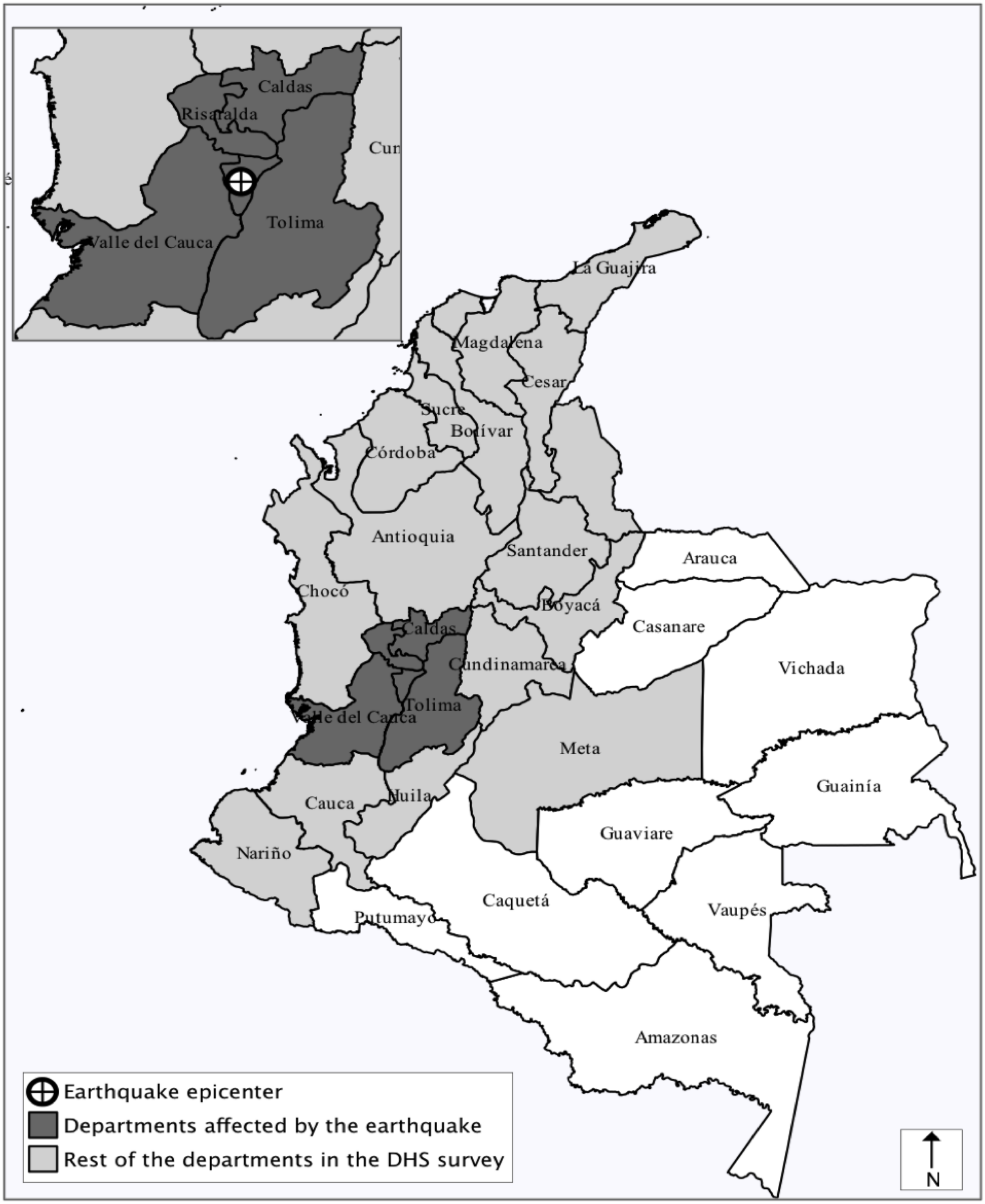
Figure 1
Colombian Departmental Map Indicating the Area Most Affected by the 1999 Earthquake



Source: Own elaboration based on ECLAC 1999 and World Bank 2003.

Table 1
Descriptive Statistics at the National Level by Survey's Year

	1990	1995	2000	2005
Children Aged 0 to 5				
Child Height-for-Age Z-score		-0.9	-0.8	-0.7
Child Age in Months		29.2	28.9	29.3
Child is Male		50.6	51.0	50.3
Child Lives in Urban Area		63.0	68.6	67.8
Mother's Age		28.1	27.9	27.8
Mother's Years of Education		6.4	7.1	7.7
HH. Head is Male		84.5	79.4	77.0
Population in Quindío (in %)		1.2	1.0	1.1
Population in Rest of Affected Departments (in %)		16.9	15.6	16.2
N		4,508	4,180	10,020
Children Aged 6 to 10				
Child is Enrolled in School	78.6	91.3	92.1	94.2
Child Age	8.1	8.0	8.0	8.1
Child is Male	48.9	49.9	50.6	50.5
Child Lives in Urban Area	65.9	62.4	67.3	68.4
HH. Head Age	43.7	43.7	43.6	44.4
HH. Head Years of Education	5.1	5.2	5.9	6.2
HH. Head is Male	82.4	81.9	76.4	73.1
Population in Quindío (in %)	1.8	1.1	0.8	1.1
Population in Rest of Affected Departments (in %)	16.9	17.3	17.8	17.7
N	4,194	5,082	5,093	13,890
Children Aged 11 to 15				
Child is Enrolled in School	73.2	81.8	84.0	88.4
Child Age	13.0	13.1	13.0	13.0
Child is Male	49.3	49.6	51.7	50.6
Child Lives in Urban Area	65.1	64.1	67.4	69.4
HH. Head Age	46.4	46.2	46.3	47.1
HH. Head Years of Education	4.8	5.2	5.6	6.0
HH. Head is Male	79.7	78.3	74.3	71.1
Population in Quindío (in %)	2.4	1.5	0.9	1.3
Population in Rest of Affected Departments (in %)	19.3	17.5	17.5	17.6
N	3,811	5,007	4,848	14,108

Source: 1990, 1995, 2000, and 2005 Colombian Demographic and Health Surveys.
Notes: Results are weighted using survey-sampling weights. "Rest of Affected Departments" denotes the departments of Caldas, Risalda, Tolima, and Valle del Cauca.

Table 2
Pre-earthquake Descriptive Statistics by Affected and Non-affected Departments – Year 1995

	Affected Departments	Non-affected Departments	Difference
Children Aged 0 to 5			
Child Height-for-age Z-score	-0.7	-0.9	0.3
Child Age in Months	29.9	29.0	0.9
Child is Male	50.9	50.6	0.4
Child Lives in Urban Area	69.9	61.5	8.4
Mother's Age	28.3	28.0	0.3
Mother's Years of Education	6.8	6.3	0.4
HH. Head is Male	81.8	85.0	-3.2
N	884	3,624	
Children Aged 6 to 10			
Child is Enrolled in School	90.7	91.5	-0.7
Child Age	8.0	8.0	-0.1
Child is Male	49.5	50.0	-0.4
Child Lives in Urban Area	66.7	61.4	5.3
HH. Head Age	43.7	43.8	-0.1
HH. Head Years of Education	5.6	5.2	0.4
HH. Head is Male	77.3	83.0	-5.6
N	1,002	4,080	
Children Aged 11 to 15			
Child is Enrolled in School	82.1	81.8	0.3
Child Age	13.0	13.1	0.0
Child is Male	47.6	50.0	-2.4
Child Lives in Urban Area	68.5	63.1	5.4
HH. Head Age	45.8	46.3	-0.4
HH. Head Years of Education	5.4	5.2	0.2
HH. Head is Male	78.7	78.1	0.5
N	1,026	3,981	

Source: 1995 Colombian Demographic and Health Survey.
Notes: Differences in pre-earthquake characteristics between affected and non-affected departments are statistically significant *** at 1%, ** at 5%, and * at 10%. Robust standard errors in brackets, clustered at the department level (results not reported). Results are weighted using survey-sampling weights. “Affected Departments” denotes the area most affected - i.e., the departments of Caldas, Quindio, Risalda, Tolima, and Valle del Cauca.

Table 3
Measuring the Impact of the Earthquake on Height-for-age Z-Scores for Children Under 5

Dependent Variable: Height-for-age Z-score	[1]	[2]	[3]
Affected * Year 2000	-0.182***		
	[0.058]		
Affected * Year 2005	-0.009		
	[0.064]		
Quindio * Year 2000		-0.296***	-0.281***
		[0.038]	[0.035]
Quindio * Year 2005		0.084	0.088
		[0.056]	[0.056]
Less Affected * Year 2000		-0.175***	
		[0.061]	
Less Affected * Year 2005		-0.017	
		[0.066]	
Less Affected (Intensity) * Year 2000			-0.618
			[0.738]
Less Affected (Intensity) * Year 2005			-0.032
			[0.470]
P-value Testing Equality Between Quindio and Less Affected Departments in 2000		0.035	
P-value Testing Equality Between Quindio and Less Affected Departments in 2005		0.118	
Year Fixed Effects	Yes	Yes	Yes
Department Fixed Effects	Yes	Yes	Yes
Region-specific Time Trends	Yes	Yes	Yes
Demographics Controls	Yes	Yes	Yes
N	18,708	18,708	18,708

Source: 1995, 2000, and 2005 Colombia Demographic and Health Surveys.
Notes: Robust standard errors in brackets, clustered at the department level. Statistically significant *** at 1%, ** at 5%, and * at 10%. Results are weighted using survey-sampling weights. Demographic controls include child age in months; child age in months squared; child gender; area of residence (urban vs. rural); household head's gender; and age, age squared and years of education of the children’s mothers. “Affected” indicates a child living in the most affected departments (Caldas, Quindio, Risalda, Tolima, and Valle del Cauca). “Quindio” indicates a child living in Quindio. "Less Affected (Intensity)” indicates for each department other than Quindio the proportion of the population indirectly affected by the earthquake.

Table 4

Measuring the Impact of the Earthquake on School Enrollment for Children Aged 6 to 10

Dependent Variable: School Enrollment	[1]	[2]	[3]
Affected * Year 1990	0.018		
	[0.067]		
Affected * Year 2000	-0.073		
	[0.056]		
Affected * Year 2005	-0.155*		
	[0.075]		
Quindio * Year 1990		-0.031	-0.021
		[0.054]	[0.052]
Quindio * Year 2000		-0.072***	-0.071***
		[0.021]	[0.017]
Quindio * Year 2005		-0.051	-0.047
		[0.035]	[0.029]
Less Affected * Year 1990		0.025	
		[0.068]	
Less Affected * Year 2000		-0.074	
		[0.060]	
Less Affected * Year 2005		-0.163*	
		[0.079]	
Less Affected (Intensity) * Year 1990			0.343
			[0.431]
Less Affected (Intensity) * Year 2000			-0.353
			[0.434]
Less Affected (Intensity) * Year 2005			-0.724
			[0.719]
P-value Testing Equality Between Quindio and Less Affected Departments in 2000		0.979	
P-value Testing Equality Between Quindio and Less Affected Departments in 2005		0.141	
Year Fixed Effects	Yes	Yes	Yes
Department Fixed Effects	Yes	Yes	Yes
Region-specific Time Trends	Yes	Yes	Yes
Demographics Controls	Yes	Yes	Yes
N	28,259	28,259	28,259

Source: 1990, 1995, 2000, and 2005 Colombia Demographic and Health Surveys.
Notes: Robust standard errors in brackets, clustered at the department level. Statistically significant *** at 1%, ** at 5%, and * at 10%. Demographic controls include child age in months; child age in months squared; child gender; area of residence (urban vs. rural); household head's gender; and age, age squared and years of education of the children’s mothers. See table 3 for a definition of the intensity variables.

Table 5

Measuring the Impact of the Earthquake on School Enrollment for Children Aged 11 to 15

Dependent Variable: School Enrollment	[1]	[2]	[3]
Affected * Year 1990	0.024		
	[0.062]		
Affected * Year 2000	-0.077*		
	[0.040]		
Affected * Year 2005	-0.148**		
	[0.067]		
Quindio * Year 1990		-0.062	-0.057
		[0.041]	[0.044]
Quindio * Year 2000		-0.057***	-0.065***
		[0.015]	[0.013]
Quindio * Year 2005		-0.049*	-0.053**
		[0.024]	[0.021]
Less Affected * Year 1990		0.037	
		[0.064]	
Less Affected * Year 2000		-0.081*	
		[0.044]	
Less Affected * Year 2005		-0.158**	
		[0.073]	
Less Affected (Intensity) * Year 1990			0.227
			[0.440]
Less Affected (Intensity) * Year 2000			-0.714**
			[0.263]
Less Affected (Intensity) * Year 2005			-0.921
			[0.545]
P-value Testing Equality Between Quindio and Less Affected Departments in 2000		0.585	
P-value Testing Equality Between Quindio and Less Affected Departments in 2005		0.136	
Year Fixed Effects	Yes	Yes	Yes
Department Fixed Effects	Yes	Yes	Yes
Region-specific Time Trends	Yes	Yes	Yes
Demographics Controls	Yes	Yes	Yes
N	27,774	27,774	27,774

Source: 1990, 1995, 2000, and 2005 Colombia Demographic and Health Surveys.
Notes: Robust standard errors in brackets, clustered at the department level. Statistically significant *** at 1%, ** at 5%, and * at 10%. Results are weighted using survey-sampling weights. See table 4 for a definition of Demographic controls and variables used.

Table 6
Measuring the Impact of the Earthquake on Height-for-Age Z-scores for Children under 5, Restricting the Sample to Years 1995 and 2000

Dependent Variable: Height-for-age Z-score	[1]	[2]
Quindio * Year 2000	-0.242***	-0.244***
	[0.024]	[0.021]
Less Affected (Intensity) * Year 2000	-0.313	-0.186
	[0.684]	[0.652]
Year Fixed Effects	Yes	Yes
Department Fixed Effects	Yes	No
Municipality Fixed Effects	No	Yes
Region-specific Time Trends	Yes	Yes
Demographics Controls	Yes	Yes
N	8,688	8,688

Source: 1995 and 2000 Colombia Demographic and Health Surveys.
Notes: Robust standard errors in brackets, clustered at the department level. Statistically significant *** at 1%, ** at 5%, and * at 10%. Results are weighted using survey-sampling weights. Demographic controls include child age in months; child age in months squared; child gender; area of residence (urban vs. rural); household head's gender; and age, age squared and years of education of the children's mothers. "Quindio" indicates a child living in Quindio. "Less Affected (Intensity)" indicates for each department other than Quindio the proportion of the population indirectly affected by the earthquake.

Table 7

Measuring the Impact of the Earthquake on School Enrollment, Restricting the Sample to Years 1990 and 1995 or Years 1995 and 2000

Dependent Variable: School Enrollment	[1]	[2]	[3]
Panel A: Children Aged 6 to 10			
Quindio * Year 1990			-0.006
			[0.053]
Quindio * Year 2000	-0.084***	-0.083***	
	[0.012]	[0.012]	
Less Affected (Intensity) * Year 1990			0.291
			[0.586]
Less Affected (Intensity) * Year 2000	-0.097	-0.087	
	[0.133]	[0.135]	
Panel B: Children Aged 11 to 15			
Quindio * Year 1990			-0.072
			[0.044]
Quindio * Year 2000	-0.051***	-0.049***	
	[0.011]	[0.011]	
Less Affected (Intensity) * Year 1990			-0.147
			[0.541]
Less Affected (Intensity) * Year 2000	-0.353***	-0.332***	
	[0.104]	[0.106]	
Year Fixed Effects	Yes	Yes	Yes
Department Fixed Effects	Yes	No	Yes
Municipality Fixed Effects	No	Yes	No
Region-specific Time Trends	Yes	Yes	Yes
Demographics Controls	Yes	Yes	Yes
N Panel A	10,175	10,175	9,276
N Panel B	9,855	9,855	8,818

Source: 1990, 1995, and 2000 Colombia Demographic and Health Surveys. Notes: Robust standard errors in brackets, clustered at the department level. Statistically significant *** at 1%, ** at 5%, and * at 10%. Results are weighted using survey-sampling weights. Demographic controls include child age in months; child age in months squared; child gender; area of residence (urban vs. rural); household head's gender; and age, age squared and years of education of the children’s mothers. “Quindio” indicates a child living in Quindio. "Less Affected (Intensity)” indicates for each department other than Quindio the proportion of the population indirectly affected by the earthquake.

Table 8

Migration by Quindio, Less Affected and Non-affected Departments - Years 2000 and 2005

	Quindio Department	Less Affected Departments	Non Affected Departments	Differences			
	[1]	[2]	[3]	[1-3]		[2-3]	
Panel A: Children Aged 0 to 5							
% who were Migrants in 2000	14.9	13.7	12.6	2.3		1.1	
% who were Migrants in 2005	32.5	23.2	26.6	5.9	**	-3.5	
Panel B: Children Aged 6 to 10							
% who were Migrants in 2000	15.5	8.0	9.0	6.5	***	-1.0	
% who were Migrants in 2005	25.1	19.6	18.4	6.7	**	1.2	
Panel C: Children Aged 11 to 15							
% who were Migrants in 2000	2.8	8.8	6.6	-3.8	***	2.2	*
% who were Migrants in 2005	21.8	15.4	15.0	6.8	***	0.4	

Source: 2000 and 2005 Colombian Demographic and Health Survey.
Notes: Differences in migrants between affected and non-affected departments are statistically significant *** at 1%, ** at 5%, and * at 10%. Robust standard errors in brackets, clustered at the department level (results not reported). “Quindio” indicates a child living in Quindio. "Less Affected” indicates Caldas, Quindio, Risalda, Tolima, and Valle del Cauca. Migrants denote those children: (1) living for one year or less in the current place of residence in 2000 or (2) living for six years or less in the current municipality in 2005.

Table 9
Measuring the Impact of the Earthquake on Height-for-age Z-scores and School Enrollment on Non-Migrants

Dependent Variable:	Height-for-age Z-score	School Enrollment Aged 6-10	School Enrollment Aged 11-15
	[1]	[2]	[3]
Quindio Department * Year 1990		-0.025	-0.058
		[0.050]	[0.042]
Quindio Department * Year 2000	-0.236***	-0.097***	-0.068***
	[0.036]	[0.017]	[0.013]
Quindio Department * Year 2005	0.095	-0.037	-0.069***
	[0.056]	[0.028]	[0.022]
Less Affected (Intensity) * Year 1990		0.354	0.243
		[0.421]	[0.421]
Less Affected (Intensity) * Year 2000	-0.584	-0.309	-0.723***
	[0.582]	[0.452]	[0.247]
Less Affected (Intensity) * Year 2005	0.029	-0.740	-0.887
	[0.468]	[0.724]	[0.534]
Year Fixed Effects	Yes	Yes	Yes
Department Fixed Effects	Yes	Yes	Yes
Region-specific Time Trends	Yes	Yes	Yes
Demographics Controls	Yes	Yes	Yes
N	15,366	22,530	21,443

Source: 1990, 1995, 2000, and 2005 Colombia Demographic and Health Surveys.
Notes: Robust standard errors in brackets, clustered at the department level. Statistically significant *** at 1%, ** at 5%, and * at 10%. Results are weighted using survey-sampling weights. Demographic controls include child age in months; child age in months squared; child gender; area of residence (urban vs. rural); household head's gender; and age, age squared and years of education of the children's mothers. "Quindio" indicates a child living in Quindio. "Less Affected (Intensity)" indicates for each department other than Quindio the proportion of the population indirectly affected by the earthquake. Migrants denote those children: (1) living for one year or less in the current place of residence in 2000 or (2) living for six years or less in the current municipality in 2005.

Table 10

Measuring the Impact of the Earthquake on Height-for-age Z-scores and School Enrollment by Gender

Dependent Variable:	Height-for-age Z-score		School Enrollment			
			Aged 6-10		Aged 11-15	
	Male	Female	Male	Female	Male	Female
	[1]	[2]	[3]	[4]	[5]	[6]
Quindio Department * Year 1990			-0.072	0.027	-0.069	-0.028
			[0.054]	[0.053]	[0.050]	[0.041]
Quindio Department * Year 2000	-0.480***	-0.284***	-0.104***	-0.038**	-0.071***	-0.061***
	[0.037]	[0.056]	[0.020]	[0.018]	[0.019]	[0.015]
Quindio Department * Year 2005	-0.234***	0.313***	-0.045	-0.044	-0.067***	-0.032
	[0.027]	[0.100]	[0.034]	[0.028]	[0.022]	[0.026]
Less Affected (Intensity) * Year 1990			0.406	0.274	-0.15	0.595
			[0.461]	[0.453]	[0.452]	[0.459]
Less Affected (Intensity) * Year 2000	-0.330	-0.893	-0.368	-0.343	-0.640***	-0.762*
	[0.814]	[0.829]	[0.505]	[0.403]	[0.208]	[0.380]
Less Affected (Intensity) * Year 2005	0.077	-0.022	-0.767	-0.678	-0.953*	-0.884
	[0.356]	[0.921]	[0.853]	[0.613]	[0.525]	[0.572]
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Department Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Region-specific Time Trends	Yes	Yes	Yes	Yes	Yes	Yes
Demographics Controls	Yes	Yes	Yes	Yes	Yes	Yes
N	9,442	9,266	14,365	13,894	13,995	13,779

Source: 1990, 1995, 2000, and 2005 Colombia Demographic and Health Surveys.

Notes: Robust standard errors in brackets, clustered at the department level. Statistically significant *** at 1%, ** at 5%, and * at 10%. Results are weighted using survey-sampling weights. Demographic controls include child age in months; child age in months squared; area of residence (urban vs. rural); household head's gender; and age, age squared and years of education of the children’s mothers. See table 7 for a definition of the intensity variables.

Appendix Table A.1
Department-level Intensity Measures

Departments		Population	Proportion of the Population Directly Affected	Proportion of the Population Indirectly Affected
		[1]	[2]	[3]
1	Quindio	547,312	59.7	87.7
2	Risaralda	920,737	5.4	27.2
3	Tolima	1,282,591	0.5	15.6
4	Valle del Cauca	4,071,491	0.4	8.6
5	Caldas	1,085,656	0.1	0.4
6	Antioquia	5,257,790	0.0	3.8
7	Bogota, D.C.	6,225,989	0.0	0.8
8	Atlantica	2,064,314	0.0	0.0
9	Bolivar	1,934,950	0.0	0.0
10	Boyaca	1,343,783	0.0	0.0
11	Cauca	1,223,965	0.0	0.0
12	Cesar	936,307	0.0	0.0
13	Cordoba	1,297,602	0.0	0.0
14	Cundinamarca	2,082,323	0.0	0.0
15	Choco	402,828	0.0	0.0
16	Huila	903,628	0.0	0.0
17	La Guajira	470,978	0.0	0.0
18	Magdalena	1,249,798	0.0	0.0
19	Meta	680,972	0.0	0.0
20	Nariño	1,590,052	0.0	0.0
21	Norte Santander	1,305,542	0.0	0.0
22	Santander	1,923,329	0.0	0.0
23	Sucre	773,107	0.0	0.0
Average [2] Through [5]			0.4	4.3
Average [2] Through [7]			0.4	5.6

Source: ECLAC (1999).
Notes: "Population Directly Affected" denotes the population who suffered direct losses in terms of housing, family members, and/or employment. "Population Indirectly Affected" denotes the population who suffered indirect losses such as disruption in commercial relations.

Appendix Table A.2
Measuring the Impact of the Earthquake on Child Nutrition and Schooling Participation

Dependent variable:	Height-for-age Z-score of children under five	School enrollment of children aged 6 to 10	School enrollment of children aged 11 to 15
	[1]	[2]	[3]
Quindio Department * Year 1990		-0.021	-0.057
		[0.052]	[0.044]
Quindio Department * Year 2000	-0.281***	-0.071***	-0.065***
	[0.035]	[0.017]	[0.013]
Quindio Department * Year 2005	0.088	-0.047	-0.053**
	[0.056]	[0.029]	[0.021]
Less Affected (Intensity) * Year 1990		0.343	0.227
		[0.431]	[0.440]
Less Affected (Intensity) * Year 2000	-0.618	-0.353	-0.714**
	[0.738]	[0.434]	[0.263]
Less Affected (Intensity) * Year 2005	-0.032	-0.724	-0.921
	[0.470]	[0.719]	[0.545]
Age (in months col. [1] - in years cols. [2-3])	-0.030***	0.193***	0.158***
	[0.004]	[0.018]	[0.027]
Age squared (in months col. [1] - in years cols. [2-3])	0.000***	-0.011***	-0.008***
	[0.000]	[0.001]	[0.001]
Male	-0.078***	-0.019***	-0.021***
	[0.014]	[0.003]	[0.004]
Urban	0.168***	0.031***	0.124***
	[0.036]	[0.007]	[0.015]
Mother's Age	0.011		
	[0.008]		
Mother's Age Squared	0.000		
	[0.000]		
Mother's Years of Education	0.063***		
	[0.003]		

Appendix Table A.2 Continuation
Measuring the Impact of the Earthquake on Child Nutrition and Schooling Participation

Dependent variable:	Height-for-age Z-score of children under five	School enrollment of children aged 6 to 10	School enrollment of children aged 11 to 15
	[1]	[2]	[3]
Household Head's Age		0.000	0.008***
		[0.001]	[0.002]
Household Head's Age Squared		0.000	-0.000***
		[0.000]	[0.000]
Household Head's Year of Education		0.007***	0.011***
		[0.001]	[0.001]
Household Head is Male	0.035*	0.003	0.008
	[0.018]	[0.006]	[0.006]
Year 1990		-0.124***	-0.047
		[0.040]	[0.034]
Year 2000	-0.054	-0.005	-0.004
	[0.035]	[0.015]	[0.016]
Year 2005	-0.107**	0.007	0.001
	[0.042]	[0.025]	[0.020]
Trends Oriental Region	0.095**	-0.009	0.018
	[0.040]	[0.008]	[0.012]
Trends Central Region	0.117***	-0.004	0.042***
	[0.036]	[0.018]	[0.014]
Trends Pacifica Region	0.109***	0.124***	0.119***
	[0.029]	[0.042]	[0.034]
Trends Bogota Region	0.110***	-0.036***	-0.003
	[0.020]	[0.006]	[0.005]
Department Fixed Effects	Yes	Yes	Yes
N	18,708	28,259	27,774

Source: 1990, 1995, 2000, and 2005 Colombia Demographic and Health Surveys. Statistically significant *** at 1%, ** at 5%, and * at 10%. Results are weighted using survey-sampling weights. “Quindio” indicates a child living in Quindio. "Less Affected (Intensity)” indicates for each department other than Quindio the proportion of the population indirectly affected by the earthquake.