The Long-Term Effect of Natural Disasters: Health and Education in Guatemala after the 1976 Earthquake

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Abstract

This paper provides causal evidence of the long-term consequences of the earthquake that hit Guatemala in 1976 on the educational attainment and adult height of Guatemalan children. I combine a unique Department-level dataset on the percentage of schools destroyed, and the percentage of people made homeless by the disaster, with individual survey data from the 2000 National Living Conditions Survey (ENCOVI). The identification strategy exploits the plausibly exogenous Department-by-cohort variation in the intensity of destruction as a unique quasi-experiment. The findings suggest significant, long-lasting detrimental effects on human capital outcomes of individuals who were in early childhood, or of school-going age, in February 1976. These children have respectively 0.2 and 0.4 fewer years of schooling on average in adulthood per each additional SD in earthquake's intensity. Females aged 4 to 9 have 0.53 fewer years. Children of unskilled workers and educated mothers experience bigger losses in years of completed schooling. Families failed to enroll girls of the affected cohorts in school altogether, or withdrew them sooner, but only delayed boys' enrollment. The earthquake also had an effect on adult height. There is a clear parental education gradient of the earthquake's impact, even after controlling for socioeconomic background. The gradient is gender specific. Men and women in the older cohort show an average reduction in adult height of 0.9 cms, but each additional year of schooling of the mother interacts with the impact of the disaster to offset the loss in stature of daughters by 0.6 cms while each additional year of father's schooling offsets the loss in stature of sons by 0.7 cms. Males aged 2 to -2 whose mothers are in the bottom quartile of the mother's height distribution are 0.4 cms shorter. These results show natural disasters are not gender neutral, can have long-term consequences on human capital formation, and can aggravate gender inequality.

JEL Codes: I10, I12, I21, Q54.

Key words: human capital formation, natural disasters, early life conditions.

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1. INTRODUCTION

Natural disasters, such as hurricanes, earthquakes, floods and droughts, disrupt the lives of individuals and their families. These events often result in negative income shocks due to loss of assets or life, and have an effect on intra household allocation decisions. The potential for disruption is bigger in poorer countries where insurance and credit markets are imperfect. Disasters that affect human capital formation during early childhood may have permanent effects on the lives of individuals and may contribute to the intergenerational transmission of disadvantage. Coping parental strategies in the aftermath of disasters are very important.[1] After a negative event in the life of a child, parents can invest resources –or fail to do so- to compensate for insults to human capital formation. Parents can also choose to "disinvest" and specialize, thus magnifying or mitigating the original impact of the shock. If parents choose or are able to compensate, the effects of a natural disaster should be smaller for children who benefited from parental investment.

This paper examines how the 1976 earthquake affected the long-term formation of human capital of children in Guatemala. It provides empirical evidence of the effects of a natural disaster in a poor country, on individuals that were affected at a crucial time in their development. By incorporating information on the family of origin, it examines the crucial role of gender and other individual characteristics that counteract, or worsen, the impact of the shock. Consequently, it relates to the existing literature on the consequences of natural disasters, and to the "early life conditions" studies that explore the effects of early human capital investments in adult life. One of the contributions of this paper is to focus on adult men and women rather than in young children, as the natural disaster literature usually does. Taking a long-term view provides a more complete picture of the cost of this type of event, and allows the assessment of the impact of the earthquake on the whole human capital formation process. Another contribution is the exploration of the heterogeneous effects on different groups of children, not always possible in "early life influences" studies due to lack of data about the family of origin. All of this is important for several reasons. First, natural disasters are a common event in the life of the poor, and its long term economic consequences are not well understood. Second, better knowledge about the potential pathways of impact can help design more efficient post-disaster interventions that minimize the damage to human capital formation of particularly vulnerable sub groups of children. An important policy implication arising from the results is that disasters are not gender neutral, and son preference can also play a role in post-disaster settings.

The data set used combines individual level information from a household survey (ENCOVI 2000) and administrative data on the destruction caused by the 1976 earthquake. The main outcomes explored are educational attainment and adult height, both measured 24 years later; the effect of the earthquake on enrollment and drop out decisions is also

[1] Almond and Currie (2010)

analyzed. The research design considers the earthquake as a natural experiment equivalent to a random negative shock, and exploits the variation in the intensity of its impact across Departments and across cohorts using a Difference in Difference model with variable treatment intensity. Variation in date of birth and Department of birth jointly determine an individual's level of exposure to the treatment. Earthquake intensity is measured by the percentage of classrooms destroyed, and the percentage of homeless people in each Department in its aftermath. The "treatment" variable is an interaction between destruction intensity at the Department level and a cohort dummy. The data set is rich in information about an individual's family of origin, and therefore parental education, area of birth, gender, father's occupation, civil war intensity and Department and year of birth fixed effects are included in the specifications as controls. Information on family composition and birth order, and indicators of health or cognitive ability in childhood, are missing. However, it is still possible to pinpoint potential pathways of transmission of the impact of the earthquake by looking at cohort differences in the timing of the shock and its effects on children with different background characteristics.[2] The identifying assumption is that in the absence of the earthquake, the difference in schooling, and adult height between affected and unaffected cohorts would have been the same across Departments with varying intensities of destruction. The results show the earthquake had significant negative effects on completed years of schooling for children aged 4 to 9 in February of 1976: a one standard deviation increase in intensity of destruction reduces years of schooling by 0.4 years. The impact for children aged 2 to -2 at the time of the disaster is smaller: an average reduction of 0.2 years of schooling.

There is evidence that the loss of public and private assets "scarred" individuals and continued to have an effect on their human capital formation years after the shock. A common thread in the findings indicates the scarcity of resources in the aftermath of the earthquake led to intra household decisions that systematically favored the investment in the human capital of male children. Schooling of males aged 4 to 9 was not affected. Girls of the same age suffered a reduction of 0.53 years of schooling on average, and the size of the effect is independent of family characteristics. Given the substantial variation in the destruction distribution, the effect is larger for girls living in harder hit Departments. The impact of the natural disaster on girls is worsened by some of the characteristics of the family of origin. ***An additional penalty exited for two groups of children: the offspring of unskilled workers, and of more educated mothers***. Daughters –but not sons- of poor unskilled manual workers in the older age group suffered an average reduction of by 0.65 years of schooling. Both male and female children of unskilled workers aged 2 to -2 in 1976 experienced a long-term average reduction in education of approximately half a year. Most likely, these liquidity constrained families lacked the capacity to buy substitutes for destroyed schools, and withdrew resources from the schooling of girls. Daughters –but not sons- of mothers with al least some education suffered and average reduction of 1.5 (girls aged 4 to 9) and 1.1 (girls aged 2 to -2) years of schooling. This effect may be related to differences in demand for girls' education. As opposed to daughters of uneducated parents

[2] Almond and Currie (2010).

who had little chance of attending regardless of a negative event taking place, girls whose mothers valued education would have been sent to school or kept in school for longer if the earthquake had not happened. After the disaster however, women's schooling was the margin on which households adjusted consumption.

When faced with scarcity of resources, families failed to enroll girls in school altogether, or withdrew them sooner, but only delayed boys' enrollment. The destruction's intensity increases the chance of never enrolling in primary or secondary education for females in the older cohort who were either daughters of unskilled workers or of educated mothers. The destruction also increases the probability of dropping out of school for girls belonging to either category in both age groups analyzed. Conditional on enrollment, the intensity of destruction delayed school entry for sons of educated mothers in both cohorts, and sons of unskilled workers aged 2 to -2.

The earthquake also reduced adult height. Males aged 2 to -2 in affected areas whose mothers are in the bottom quartile of the mother's height distribution are 0.4 cms shorter per each standard deviation increase in the intensity of the earthquake. No such impact is found for females of the same age group, or for males or females in the older cohort. There is a clear parental education gradient of the earthquake's impact, even after controlling for socioeconomic background. The gradient is gender specific. Men and women in the older cohort show an average reduction in adult height of 0.9 cms, but each additional year of schooling of the mother interacts with the impact of the disaster to offset the loss in stature of daughters by 0.6 cms while each additional year of father's schooling offsets the loss in stature of sons by 0.7 cms. Sons and daughters of mothers with no schooling and aged 4 to 9 experienced an average reduction of 1.63 cm and 1.75 cm respectively.

This paper is structured as follows: section 1 contains the Introduction. Section 2 provides the economic framework and lit review. Section 3 describes the country background and the 1976 earthquake. Section 4 talks about the dataset and provides descriptive statistics. Section 5 outlines the empirical strategy and potential sources of bias. Section 6 includes the results for completed years of schooling, while section 7 does the same for adult height. Section 8 contains robustness tests and discusses the results. Section 9 concludes.

2. FRAMEWORK

2.1 DISASTERS AND HUMAN CAPITAL FORMATION

Natural disasters have economy-wide and individual impacts (Pelling, Ozerdem and Barakat 2002). The destruction of physical infrastructure, reallocation of future public expenditure due to reconstruction, and loss of output and physical capital at the macro-level, can be accompanied by individual-level loss of assets and death of members of the household. Public and private losses have an effect on the human capital formation of children, and this paper evaluates the combined impact of both.

Natural disasters affect human capital formation directly through changes in the supply and demand of education and health services. The damage to physical infrastructure can decrease the availability, and increase the cost, of schooling and health care. An increase in the cost of education -resulting for example from increased travel and transport costs due to the destruction of nearby schools or healthcare facilities- leads to a decrease in the quantity of services demanded by households.[3] The destruction of physical capital and functioning businesses may reduce expected returns to schooling, discouraging parents to invest in education. An ex-post change in the quality of health and education related to crowding or ex-post reductions in public expenditure can also have an offsetting effect on the quantity demanded at a particular price level. Losses in household income and assets, especially when credit markets are missing or imperfect, tighten the household budget constraint resulting in a negative income effect.

Indirectly, a decline in family income or wealth raises the marginal utility of the child's contribution to household income, both for children who work outside the home, and for children engaged in agricultural or domestic chores. Additional reductions in demand for human capital can take place when reconstruction efforts increase child wage and therefore also increase the opportunity cost of staying in school, leading to a substitution effect. Both the income and substitution effects have an "anti-schooling" direction and combined reduce the quantity of education demanded (Ferreira and Schady 2008).[4] Previous research for other developing countries illustrates this theoretical prediction and shows that covariate and idiosyncratic shocks can affect school attendance (Jacoby and Skoufias, 1997); school attainment (Duryea, 1998; Skoufias and Parker, 2002); completion of secondary school (Flug, Spilimbergo, and Wachtenheim, 1998); ability of parents to pay for their child's education (Skoufias, 2003); and the labor supply of children (Jacoby and Skoufias, 1997; Beegle, Dehejia, and Gatti, 2006).

Another important way in which a disaster influences human capital formation is through the associated maternal and child malnutrition that may arise in its aftermath. Poor nutrition during childhood, specially during the in utero period and the first three years of life, can have a substantial negative impact on adult stature (Martorell, Schroeder, Rivera, and Kaplowitz 1995), educational attainment and cognitive abilities (Alderman, Behrman, Lavy, and Menon 2001) (Glewwe and King 2001) (Maluccio et al. 2009); and even men's hourly wage rates later in life (Behrman and Rosenzweig 2004). The vulnerability of children during early childhood and infancy makes them bear a disproportionate share of the effect of reductions in calorie intake.[5] After a natural disaster, many families are

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[3] Becker (1964) and (1991).

[4] It has been noted that natural disasters can also result in adult and child wage going down due to economic contraction in the post-disaster period, or that family income can increase due to relief aid. However, empirical evidence suggests the income and substitution effects have both a negative effect on the quantity of human capital goods consumed in the aftermath of natural shocks. Baez, de la Fuente, Santos (2010).

[5] This is due to the increased susceptibility to infection and high nutritional requirements of very young children; the potential for catching-up in growth later in life is limited once a child reaches 3 years of age. See Carter and Maluccio (2005),Martorell (1989) and Ruel et al (2008).

unable to smooth consumption expenditure, and can not maintain adequate calorie intake. As a consequence, the nutritional status of children in affected areas deteriorates, with long term implications for height and cognitive ability.[6] Additional long term damage may result from lack to access to health services and maternal stress. Finally, selection in terms of pregnancy resolution can lead to changes in the composition of the cohort affected.

Children acquire human capital through an interaction of genetic factors, environmental factors and parental investment.[7] In the aftermath of a disaster, parents can reinforce or compensate for its effects through the allocation of family resources to human capital production (Bellman, Pollack and Taubman 1982). The degree to which parents choose to compensate or "specialize" can be understood using the framework used by Almond and Currie (2010). They consider a two-period model of childhood, where the production of human capital *h* is a function of:

$$h = A[\gamma I_1 + (1+\gamma)I_2] \quad (1)$$

where *h* is multidimensional human capital that includes child's health and schooling, and I_1 = investment in childhood up to age *x*; and I_2 = investment in childhood after age *x*. Age *x* can be thought, for example, as age 2. The potential for catching up in growth after the 0-2 the period has been found to be limited (Carter and Maluccio, 2005; Martorell, 1989;and Ruel et al, 2008). I_1 can be thought of as composed of investments in nutrition, healthcare and parental time dedicated to the child, and I_2 to also include human capital inputs such as books, and schooling. If $\gamma \neq 0.5$, the allocation of investments to periods 1 and 2 will affect *h*, for a given level of total investment. If investment in I_1 and I_2 are complementary –for example, if healthier children learn better-, the developmental technology is CES (Heckman, 2007):

$$h = A[\gamma I_1^{\phi} + (1+\gamma)I_2^{\phi}]^{1/\phi} \quad (2)$$

For a given level of total investment I_1 + I_2, the elasticity of substitution $\sigma = 1/(1-\phi)$ gives a measure of how easy is to substitute I_1 for I_2 to produce *h*. The process of acquiring human capital after a natural disaster μ_g <0, in locality g, suffered in period 1 is:

$$h = A[\gamma(\bar{I}_1 + \mu_g)^{\phi} + (1+\gamma)I_2^{\phi}]^{1/\phi} \quad (3)$$

6 See Fogel (1994), Steckel (1995), Strauss and Thomas (1998) and Schultz (2002) and (2005).
7 Heckman (2007), Becker (1962), Becker and Tomes (1976), Cunha and Heckman (2007).

where $\bar{I}_1$ is predetermined and independent of μ_g, and $\bar{I}_1 + \mu_g > 0$. Parents observe μ_g at the end of period 1. Parents obtain utility from their consumption and from the human capital of the child:

$$U_p = U(C,h) = B[\theta(C)^{\varphi} + (1-\theta)h^{\varphi}]^{1/\varphi} \qquad (4)$$

Parents choose C^* and I_2^* to maximize utility subject to the budget constraint:

$$\bar{I}_1 + I_2 + C = \bar{y} \qquad (5)$$

At the optimum, and without discounting, the marginal utility from consumption has to be equal to the marginal utility from investing in the child's human capital:

$$\partial U / \partial C^* = \partial U / \partial h \; * \; \partial h / \partial I_2^* \qquad (6)$$

Parental responses to μ_g can be compensatory ($\partial I_2^* / \partial \mu_g < 0$), or reinforce the shock ($\partial I_2^* / \partial \mu_g > 0$). The reduced form estimate of $\partial h / \partial \mu_g$ will capture the direct effect of the shock due to malnutrition, developmental damage, or destruction of infrastructure; but it will also include these period 2 investment responses. At the optimum, the parental response will depend on the sign of $\partial I_2^* / \partial \mu_g$:[8]

$$\partial I_2^* / \partial \mu_g = \frac{(\varphi - \phi) a (I_2^*)^{\phi - 1} [b]^{(\varphi - 2\phi)/\phi} \gamma (\bar{I}_1 + \mu_g)^{\phi - 1}}{(1-\varphi)\theta(\bar{y} - \bar{I}_1 - I_2^*)^{\varphi - 2} + a\,[b]^{\varphi - \phi/\phi}\, I_2^{*\phi - 2}\,[(1-\phi) + (\varphi - \phi)(1-\gamma) I_2^{*\phi} / b]} \qquad (7)$$

If $\varphi > \phi$, the expression $\partial I_2^* / \partial \mu_g$ is always positive, it implies parents should reinforce the shock. The elasticity of substitution of the production function (between investment in period 1 and period 2) is smaller than the elasticity of substitution of the utility function (between consumption and investment in *h*). Families should consume more and invest less in human capital. If $\varphi < \phi$, the sign of $\partial I_2^* / \partial \mu_g$ will depend on: 1) the value of γ and θ (distribution parameters of the production and utility function); and 2) ϕ and φ

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[8] $a = (1-\theta)(1-\gamma)A^{\varphi} \geq 0$; and $b = [\gamma(\bar{I}_1 + \mu_g)^{\phi} + (1+\gamma) I_2^{\phi}]$. Almond and Currie (2010), Appendix B.

(substitution parameters of the same functions). If $\partial I_2^* / \partial \mu_g$ <0, the optimal response is to compensate for the shock reducing consumption and increasing investment in period 2.

In this framework, there are several ways in which a natural disaster could have heterogeneous effects on different groups of children. The CES production function with less than perfect substitution between inputs implies diminishing marginal productivity of inputs (there is a limit to the degree of sustituibility of one factor for another). Individuals with lower levels of investment in period 1 –for example, children form poorer families, or girls- will experience stronger effects from a shock than those with higher levels of I_1, because they are on a steeper portion of the production function and the marginal productivity of I_1 is still high (Almond and Currie, 2010).

The empirical evidence confirms that after a natural disaster, poorer children are particularly at risk, because droughts, earthquakes and floods affect their families the most.[9] Poorer children have lower levels of investment, a situation that accentuates the impact of a negative event. Long-term damage from shocks is also more likely to occur among poorer families, because these households are subject to more frequent or intense shocks (Currie and Hyson, 1999). Additionally, better-off households and households with access to credit are better able to smooth consumption, while worse-off families without access to credit have fewer margins on which to do so. Increasing its labor supply, selling assets, consuming cheaper and less nutritious food, and reducing investment in health and education of children, are some of the mechanism they use to adapt.[10] These mechanisms may worsen the long-term prospects of children from poorer households and reduce the productivity of further investments in their human capital.[11]

In economies with strong of pro-male bias, or where returns to resources are greater if invested in boys than in girls, household coping strategies may also have differential adverse consequences for females. The allocation of family resources towards females is one margin on which households adjust to transitory events that they are unable to smooth through credit markets.[12] In the framework analyzed in this section, differential

[9] Carter, Little and Mogues (2007) show that hurricane Mitch that hit Honduras in 1998 caused poorer households to lose a greater percentage of their productive assets and had a negative effect in long-term income growth. They also find evidence of a poverty trap in the case of the 1998-2000 drought in Ethiopia. Baez and Santos (2009) find that the effect of two earthquakes that hit El Salvador in 2001 was a reduction in household income per capita of one third of the pre-earthquake average, especially for households in more severely affected areas.

[10] For a review of household coping strategies to the impact of shocks, see Skoufias (2003).

[11] Cunha and Heckman (2007) show that the productivity of parental investments is higher at early ages for cognitive skills, and that investments across time are complementary.

[12] There is evidence of differential gender effects of idiosyncratic shocks. Sawada (2003) finds the schooling response to an income shock is consistently larger for daughters than sons in Pakistan. Skoufias and Parker (2006) show unemployment of the household head during the Mexico peso crisis was associated with higher probability that teenage females –but not males- do not attend school. Vera-Hernandez and Galiano (2008) use longitudinal data from rural Colombia and find that girls' weight is negatively affected as a consequence of the recent illness event of an adult active in the labor market.

effects for girls can arise from *ex-ante* lower levels of investment in females versus males. Additionally, if the technology of human capital production (parameters A, γ and ϕ) is assumed to be equal for boys and girls, social or cultural norms reflected in differences in the utility function parameters (B, θ and φ) could lead to differential gender outcomes. If the elasticity of substitution between consumption and investment varies across gender ($\varphi_{girls} > \varphi_{boys}$), parents see view consumption and girls' human capital as a better pair of substitutes than consumption and investment in boys. That could be the case if investment in boys generates greater potential returns to parents. Parents could also simply prefer sons to daughters. This would happen if parents get a higher share of their utility from consumption than from investment in girls relative to boys: $\theta_{girls} > \theta_{boys}$; or if for a given level of consumption and investment in human capital, parents of boys get more utility than parents of girls: $B_{boys} > B_{girls}$. In these situations it is more likely that $\partial I_2^* / \partial \mu_g$ in (7) will be positive for girls, and therefore parental response reinforces the negative effect of the natural disaster on the human capital of females. Alternatively, differential gender effects could arise in the context of a household bargaining framework if each parent prefers children of his or her own gender, and mothers have less bargaining power in the household than fathers.[13]

2.2 PREVIOUS LITERATURE

Several papers have explored the negative effect of natural disasters on human capital. The available evidence comes mainly from the study of extreme weather events such as draughts and floods. Foster (1995) estimates Euler consumption equations for Bangladesh after the 1988 floods and finds that landless households, or those with less access to credit markets, did not smooth consumption effectively resulting in post disaster child malnutrition. Hoddinot and Kinsey (2001) study the impact of the 1982-1984 drought on height growth among children in rural Zimbabwe using panel data for 222 children. The estimation controls for initial child and mother characteristics, household wealth and village dummies. The authors find that children aged 12–24 months at the time lose 1.5 to 2 centimeters of growth in the short term; that there is limited scope for catch-up 4 years after the disaster; and that the growth of children in poorer households, and children of unmarried or divorced mothers, was affected the most.

Del Ninno and Lundberg (2005) present evidence of the negative impact of the floods that affected Bangladesh in 1998 on height growth of children under five. The panel dataset used was collected in 1999, and contains information on children and their families, as well as household exposure to flood. They use a difference in difference design and an instrument to account for household or child characteristics that may be endogenous (i.e. genetic endowment or reception of post-disaster assistance). They find that exposure to the flood reduces the height of children aged 12–24 months by 0.5 standard deviations

[13] Rose (1999).

relative to international standards; that exposed children do not catch up in height to children not affected one year after the disaster; and that girls in affected areas grow more slowly than girls in areas with no flood.

In one of the very few papers that studies the effects of natural disasters in Latin America, Baez and Santos (2007) look at Hurricane Mitch, which devastated Nicaragua in 1998. They use two rounds of a household survey to explore the effects of Mitch on school enrollment, labor supply and health status of children living in affected rural municipalities. Exposure to the hurricane is proxied by municipality of residence. The timing of the data collection -1998 and 2001- allows them to use a difference in difference strategy, comparing children in affected and non affected municipalities. Individual, household and municipality characteristics are used as controls. They find no effect on school enrollment or prevalence of illness for children affected by the hurricane. The authors find in children living in areas hit by the disaster a fourfold increase in the probability of being malnourished; a reduction on health services utilization (conditional on being ill); a 60 percent increase in labor force participation; and a doubling in the percentage of students who also work. Heterogeneous impacts of the hurricane are not explored.

In another study, Santos (2010) estimates the effects of the two earthquakes that took place in El Salvador in 1991 on school attendance and child labor. The author uses longitudinal data from two waves (2000 and 2002) of a rural household survey, and an indicator of earthquake severity based on peak ground acceleration in 31 points in the country. The data set includes geographic coordinates of the dwelling and other information for 481 households located in affected areas. Results are obtained from a linear probability model that controls for soil type in the municipality, household and municipality fixed effects, and a set of pre-shock characteristics of the child. A 10 percent point increase in ground shaking is associated with a 4 percent decrease in school enrollment, with a 7.5 percent point decrease in labor force participation, and with a 5.5 increase in the probability of working outside the home. No differential effect by gender or age is found. Households with higher pre-shock wealth are more able to offset the effects of the disaster.

Yamauchi, Yohannes and Quisumbing (2009) provide further evidence that the effect of natural disasters (floods and droughts) could be worse for children from poorer families. Using panel data for Bangladesh, Ethiopia, and Malawi, they show that the children with better nutritional status (proxied by height for-age Z-scores) prior to disaster maintain investments in schooling in the post-disaster period. Health capital makes children more resilient to the effect of climatic events by increasing schooling investments and outcomes, in spite of the negative disaster impacts on the investment itself.

In spite of the big disruption caused by natural disasters on household income and assets, not much is known about their differential gender effects, or the precise intra-family decision making on human capital investments involved. As shown by Behrman (1988), households experiencing scarcity may withdraw more resources from girls than from boys, even if parents have more "egalitarian" preferences in less difficult times. He extends the structural model of Behrman, Pollack and Taubman (1982) to examine pro-male bias in the allocation of nutrients inside the household using the Indian ICRISAT panel data set. He finds that when food supplies are tight, parents exhibit male preference, and that the bias is larger among the bottom castes. The author shows some evidence that the bias does not arise from differences in future labor market productivity between boys and girls, but rather from parental tastes or unobserved factors. During the surplus season, there is no difference in the allocation of food between boys and girls, and parents seem to exhibit inequality aversion. These result are however conditional on functional forms and a particular dataset.

Few papers provide direct evidence on the effect of natural shocks on girls. Hoddinot and Kinsey (2001) find that women –but not men- living in villages affected by the 1994-1995 Zimbabwean drought suffer a reduction of 1.15 percent in body mass index with each additional 10 percent decrease from the historical rainfall level. Additional reductions are found for women in poorer households. Rose (1999) uses data for 2,297 children in 16 states of India surveyed from 1969 to 1971, to explore the effects of a positive weather event: higher than average rainfall. The measure of the shock, deviation of rainfall from its historical district-level mean, reflects a transitory component of rainfall and is assumed to be positively correlated with family income. A correction for selection from underreporting female births is applied to the estimation. The author finds that favorable rainfall shocks in childhood increase the survival probabilities of girls to a greater extent than they increase boys' survival probabilities, and the effect is stronger for landless households that have less options to smooth consumption and that are more likely at the margin of survival. Mother's education and landholdings positively affect the differential between female and male mortality, while head's education and the availability of a school in the village have a negative effect on this difference. This suggests that the effect of rainfall on girls' survival stems from the inability of the households to smooth consumption (landless households), from the bargaining power of each parent (mother's and head's schooling) in a context where parents prefer investing in children of their own sex, and from higher returns to education for boys.

The paper by Maccini and Yang (2009) is one of the few to provide evidence on the long-term effects of natural shocks.[14] In this case, the climatic event (deviation of rainfall from the historical mean for the locality) has a positive effect on average locality crop output and thus, on family income. Using information on the individual's year and location of birth from a household survey, and locality-specific rainfall data for that year, they show the amount of rainfall experienced during early life has an effect on human capital measured in 2000 of rural Indonesian women born between 1973 and 1954, but not of men. Women who experience rainfall 20 percent above average in their location of birth during early life

[14] There is a growing body of evidence on the long-term effects of different types of shocks –economic contractions, famines, pollution, maternal illness or fasting- during the in utero period, or early life. For a review see Almond and Currie (2010).

are slightly taller (0.57 cm), are 3.8 percentage points less likely to self-report poor or very poor health, attain 0.22 more completed grades of schooling, and live in households that score 0.12 standard deviations higher on an asset index. The authors explore different channels of transmission of rainfall to adult outcomes and suggest that nutrition in infancy drives the results. Rainfall's effects on household income and food availability produce variation in parents' abilities to provide nutrition, and other human capital goods for infant girls. No in utero (before the gender of the child is known) effect of rainfall is found, suggesting gender bias in the allocation of resources inside the household.

This paper contributes to the above literature by exploring the effects of a catastrophic event in a developing country almost a quarter of a century after it has happened, when individual human capital has been realized and the true cost of the disaster emerges. It also contributes to a small literature on differential gender effects of natural shocks by asking whether the long-term impact of the disaster is related to gender, or socioeconomic background. By analyzing an earthquake, it is distinct from Rose (1999) and Maccini and Yang (2009) who studied the effect of extremes of rainfall, and whose conclusions are therefore mainly relevant for rural or agricultural settings. Additionally, this paper adds to the scant knowledge of the impact of natural disasters in Latin America. More specifically, to my knowledge, it is the first econometric examination of the earthquake that hit Guatemala in 1976. In this sense, it complements work by Baez and Santos (2007) and Santos (2010).

3. BACKGROUND

3.1 THE COUNTRY IN 1976

Guatemala is a small, mostly rural country located in Central America and divided in 22 Departments. Its inhabitants are young, and half live in rural areas. In 2010, life expectancy (at 70 years) is the second lowest in Latin America. Child mortality (41 deaths per thousand) is the highest in Central America, and the second highest in the continent. The country has the highest prevalence of chronically malnourished children (44 percent) and the highest total fertility rate (3.5 children per woman) in the region; the prevalence of contraceptive use (27 percent) is the second lowest in the western hemisphere.[15] Large inequalities in assets and human capital are endemic across geographic areas and socioeconomic groups; with 51 percent of the population living in poverty.[16] Guatemala is recovering from a three-decade long civil conflict that resulted in 2000,000 deaths.[17] The government and rebels signed a peace accord in 1996.

In 1976, Guatemala was a mainly agrarian country of 6 million people, where 65 percent of the population lived in rural areas. One in six Guatemalans lived in Guatemala City. Social development was lagging: infant mortality was high (84 deaths per 1,000 live births) and

[15] CIA World Factbook, figures estimated for 2009; and World Bank (2009).
[16] World Bank, op. cit.
[17] Commission for Historical Clarification (CEH), Archdiocese of Guatemala (1999).

adult literacy was very low (47 percent). In rural areas, seven out of ten people were illiterate. Life expectancy was only 52 years. Inadequate nutrition was one of the three principal direct causes of hospitalization and there was one physician per 4,570 inhabitants. Income was very unequally distributed, and the distribution of land ownership even more skewed: the top decile of the population owned 81.4 percent of land compared to 0.5 percent of land owned by the lowest decile.[18] The fertility rate in 1978 was 6.6 births per woman; only 19.2 percent of women used some form of contraception, and most contraceptive users lived in Guatemala City.[19]

The school system consisted of five levels: pre-primary (preparatoria), primary (grades 1-6), secondary (three years), diversified (two years) and higher education. Children were to start school at age 7, but there was significant late enrollment. Excluding the Department of Guatemala –that contains the capital Guatemala City- schools were located in rural areas in a proportion of 4:1, reflecting the fact that more than 70 percent of pupils did not live in cities. According to the World Bank, in the 1970's the system faced huge problems arising from low enrollment, lack of schools and incomplete schools. Parents were often unable to finance the direct and indirect costs of schooling. Direct costs included clothes, shoes, books, tuition and transportation, in addition to the opportunity cost of services and labor not provided by pupils. In remote agricultural regions, literacy provided few advantages in employment prospects and incentives to enroll in school were weak.[20] Most children in rural areas participated in farm work; in urban areas children took care of siblings and assisted with household chores. Although overall primary school enrollment reached 34 percent of the schooling population, enrollment in the 4th to 6th grade dropped to less than half at 14 percent of pupils. Only 2 percent of the total school-aged population of children reached the last year of primary school. High repetition and high drop-out rates were related to poor health and nutrition.[21] Tables 1 and 2 in Appendix B provide a profile of the primary school system in Guatemala in 1972.

3.2 THE EARTHQUAKE AND HUMAN CAPITAL FORMATION

Guatemala lies along the Motagua Fault, in the boundary between the Caribbean and North American tectonic plates. This fault was responsible for the earthquake that took place on February 6, 1976, at 3:00 AM. The earthquake's path moved from East to West, through the middle of the country and had an intensity of 7.6 in the Ritcher scale. It killed 22,934 people, (0.4 percent of the population) and injured 77,173 (1.3 percent).[22] Most deaths resulted from crushing of adobe-wall dwellings with heavy roofs. The high number of victims resulted from the earthquake hitting the highly populated Central and Eastern regions (57.4 percent of the total population) at a time when most people were sleeping. The most affected Departments were Guatemala (containing the capital Guatemala City),

[18] World Bank (1978)
[19] Data from the 1978 Family Planning and Maternal Health Survey, Monteith et al (1985).
[20] World Bank (1983)
[21] World Bank Staff Appraisal Report, Project 4386b-GU (1983)
[22] Technical Commission on Evaluation and Planning, Guatemalan Government (1976).

Sacatepequez, Chimaltenango, El Progreso, Jalapa, Sololá, Totonicapán, Quiche, Zacapa, Baja Verapaz and Izabal. 74 percent of the total urban population, and 48 percent of the total rural population lived in these affected Departments.[23] Photographs 1 and 2 in Appendix B show the magnitude of the damage in two villages near the Capital. Graph 1 shows the distribution of the destruction of classrooms and people made homeless by the quake in each department.

Housing and infrastructure were also severely hit: bridges, aqueducts, railways, hospitals, cathedrals and roads were damaged. Information from the 1973 Census shows that more than 90 percent of dwellings in the country were made of adobe, wood or bareque, and it is estimated that 1,166,000 people, 20 percent of the nation's population, was left without a place to live.[24] The area affected by the earthquake contained 50 percent of the country's stock of housing. According to estimates at the time, 46 percent of all dwellings in affected areas were destroyed (258,478 houses).[25] Despite the loss of $750 million in assets, the country's economy expanded during 1976, the rate of growth exceeding 8 percent during 1977.[26]

The earthquake affected many households simultaneously, making the informal group-based mechanisms for mitigating risk less effective. In most cases, families had to rebuild their houses by themselves. Extended families helped survivors, but assistance may have stretched budgets and caused overcrowding at home.[27] Although damages to crops were not reported, other assets were destroyed: furniture, tools, clothing, etc. These assets had to be replaced, and time taken off paid work to reconstruct homes and other community buildings. Many families migrated to the Capital as a result of the earthquake's destruction. [28] According to anthropological accounts of the disaster's aftermath, the sale of assets, child labor, migration, and reduced food consumption were mechanisms through which households adapted.

In less poor countries, households with access to financial markets might borrow against future earnings to sustain consumption standards and invest in human capital. In Guatemala, however, credit and labour markets have been traditionally weak, and lack of functioning markets made it impossible for many people to smooth consumption, or investment in education, through credit. The combined effect of public and private losses most likely reduced human capital formation. For example, national level data from Guatemala in Graph 2 shows a negative rate of growth of the enrollment rate for Primary school in the school year following the earthquake.

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[23] UDURV

[24] World Bank (1978) and USAID (1976)

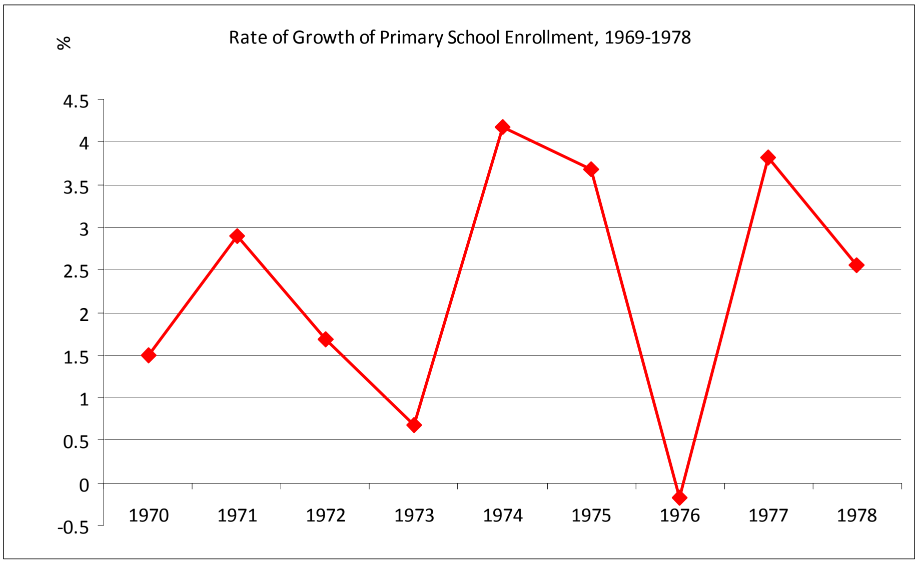
[25] Technical Commission on Evaluation and Planning, Guatemalan Government (1976).

[26] U.S. Office of Foreign Disaster Assistance (1982)

[27] Taylor(1976) p. 13: "The extended family system has provided a uniquely effective means of sheltering roofless souls. Inquires made in an attempt to identify any possible ill effects of this overcrowding revealed only an unexpected sense of togetherness in the face of collective difficulty".

[28] UDURV. (1978) and Garcia and Urrutia (1976).

GRAPH 2: RATE OF GROWTH OF PRIMARY SCHOOL ENROLLMENT 1969-1978



Source: Guatemala 1979 Statistical Yearbook

Several sources document increased transport costs and crowding in the education system in the aftermath of the disaster. The Ministry of Education implemented an emergency plan to reestablish school activities that included a system of shifts in the schools still standing, and a reduction of schooling hours per day to accommodate additional shifts. There were, however, not enough classrooms that could be used. During the emergency phase, classes were started using other government buildings if available; problems with mobility arose when children found it difficult to attend classes in other areas where they had been assigned. It is not clear for how long the shift system remained in place. [29] The systems of shifts in functioning schools continued for several years. In 1979 undamaged schools were still operating above their capacity and shifts were common.

The destruction of infrastructure also affected human capital formation. In the immediate aftermath of the disaster, government aid consisted of limited building supplies, and people had to rebuild community structures. Later on, the government's reconstruction effort aimed to repair damaged and destroyed educational infrastructure. [30] According to one source, the earthquake destroyed 5,215 classrooms, affecting school attendance of 250,000 children, out of a total school population of 637,705 children in the affected area.[31] Reconstruction activities were financed through loans from foreign international

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[29] World Bank (1980) Project Performance and Audit Report (Loan 576-GU), p 6: "All the schools built in the capital are considerably over-enrolled… the destruction of non-project schools in Guatemala City by the earthquake in 1976 has contributed to this over-enrollment "…"World Bank (1983), Staff Appraisal Report 4386b-GU. p 10: "The 1976 earthquake did little damage to the project schools, but it seriously affected their operation because students from destroyed schools have been brought in so that the schools accommodate tow or even three shifts a day".

[30] Taylor(1976), UDURV. (1978). See also Garcia and Urrutia (1976).

[31] Balcarel and Orellana (1978)

development banks and governmental agencies and channeled through the government.[32] Although the amount of financial foreign aid was important, only a minor share of loans had been utilized prior to 1980 due to administrative inefficiency. The reconstruction of school buildings was not an exception. [33] [34] Delayed reconstruction of schools increased the difficulties of acquiring education for younger cohorts of children born around the time of the earthquake.[35] [36] The long- term lack of physical capacity made crowding of the remaining infrastructure a permanent feature of the education system for many years to come. During the years that followed the earthquake, education was not a fiscal priority of the Guatemalan government. In spite of the destruction, public expenditure in primary education as a percentage of all education funds declined from about 50 percent before 1976 to 40 percent in the early 80's. Expenditures per primary school pupil remained constant between 1976 and 1979. Only 4 percent of the Ministry of Education budget in 1982 was invested in buildings, textbooks, teacher training and classroom aids.[37]

4. DATA

4.1 DATA SET

Individual-level data come from the Living Standards Measurement Survey (ENCOVI) carried out by the National Institute of Statistics (INE) during the months of July to December, 2000. This is a nationally representative survey containing information on 37,771 individuals in 7,276 households, living in urban and rural areas of the country's 22 departments. The outcome variables obtained from the survey are an individual's number of years of completed education, and her adult height measured in centimeters. From this source, I also obtain information on day, month and year of birth, gender, rural or urban residence, ethnicity, and years of schooling. The respondent's Department of birth and Department of residence in 2000 are recorded, as well as the size of the birth locality (city, town, village, hamlet, farm, etc). As part of the survey, all members of the household had their height measured in centimeters, using standard anthropometric procedures.[38]

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[32] The Ministry of Finance and the Secretaria General del Consejo Nacional de Planificacion Economica were the governmental bodies in charge of negotiating the funds. The Ministry of Education and the Ministry of Communication and Public Works were in charge of school reconstruction. USAID (1979).

[33] Abril-Ojeda (1982) and USAID (1979)

[34] World Bank (1985) Project Completion Report. Loan 1212-GU

[35] Abril-Ojeda (1982) and USAID (1979) The government of the United States granted USAID Loan V-029 for the reconstruction or repair of 106 schools covering 25% of the school population in affected areas. The loan was agreed and signed in September, 1977 but almost five years later, no funds had been disbursed.

[36] World Bank (1985) Project Completion Report. Loan 1212-GU. The World Bank Earthquake Reconstruction Project's Loan 1314-GU was meant to build 13 schools with 4, 320 pupil places. Only 5 percent of the funds had been utilized up to 1977 and only 30 percent had been utilized by 1980. Loan 1212-GU was approved in February 1976 and destined for the construction of 21 secondary schools. It was supposed to be completed in 1979, but by the end of 1979, only 9 percent of funds had been disbursed.

[37] World Bank (1983), Staff Appraisal Report 4386b-GU.

[38] Around 9% of the sample is missing information on height.

The ENCOVI survey also gathers information about the household of origin of the respondent through retrospective questions, and records the schooling and occupation of both parents of the respondent. Occupation categories included are Owner (of land or other resources) and day laborer (unskilled worker, mainly agricultural). Other categories include Salaried Worker and Independent Worker. The survey includes information about age of entry of the respondent into the labor market, and age at the time of enrollment in primary and secondary school.

In the absence of individual specific information on exposure to the earthquake destruction, its effect is assed at the level of the respondent's Department of birth. A Department level variable provides a measure of the likelihood that the individual was affected by the natural disaster's destruction during childhood.[39] The figures for destroyed classrooms were obtained from Gonzalez & Serrano (1978).[40] Additionally, the Guatemalan government provided official estimates of the number of people made homeless in each Department as a consequence of the destruction of buildings. [41] In order to use these figures as proxies for the intensity of the destruction, we assume that any difference in children's Department of birth and Department of residence in February of 1976 is random to the shock. This introduces a certain degree of measurement error, but migration before age five –that is migration of families with very young children- was not common before 1976. [42]

Information from the 1973 Population Census was also used to control for potential differences in characteristics of affected and not affected areas, specifically, the percentage of the population residing in urban areas in 1973 in each Department. Information from the 1981 Population Census and several UN Demographic Yearbooks was used to analyze potential changes in cohort composition associated with the earthquake. In addition, we use information on the intensity of violent civil conflict in Guatemala in the early 1980's, a factor that could have influenced human capital formation, particularly for the younger group of individuals in the analysis. The information was obtained from Guatemala's Commission for Historical Clarification (1999) and consists of the number of human rights violations by year and by Department.[43]

4.2 SAMPLE AND DESCRIPTIVE STATISTICS

The amount of variation in the intensity of the earthquake's destruction was substantial. Out of a total of 22 Departments, five did not suffer any destruction at all. In the remaining Departments the range of destruction goes from 0.1 percent to 87.5 percent of

[39] Finer levels of disaggregation for the intensity measure are possible, but the sample size of the household survey does not allow us to estimate the effects of the shock with precision.

[40] The Ministry of Education hired a private consulting firm to assess the damage and the investment needed to repair the school infrastructure. The data in Gonzalez and Serrano is obtained from the report of the firm to the Guatemalan government.

[41] Technical Commission on Evaluation and Planning (1976).

[42] See Schoroten (1987).

[43] The author thanks Rubiana Chamarbagwala for pointing her to these data.

classrooms; and from 0.1 to 89.3 percent of the population made homeless in the aftermath. On average, 32.5 percent of classrooms were shattered, and 30 percent of population became homeless in affected Departments. The median of the distribution of destroyed classrooms is 25 percent; the median of the distribution of homelessness is 29 percent. Graph 3 shows the distribution of the intensity of the earthquake for individuals in our sample. The most devastated Departments are Chimaltenango, El Progreso, Sacatepequez, Zacapa and Guatemala.

The degree of destruction following an earthquake is related not only to the intensity of seismic movement, but also to the quality of the construction of buildings. Table 4 provides data on the construction materials, and the proportion of the population living in urban areas in affected and non affected Departments in 1973. The main non brick construction materials used in Guatemala at the time were adobe -mud solid blocks joined by soil mortar-, and bareque –vertical and horizontal timber filled with mud and covered in plaster-.[44] The area hit by the natural disaster was more urban, and had an equal proportion of dwellings built of non brick materials as the area that did not suffer any destruction. Table 5 shows correlation coefficients for some dependent and independent variables. As expected due to the magnitude of the shock, there is a high degree of correlation between the percentage of classrooms destroyed and the percentage of people made homeless. The intensity of the damage is positively correlated (0.42 and 0.42) with the percentage of people living in urban areas in 1973; and negatively correlated with the percentage of buildings in the Department made of materials other than brick or cement (-0.29 and -0.28).[45] There is little correlation (0.02 and 0.07) between the number of victims of human rights violations during the period 1960-1996 in each Department and measures of earthquake impact. The intensity of the earthquake is very weakly correlated with years of schooling of the father (0.13 and 0.11), years of schooling of the mother (0.1 and 0.09), and mother's height (-0.01 and -0.01), suggesting that the intensity of destruction is random to these family background variables.

Table 6 compares individuals in our sample born and living in affected and unaffected areas in 2000. There is an equal proportion of females in both groups. The biggest difference between individuals in affected and unaffected Departments arises from the more urban character of affected areas. While half the population in unaffected areas was born in a city or town, around 70 percent did so in affected areas. Individuals in Departments that suffered earthquake damage report having fathers and mothers that are more educated, mothers who are taller, and fathers who are less likely to be day unskilled laborers, than individuals from Departments where destruction was minimal or equal to zero. In the absence of the negative shock, we would expect children in higher earthquake intensity Departments to be taller and more educated than children in lower intensity Departments.

[44] Santos (2010).

[45] Materials other than brick or block are adobe, wood and bareque.

The sample used contains non indigenous Guatemalans only. The very low levels of education of the indigenous population at the time do not provide enough variation across individuals in schooling outcomes to estimate the effects of the disaster with precision. Adult height is set by the balance between food intake and disease in early childhood and contains information about economic and epidemiological conditions at the time. Including indigenous people in the sample increases the risk of introducing survival bias due to the extreme levels of poverty and deprivation prevalent in older indigenous cohorts. The sample used for analysis includes individuals who were in the process of acquiring human capital in February, 1976, as well as others who were older and therefore not affected by the earthquake. Group 1 is made up of Guatemalans aged 2 to -2 in February, 1976. This cohort consists of children exposed to the effects of earthquake destruction from one year prior to conception to the age of two. Individuals in group 1 suffered the effect of the earthquake in the womb or infancy, a critical period for physical and cognitive development. Group 2 consists of those aged 4 to 9 in 1976. Children in group 2 had passed the critical developmental window by the time they were affected by the disaster, but may have still suffered from the destruction of schools or health infrastructure, and/or from a tightening of the household budget constraint. Their education may have been interrupted, or they may have missed the change to start their schooling. At the time of the survey -June 2000-, members of Group1 were aged 22 to 26, and members of Group 2 were 28 to 33 years old. All have finished growing, and given the distribution of schooling in Guatemala, it is very unlikely they will acquire further schooling.[46]

Group 3 is composed by children aged 22 to 30 in 1976, and serves as the control group in the estimations where the dependent variable is completed years of education. The age interval of Group 3 was chosen to ensure that its members already finished their schooling when the disaster happened, and is slightly wider than the age interval of the other groups to maintain a comparable number of observations. In June, 2000, individuals in this cohort were 46 to 54 years old. I use a younger cohort -Group 0- as the control group in estimations where adult height is the outcome.[47] The choice has several advantages: a) members of Group 0 were aged 19 to 21 in June 2000 (aged -3 to -5 in 1974), and have already finished their physical growth when surveyed; b) the number of missing observations for the height variable in this group is lower than in Group 3; and c) using Group 0 as control group allows the use of information on maternal height available for individuals living in extended households, where the mother of an adult is still present. Due to cultural norms, extended families living under one roof were still common in Guatemala in 2000 and the ENCOVI survey contains anthropometric information for

[46] Children aged 10 to 21 in 1976 may have also experienced disturbances in the process of human capital accumulation as a result of the natural disaster, but are not included in the sample. They were already in school in February, 1976 and, given the low levels of schooling prevalent at the time, a considerable proportion had already acquired most of their education by then. For this reason, I do not explore the effects of the earthquake on this cohort.

[47] A similar approach is used by Akbulut-Yuksel (2009).

parents who live with the families of their grown children.[48] The percent of adults in our sample who live in households where the mother is present is equal to 22 percent in Group 2, 43.5 percent in Group 1 and 63.5 percent in Group 0. The percentage is somewhat lower for adults who live in extended families where both parents are present.[49]

Table 7 shows descriptive statistics for the three cohorts used in the schooling regressions. There is an equivalent proportion of individuals born in rural areas, or born in the capital, in the three groups. The cohorts do not statistically differ in terms of the proportion of children never enrolled in secondary school (47 to 52 percent), or the average age on entry into the labor market for those working (14 years of age). The older cohort –Group 3- shows a higher percentage of illiterate individuals, and a higher proportion of children never enrolled in primary school. A growing trend can be distinguished in education: each successive cohort has higher average parental schooling, and higher average years of own education. In spite of that, women's schooling is always lower than men's. Graphs 4 to 6 illustrate the schooling distributions for Groups 1, 2 and 3. Table 8 provides descriptive statistics for the cohorts used in the height regressions. There is no difference in the proportion of individuals born in rural areas, or born in the capital between Group 0, Group 1 and Group 2. No difference is found either between cohorts in the average age of entry into the labor market (14 years of age) for those working at the time of the survey. There is a small decline over time in the proportion of children never enrolled in secondary school. The older cohorts show a higher percentage of illiterate individuals, and a higher proportion of children never enrolled in primary school. A positive trend over time can be distinguished in average parental schooling. Graphs 7 and 8 in Appendix B illustrate the height distributions for Groups 1, 2 and 0. There is no distinguishable upward time trend in average stature, especially in the women's distribution.

4.3 MIGRATION AND COHORT COMPOSITION

The destruction brought on by the earthquake could have altered the composition of the cohort of children under study, through selective fertility, mortality at birth or during infancy; or through migration. If such changes in composition are non random with respect to individual characteristics that are correlated with human capital formation -and that can not be controlled for-, the results would be biased. This section analyzes potential changes in cohort composition due to migration. Appendix A contains information on other potential sources of selection.

[48] The extended family in many Latin American countries acts in lieu of formal insurance mechanisms, and/ or government provided health and pension systems. This is particularly true for women in older generations, who may have never formally joined the labor market.

[49] Grown children living in extended families in Guatemala are very different from individuals of the same age group who still live at home in industrialized countries. Individuals in our sample who live in extended households are more likely to be male and born in rural areas; and have more years of schooling than adult individuals living in households where the mother is not present. Adult children in extended households are better off and have a lower probability of being the offspring of an unskilled day laborer; they also report having more educated mothers.

The ENCOVI 2000 survey does not contain complete migration histories for respondents, but includes questions on Department of birth, Department of residence in 2000, and Department of residence in 1995. In order to identify the effects of the shock, the analysis has to be restricted to people living in their Department of birth in 2000, or that have moved away from the Department of birth after 1995. This strategy allows the identification of the likelihood that the individual was affected by the natural disaster during childhood, but eliminates from the sample individuals who have migrated. If characteristics associated with migration are also positively or negatively correlated with subsequent accumulation of human capital, bias will be present. The direction of the bias will depend on the characteristics of those who have moved. The magnitude, direction and determinants of migratory movements in the aftermath of the 1976 quake are therefore important to the interpretation of the results of this paper. The main concern is not the migration in itself, but whether migration invalidates inference made with the dataset, given its characteristics.

People did move as a result of the earthquake experienced in 1976, and migration to the capital was noted at the time as one of the main consequences of the disaster. Anthropological accounts indicate that people migrated mainly to Guatemala City and settled in squatting camps, without any public service provision.[50] Belcher and Bates (1983) find that individuals who migrated had less assets than those who did not. The main factor associated with the migration decision was not the intensity of earthquake damage in the original location of residence, but home ownership. Homeowners and/or landowners stayed put. Along the same lines, Garcia-Estrada (1988) cites inequalities in land distribution as a major cause of internal migration in the period from 1975-1985. Johnston and Low, in their study of school-aged children in reconstructed urban settlements in Guatemala City, find that most families of earthquake migrants were of rural origin and poor. In the ENCOVI sample, 17.7 percent of those living in areas hit by the earthquake and belonging to the studied cohorts are no longer living in their Department of birth in June 2000. In areas not affected by the earthquake, a very similar percentage of individuals (17.9 percent) are no longer living in their Department of birth at the time of the survey. It is however impossible to know when people moved, and whether the move was motivated by the disaster or happened at a later date. As a reference, Belcher and Bates find that 90 percent of the earthquake affected population was still living in the same village or town in 1979 –three years after the shock-, while 10 percent had migrated. They also find the rate of migration to be slightly higher in unaffected areas.

[50] Johnston and Low (1995).

TABLE 9: MIGRANTS AND NON MIGRANTS AGED -5 TO 19 IN FEBRUARY 1976, IN AFFECTED AREAS

	Migrants	**Non Migrants**	**p-value of the difference**
Proportion female			
ALL	0.55	0.54	0.88
	(0.50)	(0.50)	
Group 3	0.50	0.54	0.32
(aged 22 to 30 in 1976)	(0.50)	(0.50)	
Group 2	0.57	0.53	0.55
(aged 4 to 9 in 1976)	(0.50)	(0.50)	
Group 1	0.57	0.52	0.20
(aged 2 to -2 in 1976)	(0.50)	(0.50)	
Group 0	0.50	0.54	0.40
(aged -3 to -5 in 1976)	(0.50)	(0.50)	
Proportion born in Guatemala Department	0.28	0.39	0.00
	(0.45)	(0.49)	
Proportion of individuals born in rural areas	0.62	0.39	0.00
	(0.92)	(0.86)	
Proportion with Mother's schooling =0	0.50	0.42	0.00
	(0.50)	(0.49)	
Proportion with Father's schooling =0	0.35	0.27	0.00
	(0.48)	(0.45)	
Proportion with Father agricultural day labourer	0.14	0.10	0.02
	(0.35)	(0.29)	
AVERAGE YEARS OF SCHOOLING			
Affected Cohorts	6.58	7.52	0.00
(Groups 1 and 2)	(5.26)	(5.00)	
AVERAGE ADULT HEIGHT (cms)			
Affected Cohorts	155.58	157.30	0.01
(Groups 1 and 2)	(9.43)	(10.34)	
N	646	2323	

Standard Deviations in parenthesis. T-test at 5% level of significance. Non Indigenous individuals only.

Descriptive statistics from our nationally representative survey in Table 9 confirm previous findings related to the characteristics of earthquake migrants. There is a very similar proportion of females in both groups, even when looking at cohorts separately, therefore ruling out gender specific patterns of attrition in the sample. When compared with non migrants, individuals born in affected areas that have migrated are more likely to be of rural origin, to have a father and/or a mother with no schooling, and to be the offspring of an unskilled day laborer. Non migrants are more likely to have been born in the Guatemala Department. Non Migrants belonging to the studied cohorts have one whole extra year of completed schooling and are almost two centimeter taller as adults when compared to migrants. All differences are statistically significant. It appears better-off individuals were more likely to have stayed put and subsequently appear in the sample. Given that migrants are not used in our estimations, positive selection may influence the results. We can expect the impact of the disaster on those displaced to be greater, and therefore, to underestimate the true effect of the shock in the whole population consisting of migrants and non migrants. In that sense, the findings are a lower bound of the effect of the earthquake's destruction.

5. EMPIRICAL STRATEGY

5.1 THE MODEL

The research design considers the earthquake as a natural experiment equivalent to a random negative shock, and exploits the variation in the intensity of its impact across Departments and across cohorts using a Difference in Difference model with variable treatment intensity.[51] Variation in date of birth and Department of birth jointly determine an individual's level of exposure to the treatment. Earthquake intensity is measured by the percentage of classrooms destroyed, and the percentage of homeless people in each Department in its aftermath. The main human capital outcomes analyzed are completed years of schooling and adult height measured in centimeters. In all specifications, I restrict the analysis to those individuals who are living in their Department of birth at the time of the survey, or that migrated after 1995.

Given the lack of individual panel data, a set of before and after cohorts is constructed in affected and unaffected Departments. We can then compare the following expressions:[52]

$E\left[Y_o^A \mid X\right]=$ Expected value of human capital outcome for children who finished their schooling before 1976 in a Department affected by the disaster.

$E\left[Y_1^A \mid X\right]=$ Expected value of human capital outcome for children who were about to start their schooling (group 2) or were born around (group 1) 1976 in a Department affected by the disaster.

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[51] An application of this expanded difference in difference model employing a single cross-section of data can be found in Duflo (2001).

[52] For models where adult height is the outcome, the expectations are defined in a slightly different way, since the control cohort is made up of children who have been born 3 to 5 years after the shock.

$E[Y_o^N \mid X]$ = Expected value of human capital outcome for children who finished their schooling before 1976 in a Department not affected by the disaster.
$E[Y_1^N \mid X]$ = Expected value of human capital outcome for children who were about to start their schooling (group 2) or were born around (group 1) 1976 in a Department not affected by the disaster.

The difference in difference estimator then is :
$\hat{\beta}_{DD} =$ ($E[Y_1^A \mid X]$ - $E[Y_o^A \mid X]$) – ($E[Y_1^N \mid X]$ - $E[Y_o^N \mid X]$

$\hat{\beta}_{DD}$ identifies the average change in human capital outcomes resulting from the earthquake's destruction. The first term of the difference captures the difference in average human capital outcomes before and after the earthquake in affected areas, while the second term expresses the difference in average human capital outcomes before and after the earthquake in areas not hit by the disaster. The reduced form estimate of $\hat{\beta}_{DD}$ is a measure of the final net impact of the earthquake and incorporates all household compensatory or reinforcing responses, and government strategies to deal with its aftermath.

The equation estimated is:

$$Y_{idt} = a + \beta(Affected_{it} * I_d) + war_{dt} + r_t + q_d + p'\mathrm{X}_{idt} + \varepsilon_{idt}$$

Where Y_{idt} is the human capital outcome of individual i, living in Department d, and born in year t. $Affected_{it}$ is a dummy equal to one if individual belongs to an affected cohort, and zero otherwise. I_d captures the intensity of earthquake destruction in Department d, and measures either the percentage of classrooms destroyed, or the percentage of people made homeless, in each Department. $\hat{\beta}$ -the coefficient of the interaction between the intensity of destruction and cohort of birth- is the difference in difference estimator and captures the effect of exposure to the intensity of the earthquake's damage on adult human capital outcomes. war_{dt} is a dummy variable for the Departments with the highest number of human rights violations during the period 1960-1999, and serves to control for a contemporaneous event that could have affected human capital formation.[53] X_{idt} is a vector of individual characteristics, included to control for individual heterogeneity. The vector contains pre-shock variables correlated to the household of origin's degree of vulnerability to a disaster and to human capital outcomes as controls. Parental education, for instance, is correlated with economic status and with children's schooling through family income, intergenerational transmission of ability and the effect of parental preferences for the education of their off-spring.[54] The very low levels of schooling among Guatemalan parents of the studied cohorts allow the assumption that they finished their

[53] Chamarbagwala and Moran (2010).
[54] Solon (1999).

education before starting a family, and that therefore, parental education is exogenous to the shock. Father's occupation is included as a measure of socioeconomic status, permanent income and access to information and resources. This variable could potentially be endogenous since the survey recalls father's occupation retrospectively, and occupation choice in some cases may have been affected by the earthquake. However, given the nature of the occupational categories, and the limited degree of social mobility prevalent at the time in Guatemala, this is not a big concern.

Mother's stature has also been included in regressions where adult height is the dependent variable, to account for intergenerational transmission of vulnerability and health.[55] Adult height is a proxy for genetic endowment and long term investments in health. Mothers' health works as a buffer for the child against environmental insults during the in utero period. Mothers with better genetic endowment will transmit part of this advantage to children.[56] The individual characteristics vector is augmented with a set of dummies for quantiles of mother's height, plus a dummy for missing mother's stature in models where adult height is the dependent variable. Year of birth fixed effects r_t , and departmental fixed effects q_d, are included to control for bias arising from time invariant Department characteristics, or cohort specific shocks.[57] The error term ε_{idt} is conditionally uncorrelated with the intensity of the shock, and clustered at the Department level to allow for spatial correlation.[58]

Given the available data, it is not possible to disentangle the precise mechanism through which human capital formation was affected in the earthquake's aftermath. It is however reasonable to assume individuals in Group 2 (aged 4 to 9 in 1976) will suffer a more direct impact from the destruction of schools and other buildings, as well as the negative shock on the household budget constraint. Younger individuals in Group 1 (2 to -2 in 1976), will experience the combined negative effect of any lack of infrastructure that remains years after the disaster; and insult during a critical development stage in early childhood. The impact on children aged 0 to -2 also includes the effects of the earthquake on their prenatal environment. Since the magnitude or significance of the long term impact may differ in these two groups, we run separate regressions for each cohort. Additionally, the classroom destruction measure may capture more precisely the direct shock to the supply

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[55] Ramakrishnan et al (1999) find evidence of intergenerational transmission of height for 215 mother-child pairs in rural Guatemala. For every 1 cm increase in maternal birth length, infant's birth length increased by 0.2 cm, after adjusting for the effects of maternal age, gestational age, sex of the infant and other confounders.

[56] Almond and Currie (2010). Kelly (2009) show that the impact of a negative health shock on anthropometric measures was significant only for British children of short mothers or mothers who smoked. Bhalothra and Rawlings (2008) document a stronger impact of income or public health shocks on neonatal mortality among shorter mothers.

[57] One reason to include year fixed effects is the downward trend in school completion across age in poor countries. Additionally, there may be sharp thresholds in age that determine long lasting insult to health and cognitive ability. Heckman (2007).

[58] Bertrand, Duflo, and Mullainathan (2004).

of schooling. The percentage of people made homeless may be more related to the impact on the household's budget constraint.

5.2 POTENTIAL SOURCES OF BIAS

The identification strategy allows for baseline differences in levels of human capital between affected and unaffected areas, but rests on the assumption that in the absence of the earthquake, the trend of educational attainment and stature over time would have been similar across affected and unaffected Departments. Pre-existing differences in human capital formation trends between affected and unaffected areas would threaten identification. Disaster hit areas tended to be more urban and affluent compared to less affected areas. Graph 9 in the Appendix plots the intensity of destruction against the percentage of people living in urban areas in 1973.[59] There is positive correlation between the level of urbanization and damage. The correlation is driven by the destruction in the Guatemala, Sacatepequez and Chimaltenango Departments. A priori differences between urban and rural trends are therefore not ruled out. In order to deal with this issue, the estimations include a set of interactions between the percentage of urban population in each department in 1973, and year of birth indicators. These interactions control for a potentially different time trend in human capital formation in more urban Departments.[60] The identification strategy also assumes that people did not move out of their Department and came back later in life. This assumption is reasonable since the usual migration pattern for non indigenous people in Guatemala during the 1970's was unidirectional [Schroten, 1987]; and migration after the earthquake mainly consisted of whole families with little or no assets left, who settled permanently in shanty towns in the outskirts of Guatemala City [Johnston and Low, 1995].

Although the intensity of the earthquake is exogenous to individual characteristics, vulnerability to the effects of its destruction may be a function of personal circumstances. If building material is non random to unaccounted household characteristics also related to human capital formation, differences in the robustness of construction materials could introduce potential endogeneity. The data does not contain information on the building material of the house where the informant lived in 1976, and therefore it can not be directly controlled for. However, it is known that most of the houses ruined in 1976 were adobe or bareque houses with clay roofing tiles, which had very little resistance to horizontal forces. After the earthquake, buildings that resisted or suffered less damage were cement and concrete block houses.[61] Data from the 1973 Population Census in Table 3 shows that there was little variation across affected Departments in terms of building materials. If the capital Ciudad de Guatemala is excluded, Departments hit by the quake are shown to be less urban than non affected Departments, and almost the totality of the

[59] These figures were obtained from the 1973 Population Census.
[60] Results obtained from estimations that did not include the trend variables are very similar to results reported in this paper and are available on request.
[61] Marroquin and Gandara (1976) and Bates and Killian (1982).

houses in them are built of non brick materials. [62] In the Guatemala Department, 30 percent of dwellings are made from brick or concrete blocks, the highest percentage of any Department. There was not that much variation at the individual level either: more than 60 percent of all dwellings were made of adobe or bareque. In addition, the retrospective information in ENCOVI 2000 helps us to account for characteristics of the family of origin (socioeconomic status) that may be correlated with both dwelling construction material and human capital outcomes.

Since intensity is measured at the Department level, it identifies affected and non affected individuals with error. People will be assigned to the affected group even though they may not have suffered directly as a result of the earthquake. Lack of retrospective data on individual exposure does not allow a more accurate estimation of the impact of the disaster. The estimated coefficient $\hat{\beta}$ is therefore a weighted average of the impact on different individuals, and underestimates the effect of the shock upon those children directly affected, by an unknown factor. This introduces measurement error, but on the other hand, half of affected Departments report levels of destruction greater than 25 percent of classrooms destroyed or 30 percent of the population made homeless. The magnitude of the damage to infrastructure and personal assets most likely implied all households in the locality were negatively affected by the earthquake directly or indirectly. Finally, the survey also gathers information about the household of origin of the respondent through retrospective questions. Recall bias and ensuing measurement error may attenuate the significance of the results

6. EDUCATION

6.1 BASELINE RESULTS FOR COMPLETED YEARS OF SCHOOLING

Table 10 presents baseline estimates of the effect of the earthquake on years of schooling for cohorts 1 and 2, from a model that includes controls for parental education, area of birth, gender, civil war intensity and Department and year of birth fixed effects. The "implied effect" size is reported, that is, the effect of a one standard deviation increase in Intensity on the outcome variable: $\hat{\beta}[sd(Destruction)/sd(Outcome)]$. Columns (1) to (3) in Panel A show that the intensity of earthquake destruction measured as the percentage of classrooms destroyed in a Department has a negative and statistically significant effect on the human capital formation of children in Group 2 -aged 4 to 9-, measured in years of completed schooling. This effect is robust to conditioning on individual family background characteristics. The model in column (3) includes a set of dummies for occupation of the father. The inclusion of parental occupation does not affect the sign or substantially change the magnitude of the results. The implied effect of the disaster in this cohort is equivalent to a reduction of 0.4 years of completed education. At the mean of classroom destruction (32.5 percent), a student living in an affected area and aged 4 to 9 years old in February, 1976 suffer a loss of 0.6 years, when compared with a student living in an

[62] 20 percent of all dwellings were located in Guatemala City.

unaffected Department. At the two modes of the destruction variable -17 percent and 87 percent-, the long-term penalty for children in Department hit by the earthquake rises to 0.3 and 1.6 years of schooling, respectively.

Results in Columns (4) to (6) show that the effect of destruction on schooling for the cohort of younger children -aged 2 to 0 in February 1976, or born up to two years later-, is negative, but much smaller in magnitude and not always statistically significant. The coefficient for intensity –destroyed classrooms- in Column (4) of Panel A is negative and statistically significant after controlling for maternal education, but it size is reduced in half compared to the effect in the older cohort. The parameter increases slightly in size after including father's schooling and father's occupation, but loses significance suggesting that, for this age group, family income or wealth provided compensation for the adverse events that lowered human capital formation. The implied effect of the shock is equal to 0.04 of a standard deviation: a reduction of 0.2 years of schooling. At the mean of classroom destruction (32.5 percent), a child living in an affected area losses a third of a year of schooling, compared with a student living in an affected Department. At values of 17 percent and 87 percent classroom destruction, the long-term education penalty for being in an affected Department rises to 0.15 and 0.75 years of schooling.

Panel B shows estimations that use the percentage of individuals made homeless as a consequence of the earthquake as a proxy for destruction. This variable was obtained from a different source and provides a measure of the robustness of the previous findings. Earthquake destruction measured by percent of the population made homeless has a negative and statistically significant effect on the human capital formation of children in Group 2, shown in Columns (1) to (3). The coefficients in Panel B are very similar, if slightly higher, to those obtained using destroyed classrooms as a proxy for intensity. After controlling for parental education, one standard deviation increase in homeless population reduces completed education by 0.35 years. At the mean of the variable (30.6 percent), a child living in an affected area would see her schooling reduced by 0.6 years, when compared with a student living in an affected Department. Columns (4) to (6) present the results for the younger cohort (Group 1). The parameter of interest is similar in size or slightly smaller when compared to Panel A, but it is not significant in any specification. While for older children both the destruction of classrooms and the loss of dwellings seem to have an effect on education, for younger children, only the destruction of classrooms seems to matter. This suggests that while the older cohort suffered from the combined impact of negative income shocks and destruction of infrastructure, the younger cohort's education was scarred mainly through the delays in school reconstruction.

6.2 DIFFERENTIAL EFFECTS BY GENDER

In light of the relative lack of knowledge about heterogeneity in the impact of early-life conditions, or in the effect of natural disasters, this section explores differential effects by gender.[63] Table 11 summarizes the results of running the specifications for boys and girls

[63] Almond and Currie (2010).

separately. Each coefficient comes from a different regression that includes controls for parental education and occupation, area of birth, civil war intensity, and Department and year of birth fixed effects.

The results reveal that the older cohort girl's educational attainment was severely and differentially affected. Columns (1) and (2) in the first panel show the effect of earthquake destruction on years of schooling for females –measured, respectively, by classrooms destroyed and by population made homeless-. The coefficients are negative and statistically significant. At the mean of classroom destruction, a female child living in an affected area and aged 4 to 9 years old in February, 1976 suffered an average reduction of almost one full year (0.8) of education, when compared with a female student living in an unaffected Department. At the modes of the destruction distribution (17 and 87 percent), the long-term penalty for living in an affected Department for females amounts to 0.4 and 2.16 years of completed schooling, respectively. A one standard deviation increase in classroom destruction reduces years of education by 0.53 years. This effect is higher than the implied effect obtained when using the whole sample. Columns (3) and (4) in the same panel illustrate the results for boys. The coefficients are negative, but half the size of those observed for girls, and not statistically significant. A male child living in an affected area and aged 4 to 9 years old in February, 1976 would on average show no difference in terms of completed years of schooling in June 2000, when compared with a male student living in an unaffected Department.

The second panel in Table 11 shows the same coefficient for males and females aged 2 to -2 in 1976. The coefficients for females, in Columns (1) and (2) are negative, but not statistically significant. In terms of magnitude, they are less than a third of the size of the coefficients for females in Group 2. The coefficients for males in Columns (3) and (4) are negative, small and not statistically significant either. These results suggest girls of schooling age suffered the biggest long-term losses in completed years of education as a result of the 1976 earthquake.

6.3 MODELS WITH INTERACTIONS

Additional heterogeneity in long-term outcomes could arise due to differences in coping mechanisms correlated with parental resources and schooling; and/or differences in parental investment for certain groups of children. For example, poorer households may have fewer options to cope with the disaster and maintain pre-shock levels of investment in human capital. Rural residency, parental education and occupation, or mother's health capital (proxied by her height) may have a mediating effect on the impact of the shock. The following estimations allow the effect of earthquake destruction to vary by individual characteristics through an interaction term.

Table 12 presents the results of estimations using the older cohort sample. The top panel in the table presents coefficients obtained for females, and indicate that the negative effect of the natural shock is worsened or cushioned by some the characteristics an individual's family of origin; but also that the introduction of interaction terms does not decrease the magnitude or the statistical significance of the destruction's main effect. This suggests a cohort wide long term penalty in completed years of schooling for females in this age group and corroborates the results from the previous section. Column (2) shows the coefficient of the interaction of being born in a rural area and the intensity of the earthquake's destruction. The parameter of interest is very small, positive and not statistically significant, suggesting that females born in rural areas were not differentially affected by the negative shock.

Columns (3) to (6) show the results of models that interact earthquake intensity with mother's or father's years of schooling. Colum (3) contains estimates for the whole female sample, while column (4) presents coefficients for females with mothers with at least one year of education. The interaction term for mother's schooling is not statistically significant in specifications (3) or (4), but a test of joint significance rejects the null at the 5 percent level and 0.1 percent level, respectively. Looking at the whole sample of females, it would seem that the mother's education interaction has the "wrong" sign and that mother's schooling makes the effect of the disaster worse. However, when we look only at girls whose mothers had some schooling, the size of the main effect of the earthquake's destruction is three times higher and the sign of the interaction is positive, suggesting a protective effect of mothers schooling. The implied size of the main effect in model (3) –all females- is 0.1 of a standard deviation (half a year of schooling), while the implied effect in model (4) –only daughters of mothers with at least one year of schooling- is 0.3 of a standard deviation (1.5 years). Together, the results show the effect of earthquake destruction on schooling was felt disproportionately by daughters of women who were already educated, and that for this group of females, the negative impact of the shock was "cushioned" by mother's education. This makes sense, since in a country with very low levels of education, educated mothers would have had very different preferences for the schooling of girls compared to uneducated mothers, regardless of household income. Households where the mother had at least some schooling would have valued education more and had a demand for girl's schooling.

The interaction of intensity with father's schooling in the model in Column (5) is statistically significant and negative. Father's education would also seem to have the "wrong" sign, apparently worsening the negative effect of the shock. Yet, when we look at women whose fathers had at least one year of schooling, the significance of the interaction coefficient disappears, and the size of the main effect doubles. The implied size of the main effect increases from 0.09 standard deviations (approximately 0.4 years of schooling) to 0.2 of a standard deviation (one year of schooling). ***The earthquake differentially reduced the number of completed years of schooling of girls with educated fathers and mothers***. In the absence of the shock, these girls would have been sent to school or kept in school for longer. The size of the main effect obtained when we look at daughters of mothers with schooling versus daughters of fathers with schooling suggests that maternal schooling is driving the demand for education of girls in this group.

Column (7) shows the coefficient on the interaction of intensity and father's occupation being an unskilled day laborer.[64] The coefficient on the interaction is negative, large, and significant, the size of the cumulative implied effect of the interaction and the main effect equal to 0.13 of a standard deviation (0.65 yeas of schooling). The results indicate females from poorer households were the father was unskilled were more severely affected by the disaster than females from more affluent families. [65] The daughter of a unskilled laborer living in an affected area, and aged 4 to 9 years old in 1976, losses 1.42 years of completed education at the mean of destruction; and 0.74 and 3.81 years at the two modes of 17 and 87 percent of destroyed classrooms. ***Girls from poorer households -likely to face more binding liquidity constraints and/or have lower initial levels of human capital investment- suffered disproportionately from the negative effects of the disaster***. Finally, column (8) shows the coefficient on the interaction of earthquake intensity and having a mother in the first quantile of the mother's height distribution.[66] The interaction term is not statistically significant, and the main effect does not change. There is no differential earthquake impact for daughters of mothers with lower stocks of health capital.

The bottom panel of Table 12 presents the results obtained from models with interactions for males in Group 2. In this table, neither the coefficients measuring the main effect of the earthquake destruction on schooling, nor the coefficient on the interaction terms, are significant. All coefficients are smaller in magnitude, compared to the ones obtained for the female sample. The one exception is the model in column (3) that includes an interaction term of intensity with mother's schooling. This coefficient is negative, small and significant. The results in column (4) –where we look only at sons of mothers with at least some schooling- suggest again that the "wrong sing" on the interaction in column (3) is driven by the fact that families where the mother had any schooling had a demand for education; whereas children of mothers with no schooling were less likely to have been sent to school, with or without an earthquake. In this specification, the statistical significance of the interaction disappears, and the size of its coefficient decreases; while the size of the main effect increases by one order of magnitude. Finally, neither the main effect, nor the interaction term in column (8) are statistically significant. Having a shorter mother with lower stocks of health does not seem to have a differential effect in terms of reduced schooling for boys aged 4 to 9 either. ***Overall, the results show that the 1976 earthquake did not reduce schooling for males in the older cohort, even when taking into account potential heterogeneous impacts across family characteristics. Females from this age group however, suffered a reduction in education across the board regardless of their family background. Daughters of unskilled day laborers fared even worse than the rest***.

Results for the younger cohort (Group 1) are illustrated in Table 13. The top panel presents results obtained for females, the bottom panel contains results for males. The interaction of being born in a rural area and the intensity of the earthquake's destruction in column

[64] "Jornalero o peon" in the survey; that is, an unskilled laborer or farm worker.
[65] Guatemala's Statistical Institute (INE) found that in 2006, 80% of jornalero workers were poor. INE (2007).
[66] The reference group for models with a mother's height interaction is group 0: children aged -3 to -5 in 1976.

(2) is positive and significant for males. The main effect of the intensity of destruction is negative and significant at the 1 percent level in this model, suggesting that the natural disaster had a negative effect on the male urban population, and that rural residency cushioned the negative impact of the destruction on human capital accumulation for boys. For urban boys, one standard deviation increase in the intensity of the shock translates into a 0.13 standard deviation reduction in completed schooling (0.6 years), whereas the education of boys residing in rural areas only decreased by 0.14 years. It is possible that pupils in urban areas suffered the most from the effects of crowding in functioning schools, reducing the quality of education and the number of years of schooling they completed. Alternatively, more dynamic markets for child labor in urban areas could have increased the number of male students who dropped out. It is also possible that the impact on boys is non linear and concentrated at higher levels of destruction.

Columns (3) to (4) and (6) to (7) contain models with interaction terms of intensity and maternal or paternal education. The coefficient on the interactions is negative and statistically significant for both genders. Parent's education level does not protect offspring from the negative effect of the shock on schooling, but rather makes it worse. Yet, when we look at the model in column (4) –where the mother had at least some schooling- the interaction coefficients lose significance. The results show clearly that for females the "wrong sign" is driven by the reduction in completed years of education for daughters of educated mothers. The main effect coefficient for this sub sample is large and significant, its implied effect equal to a reduction of 1.1 years of schooling. The main effect and the interaction are jointly significant at the 0.1 percent level. Column (6) presents a model that includes an interaction of intensity with father's education, conditional on the father having at least one year of education. The earthquake had a large negative and significant main effect on daughters of educated fathers, equivalent in size to the main effect found for daughters of educated mothers. The interaction term is small, positive and significant, providing evidence that father's schooling does protect girls from the negative effect of the disaster in this smaller sub sample. For daughters of fathers with some schooling, one standard deviation increase in the intensity of the shock results in a reduction in schooling of 0.3 years; whereas the same change the destruction variable will produce a reduction of 0.8 years of schooling for daughters of fathers with no education. Neither the main effect nor the interaction term are significant for the male sample. Father's level of schooling is positively correlated with family income and wealth, so it is likely that households with more educated fathers were less income constrained and more likely to send girls in this younger group to school. Under scarcity, fathers' income may have mattered more for children at the margin -i.e. younger girls-, whereas boys' schooling was less elastic to father's income.

Estimates from a model that includes an interaction between the father of the child being an unskilled manual day laborer and the intensity of the destruction are shown in column (7). For both males and females in this younger cohort, the parameter is negative, large and significant. In both cases, the main effect and the interaction are jointly significant at the 0.1 percent level. The size of the interaction coefficient is twice as big for females and significant the 1 percent level. At the mean of classroom destruction (32.5 percent), the daughter of a manual laborer living in an affected area and aged 2 to -2 years old losses 1.83 years of schooling on average. At 17 and 87 percent destruction levels, the average long-term penalty for living in an affected Department for a female from a laborer household equals 0.96 and 4.9 years of completed schooling, respectively. Boys aged 2 to -2 in February of 1976 and coming from an unskilled day worker's family also show a reduction in education of one whole year at the average value of destruction. Boys born in Departments where the destruction of classrooms reached 17 or 87 percent, have their schooling reduced by 0.5 and 2.7 years of education, respectively. One standard deviation increase in the destruction variable will translate into a reduction in completed schooling of 0.4 years for girls and 0.37 years for boys. The results suggest a socioeconomic background differential impact of the shock for both genders in the younger cohort. This finding differs from the result obtained in the sample of older children, where the father being an unskilled worker only reduced the schooling of girls. Finally, I find having a shorter mother with lower stocks of health does not seem to make the consequences of the disaster worse for this cohort either. Neither the main effect nor the interaction terms in column (8) are statistically significant for males or females.

6.4 EFFECTS ON ENROLLMENT AND DROP OUT DECISIONS

Although the data does not allow us to disentangle all the mechanisms that led to a reduction in years of schooling, it is possible to test if the earthquake's intensity and family characteristics are related with enrollment, and drop out decisions.[67] Households making decisions at the margin differ in their behavior towards boys and girls. ***When faced with scarcity of resources, families failed to enroll girls in school altogether, or withdrew them sooner; but only delayed boys' enrollment.*** Tables 14 and 15 show estimates for the probability of never having been enrolled in school. The destruction increases the probability of never enrolling in primary or secondary education for females in the older cohort who were either daughters of unskilled workers or of educated mothers. These results are statistically significant and suggest that in the immediate aftermath of the earthquake some families decided against female enrollment, and girls about to enter the school system "missed their chance". Even girls who managed to enroll in school are negatively affected. Gender differences in secondary school enrollment appear to be related with girls dropping out of school. Table 16 shows that, conditional on enrollment, the intensity of the earthquake increases the probability of dropping out of school for girls belonging to either category in both cohorts. In contrast, the effect of the earthquake on boy's is limited to delayed school entry and/or a reduction in the probability of enrolling in *secondary* school. Conditional on enrollment, the intensity of destruction delayed school entry for sons of educated mothers in both cohorts, and sons of unskilled workers aged 2 to -2 (Table 17). This evidence is consistent with household responses to the shock that systematically favor investment on male over female children.

[67] Results are obtained using the same difference in difference set up described before. When the outcome is binary, a LPM is used. Ai and Norton (2003).

TABLE 18: ENROLLMENT AND DROP OUT DECISIONS

	Cohort 1 Aged -2 to 2		Cohort 2 Aged 4 to 9	
	Men	Women	Men	Women
NEVER ENROLLED IN PRIMARY				
Father Unskilled Day Worker				(+)
Mother's Educ>0				(+)
NEVER ENROLLED IN SECONDARY				
Father Unskilled Day Worker	(+)			(+)
Mother's Educ>0	(+)			(+)
DELAYED SCHOOL ENTRY				
Father Unskilled Day Worker	(+)			
Mother's Educ>0	(+)		(+)	
DROP OUT AFTER 3 YEARS				
Father Unskilled Day Worker		(+)		(+)
Mother's Educ>0		(+)		(+)

Effects in black significant at the 5 percent or higher. Effects in blue signficant at the 10 percent.

7. HEIGHT

7.1 BASELINE RESULTS FOR MEN AND WOMEN

This section reports looks at adult stature as an outcome. Given gender differences in average height, specifications for males and females are run separately. Models include controls for parental education and occupation, area of birth, civil war intensity and Department and year of birth fixed effects. A set of dummies for quantiles of mother's height, plus a dummy for missing mother's stature, are also included.

The top panel of Table 19 summarizes the results for the older cohort, Group 2, using the percentage of classrooms destroyed and the percentage of the population made homeless in each Department as a measure of destruction. The coefficients of both measures of damage are negative for males and females, but not statistically significant. The only exception is the coefficient on the intensity of the earthquake proxied by the number of people made homeless. This coefficient is significant at the 10 percent level for males. One standard deviation increase in the intensity of the earthquake will reduce adult height by 0.6 cms for males in this cohort. The second panel in Table 19 shows the same coefficient for males and females in Group 1, aged 2 to -2 in February of 1976. The coefficients are positive for males and negative for females, but not statistically significant in either case. The results suggest that the long-term impact of the disaster on stature -if any-, was focused on particular sub groups of the sample. They also point out that the effect on adult height of the destruction of classrooms may differ from the effect produced by the destruction of dwellings.

7.2 MODELS WITH INTERACTIONS

Table 20 provides the results of estimations for males and females in the older cohort. I explore the role of rural residency, parental education, mother's life-long stock of health (proxied by her height), or father's occupation in mediating the impact of the earthquake on adult height. The top panel presents the coefficients of the interaction term for mother's schooling. The first two columns show the results for females: the parameters are positive and statistically significant, indicating a protective mediating effect of mother's education on the impact of earthquake destruction on females' height. The main effect is negative and significant at the 10 percent level, and bigger in magnitude after the introduction of the interaction. Both coefficients are jointly significant at the 5 percent level. ***Maternal education "cushions" the impact of the shock on stature for girls***. While one standard deviation in the intensity of the earthquake translates into a reduction in height for girls of 0.91 cms, the protective effect of mother's education is comparable in size: one standard deviation in the mother's education interaction variable increases height by 0.63 cms. At the mean of earthquake intensity, a daughter of a mother with no schooling -more than half of the sample- will be 1.6 centimeters shorter on average, while the daughter of a mother with 2.14 years of schooling -the mean for this cohort- will be 1.1 centimeters shorter. When we look at daughters of mothers with at least one year of schooling -the model in column (3)-, the significance of the main effect and of the interaction term disappears. The magnitude of both parameters is also greatly reduced. ***The stature of daughters of educated mothers does not seem to be affected and the long term penalty on height observed is driven by the impact of the earthquake on daughters of mothers with no education.*** Column (4) shows the main effect coefficient obtained for a sample of girls with mothers without education. The parameter of interest is negative, twice as large as the one found for the whole sample, and significant at the 10 percent level. One standard deviation in the intensity of the earthquake converts into a 1.75 cms reduction in height for girls in this sub group.

The last four columns of Table 20 show results for males: the coefficients of the maternal schooling interactions are positive but not statistically significant. The main effect is significant and large, but the two parameters are not jointly significant. These results hold when we look at the whole sample in columns (5) and (6), and only to sons of mothers with at least one year of schooling in column (7). Mother's education does not seem to protect males from a long term reduction in height. Moreover, once we control for the potential interaction of maternal schooling and the earthquakes destruction, a big and significant negative main effect appears. This suggests that the effect of the earthquake's destruction on height is higher for children of uneducated mothers. Column (8) shows the main effect coefficient obtained for males with mothers without education. The parameter of interest is negative, twice as large as the one found for the whole sample, and significant at the 5 percent level. It is equal in magnitude to the one found for females of similar characteristics. One standard deviation in the intensity of the earthquake converts into a reduction in height for boys of 1.63 cms. ***As opposed to reductions in years of schooling, where the main effect was found on children in the upper half of mothers'***

schooling distribution, these results indicate males and females who come from families where the mother was in the bottom half of the education distribution suffered reductions in adult height. These losses may relate to the fact that uneducated mothers are also likely to live in poor households. However, given that less than half of the cohort has a mother with any schooling, and that other family background characteristics correlated with household income are controlled for in the model, the effect may stem from the relation of mothers' education to health, hygiene and nutrition practices that can improve health and foster children's physical growth. These practices could be even more important in the aftermath of a natural disaster.

The bottom panel presents the coefficients of the interaction term for father's schooling. The interaction of father's schooling with earthquake intensity for females presented in the first three columns is positive, but not significant. This result holds when we look at the whole sample, or only at daughters of educated fathers. Next, we run a model without interactions for children of uneducated fathers. The results for girls in column (4) show a negative -but not statistically significant- main effect of the destruction on adult height. In the last four columns that present results for males however, the coefficient on the interaction is positive, larger and statistically significant at the 1 percent level. ***The results show a protective effect of father's schooling on the negative long-term effect of the shock on males' height only***. The main effect coefficient increases in magnitude and significance after the introduction of the interaction. While an increase of one standard deviation in the intensity of the earthquake translates into a 0.93 cms reduction in height for boys, the protective effect of father's schooling is also high: one standard deviation in the father's education interaction increases height by 0.7 cms. At the mean of earthquake intensity, the son of a father with no schooling will be 1.5 centimeters shorter while the son of a father with average education will be only 0.9 centimeter shorter on average.

Column (8) shows the main effect obtained for males with fathers without education. The parameter of interest is negative, four times bigger than the one found for the whole sample, and significant at the 1 percent level. One standard deviation in the intensity of the earthquake converts into a 2.5 cms average reduction in height for sons of uneducated father's. The results of this panel suggest a gender specific role of the mediating effect of father's schooling: the education of the father protects boys –but not girls- from long term losses in health capital. Additionally, we find a large and significant reduction in adult height for boys with mothers or fathers with no schooling.

Table 21 presents results of specifications that include an interaction of intensity with parental schooling for aged 2 to -2 in 1976. The top panel shows the coefficient of the mother's schooling interaction. There is no evidence of a reduction in adult height, or any mediating role of mother's education for men or women of this cohort. The only exception is the coefficient of the main effect of the earthquake in column (4), obtained in a model that looked at daughter's of mothers with no schooling. The parameter is negative, four times larger than the coefficient for the whole sample of females, and significant at the 10 percent level. One standard deviation in the intensity of the earthquake translates into a

0.93 cms reduction in height for girls whose mothers were not formally educated. The same parameter for boys is positive, but not significant. The bottom panel of the table presents the results of specifications that include a father's schooling interaction. In all models for men and women, the coefficient of the interaction is positive, but very small in magnitude and not significant. The only statistically significant parameter is the main effect of the earthquake in column (8), obtained in a model that looked at son's of fathers with no schooling. The parameter is negative, and one order of magnitude larger than the coefficient for the whole sample of males. One standard deviation in the intensity of the earthquake translates into a 1 cm reduction in adult height for boys whose father had no education. Overall, we find no mediating role of parental schooling on the impact of the natural shock's destruction on adult height. ***However we do find a significant reduction in stature in the younger cohort that follows a mirror image pattern: daughters of mothers with no schooling and sons of fathers with no schooling suffered a long term loss in height of approximately one centimeter per standard deviation of destruction.***

Table 22 illustrates the results of estimations that explore the role of rural residency, being the offspring of an unskilled day worker, and mother's life-long stock of health (proxied by her height) in mediating the impact of the earthquake on stature. The top panel presents the results for females. The interactions of intensity and being born in a rural area; and intensity and being the daughter of an unskilled day laborer are negative, large, and significant at the 10 percent level. The magnitude of the parameters is very similar when using either measure of destruction (classrooms destroyed or population made homeless). The main effect and the interaction parameter are not jointly significant in either case. For girls born and residing in rural areas, one standard deviation in the intensity of the earthquake results in 0.5 cm reduction in adult height. Daughters of unskilled day laborer experienced a reduction in stature of 0.25 cms per standard deviation increase in the intensity of destruction. I find no statistically significant effect for females of the interaction of a lower stock of health of the mother and shock's intensity. In contrast to the results obtained for women, the interaction of the number of people made homeless by the earthquake and rural birth is positive and significant at the 10 percent level for males. We fail to reject the null hypothesis in a test of joint significance on the main effect and interaction coefficient at the 5 percent level. The protective effect for males of residing in rural affected areas in 1976 versus affected urban localities is an increase of 0.4 cms in height per standard deviation in the intensity of the earthquake. A similar protective effect of rural residency was found for schooling.

Columns (3) and (6) present the results of the models that include an interaction between intensity and an indicator for the mother being in the first of four quantiles of the mother's height distribution. Since maternal height can be used as a proxy for life-long nutrition and health, this coefficient will show any differential impact on children of mothers with a reduced stock of health capital. The results show a large and statistically significant negative effect of the disaster on the adult height of males whose mothers were short, and the parameter is significant at the 1 percent level. The main effect is always positive but not statistically significant. Both parameters are jointly significant at the 1 percent level.

One standard deviation in the intensity of the earthquake results in a 0.4 cm reduction in adult height for sons of shorter mothers. There is no evidence of such an effect on females. The average long term penalty in height for an adult male with a shorter mother is on average 0.9, 1.8 and 4.8 centimeters respectively, at values of the intensity of destruction of 17, 32.5, and 87 percent of classrooms destroyed. The magnitude of the reduction in height obtained using the percentage of homeless population as a measure of intensity is very similar. Taken together, the results of this table present evidence that the stature of girls from families residing in rural areas, or with an unskilled worker father, was differentially and negatively affected by the disaster in the younger group. In contrast, rural residency cushioned the negative impact of the earthquake on adult height for males in Group 1, in exactly the same way it mitigated the impact of the destruction on their completed years of schooling. Finally, the negative effect of the earthquake on the adult stature of younger males –but not females- was made worse by lower stocks of health of the mother, proxied by her height.

8. DISCUSSION

8.1 ROBUSTENESS CHECK

The identification of the effect of earthquake destruction on measures of human capital formation presented in this paper rests on the assumption that in the absence of the natural disaster, the difference in educational attainment or adult height between the cohort affected by the quake and the older group of individuals that constitutes the control group would have been similar across Departments. If there were differential cohort trends in educational attainment or stature between Departments experiencing different degrees of destruction, it would not be possible to interpret the estimates as causal.

This identification assumption can be tested by comparing age groups not affected by the shock. In this control or "placebo" experiment, individuals aged 22 to 30 in February -a pseudo "treatment group"-, and individuals aged 31 to 35 -a control group-, are compared using the same difference in difference specification used in previous sections. Since it is fair to assume that individuals in both age groups had finished their schooling and physical growth at the time of the disaster, the coefficient for the interaction between a dummy for being aged 22 to 30 in 1976, and the parameter of interest showing the effect on schooling or height in should be insignificant and close to zero. Table 23 in the Appendix presents the results of this exercise using percentage of classrooms destroyed and percentage of population made homeless as measures of earthquake destruction, and years of schooling and adult height as independent variables. The impact of the "false earthquake" is very small and not statistically significant for men or women, in both specifications. The results in this table give support to the identification assumption and encourage the interpretation of the estimates as the causal effect of the disruption caused by the natural disaster, and not as the product of differential Departmental cohort trends.

8.2 SUMMARY AND DISCUSSION

One of the limitations of looking back in time after individual's human capital has been realized is that the dataset does not show the level of parental investment or the characteristics of the environment children in the sample grew in. Information on family composition and birth order, or indicators of health in childhood that could have influenced household allocation, are also missing from the data. However, it is still possible to pinpoint potential pathways of transmission of the impact of the earthquake by looking at differences in the timing of the shock and in its effects on different groups of children. After a negative event in the life of a child, parents can allocate resources –or fail to do so- to compensate for insults to human capital formation. Parents can also choose to "disinvest" and specialize, and thus accentuate differences between children. If parents choose or are able to compensate, the effects of the earthquake should be smaller for those children who benefited from parental investment.

Overall, the results indicate the shock had a negative effect on the completed years of schooling of children in the two cohorts analyzed. In the sample as a whole, classroom destruction reduces education by 0.4 years for children aged 4 to 9, on average.[68] The effect is smaller - a reduction of 0.2 years- for children aged 2 to -2. Several factors could be behind the observed reduction in years of schooling. The destruction of infrastructure, delays in enrollment, lack of enrollment, or cognitive deficits in pupils due to developmental insult are some of them. The smaller magnitude of the effect and the fact that only the number of classrooms destroyed intensity variable -not the percentage of homeless population- is significant in the younger group regressions, suggests that the cohort-wide negative effect of the disaster on years of completed schooling for older children is related to the physical destruction of education infrastructure. Table 24 summarizes the reductions in schooling when the sample is stratified by gender.

TABLE 24: EARTHQUAKE'S EFFECT ON COMPLETED YEARS OF SCHOOLING, by GENDER

	Cohort 1 Aged -2 to 2		**Cohort 2 Aged 4 to 9**	
	Men	Women	Men	Women
All				0.5
Mother's Educ>0		1.1		1.5
Father's Educ>0		0.3		1.0
Father's Educ=0		0.3		
Father Unskilled Day Worker	0.4	0.4		0.7
Born in Urban Area	0.6			

Reduction resulting from a one SD increase in earthquake intensity. Effects significant at the 5 percent or higher.

[68] All effects are expressed as resulting from a one standard deviation increase in the intensity of earthquake's destruction.

It is clear that in areas affected by the disaster, parents choose to invest in the education of boys versus girls. All girls aged 4 to 9 suffered reductions in their schooling equivalent to half a year of education, even after controlling for family background characteristics. When having to choose between consumption and investment in human capital, families seem to have viewed investment in girls as a better substitute for consumption than investment in boys. The long-term losses were even more important for daughters of educated parents (for whom demand for the education of girls was positive) and daughters of unskilled day workers (income constrained households), in both cohorts. The fact that we observe a clear gender pattern in the long-term effect suggests parents compensated for the shock for boys, but reinforced the negative effects of the earthquake on girls. These gender-specific investment strategies may stem from differences in expected returns –in the labor or marriage markets, or in support in old age-, or differences in social and cultural norms that make parents prefer boys over girls.

The reduction in females' human capital formation found can not be driven by gender differences in earthquake intensity. There is no reason to believe the distribution of intensity of destruction would have differed for parents of boys versus parents of girls; or that families with certain omitted characteristics related to human capital formation would have had more daughters than sons. Table 25 shows females and males in the sample have parents with very similar characteristics. Guatemala in the 1970's was a very poor country and families had very little access –if any at all- to contraception.[69] Technology that reveals the sex of the fetus was not available. To this day, abortion is illegal and the prevailing conservative Catholic culture discourages the use of effective family planning methods. These factors made very difficult –or impossible- for families to choose the number of pregnancies, the sex of the child, or to implement a gender stopping rule, and therefore alter the gender composition of their offspring in the studied cohorts. Selection due to migration also seems unlikely, since the proportion of females in migrant and non migrants groups of all cohorts is the same, as seen in Table 9. Although data on sex ratios at birth is not available, sex ratios measured in childhood and adulthood in affected and unaffected areas do not differ for the sample under study, as seen in Appendix A.

[69] See Appendix A. Only 19.2 percent of women used contraception methods; 69 percent of women declared they were not interested in contraception; 77 percent of women had never talked to a health worker about family planning; 61 percent had never discussed with their partner the use of contraception; and 60 percent of women believed contraception was against God's will. Source: 1978 Family Planning and Maternal Health survey.

TABLE 25: FAMILY CHARACTERISTICS, by GENDER

	OLDER COHORT (4 to 9)		p-value	YOUNGER COHORT (2 to -2)		p-value
	Males	Females	of the difference	Males	Females	of the difference
Proprotion born in Guatemala Department	0.34 (0.48)	0.35 (0.48)	0.88	0.40 (0.50)	0.36 (0.48)	0.22
Proportion born in Rural Area	0.52 (0.40)	0.49 (0.39)	0.76	0.47 (0.85)	0.52 (0.88)	0.52
Proportion with Mother's schooling =0	0.45 (0.50)	0.49 (0.50)	0.54	0.42 (0.49)	0.36 (0.48)	0.19
Proportion with Father's schooling =0	0.31 (0.46)	0.32 (0.47)	0.75	0.24 (0.43)	0.24 (0.43)	0.93
Proportion with Father agricultural day labourer	0.10 (0.31)	0.12 (0.32)	0.70	0.09 (0.29)	0.08 (0.29)	0.97
Average Mother's Educ (years)	2.90 (3.86)	3.00 (4.16)	0.65	3.82 (4.67)	3.70 (4.23)	0.73
Average Father's Educ (years)	4.10 (4.57)	4.00 (4.74)	0.83	5.13 (5.37)	5.11 (5.19)	0.95
Average Mother's Height (cms)	146.79 (5.48)	147.70 (6.07)	0.42	150.60 (6.24)	151.00 (6.88)	0.62

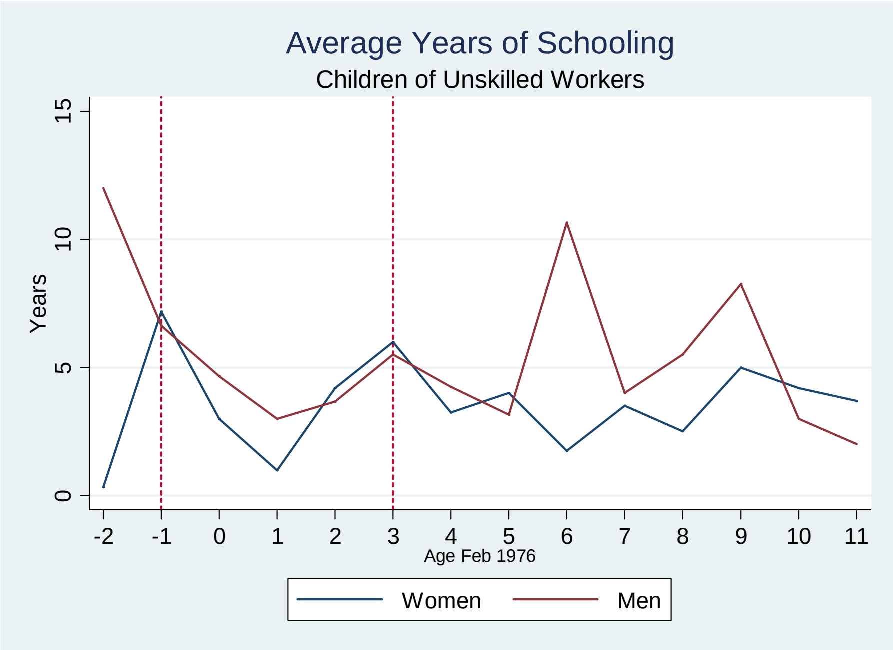
Standard Deviations in parenthesis. T-test at 5% level of significance. Non Indigenous and non migrant individuals only.

The long term impact of the earthquake for both men and women also depends on characteristics of the family of origin, and these characteristics interact with the gender of the child. The biggest average losses in education are found for daughters of parents with at least some schooling: 1.5 (mother's schooling>0) and 1 year (father's schooling>0) in the older cohort; and 1.1 and 0.3 years for the younger group, respectively. No corresponding pattern exists for males. In contrast to daughters of uneducated parents - whose schooling did not contribute much, or at all, to total household utility and had little chance of attending regardless of a negative shock taking place-, girls whose parents valued education would have been sent to school or kept in school for longer if the earthquake had not happened. After the disaster however, women's schooling was the margin on which households adjusted consumption. This suggests that, in addition to differences across gender, the elasticity of substitution between consumption and investment in girls varies by parental education.

An additional penalty existed for children from poorer households. For example, daughters –but not sons- of poor unskilled manual workers in the older age group suffered an average reduction in schooling of 0.65 years. It is likely income and liquidity constrained households lacked capacity to buy substitutes for destroyed schools (private education, schools in other locations), or to smooth calorie consumption; and withdrew more resources from girls than from boys. This could happen if the elasticity of substitution between consumption and girls' investment in worse-off poor families was higher than the same elasticity in better-off ones (preferences). In addition, poorer families faced more binding budget constraints and may not have had enough resources to invest adequately in all children -regardless of their preferences-, and choose to invest in males based on their higher market returns to human capital. For poor females, parental preferences and poverty added up in detriment of their human capital formation.

Surprisingly, parents of children in the younger cohort seem to have had less gender bias in the allocation of household resources. Both male and female children of unskilled workers aged 2 to -2 in 1976 show an average reduction of 0.4 school years. The only reduction in schooling found that applies to boys only is for males of this cohort living in urban areas. Graph 10 plots the unconditional mean of years of schooling for sons and daughters of income constrained families living in areas hit by the earthquake against, the age of the child in February, 1976.

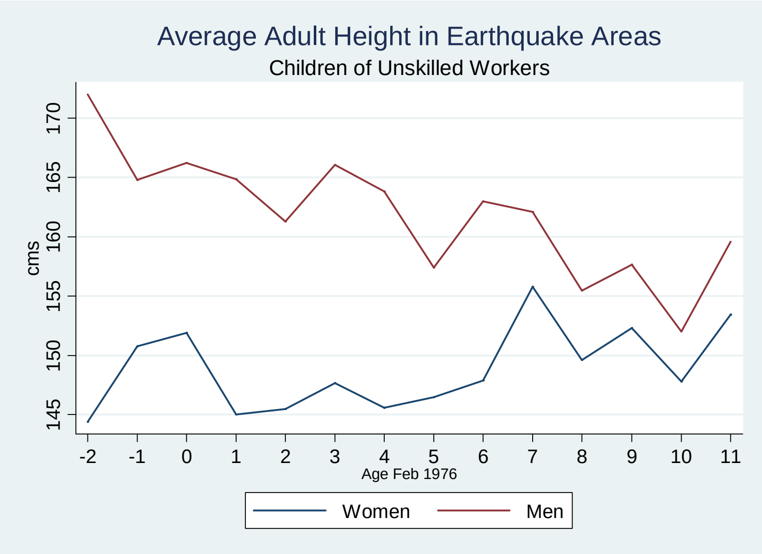
GRAPH 10: AVERAGE YEARS OF SCHOOLING IN AFFECTED AREAS, CHILDREN OF UNSKILLED WORKERS



The graph shows investment in older boys was higher than in girls': average male education is always greater than average female schooling for children older than five. The only point in the curve where the difference decreases is the one corresponding to children aged 7 in February of 1976. This is exactly the school entry age and suggests that although parents of older children in poor families chose to educate boys over girls, the shock to demand and supply of schooling the year the earthquake hit was so great that it even affected the schooling of males who were supposed to enter the school system that very year. The male-female gap in average schooling disappears suddenly for children aged five or younger. Men and women aged five and born up until 1978 have almost exactly the same amount of average schooling. Even more so, girls born during the period 1975-1977 have higher average education than boys. ***Did parents in the younger age group have more egalitarian preferences between boys and girls?*** Such a sharp discontinuity in parental preferences is very difficult to explain. I believe the answer is related to the effects of developmental insult during a "critical period" in early childhood and in utero.[70] Malnutrition during this time results in permanent biological damage that, although has an adaptive function and helps the child survive, has serious adverse later life consequences on mortality rates (Barker and Levy, 1994), reduced adult height and obesity, (Deaton, 2007; Fung, 2009; Luo et al., 2006), and cognitive outcomes and earnings (Almond, 2006; Almond et al., 2007). Evidence for this is found in the fact that the average schooling curve for both males and female aged 3 to -1 in 1976 is V-shaped, with the lowest average outcome corresponding to children in utero or aged one the year of the shock. Developmental insult before birth or during the first year of life may have changed the human capital production function making later investments in health and education less effective (Heckman, 2007). Gender specific investment responses from income constrained parents of the younger cohort can not be ruled out, but the fact that a reduction in average male education still shows in the data indicates that the magnitude of the insult made any parental response insufficient to compensate for its effect on males. It is very likely that cognitive impairment was not evident for parents until children were of school age, and therefore compensation strategies that favor boys over girls could not be applied soon enough to be effective. Parents, however, would be immediately aware of damage to the physical growth of male children after birth, and could compensate accordingly. As seen in Table 26, the intensity of the shock reduces the adult height of daughters –but not sons- in this sub sample by (0.25 cms). Graph 11 clearly shows that the gender gap in average adult height in affected areas widens progressively for children seven and younger in February, 1976, in contrast to the pattern observed in the previous completed education graph.

[70] Barker(2009)

GRAPH 11: AVERAGE ADULT HEIGHT OF CHILDREN OF UNSKILLED WORKERS IN EARTHQUAKE AFFECTED AREAS



The relationship between family characteristics, child's gender, and earthquake's long-term effects is also evident when looking at adult height, as Table 26 shows. The intensity of the shock reduces the adult height of daughters –but not sons- of poor unskilled manual workers (0.25 cms). There is evidence that parental education mediates the impact the shocks intensity on adult height, and that this mediating role is gender specific. A large reduction in stature is found for males (1.63 cms) and females (1.75) aged 4 to 7 who come from families where the mother had no schooling, even after controlling for socioeconomic background. The role of mothers' education in better disease prevention, hygiene and nutrition practices could be associated with these findings.

For males whose fathers have no schooling an increase in one standard deviation in intensity translates into a reduction of 2.5 cms in adult height, but there is no effect for females. Maternal schooling interacts with intensity of destruction to protect the physical growth of girls, but not of boys. Likewise, father's schooling protects boys –but not girls- from long term losses in health capital. In the younger cohort aged 2 to -2, the gender of the parent without schooling also seems to matter. A reduction of 0.93 cms was found for daughters –but not sons-of mothers with no schooling; while sons –but not daughters-of uneducated fathers were one centimeter shorter.

TABLE 26: REDUCTION IN ADULT HEIGHT (cms)

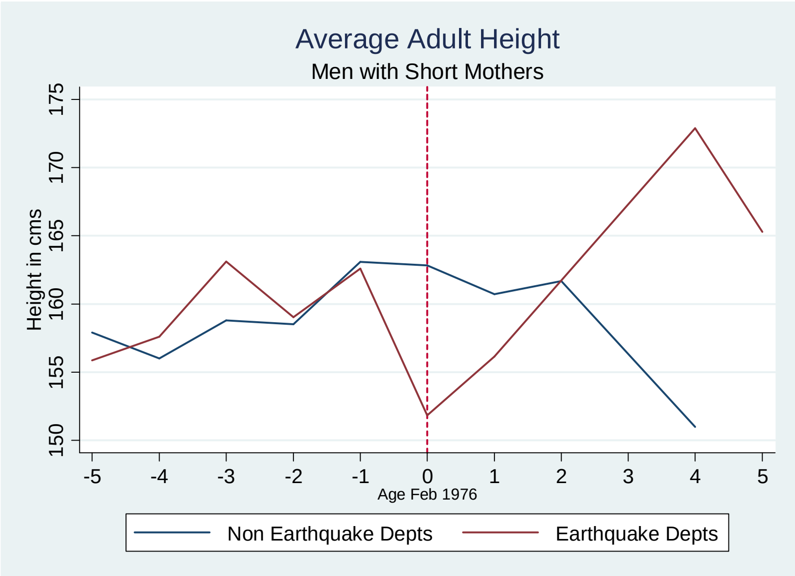
	Cohort 1 Aged -2 to 2		Cohort 2 Aged 4 to 9	
	Men	Women	Men	Women
All				
Main Effect				0.91
Mother's Educ Interaction				(+) 0.63
Main Effect			0.93	
Father's Educ Interaction			(+)0.70	
Mother's Educ= 0		0.93	1.63	1.75
Father's Educ= 0	1.0		2.50	
Father Unskilled Day Worker		0.25		
Mother's Height in Q1	0.40			

Reduction resulting from a one SD increase in earthquake intensity. Effects in black significant at the 5 percent or higher. Effects in blue signficant at the 10 percent.

Gender bias in household allocation that make mothers use resources to improve the human capital of their daughters, and makes fathers invest in human capital of their sons has been widely documented in developing countries (Strauss and Thomas, 1995; Duflo, 2003). In particular, Thomas (1990) and (1994) shows that when receiving a subsidy –a positive income shock-, mother's education has a bigger impact on height of daughters than sons and that fathers' education affects sons' height more, in Brazil, Ghana and the US. Differential gender effects like the ones observed for height could arise if mothers get more utility from investing in girls and, conversely, fathers get more utility from investing in boys. This is the case if, for example, children participate in work at an early age, and girls help mothers in housework while boys help fathers in agricultural work. That this pattern is found only for adult height -but not for completed schooling-, may be related to the fact that mothers have a greater capacity to influence the distribution of food and nutrients, than to influence the distribution of resources used to buy education.

The same "early life conditions" mechanism observed for children of unskilled workers in the younger cohort seems to be behind the effect of the earthquake on the stature children of shorter mothers. Males aged 2 to -2 whose mothers are in the bottom quartile of the mother's height distribution are 0.4 cms shorter per each standard deviation in the intensity of the earthquake. Children of shorter mothers may have been differentially affected because mother's health has a protective role against environmental insult during gestation and is a proxy for heritable health genetic endowment. Graph 12 shows a big difference in average adult height of males from affected and unaffected areas younger than five. No such pattern is found for females of the same age group, or for males or females in the older cohort. The adult height curve for earthquake affected areas has a clear V-shape, with the vertex on age 0, suggesting a "critical period" developmental injury. The results are in line with Kelly (2009), that finds that a negative health shock during pregnancy decreases birth weight and cognitive development for children of short mothers, and Fung (2009) who finds much stronger adverse effects for boys than for girls of the 1959-61 China Famine.

GRAPH 12: AVERAGE ADULT HEIGHT OF MEN WITH MOTHERS IN THE FIRST QUARTILE OF THE MOTHER'S STATURE DISTRIBUTION



Finally, rural residency seems to shelter both male schooling and adult height in the younger cohort. The protective effect for males of residing in rural affected areas in 1976 versus affected urban localities is an increase of 0.4 cms in height per standard deviation in intensity of the earthquake. A similar protective effect of rural residency was found for schooling. Boys residing in urban areas experienced an average reduction of 0.6 years of schooling when compared with rural males. Early labor market entry due to reconstruction efforts, or higher levels of destruction intensity in urban areas, could have affected urban males differentially compared to rural ones. Tables 27 and 28 show that the intensity of the destruction increases the probability of dropping out school, of never enrolling in secondary, and of entering the labor market early for urban males in this group. No statistically significant effects are found for males living in Departments with higher intensity values or for the cohort as a whole. No effects are found for the older cohort either. Consequently, differences in intensity can be ruled out as an explanation for the stronger impact on urban boys aged 2 to -2. The idea that an increase in demand for child labor is driving the results is puzzling: the disaster would have induced early labor market entry in the younger, but not the older cohort even after allowing for delays in reconstruction. It is also possible that households protected their investments in the schooling of older children by disrupting the schooling of younger siblings in urban areas.[71] The lack of information on household composition and birth order in the dataset does not allow further exploration of the precise way in which the earthquake translated into reduced schooling for younger males in urban areas. Finally, it is also likely parents in

[71] A similar result was observed by Thomas et al (2004) after the economic crisis in Indonesia in 1997-1998.

urban areas had more egalitarian preferences, while parents in rural areas placed more value on conservative social norms and agricultural activities that favor sons. If so, rural boys would have been fared better than urban boys.

CONCLUSIONS

This study examines how the 1976 earthquake affected the long-term formation of human capital of children in Guatemala. Overall, the earthquake had a negative effect on the completed years of schooling of children in the two cohorts analyzed. In the sample as a whole, one standard deviation increase in earthquake's destruction reduces education by 0.4 years for children aged 4 to 9, on average. The effect is smaller - a reduction of 0.2 years- for children aged 2 to -2. The natural disaster also had a long term negative effect on adult height.

There is evidence that the scarcity of resources in the aftermath of the earthquake led to intra household decisions that systematically favored the investment in the human capital of male children. When the sample is stratified by gender, the results do not show any reduction in the schooling of males in the older cohort, even when taking into account potential heterogeneous impacts across family characteristics. Females aged 4 to 9 suffered a reduction in education across the board regardless of their family background, equivalent to half a year of education. Girls from poorer households -likely to face more binding liquidity constraints and/or have lower initial levels of human capital investment- suffered disproportionately from the negative effects of the disaster. One standard deviation in destruction decreases completed education in this sub group by 0.7 years for girls aged 4 to 9 in 1976; and by 0.4 years for boys and girls aged 2 to -2. The earthquake also differentially reduced the number of completed years of schooling of girls with educated fathers and mothers. One standard deviation in destruction decreases education of daughters of mothers with at least some schooling by 1.5 years for girls aged 4 to 9 in 1976; and by 1.1 for girls aged 2 to -2. Additionally, there is evidence that families failed to enroll girls in school altogether, or withdrew them sooner; but only delayed boys' enrollment.

There is a clear parental education gradient of the effect of the earthquake on adult height, and this gradient is gender specific. Men and women in the older cohort suffered an average reduction in adult height of 0.9 cms, but each additional year of schooling of the mother interacts with the effects of the earthquake to offset the loss in stature of daughters by 0.6 cms while each additional year of father's schooling offsets the loss in stature of sons by 0.7 cms. Sons and daughters of mothers with no schooling and aged 4 to 9 experienced an average reduction of 1.63 cm and 1.75 cm respectively, even after controlling for socioeconomic family background and mother's height. Males aged 2 to -2 whose mothers are in the bottom quartile of the mother's height distribution are 0.4 cms shorter per each standard deviation increase in the intensity of the earthquake.

An important policy implication arising from the results is that disasters are not gender neutral, and son preference can also have consequences after natural disasters. The observed differences in outcomes of males and females aggravate existing human capital inequality, and could reflect differential household investment responses. Gender bias in the allocation of household resources seems to be stronger for more constrained families, suggesting that targeted post-disaster interventions are necessary. Taken as a whole, the findings reinforce evidence for gender specific effects of positive or negative events in early childhood in Rose (1999), Macinni and Yang (2009) –covariate weather shocks-; and Sawada (2003) and Parker and Skoufias (2006) –idiosyncratic income shocks-. The results also support the findings in Behrman (1988): in times of scarcity, parents adopt resource allocation strategies that are detrimental to females.

APPENDIX A: CHANGES IN COHORT COMPOSITION

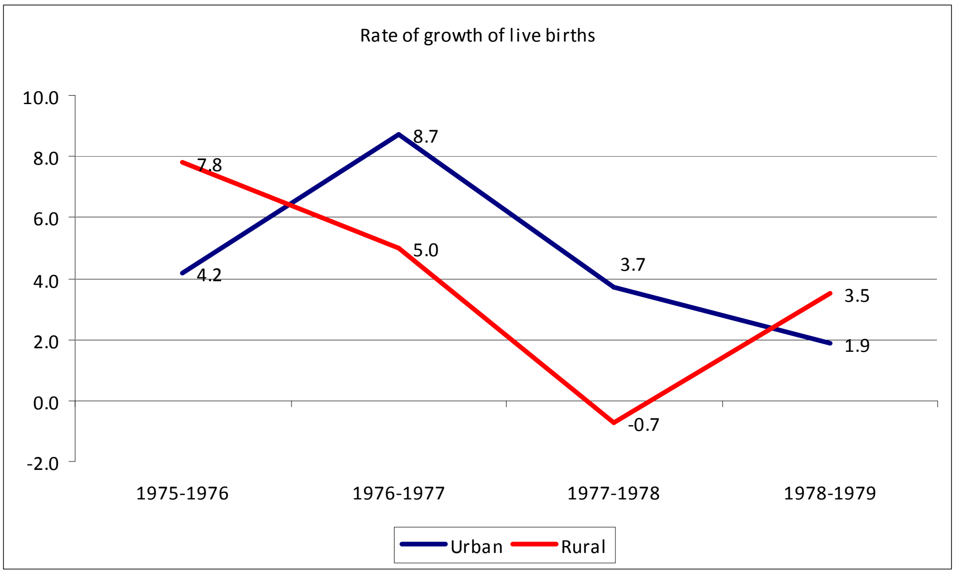
The destruction brought on by the earthquake could have altered the composition of the cohort of children under study through selective fertility or mortality. If such changes in composition are non random with respect to individual characteristics that are correlated with educational attainment or height, our results would be biased. In this section we analyze potential changes in cohort composition, based on the available information.

Changes in Fertility: It is possible that a smaller number of children were conceived in the immediate aftermath of the disaster. Given the very low rate of contraceptive use in Guatemala during the 1970's, women's stress levels and malnutrition are likely to have had more of an effect than actual contraceptive use. According to data from the 1978 Family Planning and Maternal Health survey, only 19.2 percent of women used contraception methods (this percentage included non reliable methods such and rhythm and withdrawal); 69 percent of women were not interested in contraception; 77 percent of women had never talked to a health worker about family planning; 61 percent had never discussed with their partner the use of contraception; and 60 percent of women believed contraception was against God's will. Most contraceptive users lived in the capital (Montheith et al, 1985). Guatemala's unstable political climate, and the powerful alliance between church and state on issues relating to family planning, are thought to be related to the limited supply and demand for contraception. Santiso-Galvez and Bertrand (2004) document the acute lack of doctors and nurses with knowledge and skills to provide contraceptive services during the 1970s and 1980's. The only University that trained health care personnel in the country (Universidad San Carlos) did not allow coursework in reproductive health for the training of doctors or nurses until in the 1980s. This subject matter had never been incorporated into the curriculum before, and even during the 1980's, it was done so only on an extracurricular basis, carried out by a U.S.-based and funded organization.

Women's stress levels and malnutrition could have reduced fertility, particularly among more vulnerable or affected households. Potential selection arising from changes in fertility would reduce the share of individuals with poor parents in our sample. Graph A.1 plots the rate of growth of live births in Guatemala for the period 1975-1979, and shows a slower pace of growth in births immediately after the earthquake (1976-1977), mainly in more deprived rural areas.[72] If having poor parents is associated with less favorable outcomes later in life, selective fertility reduction gives the cohort born after 1976 better outcomes than the comparison group through positive selection, and leads to underestimation of the effect of the earthquake.

[72] Information at the Department level that could distinguish between hit areas and areas not affected is not available.

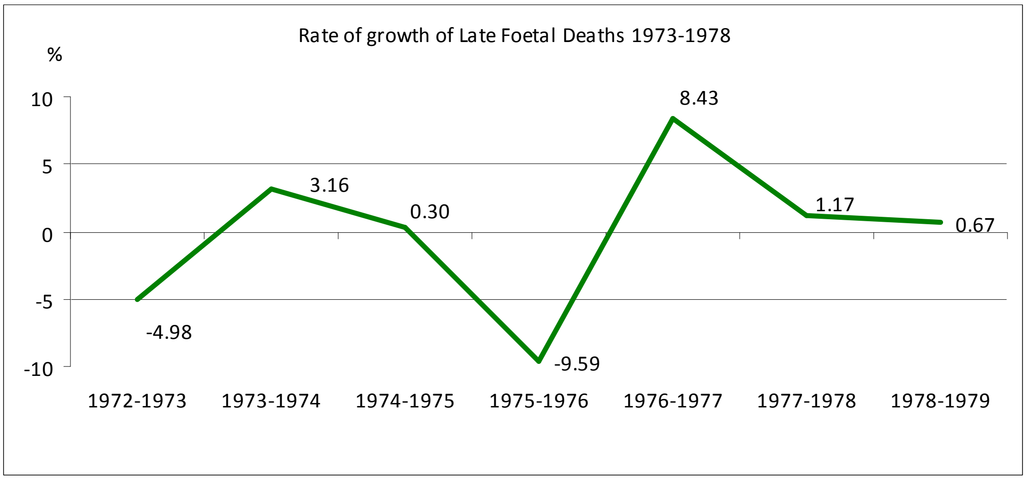
GRAPH A.1: GROWTH OF LIVE BIRTHS



SOURCE: 1981 UN DEMOGRAPHIC YEARBOOK
*1973 data point from 1976 Guatemala Statistical Yearbook

Changes in cohort composition before birth: Relevant cohort change can happen before birth, through mortality during the in utero period. A negative shock in utero could result in higher average health and cognitive ability for survivors. Graph A.2 shows the total number of foetal deaths in Guatemala for the years 1973-1978.[73] There is evidence of a higher rate of growth of in the number of pregnancies not coming to term in the period following the disaster (1976 to 1977). If so, surviving children may have a better genetic endowment that correlates positively with higher educational attainment and adult height, biasing the results downwards.

GRAPH A.2: LATE FOEATAL DEATHS

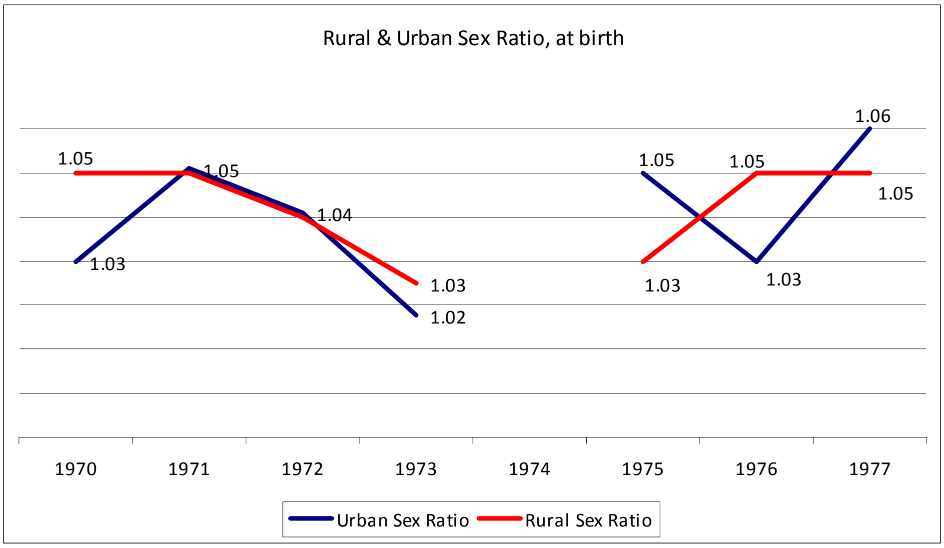


SOURCE: 1981 UN DEMOGRAPHIC YEARBOOK

[73] Late foetal death is defined as that happening after 28 weeks of gestation, plus those with unknown gestational age. UN Demographic Yearbook, 1980.

Previous work by Trivers and Willard (1973), Kraemer (2000), and Almond and Mazumder (2008) suggest greater fragility of males before birth, which continues to show as higher male mortality throughout life. If surviving male babies have on average a more favorable genetic endowment, any difference in outcomes could be related to this form of selection. Graph A.3 shows the sex ratio at birth in rural and urban Guatemala for the period 1970 to 1977.[74]

GRAPH A.3: SEX RATIO AT BIRTH



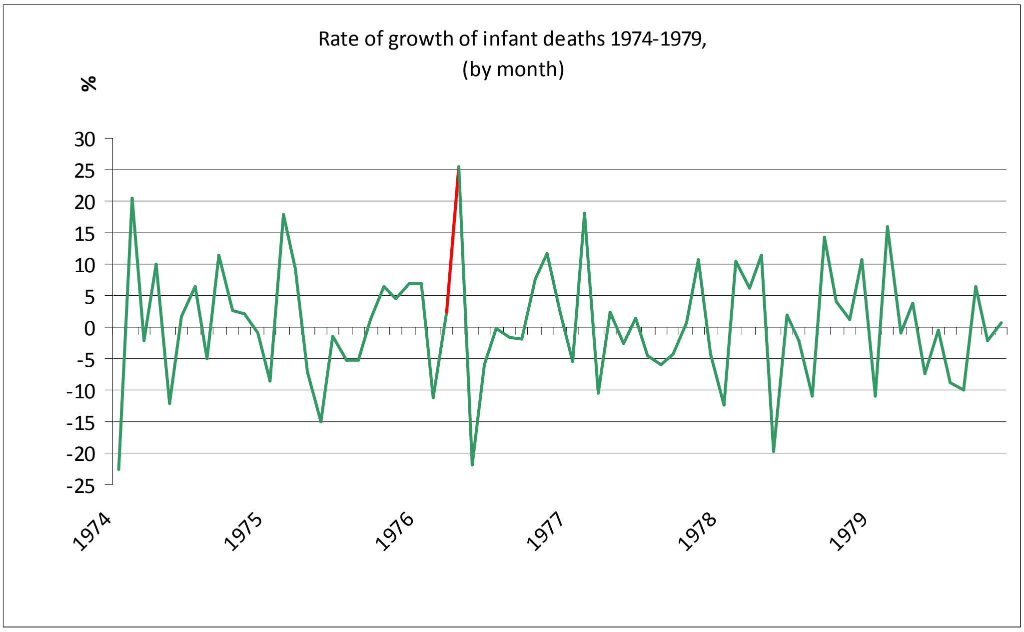
SOURCE: 1981 UN DEMOGRAPHIC YEARBOOK
*1973 data point from 1976 Guatemala Statistical Yearbook

There is no information on the number of males and females born in 1974. In spite of lacking complete information, a decrease in the number of boys born relative to girls in the year 1976 in urban areas can be observed, although the magnitude of the difference with respect to other years is very small.

Changes in cohort composition after birth: Changes in cohort composition can also take place after birth. The lack of access to health services, clean water and proper nutrition in affected areas could have resulted in a higher than average number of infant deaths during the period following the disaster. Bozzoli et al (2009) suggest that higher childhood mortality rates also produce selection, and in some situations the selection effect overcomes the harmful consequences of early life insults. If so, we would not expect to find any differences in human capital outcomes between children in affected and unaffected areas; or to underestimate the results of the negative shock in long term outcomes. The national infant mortality rate shown in Graph A.4 does show an increase in the number of infant deaths after 1976 between the months of February and March of 1976, although it is difficult to establish whether the variation in subsequent months differs from the historical pattern.

[74] The normal sex ratio at birth in Guatemala is assumed to be from 103 boys to girls to 105 boys to 100 girls. CIA World Factbook.

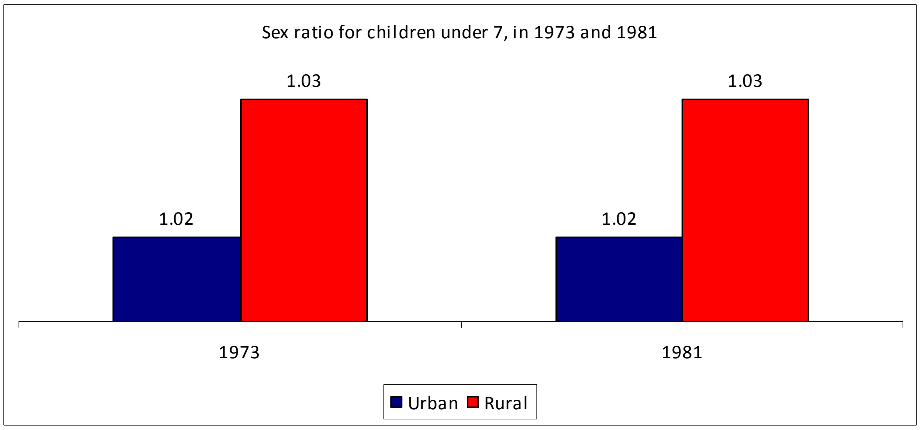
GRAPH A.4: RATE OF GROWTH IN THE NUMBER OF INFANT DEATHS 1974-1979, by Month



SOURCE: 1980 UN DEMOGRAPHIC YEARBOOK

Moreover, any difference in the sex ratio for the youngest cohort of interest -born in the period 1976 to 1979- seems to disappear by age seven. Graph A.5 shows the sex ratio for the group of children seven or younger measured in the 1973 census and in the 1981, for urban and rural areas.

GRAPH A.5: SEX RATIO FOR CHILDREN UNDER SEVEN



SOURCE: 1973 & 1981 POPULATION CENSUS

The aggregate data do not show any difference between the two periods. Table 1 provides the sex ratio for the same age group measured in 1973 and 1981 for affected and non affected Departments.

TABLE A.1 SEX RATIO FOR CHILDREN UNDER SEVEN

AFFECTED	1973	1981
SACATEPEQUEZ	1.02	1.01
CHIMALTENANGO	1.02	1.01
QUICHE	1.03	1.03
GUATEMALA	1.03	1.02
EL PROGRESO	1.02	1.03
JALAPA	1.02	1.01
SOLOLA	1.03	1.01
TOTONICAPAN	1.04	1.00
ZACAPA	1.03	1.02
BAJA VERAPAZ	1.04	1.05
IZABAL	1.02	1.03
Average	1.02	1.02
NOT AFFECTED	**1973**	**1981**
ESCUINTLA	1.03	1.07
SANTA ROSA	1.04	1.04
QUETZALTENANGO	1.01	1.02
SUCHITEPEQUEZ	1.03	1.02
RETALHULEU	1.02	1.02
SAN MARCOS	1.03	1.02
HUEHUETENANGO	1.01	1.01
ALTA VERAPAZ	1.03	1.01
PETEN	1.04	1.05
CHIQUIMULA	1.02	1.04
JUTIAPA	1.01	1.03
Average	1.02	1.03

SOURCE: 1973 & 1981 Population Censuses

The difference between the two periods in affected and non affected areas is very small. It seems that any difference in the sex ratio introduced by “culling of the weakest” during pregnancy or early childhood is not apparent by age seven, probably because by this age the sex ratio captures the effect of changes in cohort composition before birth (stress increases the number of female versus male births and makes surviving males stronger), and the effect of changes after birth that may favor the survival of boys over girls if parents exhibit male preference in intra household resource allocation.

A similar result emerges when looking at the sex composition white non migrants in the ENCOVI 2000 survey, of the sample under study. Table A.2 shows the proportion of females by age in 1976.

TABLE A.2 PROPORTION FEMALE, ENCOVI 2000

	PROPORTION FEMALE		p-value
	Affected	Not Affected	of the difference
Age in 1976			
-2	0.50	0.52	0.72
	(0.50)	(0.50)	
-1	0.53	0.55	0.76
	(0.50)	(0.50)	
0	0.56	0.55	0.79
	(0.50)	(0.50)	
1	0.56	0.51	0.48
	(0.50)	(0.50)	
2	0.49	0.51	0.67
	(0.50)	(0.50)	
3	0.53	0.56	0.63
	(0.50)	(0.50)	
4	0.56	0.54	0.78
	(0.50)	(0.50)	
5	0.49	0.56	0.35
	(0.50)	(0.49)	
6	0.57	0.50	0.32
	(0.50)	(0.50)	
7	0.53	0.56	0.65
	(0.50)	(0.50)	
8	0.48	0.58	0.19
	(0.50)	(0.50)	
9	0.57	0.50	0.73
	(0.50)	(0.50)	

Standard Deviations in parenthesis. T-test at 5% level of significance. Non Indigenous and non migrants only.

The data show no statistically significant difference in the proportion of females in affected and non affected areas. Twenty-four years after the earthquake, the sex ratio captures the effect of changes in cohort composition before birth, the effect of changes after birth that may favor the survival of boys over girls if parents exhibit male preference in resource allocation, and biological differences in mortality between adult males and females. There is no evidence that these processes affect sex composition differentially for individuals born and living in affected and non affected Departments in the sample.

Taken as a whole, the incomplete information on fertility and neonatal and infant mortality during the 1970's available for Guatemala does not rule out a positive selection effect in the individuals present in the sample in 2000. This would bias our estimates downwards and suggests the impact of the natural disaster found is conditional on survival to the year of the survey, and therefore should be interpreted as a lower bound of the total effect. On the other hand, differences in sex composition are not apparent for the cohort under study.

APPENDIX B

PHOTO 1: VILLAGE OF PATZICIA, GUATEMALA. FEBRUARY, 1976

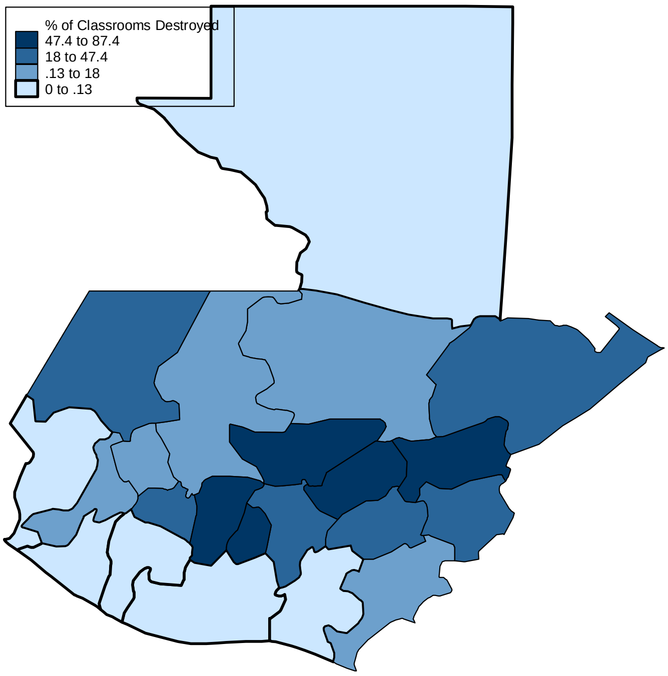
The image shows adobe block rubble which is all that remains of the houses that formerly lined this street. The adobe block buildings had very little resistance to horizontal forces and most of them were completely destroyed. Collapse of the heavy adobe walls, roof tiles and beams caused most of the casualties. Many of the adobe blocks are still intact but the mortar between the blocks failed during the seismic shaking. Source: Slide 43, U.S. Geological Survey Open-File Report 77-165.

PHOTO 2: VILLAGE OF SAN MARTIN JILOTEPEQUE. FEBRUARY, 1976

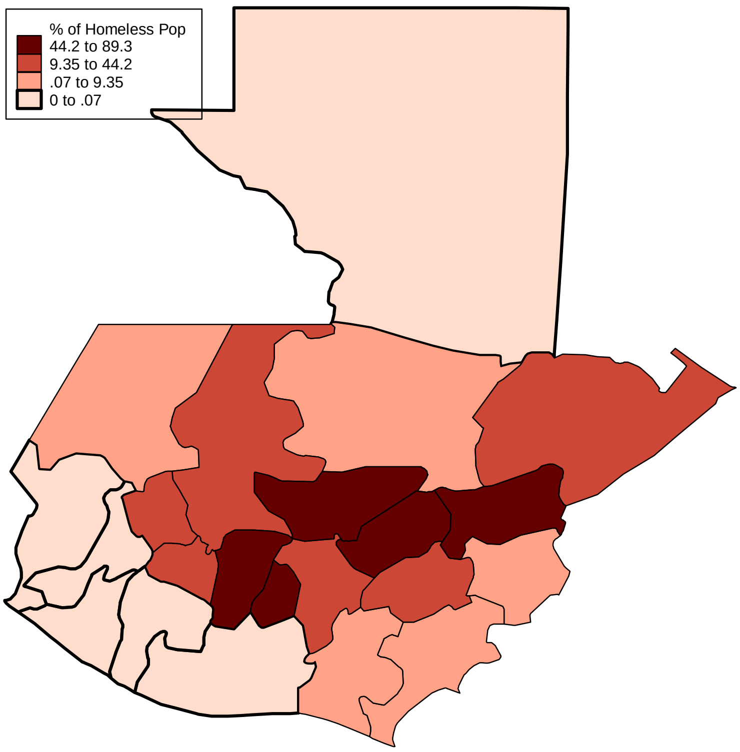
A typical highland village, located 33 kilometers northwest of Guatemala City that was devastated by the February 4 earthquake. Traditional adobe houses with tile roofs were almost completely destroyed, but the school buildings made of reinforced concrete block and corrugated asbestos roofs in the right part of this view are essentially undamaged. Source: slide 42, U.S. Geological Survey Open-File Report 77-165.

GRAPH 1: EARTHQUAKE DESTRUCTION, BY DEPARTMENT

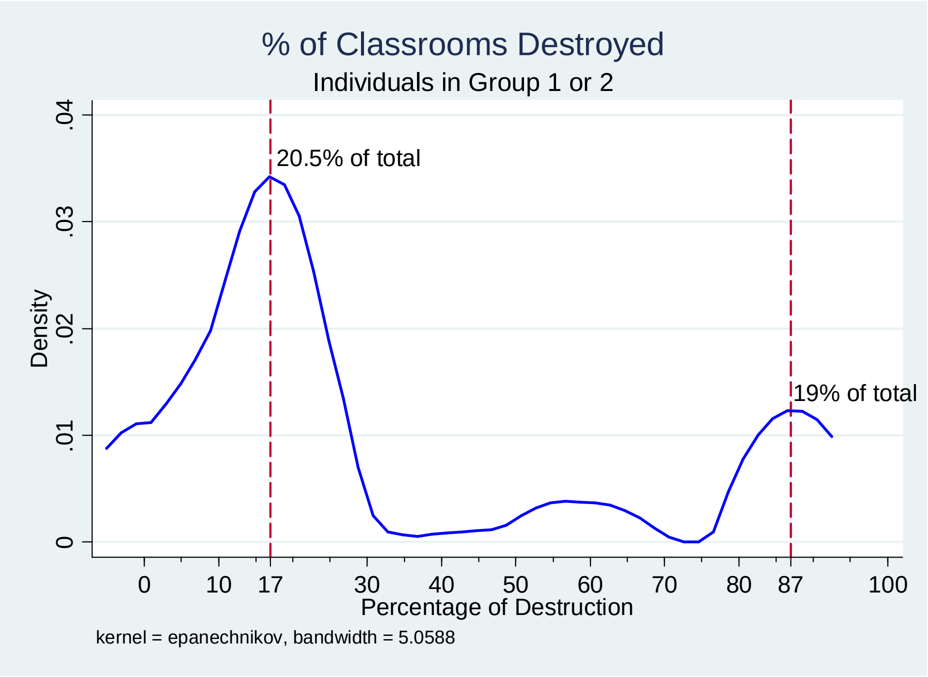
Percentage of Classrooms Destroyed

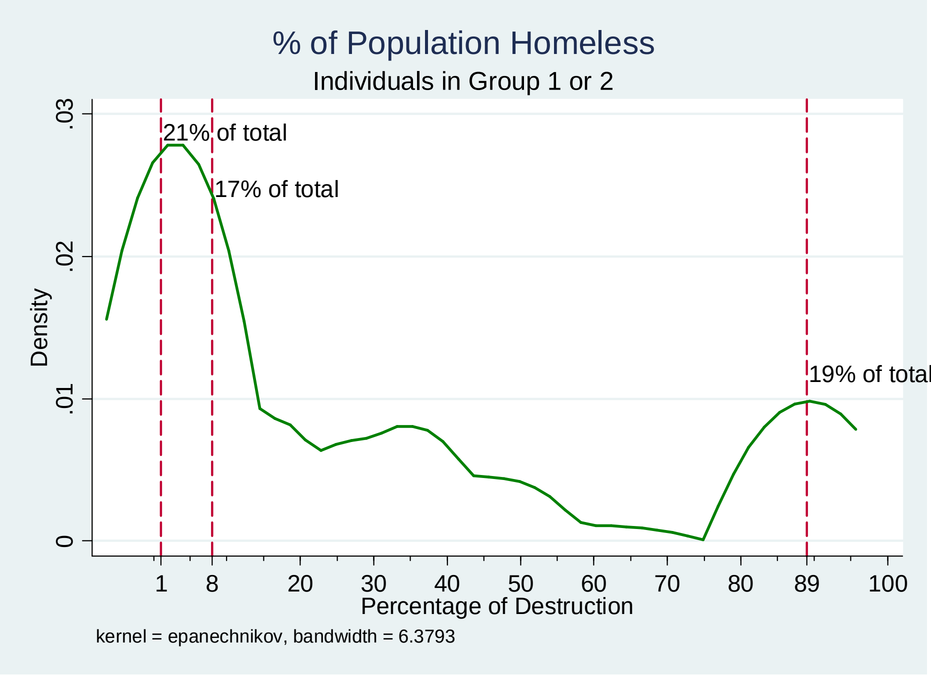


Percentage of Population made Homeless by the Earthquake

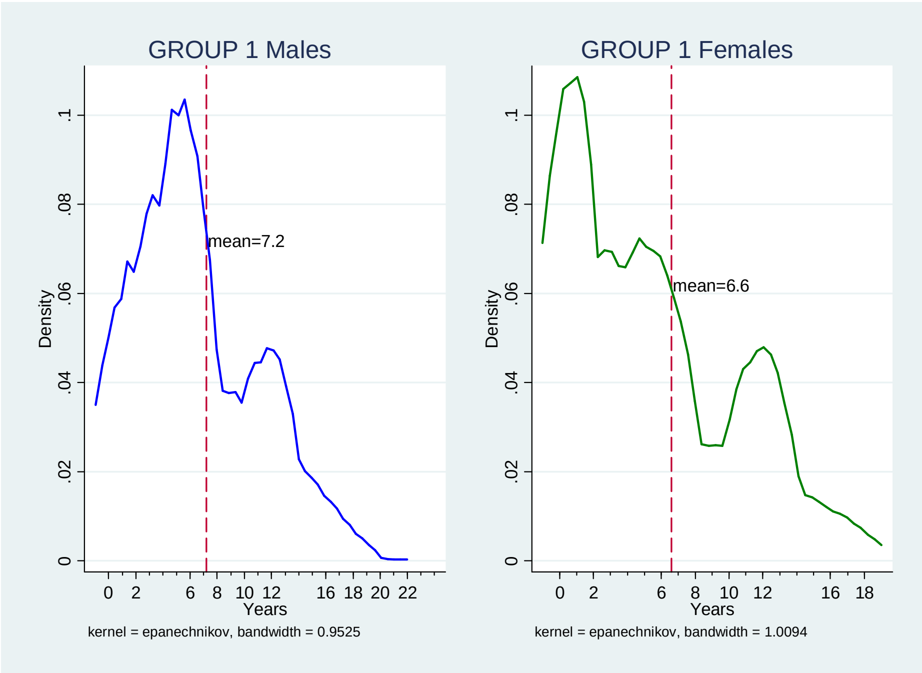


GRAPH 3: DISTRIBUTION OF INTENSITY OF THE DAMAGE FOR INDIVIDUALS IN AFFECTED COHORTS

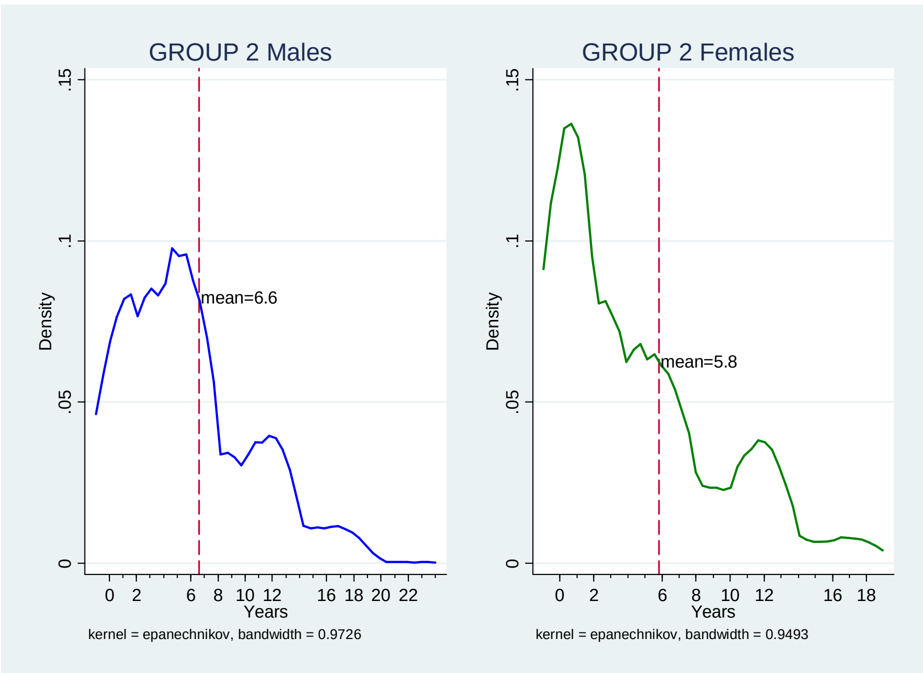




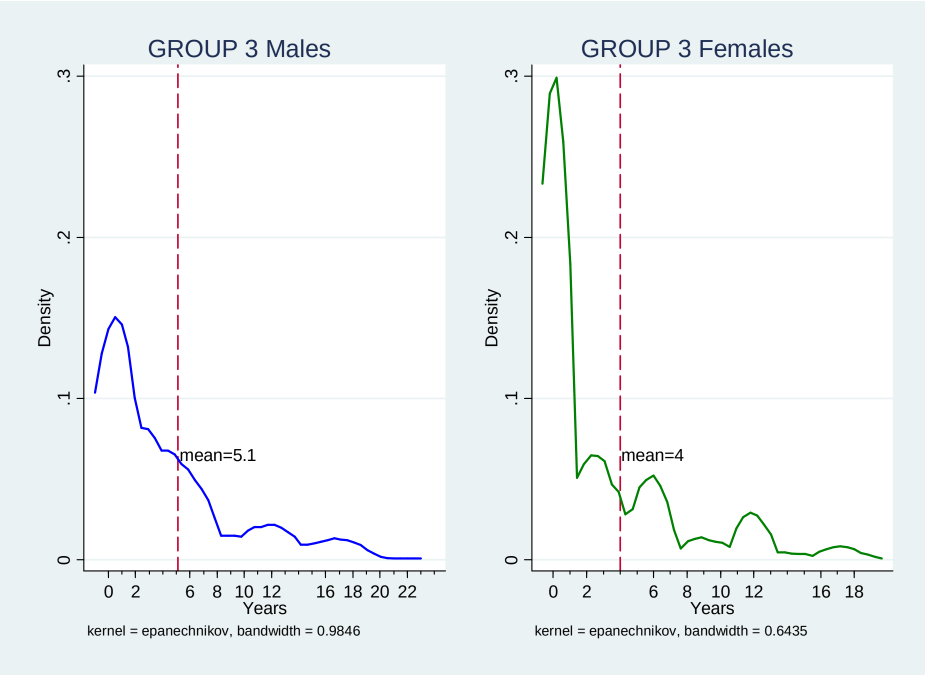
GRAPH 4: SCHOOLING DISTRIBUTION, Cohort 1



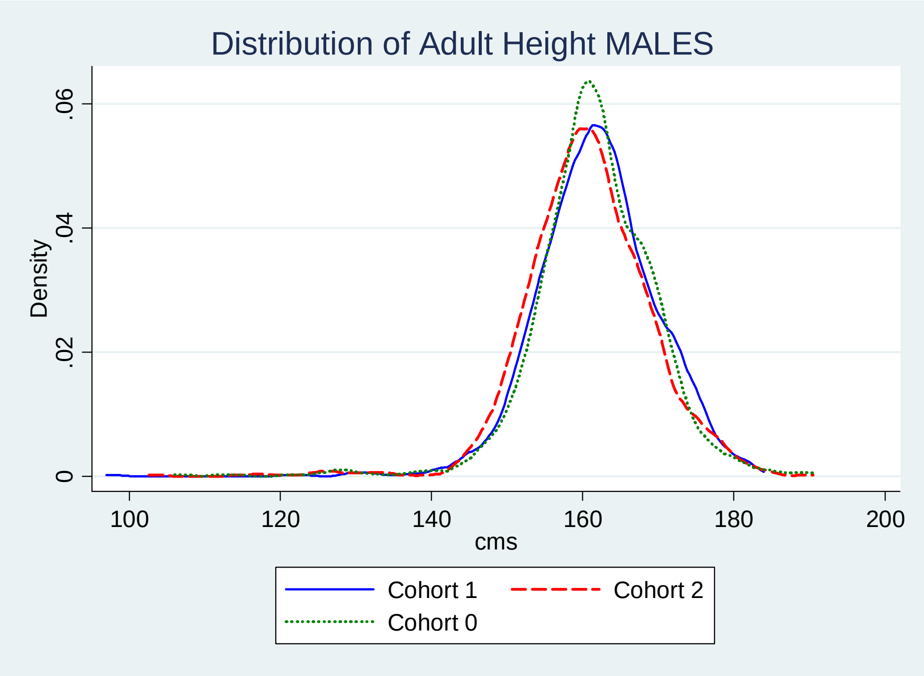
GRAPH 5: SCHOOLING DISTRIBUTION, Cohort 2



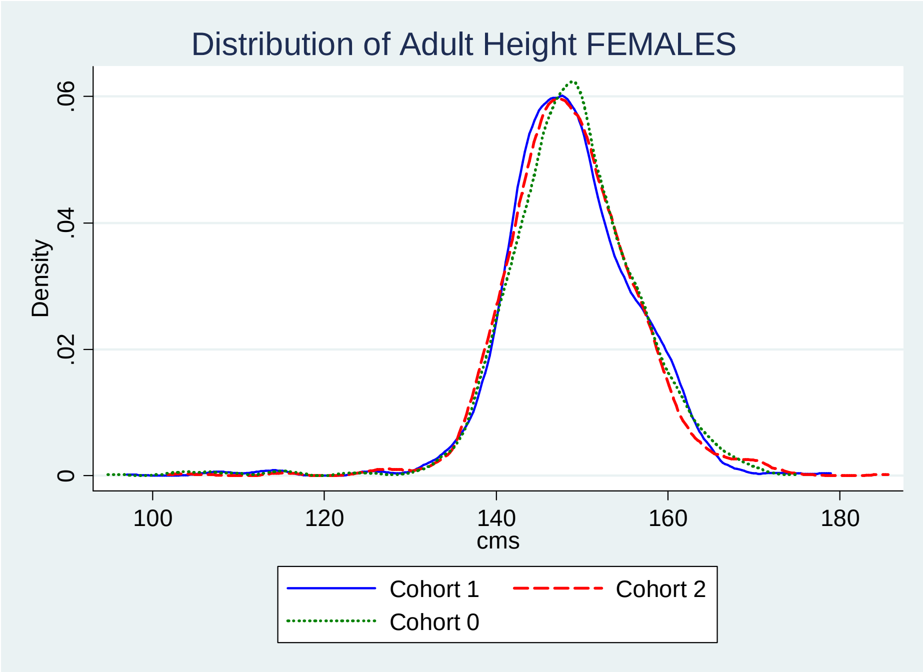
GRAPH 6: SCHOOLING DISTRIBUTION, Cohort 3



GRAPH 7: MALE ADULT HEIGHT DISTRIBUTION, BY COHORT



GRAPH 8: FEMALE ADULT HEIGHT DISTRIBUTION, BY COHORT



GRAPH 9: % OF URBAN POPULATION AND PER DEPARTMENT, and INTENSITY OF THE EARTHQUAKE'S DESTRUCTION

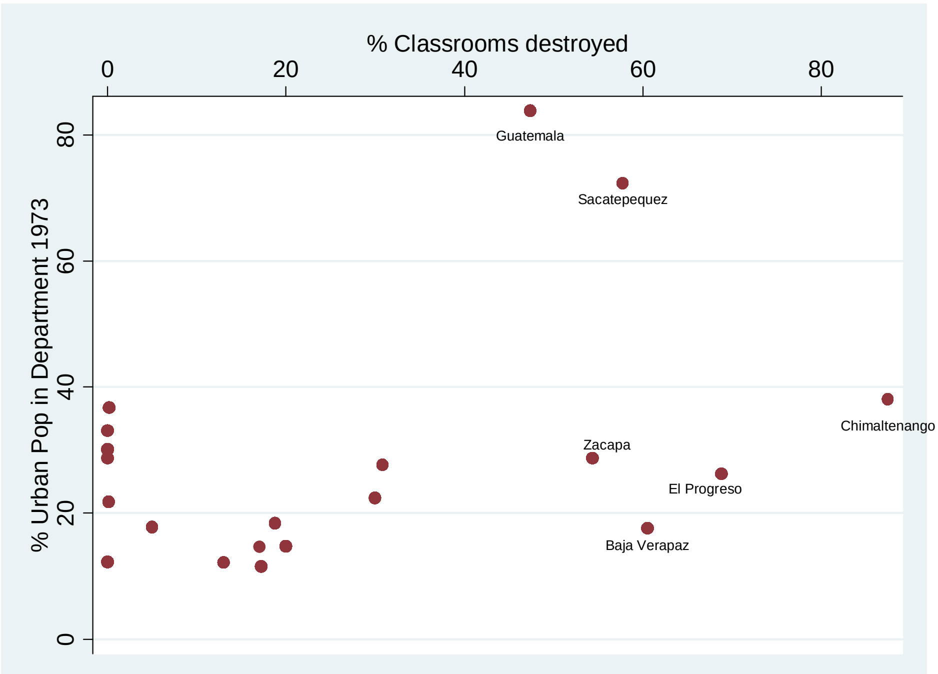


TABLE 1: PRIMARY SCHOOL SYSTEM IN 1972

PROFILE OF THE PRIMARY SCHOOL SYSTEM (Private and Public) 1972

DEPARTMENT	Number of Schools		Teacher/School Ratio		School Age	% Urban School	% Rural School	% School
Affected:	Urban	Rural	Urban	Rural	Population	Aged Pop	Aged Pop	Enrollment
Guatemala	401	227	10.6	2.3	229,240	67	33	69
El Progreso	10	112	9.4	1.6	17,400	27	73	63
Sacatepequez	42	42	6.6	1.7	21,260	70	30	57
Chimaltenango	35	203	7.6	1.4	44,000	39	61	45
Baja Verapaz	11	121	7.6	1.2	23,680	19	81	37
Zacapa	20	137	8.2	1.3	23,920	31	69	60
Jalapa	17	140	7.6	1.2	27,380	31	69	45
Solola	23	70	6.7	1.8	27,160	36	64	31
Totonicapan	13	96	7.6	2.1	36,440	15	85	29
Quiche	22	227	6.2	1.3	66,350	11	89	22
Izabal	20	170	7.9	1.6	38,180	18	82	48
Average	**56**	**140**	**7.8**	**1.6**	**50,455**	**33**	**67**	**46**
Not Affected:								
Escuintla	35	281	8.9	1.8	59,830	29	71	61
Santa Rosa	23	222	7.5	1.4	43,500	21	79	53
Quetzaltenango	76	299	7.5	1.6	68,340	37	63	54
Suchitepequez	46	247	6.8	1.4	44,660	31	69	52
Retalhuleu	24	134	6.6	1.5	27,520	28	72	56
San Marcos	43	518	6.9	1.3	87,320	13	87	44
Huehuetenango	56	385	5.8	1.3	78,960	16	84	31
Alta Verapaz	27	267	6.7	1.2	58,700	11	89	21
Peten	15	54	7.9	1.4	15,320	34	66	46
Chiquimula	26	215	8.3	1.3	36,860	26	74	48
Jutiapa	23	309	9.0	1.4	57,240	19	81	54
Average	**36**	**266**	**7.4**	**1.4**	**52,568**	**24**	**76**	**47**
National	**1,100**	**4,883**	**7.6**	**1.5**	**1,183,715**	**28.8**	**71.2**	**46.6**

Source: USAID (1978)

TABLE 2: ENROLLMENT IN PRIMARY SCHOOL SYSTEM IN 1972, RURAL

ENROLLMENT IN PRIMARY SCHOOL, RURAL (1972)

DEPARTMENT	% Enrollment All Grades	% Enrollment 4 to 6th grade	% Enrollment 6th grade	% of Schools with 6th grade
Guatemala	47	22	5	38
El Progreso	55	22	4	36
Sacatepequez	39	16	2	9
Chimaltenango	30	10	1	8
Baja Verapaz	23	8	1	7
Zacapa	40	18	3	30
Jalapa	42.5	11	1	14
Solola	18	9	1	11
Totonicapan	21	9	1	6
Quiche	14	9	1.5	5
Izabal	42	18	3	30
Average	**34**	**14**	**2.1**	**17.6**
Not Affected:				
Escuintla	32	19	4	38
Santa Rosa	37	15	1.7	15
Quetzaltenango	26	14	2	20
Suchitepequez	28	11	1.7	14
Retalhuleu	29	15	3	17
San Marcos	26	11	2	18
Huehuetenango	22	8	1	5
Alta Verapaz	10	8	1	7
Peten	71	9	1	11
Chiquimula	42	14	2	18
Jutiapa	54	14	1.8	13
Average	**34**	**13**	**1.9**	**16.0**
TOTAL RURAL PUBLIC	**28.5**	**13.8**	**2.2**	
TOTAL RURAL PRIVATE	**4**	**10**	**1.7**	

Source: USAID (1978)

TABLE 3: BUILDING MATERIALS OF PRIVATE DWELLINGS IN 1973

BUILDING MATERIAL OF PRIVATE DWELLINGS (%)

Affected:	% out of National Total	Brick or concrete	Adobe	Wood	Bajareque	Maize cane	Other
Guatemala	20	28.2	52.5	7.8	2.5	8.1	0.9
El Progreso	2	0.6	53.6	4.4	22.5	17.9	0.9
Sacatepequez	2	6.3	55.0	5.3	1.5	30.9	1.0
Chimaltenango	4	5.3	61.7	5.6	7.4	19.1	0.9
Baja Verapaz	2	0.3	45.5	8.5	24.0	21.2	0.4
Zacapa	2	2.6	29.8	2.9	47.6	15.9	1.2
Jalapa	2	0.2	51.8	5.9	21.4	20.1	0.5
Solola	2	0.9	44.9	12.6	9.2	26.9	5.5
Totonicapan	3	0.2	87.9	3.2	4.6	3.7	0.3
Quiche	6	0.1	59.1	8.8	6.1	25.4	0.6
Izabal	3	4.8	1.6	35.2	12.9	44.9	0.6
Total	49	12.6	51.1	9.1	9.2	17.0	1.0
Total (without Guatemala City)	29	2.1	50.2	10.0	13.7	23.0	1.1
Not Affected:							
Escuintla	6	17.6	6.2	45.0	2.2	27.3	1.7
Santa Rosa	3	5.2	39.6	12.2	15.5	25.1	2.4
Quetzaltenango	6	5.1	47.0	26.0	5.7	12.8	3.4
Suchitepequez	4	9.8	1.9	58.2	0.9	26.8	2.5
Retalhuleu	3	7.1	1.7	53.0	0.7	35.9	1.6
San Marcos	7	1.7	28.3	34.6	13.3	19.7	2.3
Huehuetenango	8	0.3	53.2	9.3	17.0	19.1	1.2
Alta Verapaz	6	2.1	2.0	15.5	9.2	69.2	1.9
Peten	1	3.0	3.2	19.3	22.1	50.6	1.8
Chiquimula	3	0.9	31.4	1.5	37.0	25.3	3.9
Jutiapa	5	1.8	53.1	3.0	24.8	16.1	1.1
Total	51	5.0	24.3	25.2	13.5	29.8	2.2
National	**100**	**8.6**	**39.2**	**17.2**	**10.9**	**22.4**	**1.6**

Source: 1973 Census

TABLE 4: DESCRIPTIVE STATISTICS IN 1973, BY DEPARTMENT

Department	**% of Urban Population * (1973)**	**% dwellings adobe, wood or bareque* (1973)**	**% Population victim of human rights violations** (1960-1996)**
Guatemala	83.8	71.8	0.1
Sacatepequez	72.4	93.7	0.0
Chimaltenango	38.1	94.7	1.3
Solola	33.3	99.1	0.7
Zacapa	28.8	97.4	0.2
Jalapa	27.6	99.8	0.0
El Progreso	26.2	99.4	0.0
Chiquimula	22.4	99.1	0.1
Izabal	18.4	95.2	0.3
Jutiapa	17.8	98.2	0.0
Baja Verapaz	17.6	99.7	1.7
Huehuetenango	14.8	99.7	1.6
Totonicapan	14.6	99.8	0.1
Alta Verapaz	12.1	97.9	1.3
Quiche	11.5	99.9	6.3
Quetzaltenango	36.7	94.9	0.2
Santa Rosa	21.8	94.8	0.0
Escuintla	30.1	98.2	0.1
Suchitepequez	30.1	90.2	0.2
Retalhuleu	28.7	92.9	0.1
San Marcos	12.3	98.3	0.3
Peten	33.1	97.0	1.1
In affected area: (without Capital)			
MEAN	29.3	96.2	0.8
	(25.4)	(98.1)	(1.0)
MEDIAN	22.4	98.2	0.2
	(20.4)	(99.1)	(0.3)
SD	20.2	6.6	1.5
	(15.7)	(2.1)	(1.7)
In unaffected area:			
MEAN	27.6	95.2	0.3
MEDIAN	30.1	94.9	0.2
SD	8.1	2.9	0.4

SOURCE:
* 1973 Population Census, National Institute of Statistics and Censuses.
** Commission for Historical Clarification, Archdiocese of Guatemala.

TABLE 5: CORRELATION COEFFICIENTS FOR SELECTED VARIABLES

	% Classrooms Destroyed	% Homeless Population	% of Urban Pop in 1973	% Non brick dwellings	% Population victim of HR violations	Years of Educ. Father	Years of Educ. Mother
% Classrooms Destroyed	1.00						
% Homeless Population	0.95	1.00					
% of Urban Population in 1973	0.42	0.42	1.00				
% Non brick dwelling	-0.29	-0.28	-0.90	1.00			
% Population victim of HR violations	0.02	0.07	-0.38	0.31	1.00		
Years of Educ., Father	0.13	0.11	0.37	-0.38	-0.16	1.00	
Years of Educ., Mother	0.10	0.09	0.38	-0.39	-0.20	0.69	1.00
Mother's Height	-0.01	0.01	0.17	-0.16	-0.23	0.31	0.37

TABLE 6: DESCRIPTIVE STATISTICS FOR AFFECTED AND UNAFFECTED AREAS

	Not Affected	Affected	t-statistic of difference
Proportion female	0.54	0.53	0.64
Proportion born in rural areas	0.50	0.28	13.15
Proportion with Mother's schooling =0	0.57	0.42	7.69
Proportion with Father's schooling =0	0.40	0.27	6.82
Proportion Father receives a wage	0.15	0.20	-3.16
Proportion Father independent worker	0.20	0.29	-5.24
Proportion Father agricultural day labourer	0.23	0.10	9.38
Proportion Father owner	0.13	0.11	1.2
Mean of Father's Schooling	2.71	4.65	-10.66
SD	3.50	5.04	
Mean of Mother's Schooling	1.85	3.41	-10.34
SD	2.92	4.27	
Mean of Mother's Height	148.84	149.78	-1.97
SD	7.48	6.53	
Mean of Years of Schooling	5.80	7.62	-9.68
SD	4.55	4.82	
Mean of Height (Women)	149.86	151.13	-1.72
SD	14.00	12.39	
Mean of Height (Men)	160.55	163.94	-3.28
SD	21.13	11.95	
N	1520	1072	

T-test at 5% level of significance.

TABLE 7: DESCRIPTIVE STATISTICS, COHORTS USED IN THE SCHOOLING REGRESSIONS

	Group 1		Group 2		Group 3	
Age in February 1976	2 to -2		4 to 9		22 to 30	
Age in June 2000	22 to 26		28 to 33		46 to 54	
Proportion born in rural areas	0.41		0.45		0.43	
Proportion born in Guatemala City	0.16		0.15		0.17	
Proportion illiterate	0.08		0.11		0.22	
Proportion never enrolled in Primary school	0.12		0.15		0.33	
Proportion never enrolled in Secondary school	0.47		0.52		0.47	
Averg age of entry in the labour market (for those receiving a wage)	14		13.7		13.7	
Proportion Father day labourer	0.15		0.21		0.23	
Mean of Father's Schooling	3.9		3		2.5	
Mean of Mother's Schooling	2.8		2.1		1.8	
N	1434		1158		958	
Years of Schooling	Men	Women	Men	Women	Men	Women
Mean	7.2	6.6	6.6	5.8	5.1	4
Median	6	6	6	6	4	3
SD	4.6	5	4.6	4.8	5.1	4.7

* INDIVIDUALS IN THIS SAMPLE ARE NON INDIGENOUS ONLY

TABLE 8: DESCRIPTIVE STATISTICS, COHORTS USED IN THE ADULT HEIGHT REGRESSIONS

	Group 1	Group 2	Group 0
Age in February 1976	2 to -2	4 to 9	-3 to -5
Age in June 2000	22 to 26	28 to 33	19 to 21
Proportion born in rural areas	0.41	0.42	0.4
Proportion born in Guatemala City	0.16	0.15	0.17
Proportion illiterate	0.08	0.11	0.07
Proportion never enrolled in Primary school	0.12	0.15	0.09
Proportion never enrolled in Secondary school	0.50	0.52	0.44
Averg age of entry in the labour market (for those receiving a wage)	14	13.7	13.6
Proportion Father day labourer	0.15	0.2	0.08
Mean of Father's Schooling	3.9	3	4.2
Mean of Mother's Schooling	2.8	2.1	3.2
N	1434	1158	1093

Adult Height (cm)	Men	Women	Men	Women	Men	Women
Mean	164	151	162.6	151.4	163.2	151
Median	164.2	151	163	151.2	163.6	151
SD	7.15	7.8	7.4	7.1	8	8.1

* INDIVIDUALS IN THIS SAMPLE ARE NON INDIGENOUS

TABLE 10: YEARS OF SCHOOLING, BASELINE RESULTS

CLASSROOMS, BASELINE RESULTS FOR SCHOOLING

	GROUP 2 (1) b/se	(2) b/se	(3) b/se	GROUP1 (4) b/se	(5) b/se	(6) b/se
Classrooms	-0.01733 **	-0.01796 **	-0.01752 **			
	(0.007)	(0.008)	(0.008)			
Classrooms				-0.00798 **	-0.00855 *	-0.00814
				(0.004)	(0.005)	(0.005)
Mother's Educ~n	0.63036 ***	0.42773 ***	0.41513 ***	0.55432 ***	0.32879 ***	0.32297 ***
	(0.035)	(0.033)	(0.034)	(0.036)	(0.035)	(0.032)
Father's Educ~n		0.31535 ***	0.30303 ***		0.31914 ***	0.30510 ***
		(0.044)	(0.040)		(0.026)	(0.026)
Day Labourer			-1.13541 ***			-1.13078 ***
			(0.211)			(0.218)
Salaried worker			-0.14779			-0.22905
			(0.298)			(0.318)
Independent w~r			0.28808			0.16923
			(0.170)			(0.260)
Other worker			-0.53291			-0.27757
			(0.659)			(0.518)
R-Square	0.462	0.495	0.505	0.471	0.506	0.513
N	2091	2017	2017	2374	2287	2287

* p<0.10, ** p<0.05, *** p<0.001

HOMELESS, BASELINE RESULTS FOR SCHOOLING

	GROUP 2 (1) b/se	(2) b/se	(3) b/se	GROUP1 (4) b/se	(5) b/se	(6) b/se
Homeless	-0.01882 **	-0.01839 **	-0.01753 *			
	(0.008)	(0.008)	(0.009)			
Homeless				-0.00661	-0.00622	-0.00559
				(0.004)	(0.005)	(0.005)
Mom Educ	0.63067 ***	0.42800 ***	0.41536 ***	0.55428 ***	0.32879 ***	0.32293 ***
	(0.035)	(0.033)	(0.034)	(0.036)	(0.035)	(0.032)
Dad Educ		0.31513 ***	0.30286 ***		0.31890 ***	0.30488 ***
		(0.044)	(0.040)		(0.026)	(0.026)
Day Labourer			-1.13186 ***			-1.13026 ***
			(0.210)			(0.218)
Salaried worker			-0.14731			-0.22877
			(0.299)			(0.318)
Independent w~r			0.28702			0.16980
			(0.170)			(0.260)
Other worker			-0.53181			-0.28035
			(0.662)			(0.520)
R-Square	0.463	0.495	0.505	0.471	0.506	0.513
N	2091	2017	2017	2374	2287	2287

* p<0.10, ** p<0.05, *** p<0.001

TABLE 11: RESULTS BY GENDER, Group 2 and Group 1

GROUP 2

	Women b/se	Women b/se	Men b/se	Men b/se
Classrooms De~r	-0.02480 **		-0.01012	
	(0.008)		(0.013)	
Homeless Pop		-0.02074 **		-0.01359
		(0.009)		(0.014)
R-Square	0.501	0.501	0.508	0.508
N	1082	1082	935	935

* p<0.10, ** p<0.05, *** p<0.001

GROUP 1

	Women b/se	Women b/se	Men b/se	Men b/se
Classrooms De~r	-0.00647		-0.01235	
	(0.007)		(0.007)	
Homeless Pop		-0.00406		-0.00996
		(0.007)		(0.007)
R-Square	0.512	0.512	0.518	0.518
N	1203	1203	1084	1084

* p<0.10, ** p<0.05, *** p<0.001

TABLE 12: MODELS WITH INTERACTIONS, GROUP 2

INTERACTIONS, Females GROUP 2

	All b/se	All b/se	All b/se	Mom_Ed>0 b/se	All b/se	Dad_Ed>0 b/se	All b/se	All b/se
Classrooms Dest	-0.0248 **	-0.0280 **	-0.0234 **	-0.0728 ***	-0.0204 **	-0.0411 **	-0.0191 **	-0.0208 **
	(0.008)	(0.011)	(0.008)	(0.016)	(0.008)	(0.014)	(0.009)	(0.007)
Int Born Rural		0.0064						
		(0.010)						
Int Mom Ed			-0.0008	0.0014				
			(0.001)	(0.002)				
Int Dad Ed					-0.0026 **	-0.0006		
					(0.001)	(0.001)		
Int Day Labour							-0.0247 **	
							(0.010)	
Int MomQ1 Hei~t								0.0172
								(0.011)
R-Square	0.501	0.502	0.502	0.496	0.503	0.485	0.503	0.468
N	1082	1082	1082	451	1082	600	1082	1169

INTERACTIONS, Males GROUP 2

	All b/se	All b/se	All b/se	Mom_Ed>0 b/se	All b/se	Dad_Ed>0 b/se	All b/se	All b/se
Classrooms Dest	-0.0101	-0.0134	-0.0021	-0.0216	-0.0081	-0.0094	-0.0085	0.0090
	(0.013)	(0.011)	(0.012)	(0.038)	(0.013)	(0.032)	(0.014)	(0.007)
Int Born Rural		0.0059						
		(0.011)						
Int Mom Ed			-0.0046 **	-0.0002				
			(0.002)	(0.002)				
Int Dad Ed					-0.0008	0.0012		
					(0.001)	(0.002)		
Int Day Labour							-0.0102	
							(0.019)	
Int MomQ1 Hei~t								0.0481
								(0.034)
R-Square	0.508	0.508	0.512	0.494	0.508	0.452	0.508	0.449
N	935	935	935	380	935	515	935	985

* p<0.10, ** p<0.05, *** p<0.001

TABLE 13: MODELS WITH INTERACTIONS, GROUP 1

INTERACTIONS, Females GROUP 1

	All b/se	All b/se	All b/se	Mom_Ed>0 b/se	All b/se	Dad_Ed>0 b/se	All b/se	All b/se
Classrooms Dest	**-0.0065**	**-0.0134**	**0.0009**	**-0.0342 ****	**-0.0054**	**-0.0359 ****	**0.0014**	**-0.0053**
	(0.007)	**(0.011)**	**(0.007)**	**(0.014)**	**(0.006)**	**(0.014)**	**(0.007)**	**(0.008)**
Int Born Rural		**0.0161**						
		(0.014)						
Int Mom Ed			**-0.0030 ****	**-0.0017**				
			(0.001)	**(0.002)**				
Int Dad Ed					**-0.0004**	**0.0027 ***		
					(0.001)	**(0.002)**		
Int Day Labou~r							**-0.0550 *****	
							(0.013)	
Int MomQ1 Hei~t								**0.0160**
								(0.019)
R-Square	**0.512**	**0.513**	**0.514**	**0.416**	**0.512**	**0.452**	**0.518**	**0.459**
N	**1203**	**1203**	**1203**	**581**	**1203**	**740**	**1203**	**1290**

INTERACTIONS, Males GROUP 1

	All b/se	All b/se	All b/se	Mom_Ed>0 b/se	All b/se	Dad_Ed>0 b/se	All b/se	All b/se
Classrooms Dest	**-0.0123**	**-0.0275 *****	**-0.0027**	**-0.0061**	**0.0002**	**-0.0098**	**-0.0107**	**0.0016**
	(0.007)	**(0.007)**	**(0.008)**	**(0.024)**	**(0.007)**	**(0.017)**	**(0.007)**	**(0.013)**
Int Born Rural		**0.0364 ****						
		(0.011)						
Int Mom Ed			**-0.0042 ****	**-0.0014**				
			(0.002)	**(0.001)**				
Int Dad Ed					**-0.0047 *****	**-0.0027**		
					(0.001)	**(0.002)**		
Int Day Labou~r							**-0.0204 ****	
							(0.007)	
Int MomQ1 Hei~t								**-0.0083**
								(0.012)
R-Square	**0.518**	**0.523**	**0.523**	**0.521**	**0.525**	**0.470**	**0.519**	**0.455**
N	**1084**	**1084**	**1084**	**494**	**1084**	**643**	**1084**	**1134**

* p<0.10, ** p<0.05, *** p<0.001

TABLE 14: GROUP 1, PROBABILITY OF NEVER BEEN ENROLLED IN SCHOOL

GROUP 1, PROBABILITY OF NEVER BEEN ENROLLED IN PRIMARY SCHOOL

	Women b/se	Men b/se	Wom_Mom_Ed>0 b/se	Men_Mom_Ed>0 b/se	Women b/se	Men b/se
Classrooms Des	**-0.0006**	**0.0001**	**0.0010**	**-0.0019**	**-0.0009**	**0.0002**
	(0.001)	**(0.001)**	**(0.001)**	**(0.001)**	**(0.001)**	**(0.001)**
Day Lab Int					**0.0020**	**-0.0008**
					(0.002)	**(0.001)**
R-Square	**0.226**	**0.166**	**0.168**	**0.148**	**0.227**	**0.166**
N	**1203**	**1084**	**581**	**494**	**1203**	**1084**

GROUP 1, PROBABILITY OF NEVER BEEN ENROLLED IN SECONDARY SCHOOL

	Women b/se	Men b/se	Wom_Mom_Ed>0 b/se	Men_Mom_Ed>0 b/se	Women b/se	Men b/se
Classrooms Des	**0.0003**	**0.0017**	**0.0013**	**0.0048 ****	**-0.0000**	**0.0014**
	(0.001)	**(0.002)**	**(0.002)**	**(0.002)**	**(0.001)**	**(0.002)**
Day Lab Int					**0.0026**	**0.0029 ***
					(0.002)	**(0.002)**
R-Square	**0.163**	**0.233**	**0.299**	**0.390**	**0.165**	**0.234**
N	**1203**	**1084**	**581**	**494**	**1203**	**1084**

* p<0.10, ** p<0.05, *** p<0.001

TABLE 15: GROUP 2, PROBABILITY OF NEVER BEEN ENROLLED IN SCHOOL

GROUP 2, PROBABILITY OF NEVER BEEN ENROLLED IN PRIMARY SCHOOL

	Women b/se	Men b/se	Wom_Mom_Ed>0 b/se	Men_Mom_Ed>0 b/se	Women b/se	Men b/se
Classrooms Des	**-0.0001**	**-0.0002**	**0.0025 ****	**-0.0009**	**-0.0005**	**-0.0004**
	(0.001)	**(0.001)**	**(0.001)**	**(0.001)**	**(0.001)**	**(0.001)**
Day Lab Int					**0.0017 ***	**0.0017**
					(0.001)	**(0.001)**
R-Square	**0.221**	**0.163**	**0.188**	**0.162**	**0.222**	**0.164**
N	**1082**	**935**	**451**	**380**	**1082**	**935**

GROUP 2, PROBABILITY OF NEVER BEEN ENROLLED IN SECONDARY SCHOOL

	Women b/se	Men b/se	Wom_Mom_Ed>0 b/se	Men_Mom_Ed>0 b/se	Women b/se	Men b/se
Classrooms Des	**0.0027 ****	**0.0013**	**0.0031 ***	**0.0031**	**0.0026 ****	**0.0012**
	(0.001)	**(0.002)**	**(0.002)**	**(0.002)**	**(0.001)**	**(0.002)**
Day Lab Int					**0.0005**	**0.0006**
					(0.001)	**(0.002)**
R-Square	**0.138**	**0.209**	**0.333**	**0.408**	**0.138**	**0.209**
N	**1082**	**935**	**451**	**380**	**1082**	**935**

* p<0.10, ** p<0.05, *** p<0.001

TABLE 16: PROBABILITY OF DROPPING OUT AFTER 3 YEARS OF SCHOOLING

GROUP 2, PROBABILITY OF DROPPING OUR OF PRIMARY SCHOOL AFTER 3 YEARS

	Women b/se	Women b/se	Women b/se	Men b/se	Men b/se	Men b/se
Classrooms Des	**0.0018**	**0.0014**	**0.0009**	**0.0003**	**-0.0000**	**0.0005**
	(0.001)	**(0.001)**	**(0.001)**	**(0.002)**	**(0.002)**	**(0.002)**
Int Mom Educ		**0.0002 ***			**0.0002 ***	
		(0.000)			**(0.000)**	
Day Lab Int			**0.0043 ****			**-0.0013**
			(0.002)			**(0.001)**
R-Square	**0.266**	**0.267**	**0.272**	**0.235**	**0.236**	**0.236**
N	**803**	**803**	**803**	**768**	**768**	**768**

GROUP 1, PROBABILITY OF DROPPING OUR OF PRIMARY SCHOOL AFTER 3 YEARS

	Women b/se	Women b/se	Women b/se	Men b/se	Men b/se	Men b/se
Classrooms Des	**0.0011**	**0.0004**	**0.0007**	**0.0004**	**-0.0001**	**0.0002**
	(0.001)	**(0.001)**	**(0.001)**	**(0.001)**	**(0.001)**	**(0.001)**
Int Mom Ed		**0.0002 ****			**0.0002**	
		(0.000)			**(0.000)**	
Day Lab Int			**0.0065 ****			**0.0031**
			(0.002)			**(0.002)**
R-Square	**0.241**	**0.244**	**0.249**	**0.210**	**0.212**	**0.212**
N	**922**	**922**	**922**	**922**	**922**	**922**

* p<0.10, ** p<0.05, *** p<0.001

TABLE 17: AGE OF ENTRY INTO PRIMARY SCHOOL

GROUP 2, AGE OF ENTRY TO PRIMARY SCHOOL

	Women b/se	W_Mom_Ed>0 b/se	Women b/se	Men b/se	M_Mom_Ed>0 b/se	Men b/se
Classrooms Des	**0.0059**	**-0.0069**	**0.0050**	**-0.0032**	**0.0124** **	**-0.0041**
	(0.008)	**(0.005)**	**(0.009)**	**(0.025)**	**(0.005)**	**(0.025)**
Day Lab Int			**0.0041**			**0.0078**
			(0.005)			**(0.012)**
R-Square	**0.111**	**0.228**	**0.111**	**0.107**	**0.265**	**0.108**
N	**846**	**423**	**846**	**789**	**363**	**789**

GROUP 1, AGE OF ENTRY TO PRIMARY SCHOOL

	Women b/se	W_Mom_Ed>0 b/se	Women b/se	Men b/se	M_Mom_Ed>0 b/se	Men b/se
Classrooms Des	**0.0022**	**-0.0039**	**0.0019**	**-0.0042**	**0.0135** ***	**-0.0056**
	(0.008)	**(0.007)**	**(0.008)**	**(0.023)**	**(0.003)**	**(0.023)**
Day Lab Int			**0.0028**			**0.0162** *
			(0.005)			**(0.009)**
R-Square	**0.123**	**0.242**	**0.123**	**0.106**	**0.229**	**0.107**
N	**967**	**543**	**967**	**947**	**481**	**947**

* p<0.10, ** p<0.05, *** p<0.001

TABLE 19: ADULT HEIGHT RESULTS BY GENDER, Group 2 and Group 1

GROUP 2

	Women b/se	Women b/se	Men b/se	Men b/se
Classrooms De~r	**-0.03634**		**-0.02933**	
	(0.027)		**(0.017)**	
Homeless Pop		**-0.02588**		**-0.03055** *
		(0.030)		**(0.017)**
R-Square	**0.180**	**0.179**	**0.213**	**0.214**
N	**1108**	**1108**	**846**	**846**

* p<0.10, ** p<0.05, *** p<0.001

GROUP 1

	Women b/se	Women b/se	Men b/se	Men b/se
Classrooms De~r	**-0.01169**		**0.01597**	
	(0.025)		**(0.021)**	
Homeless Pop		**-0.00067**		**0.01310**
		(0.027)		**(0.024)**
R-Square	**0.189**	**0.188**	**0.175**	**0.175**
N	**1198**	**1198**	**974**	**974**

* p<0.10, ** p<0.05, *** p<0.001

TABLE 20: MODELS WITH PARENTAL SCHOOLING INTERACTIONS, GROUP 2

GROUP 2, MOTHER'S EDUCATION INTERACTION

	All_Wom b/se	All_Wom b/se	Mom_Ed>0 b/se	Mom_ed_0 b/se	All_Men b/se	All_Men b/se	Mom_Ed>0 b/se	Mom_Ed_0 b/se
Classrooms Des	-0.04782		-0.01401	-0.07687 *	-0.03564 **		-0.08365 **	-0.07792 **
	(0.028)		(0.037)	(0.043)	(0.017)		(0.040)	(0.025)
Mother Ed Int	0.00622 **		0.00200		0.00359		0.00346	
	(0.003)		(0.002)		(0.003)		(0.004)	
Homeless Pop		-0.03897				-0.03476 *		
		(0.031)				(0.017)		
Mother Ed Int		0.00684 **				0.00247		
		(0.003)				(0.003)		
R-Square	0.184	0.183	0.204	0.169	0.214	0.214	0.239	0.198
N	1108	1108	567	541	846	846	429	489

GROUP 2, FATHER'S EDUCATION INTERACTION

	All_Wom b/se	All_Wom b/se	Dad_Ed>0 b/se	Dad_ed_0 b/se	All_Men b/se	All_Men b/se	Dad_Ed>0 b/se	Dad_Ed_0 b/se
Classrooms Des	-0.04048		-0.02526	-0.04830	-0.04534 **		-0.07066 *	-0.11780 **
	(0.029)		(0.031)	(0.031)	(0.018)		(0.035)	(0.042)
Father Ed Int	0.00218		0.00187		0.00553 ***		0.00851 **	
	(0.004)		(0.003)		(0.001)		(0.003)	
Homeless Pop		-0.03128				-0.04612 **		
		(0.032)				(0.018)		
Father Ed Int		0.00307				0.00538 ***		
		(0.004)				(0.001)		
R-Square	0.180	0.180	0.204	0.196	0.217	0.216	0.238	0.215
N	1108	1108	706	460	846	846	571	376

TABLE 21: MODELS WITH PARENTAL SCHOOLING INTERACTIONS, GROUP 1

GROUP 1, MOTHER'S EDUCATION INTERACTION

	All_Wom b/se	All_Wom b/se	Mom_Ed>0 b/se	Mom_ed_0 b/se	All_Men b/se	All_Men b/se	Mom_Ed>0 b/se	Mom_Ed_0 b/se
Classrooms Des	-0.01173		0.02200	-0.04474 *	0.01987		-0.00862	0.04013
	(0.023)		(0.027)	(0.025)	(0.022)		(0.026)	(0.045)
Mother Ed Int	0.00001		-0.00304		-0.00150		-0.00177	
	(0.003)		(0.004)		(0.003)		(0.004)	
Homeless Pop		0.00134				0.01691		
		(0.026)				(0.025)		
Mother Ed Int		-0.00069				-0.00164		
		(0.002)				(0.003)		
R-Square	0.189	0.188	0.199	0.196	0.176	0.175	0.197	0.182
N	1198	1198	673	525	974	974	527	447

GROUP 1, FATHER'S EDUCATION INTERACTION

	All_Wom b/se	All_Wom b/se	Dad_Ed>0 b/se	Dad_ed_0 b/se	All_Men b/se	All_Men b/se	Dad_Ed>0 b/se	Dad_Ed_0 b/se
Classrooms Des	-0.01356		-0.02281	-0.00850	0.01389		0.02729	-0.10278 **
	(0.026)		(0.029)	(0.022)	(0.024)		(0.029)	(0.048)
Father Ed Int	0.00055		0.00102		0.00064		-0.00015	
	(0.002)		(0.002)		(0.002)		(0.003)	
Homeless Pop		-0.00095				0.01032		
		(0.029)				(0.027)		
Father Ed Int		0.00008				0.00097		
		(0.002)				(0.003)		
R-Square	0.189	0.188	0.209	0.230	0.175	0.175	0.195	0.199
N	1198	1198	827	371	974	974	684	391

* p<0.10, ** p<0.05, *** p<0.001

TABLE 22: MODELS WITH OTHER INTERACTIONS, GROUP 1

GROUP 1, WOMEN INTERACTIONS

	1 b/se	2 b/se	3 b/se	4 b/se	5 b/se	6 b/se
Classrooms Des	0.0065 (0.027)	-0.0062 (0.025)	-0.0116 (0.025)			
Rural Int	-0.0449 * (0.023)					
Day Lab Int		-0.0346 * (0.017)				
Mom Q1 Int			-0.0011 (0.028)			
Homeless Pop				0.0167 (0.031)	0.0050 (0.026)	-0.0009 (0.027)
Rural Int				-0.0427 * (0.025)		
Day Lab Int					-0.0371 * (0.018)	
Mom Q1 Int						0.0033 (0.029)
R-Square	0.191	0.189	0.189	0.191	0.189	0.188
N	1198	1198	1198	1198	1198	1198

GROUP 1, MEN INTERACTIONS

	1 b/se	2 b/se	3 b/se	4 b/se	5 b/se	6 b/se
Classrooms Des	0.0052 (0.025)	0.0152 (0.021)	0.0182 (0.020)			
Rural Int	0.0296 (0.024)					
Day Lab Int		0.0086 (0.030)				
Mom Q1 Int			-0.0553 *** (0.014)			
Homeless Pop				-0.0002 (0.027)	0.0111 (0.024)	0.0148 (0.023)
Rural Int				0.0373 * (0.021)		
Day Lab Int					0.0237 (0.030)	
Mom Q1 Int						-0.0499 *** (0.011)
R-Square	0.177	0.175	0.177	0.177	0.175	0.176
N	974	974	974	974	974	974

* p<0.10, ** p<0.05, *** p<0.001

TABLE 23: ROBUSTNESS TEST FOR SCHOOLING AND ADULT HEIGHT

PLACEBO TEST FOR SCHOOLING: Treatment group aged 22-30, control group aged 31-35 in 1976

	Women b/se	Women b/se	Men b/se	Men b/se
Classrooms De~r	**0.0023**		**-0.0027**	
	(0.006)		**(0.007)**	
Homeless Pop		**0.0009**		**0.0043**
		(0.005)		**(0.007)**
R-Square	**0.532**	**0.532**	**0.483**	**0.483**
N	**1227**	**1227**	**1090**	**1090**

* p<0.10, ** p<0.05, *** p<0.001

PLACEBO TEST FOR ADULT HEIGHT: Treatment group aged 22-30, control group aged 31-35 in 1976

	Women b/se	Women b/se	Men b/se	Men b/se
Classrooms De~r	**0.01275**		**-0.01023**	
	(0.017)		**(0.017)**	
Homeless Pop		**0.00670**		**0.00060**
		(0.015)		**(0.017)**
R-Square	**0.268**	**0.268**	**0.208**	**0.208**
N	**1143**	**1143**	**958**	**958**

* p<0.10, ** p<0.05, *** p<0.001

TABLE 27: MALES IN URBAN AREAS, GROUP 1

MALES GROUP 1, PROBABILITY OF NOT ENROLLING IN SCHOOL

	PRIMARY Urban b/se	Higher_Int b/se	SECONDARY Urban b/se	Higher b/se
Classrooms Des	**0.0003**	**0.0004**	**0.0037 ****	**0.0011**
	(0.001)	**(0.001)**	**(0.002)**	**(0.002)**
R-Square	**0.156**	**0.187**	**0.284**	**0.252**
N	**621**	**828**	**621**	**828**

MALES GROUP 1, PROBABILITY OF DROPPING OUT OF SCHOOL

	AFTER YEAR 3 Urban b/se	Higher_Int b/se	AFTER YEAR 7 Urban b/se	Higher b/se
Classrooms Des	**0.0011**	**0.0005**	**0.0045 ****	**0.0020**
	(0.001)	**(0.001)**	**(0.002)**	**(0.001)**
R-Square	**0.201**	**0.257**	**0.376**	**0.447**
N	**570**	**691**	**570**	**691**

* p<0.10, ** p<0.06, *** p<0.001

TABLE 28: PROBABILITY OF EARLY ENTRY INTO THE LABOR MARKET, MALES

PROBABILITY OF ENTERING THE LABOUR MARKET BEFORE AGE 13

	GROUP 2 All b/se	Urban b/se	High_Inten b/se	GROUP 1 All b/se	Urban b/se	High_Inten b/se
Classrooms Des	**0.0006**	**0.0017**	**0.0008**			
	(0.002)	**(0.002)**	**(0.002)**			
Classrooms Des				**0.0007**	**0.0025** *	**0.0012**
				(0.001)	**(0.001)**	**(0.001)**
R-Square	**0.160**	**0.150**	**0.183**	**0.151**	**0.144**	**0.163**
N	**920**	**493**	**703**	**1059**	**603**	**809**

* p<0.10, ** p<0.05, *** p<0.001

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