Reallocating Children's Time: Coping Strategies after the 2010 Haiti Earthquake

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Abstract

This paper analyses the impact of the 2010 Haiti earthquake on the household decision about children's time allocation. We count with a separated measure of the geographical variation of the earthquake magnitude and one of its damage at household-level that allow us to estimate the causal impact of household's vulnerability on the decision about the time allocation of 10-17 years old children. In addition to analyze the effect on schooling and leisure, we are able to disentangle the effect on market work and household chores activities. We also count with children self-reported data, which potentially reduces measurement error. Our results suggest that vulnerability at the time of the earthquake is associated to lower investments in children's human capital, which therefore, perpetuates household's poverty.

JEL Codes: J13, J22, O54, P46, Q54.

Keywords: Child Labour, School Attendance, Natural Disasters, Haiti

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1 Introduction

The acceleration of global climate change, the increasing intensity and frequency with which natural and environmental disasters are being experienced worldwide is striking. Latin America and the Caribbean (LAC) are one of the more disaster-prone areas of the world (Borensztein et al. 2009, Heger et al. 2008, Rasmussen 2004) and suffer the lowest level of insurance coverage (Grislain-Letrémy 2013, Borensztein et al. 2009). Overall, the financial cost of natural disasters in the region has risen from US$16 billion between 1985 and 1999, to more than US$26 billion between 2000 and 2014 (EM-DAT 2015). Largely motivated by the raise in the number and impacts of extreme natural events worldwide, and a better measurement of their magnitude, the last few years have seen an increase in the studies investigating both the causes and effects of natural disasters in many dimensions. The effects of natural disasters on the accumulation of individuals' human capital is a key issue for its economic and social relevance. The theoretical impact of natural disasters on human capital is ambiguous due the varying nature of the effects involved. Even though mounting evidence show that the net effects can be largely negative and, according to some studies, long-lasting (Baez et al. 2010), we still know little about the operating channels as well as household capacity to protect their human capital investment when confronted by such shocks.

The primary objective of this paper is to analyse the impact of the 2010 Haiti earthquake on the household decision about children's time allocation. We argue that reallocating children's time is a household coping strategy against an extreme adverse shock, which could lead to persistent negative effects on human capital (Jacoby and Skoufias 1997). We highlight the point that the full impact of natural disasters is not entirely natural, they are triggered by external hazards but they also stem from vulnerability. The concept of vulnerability varies among disciplines and research areas. The disaster risk literature defines vulnerability as "the capacity to be harmed" (Field 2012). More specifically, we use here the definition of Dayton-Johnson (2004): "vulnerability is the expected value of the damage that would occur conditional on the realization of the shock". In this paper, we thus estimate the impact of vulnerability to natural disaster on household decision about the time allocation of 10-17 years old children to schooling, working and household chores activities.

Since the earthquake that hit Haiti on 12 January 2010 was largely unanticipated and hit directly only some areas of the country, it constitutes a unique natural experiment setting for the study of households' responses to this sort of shocks. The earthquake was one of the four greatest killers recorded worldwide since 1990. It smacked headlong into the metropolitan area of Port-au-Prince, home to over one in five Haitians, destroying public buildings and housing as it went. The shock have also affected households far beyond the capital. Despite the immediate response from the international community, with rescue teams and pledges of financial assistance and support for reconstruction and development, things are still far from back to normal. In fact, the assistance was not particularly targeted to the most affected or vulnerable (Échevin 2011). Institutional assistance largely overlooked the population outside the conurbation of Port-au-Prince, even though just over six in ten of the households hit were outside the capital. Three years after the earthquake just over one-third barely managed to make ends meet (Herrera et al. 2014). In Haiti, half of the population is under 21 years old and nearly 60 percent of Haitians have no more than primary school education. In 2012, almost 30 percent of 10-17 years old children are not in school or dedicate only few hours to studying because they need to contribute to household income or work in the household (Zanuso et al. 2014)[1].

This paper uses original information collected during an extended fieldwork aimed to design, coordinate and implement the first nationwide survey about living conditions and labour market after the 2010 earthquake. The *L'Enquête sur les Conditions de Vie des Ménages après le Séisme* (ECVMAS) survey consists of 4,950 households interviewed in 2012 and it is representative of the entire population of the country (Herrera et al. 2014).[2] Additionally, we match at Primary Sampling Unit's level the rich household and individual ECVMAS data with the measures of the strength of ground motion made available by the U.S Geological Survey.[3] These data allow us to distinguish between the natural hazard occurrence, which is the observed physical intensity of the 2010 earthquake, and the natural disaster impact (measured by a damage score of the dwelling), which involve the interaction of the natural hazard and vulnerability. Two additional features of the data make it suitable for the purpose of our paper. First, it includes children self-reported information about the allocation of their own time. Given the social stigma associated with child labour and absence from school, parents might tend to under-report them. Therefore, it is expected that asking children directly would reduce this source of measurement error. Second, in contrast to most of the literature on the topic (Edmonds 2007), our data allows us to disentangle the effect on working hours and hours dedicated to household chores.

In this study, we focus on the medium-term consequences of the earthquake. To identify the lasting effect of the household's socio-economic vulnerability at the time of the earthquake on current decision of children's time allocation (extensive and intensive margins), we adopt a control-function approach, where we account for changes in household' and child's characteristic between the 2010 earthquake and the time of interview (2012). The ECVMAS survey includes key retrospective questions corresponding to the period just before the 2010 earthquake. The data quality literature stresses that when a phenomenon of large magnitude happens, the risk of measurement error associated to recall is reduced (De Nicola and Giné 2014, Dex 1995). According to Brown and Kulik (1977), "flashbulb" memories theory[4], a highly surprising and consequential event, like the 2010 earthquake, give rise to memories that show little forget-

[1]All data in this paper are from ECVMAS 2012, unless otherwise indicated.

[2]ECVMAS was conducted by the Haitian Institute of Statistics (IHSI) is part of a programme supported by the French National Research Agency (ANR), DIAL Research Unit and the World Bank. The methodology was a variation on the 1-2-3 Survey, developed by DIAL to measure the informal economy and poverty. Javier Herrera, IRD Research Director, was the ANR project manager and Claire Zanuso was the ANR project Coordinator from 2011 to 2014 and survey coordinator in Haiti.

[3]A common geological measure of local hazard that earthquakes cause is peak ground acceleration (PGA), or the maximum acceleration that is experienced by a physical body, e.g. a building, on the ground during the course of the earthquake motion. PGA is considered a good measure of hazard to short buildings, up to about seven floors.

[4]The construct of flashbulb memory was introduced in a seminal paper by Brown and Kulik

ting (Winograd and Neisser 2006). In addition to 2010 characteristics, we also control for Primary Sampling Unit (PSU) fixed-effects to account for unobservable characteristics, such as services supply (schools, roads, etc.), labour market conditions and aid received as consequence of the earthquake. Finally, we are able to disentangle the vulnerability component of the total destruction effect of the earthquake by controlling for its physical impact (i.e. peak ground acceleration). That is, we are able to control by the earthquake's intensity and calculate the marginal effect of the residual part of the impact, the vulnerability to a natural disaster.

Results from both extensive and intensive margins show that households vulnerability to natural disaster is negatively associated to investments in children's human capital, which therefore, perpetuates household's poverty. Interestingly, we find a positive association between vulnerability and the probability of child labour (without attending school) and the time children spent in household chores. However, we find no relationship between vulnerability and the amount of hours children spend studying, working (market) or at leisure. These results highlight the importance of disentangling market and home work activities to assess correctly child labour issues. Moreover, we find evidence of gender and siblings differences. Older males work longer hours for the market and fewer hours in home production. In addition, the further away a child is biologically from the household head is associated to lower investments in children's human capital.

This paper contributes to two strands of literature. First, it contributes to the literature looking at the effect of natural disasters on economic well-being and households coping strategies. We find evidence that vulnerable households can resort to coping strategies which lead to persistent effects on human capital, such as taking children out of schools, reducing the time for studying or increasing their work participation (Baez et al. 2010, De Janvry et al. 2006). Second, this paper contributes to the child labour literature at bringing more evidence on the differentiated impact on working and household chores hours.

The paper is organized in 7 sections. Section 2 reviews the relevant literature on the effects of natural disasters on human capital and child labour and presents the general framework used to evaluate the situation for children in Haiti. Section 3 provides background information on the natural disaster and the socioeconomic context in which it took place. Section 4 describes the data used in the analysis and provides a discussion of intensity, vulnerability and damage measures. Section 5 presents the empirical strategies to identify the mentioned effects. This is followed by a presentation of the results in Section 6. Finally, Section 7 concludes the paper and discusses policy options.

2 Previous Findings and Conceptual Framework

The questions we address in this paper are at the conjunction of two fields of research: the impact of natural disasters and child labour studies. In both cases, the literature barely cover the specific case of Haiti.

(1977) to account for memories of events such as the assassination of John F. Kennedy.

2.1 Impact of Natural Disasters

In part due to climate change, there has been a recently substantial growth in interest in the impact of natural disasters. This trend is set to grow due to a worrying rise in the impact of natural disasters on economic welfare over the last decade. Research focusing more specifically on countries' resilience suggests that these disasters have devastating effects on economic growth in developing countries because they prevent physical and human capital accumulation, although the channels behind this phenomenon remain unclear (Skoufias 2003). Most of the existing studies on the economic impact of natural disasters have been driven by the availability of the international Emergency Disasters Database (EM-DAT) base on disasters and their damage, which covers all countries worldwide since 1900. Particular attention has been paid to the human and economic costs of these disasters. These studies conclude, as expected, that: developing countries are more vulnerable to disasters, even though they are not more exposed than developed countries to natural hazards (i.e. physical and environmental factors). The channels through which the disasters produce such different impacts remain the "black box" of these macroeconomic studies even though some put forward institutional factors (governance, inequalities, etc.) (Cavallo and Noy 2009, Noy 2009, Kahn 2005).

To the best of our knowledge, the only existing study evaluating the 2010 earthquake's impact in Haiti adopts an indirect and macroeconomic approach (Cavallo et al. 2010). It sets out primarily to put a figure to the sum total financial impact of the earthquake. The estimates are based on strong assumptions and are not very reliable, as the authors themselves argue. Neither do they give any clues as to the mechanisms at work, which can only be explored by more empirical approaches. Other research on the evaluation of the impact of the disasters and household strategies following a disaster are based on case studies, but few address the impact of a high-magnitude earthquake due to a lack of suitable data (see Doocy, Daniels, Packer, Dick and Kirsch (2013) for a review, Yang (2008) for China, and Halliday (2006), for El Savador)

2.2 Effects of Natural Disasters on Education and Child Labour

Modeling the impacts of natural disasters on human capital in a comprehensive manner is not straightforward. The literature have developed theoretical frameworks to model different pieces of the causal chain linking different shocks – including natural disasters – to proxy determinants of human capital and other dimensions of human welfare, but there is no consensus of whether natural disasters have consequences on the creation and use human capital (Baez et al. 2010). The existing economic literature strongly suggests that the capacity of households in poor countries to smooth consumption across time and states of nature is limited. This seems to be especially true in the case of large generalized shocks such as natural disasters, when some of the informal mechanisms of risksharing become less widespread (Jacoby and Skoufias 1997, Beegle et al. 2002). We do not seek to review the whole existing findings at the household level on the impacts of natural disasters on human capital, and we cite only those studies which are directly related to the issue under investigation in this article, which is the impact on education and child labour (see Baez et al. (2010) for a recent and synthetic review on consumption, nutrition and health dimensions). In fact, while natural hazards can affect a person's human capital throughout its entire life, it is at early stages in life when any such impacts most matter if they are not properly and timely addressed.

The theoretical impact of natural disasters on schooling is ambiguous due the varying and sometimes contradicting effects involved. On the one hand, the damages or destruction of schools and complementary infrastructures and resources (e.g. roads and teachers) can lead to a worsening the whole education system. Additionally, if natural shocks worsen the economic situation of households and the access to credit, insurance or other coping mechanisms is limited, dropping children out of school may be the last resort to reduce outgoings (Jensen 2000, Jacoby and Skoufias 1997) or to increase household income by putting them to work or increasing their participation to house chores activities (Basu and Van 1999, Edmonds 2007). (Huisman and Smits 2009) show this will specially be the case in countries where laws regarding compulsory education are not strictly enforced (such as in Haiti). On the other hand, if a natural disaster changes the opportunity cost of sending children to school, through a reduction in market wages for example, or if international assistance increase the supply of education services (Adelman and Holland 2015), the direction of the overall effect remains unclear (Baez et al. 2010).

Empirically, it is complex to disentangle all these mechanisms. To the best of our knowledge, only one research try to assess the effects of a large earthquake on child labour. Santos (2007) finds that children in households most affected by the 2001 earthquakes in El Salvador were three times more likely to work (from 6.5 percent to 16.5 percent) after the shock. The intensive margin results show an increase of about 32 hours per week relative to children in control areas. Studies assessing the effects of others types of disasters (e.g. droughts, floods, rainfall shocks, hurricanes) find that those extreme shocks are associated with declining enrollment rates or delays in school enrollment (Alderman et al. 2006, Jensen 2000, Jacoby and Skoufias 1997). Many studies show that natural disasters are strongly correlated with an increase of workforce, including children, and more hours devoted to off-farm activities at the expense of lower wages (Jalan and Ravallion 1999, Beegle et al. 2003, De Janvry et al. 2006, Santos 2007, Baez and Santos 2007). Baez and Santos (2007) estimate than as a consequence of Hurricane Mitch in Nicaragua, child labour force participation increases in 8.5 percentage points and the proportion of children both enrolled in school and working more than doubled. Most of case studies evidence that the impact can be largely negative and some of them show the potential detrimental effects can be long-lasting (Alderman et al. 2006). Others studies on human capital and shocks (not only natural disasters) further stresses that educational achievement is highly path-dependent (Bustelo et al. 2012, Strauss and Thomas 2007).

2.3 Children's Time Allocation in Developing Countries

Literature about children's time allocation in developing countries point to a number of determinants of the demand for education and the supply of child labour. A detailed overview of recent developments of this literature can be found in Edmonds (2007), and an older review with a more theoretical focus is Basu and Van (1999). As Basu and Van (1998) mention, the allocation of children's time to non-labour activities (education or leisure) represents a luxury good for poor households, which can be consumed only once their income rises beyond a certain threshold. Sending children to work, in contrast to sending them to schools, carries negative consequences both for the children's future wellbeing and, through the positive externalities of education on growth, for the growth of the society as a whole (Basu and Van 1999).

Theoretical and empirical studies on the main determinants of household' decision to send children to work rather than to school can be grouped into two main veins: the demand for education, introduced by Becker (1964), and the one focuses on the impact of various constraints affecting the supply of child labour, the demand for education, or both simultaneously. According to Becker (1964) theory, whether to send their children to school are the result of a trade-off between the expected returns to and the cost of education (e.g. tuition, material, compulsory uniform, transport, and opportunity cost). It predicts that children may work because the net returns relative to alternative uses of time such as school attendance are low (compared with its cost) and the returns to work experience are relatively wide. The second vein highlights the impact of various constraints the allocation of children's time between schooling and labour (Bhalotra 2007). Imperfections in the markets for labour and land (Bhalotra and Heady 2003), poverty (Basu and Van 1998) and credit market imperfections (Jacoby and Skoufias 1997, Ranjan 2001, Cigno and Rosati 2006) are the main set of constraints explaining the emergence of child labour and the concomitant fall-off in school attendance. All these constraints, in addition to the degree of altruism of the decision-taker in the household (Baland and Robinson 2000), drive the final decision about the child's time allocation. This framework suggests how an external negative shock might affect household' decision in developing countries. In fact, even where incentives favour education over work, a household may be obliged by budget constraint to send a child to work. When poverty constraints are binding, the opportunity cost of forgone wages or other remuneration of studying is too high, parents will choose not to send the children to school and will have them work instead. Moreover, when capital markets are imperfect, this model predicts that even altruistic parents may sacrifice investments in children's education.

The existing empirical research about child labour tend to focus on the effects of factors at only one level, either the characteristics of parents and their households (Basu et al. 2010, Buchmann 2000, Patrinos and Psacharopoulos 1997) or country level (Fan 2004, Levy 1985). This is problematic, since we know that the decisions of parents regarding work and schooling of their children are influenced by factors at the household level as well as by characteristics of the context in which the household is living (e.g. the local labour market and the available educational facilities characteristics) (Huisman and Smits 2009).

Webbink et al. (2013) develop a new framework including simultaneously three categories of child labour determinants (according to the different strands of literature : economics, sociology and anthropology): resources (Basu and Van 1998, Ranjan 2001), family factors (or structural factors) (Edmonds 2006), and cultural explanations (Delap 2001). This paper adds vulnerability as an extra dimension to the analyses.

Birkmann (2006) notes that we are still dealing with a paradox: "we aim to measure vulnerability, yet we cannot define it precisely". The concept of vulnerability varies among disciplines and research areas. There are 6 different frameworks and more than 25 definitions of vulnerability clearly identified so far (see Birkmann (2006), Cutter et al. (2009), and Ciurean et al. (2013) for a review). In this view, the concept of vulnerability needs to be placed into context and be properly defined, because there is no generally accepted, universal definition of vulnerability. Moreover, the evaluation of vulnerability and the combination of the hazard and the vulnerability to obtain the risk differs between natural phenomena. The disaster risk literature defines vulnerability as "the capacity to be harmed" (Field 2012). In quantitative risk assessment (before the shock occurrence), risk is expressed as a function of the hazard, the elements at risk and the vulnerability. From a natural sciences perspective, vulnerability is defined as the expected degree of loss for an element at risk as a consequence of a certain event (Dayton-Johnson 2004, Fuchs et al. 2007). In our ex-post vulnerability assessment, our measure of vulnerability is not an expected degree of loss but the observed level of damages on dwellings, ranges from 0 (no damage) to 9 (complete destruction).

As we mentioned, the existing literature on the effects of large adverse shocks on children is surprisingly limited. Rarely has there been an opportunity to study such a large and exogenous event such as the 2010 earthquake in Haiti. Second, we explore the effects of the earthquake almost three years after the episode. The persistence of adverse effects on children hints at important long run consequences of shocks, especially if we take into account that education is an important determinant of future earnings and welfare. This paper has significant implications for the literature on household decision making since our findings suggest that children are worse off after a natural disaster. More generally, our work contributes to the better understanding of natural disasters on human capital accumulation. In other words, to understand disasters we must not only know about the types of hazards that might affect people, but also the different levels of vulnerability of different groups of people. This constitutes valuable information for policy makers, as well as others organizations and institutions, interested in designing comprehensive policies to reduce this vulnerability or improve resilience to large negative shocks.

3 Context

3.1 Haitian context

Haiti is the poorest country in the Western Hemisphere and ranks 161 among 186 countries in the Human Development Index of the United Nations Development Programme [5]. Three years after the 2010 earthquake, poverty is high, particularly in rural areas, just over one-third barely managed to make ends meet (Herrera et al. 2014). According to the new national poverty line produced by the government of Haiti and based on the ECVMAS 2012, more than one in two Haitians was poor, living on less than $2.41, and one person in four was living below the national extreme poverty line of $1.23 a day. A comparison of household earnings with the level of income deemed by households to be the minimum required to live finds that nearly eight in ten households can be classified as "subjective poor" (Herrera et al. 2014). With a population of 10.4 million people [6]. Haiti is also one of the most densely populated countries in Latin America. Half of the population is under 21 years old and nearly 60 percent of Haitians have no more than primary school education. In 2012, almost 30 percent of 10-17 years old children (the focus of this study) are not in school or dedicate only few hours to studying because they need to contribute to household income or work in the household (Zanuso et al. 2014).

Prior to the earthquake, the country had already one of the poorest education systems in the world. Right after its independence (in 1804), the importance of education was recognized and the first Constitution, promulgated in 1805, noted explicitly that "education shall be free. Primary education shall be compulsory. State education shall be free at every level". These principles were never put into practice. The education offered to Haitian children was, and still is, inadequate in terms of quality, quantity and accessibility (Lunde 2010). Both the direct costs of going to school (e.g. tuition and other fees, mandatory uniforms, transport, books) as well as the opportunity costs, particularly in the form of lost labour for the household, remain barriers to achieving universal primary enrollment and completion. Private education system has grown by default and continuously, from 20 percent in the 1959-1960 to 75 percent in 1995-1996 (Salmi 2000). In 1997, the Ministry of National Education, Youth and Sport (MENJS) [7] set out a national education and training plan (PNEF)[8] to reform the education system in Haiti. The reformed Haitian education system is used as a frame of reference here, even if some parts of the country, especially in rural areas, the traditional educational system still operates (Lunde 2010). In the reformed system, education comprises three core levels: (i) pre-school for 3-5 year olds, not compulsory; (ii) primary education for 6-14 years old; and, (iii) secondary education for 15-18 year olds (see Fig.A.2). The legal age to admission to school is 6 years and, in the reformed system children who undergo normal progression complete primary at the age of 14. In fact, the last school census before the earthquake (2002-2003) highlighted that the average age of students in grade 6, for instance, was 16 years old, when the corresponding age for that grade should be 11 or 12 years old (Adelman and Holland 2015).

Unless the earthquake affected strongly education services, the number of schools were still larger in 2011-12 than in 2002-03. In addition, between 2002 and 2011 total social expenditure in the country was reduced from 2.7 percent

[5] Human Development Index of the United Nations Development Programme https://data.undp.org/dataset/Human-Development-Index-HDI-value/8ruz-shxu

[6] Based on available population projections of the Haitian Institute of Statistics and Informatics (IHSI), 2012.

[7] *Ministère de l'Education Nationale de la Jeunesse et des Sports.*

[8] textitLe Plan National d'Education et de Formation, 1998

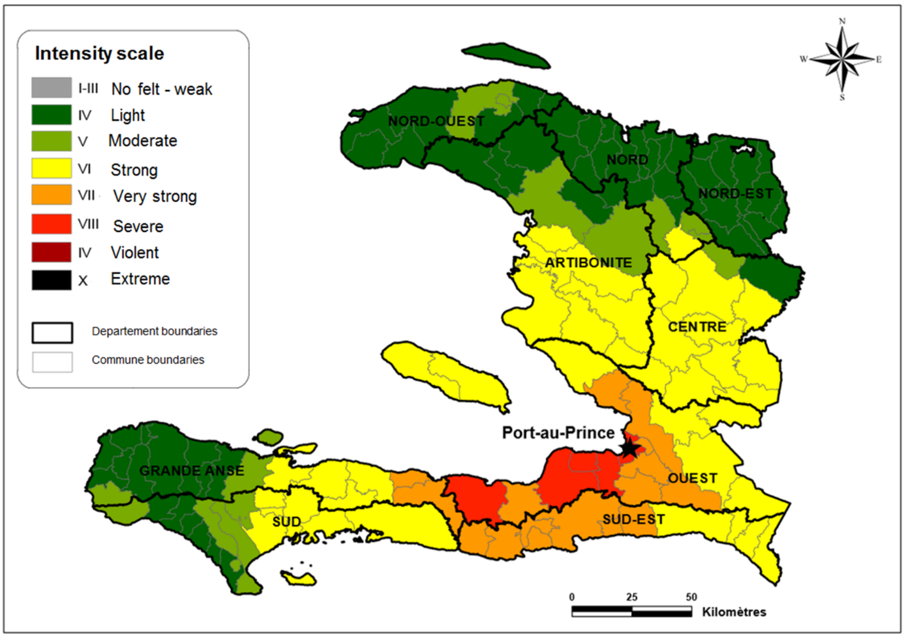
to 1.5 percent of GDP. Lamaute-Brisson (2013) reveals that the evolution of government education expenditure was erratic between 2002 (1.65 percent of GDP) and 2005 and then it collapsed in 2006 (0.57 percent of GDP) until 2011 (0.59 percent of GDP), when it picked up. Two main components explain this volatility: the fragile political situation and the volatility of GDP growth itself. In the aftermath of the earthquake, the Economic and Social Assistance Fund of Haiti (*Fond d'Assistance Economique et Social-FAES*, created in 1990) was in charge of light infrastructure implementation to facilitate the return to school on the basis of domestic public resources and external financing.

In 2002, Haiti counted with a total of 15,268 schools, of which 92 percent were non-public, accounting for more than 80 percent of enrolled students. The 2011-12 census, conducted less than two years after the 2010 earthquake, counted 16,072 schools across the country in total, of which more than 88 percent were private institutions. This persistent large share of non-public education provision makes it difficult to assure quality of education in Haiti as non-public schools, very heterogeneous, largely ignore government regulations, accreditation standards (Lunde 2010). In 2012, according to ECVMAS survey, private education represents about 65 percent of primary and secondary school enrollment. One of the highest proportion of private school enrollment in the world. We believe that the results of this research are of interest beyond Haiti, as key features of the Haitian system – low state capacity and historical lack of well-developed and functioning system of public schools – are common to many low-income countries, while the rapid growth of nonpublic schools in many of these countries makes the Haitian case, with a large and vibrant nonpublic sector, increasingly relevant.

3.2 The 2010 Earthquake

The earthquake that hit Haiti on 12 January 2010 was one of the four greatest killers recorded worldwide since 1990. Official figures place it as being twice as lethal as any previous earthquake of the same magnitude (Bilham 2010). Although recent surveys by international institutions suggest that the official death count is overestimated, there is no question about the severity of its repercussions (Kolbe et al. 2010, Schwartz et al. 2011, Doocy, Jacquet, Cherewick and Kirsch 2013). Haiti is one of the most vulnerable developing countries when it comes to natural disasters and the most exposed country in the region (Heger et al. 2008, Briguglio 1995). It has been hit by just over 50 natural disasters since 1900. Another aspect, which might explain why Haiti is even more vulnerable than its neighbors Dominican Republic and Jamaica, is the level of development and incomplete insurance markets, that increase the impact of the shocks when they do arise (Strobl 2012).The earthquake's repercussions were much more dramatic here than in other countries hit by stronger earthquakes. The context surrounding the earthquake was particularly ill-fated in that Haiti had been victim to either a tropical storm or severe flooding every year of that entire decade. The international EM-DAT database shows that these disasters prior to the earthquake affected over one million people in total and were responsible for nearly 7,000 deaths (EM-DAT 2015). Other countries have been struck by similar or stronger earthquakes, but the repercussions were much more dramatic for Haiti (Cavallo et al. 2010). For instance, an earthquake of the same magnitude hit Christchurch, New Zealand's second-largest city, that same year with no fatalities (see the case of Chile for a stronger earthquake in 2010). The same holds true for extreme weather events such as Hurricane Ike (2008), which battered Cuba and Haiti causing seven fatalities in Cuba, but one hundred times that number in Haiti (793).

Figure 1: 2010 Earthquake intensity



The 2010 earthquake was largely unanticipated and smacked headlong into the metropolitan area of Port-au-Prince, home to over one in five Haitians, destroying public buildings and housing as it went. However, the rest of the country was not spared even if the physical intensity of the shock was lighter far beyond the capital. It constitutes a unique natural experiment setting for the study of households' responses to this sort of shocks.

Material and human damage was huge in the area hit by the earthquake, but did not affect all the households in the same way. In Haiti, three times more makeshift dwellings than permanent buildings were destroyed in the hardest hit areas. Moreover, makeshift housing in the least-affected areas suffered greater damage than permanent buildings in the hardest hit areas (Herrera et al. 2014). The earthquake may well be a natural phenomenon, but the disaster was also the result of massive social inequalities and vulnerabilities that magnified the quake's effects among the most disadvantaged. These vulnerabilities are still there, if not worse, following the earthquake such that the next shock will hit an even more vulnerable population.

Despite the immediate response from the international community, with rescue teams and pledges of financial assistance and support for reconstruction and development, things are still far from back to normal. Six months after the earthquake, Échevin (2011) finds that the location of households emerges as the main criterion to explain the assistance allocation, the programs were not specifically targeted at people who need it the most, because of their low level of subsistence or losses due to the earthquake [9]. Herrera et al. (2014) corroborate these results at medium term, with ECVMAS representative survey. Institutional assistance largely overlooked the population outside the conurbation of Port-au-Prince, even though just over six in ten of the households hit were outside the capital. In fact, more earthquake victims were living outside the camps than in them where a large proportion of the aid was concentrated . Most of the households had ceased receiving aid even though their situation had not improved. A full 80 percent of the population reported that aid had stopped more than three months before mid-2012. Reconstruction aid reached just 7 percent of the households that suffered extensive damage to their housing. Most of the rubble clearing work had been done by the people themselves and some of the debris had still not been cleared. All in all, the aid provided by the institutions was short-term emergency aid, heavily oriented to the most directly and stronger hit areas, but not effective in targeting the most vulnerable people in these directly affected area and even neglecting the indirectly affected ones (Herrera et al. 2014).

The Haitian education sector was one of the sectors most severely affected by the 2010 earthquake, suffering great losses in terms of both infrastructure and manpower (GTEF 2011). According to the Ministry of National Education and Professional (MENFP) Training, 4,268 education infrastructure (schools, training centers and institutions of higher education) were destroyed or structurally affected and most all services were suspended until April of 2010. The Economic and Social Assistance Fund (Fond d'Assistance Economique et Social-FAES) was in charge of light infrastructure implementation to facilitate the return to school. As we mentioned above for international assistance, in absence of recent data, the education programmes' focus (e.g. UNICEF's emergency assistance for education services, *Ti Manman Cheri* a conditional transfers program for school retention) was mainly geographical, and most of the time favored the Metropolitan area (Lamaute-Brisson 2013). Beyond the response to the emergency situation, the principle of universal access to primary education, was reiterated in the operational plan for founding the Haitian education system (2010-2015) (see Lamaute-Brisson (2013, 2015) for a more exhausting and historical view of social protection systems in Haiti). This recommendation finds its translation in the Programme of Free and Compulsory Universal Schooling (PSUGO) —also called *Lekòl Timoun yo*— released in 2011. PSUGO aims to increase and sustain demand for education with immediate effects, while the change in quality is slower. During the first year, the achievement was mainly in two departments, West (including Metropolitan area) and Artibonite. According to MENFP, between 2010 and 2013, 288 schools were built (or rebuilt), 108 in the West department. The formation and recruitment of well qualified teachers is still a challenge in itself despite the efforts that have been initiated (4,123 teachers were recruited in 2012-2013, the target is 8,000 at the end of

[9] This study is based on the post-earthquake food security-oriented survey, conducted in June 2010 by the CNSA in collaboration with ACF, FEWS-Net, Oxfam GB, FAO, UNICEF and WFP. The survey is representative of the population in the directly affected areas, and of certain non-directly affected areas, but not at national level.

PSUGO Programme).

4 Data

This study combines data from two different sources: the first is the ECVMAS household-level data; the second is the magnitude and location measures of the 2010 earthquake.

4.1 Nationwide Household Data

This paper is based on the information collected during an extended fieldwork aimed to design, coordinate and implement the first nationwide survey about living conditions and labour market after the 2010 earthquake. The Post Earthquake Living Conditions Survey (ECVMAS) consists of 4,950 households including 23,775 individuals interviewed in the second half of 2012. This original data set covers the entire country and is representative at department level and Metropolitan area, other urban area and rural level [10]. While 22 percent of the total population lives in metropolitan area of Port-au-Prince, the capital, slightly over half (52 percent) lives in rural areas; the rest resides in other urban areas (Herrera et al. 2014).

The 2012 Haiti ECVMAS questionnaire was a variation on the 1-2-3 Survey, whose methodology was developed by DIAL laboratory researchers to measure the informal economy and poverty (Razafindrakoto et al. 2009). This survey contains quantitative information on household consumption expenditures, production, income and assets. We made two major adjustments to this generic framework. The first tailored the questionnaire to Haitian circumstances. The second change was made to include the upheavals caused by the earthquake. Specific earthquake-related issues were considered, such as the disaster's direct impact, household response strategies, aid received, other hazards and perceived shocks as well as residential and employment pathways (before and after the earthquake) Herrera et al. (2014).

Our variable of interest, vulnerability, corresponds to the degree of destruction of a given element (e.g. dwelling) at risk at risk resulting from the occurrence of a natural hazard (earthquake) of a given magnitude and expressed on a scale from 0 (no damage) to 9 (total damage). This is a simple definition, developed by technical/engineering literature for natural hazards, commonly used in risk assessment due to natural hazards and climate change since the seminal research on the concept in the 1970s. Figure A.1 illustrates the concept and shows that the average destruction score for very poor housing in strong to very strong intensity zones is 1.5, which is a higher score than for permanent housing in the destructive to violent areas (1.2). Of course, during the last decades, various schools of literature proposed different and more sophisticated conceptual

[10] The geographic divisions of Haiti are 10 departments, 41 districts, 133 communes and 565 sections within the communes. The country can also be divided in 11,967 Primary Sampling Units (PSUs) the smallest statistical division. The ECVMAS sample counts 500 PSUs, including 30 PSUs in camps.

models with the final aim of developing methods for measuring vulnerability, but no consensus has emerged so far (see Ciurean et al. (2013) for a recent and extended review of conceptual frameworks of vulnerability assessments for natural disasters reduction). Vulnerability is not only site-specific and scale dependent but also varies for different types of hazards (e.g. earthquakes, floods, tsunamis, etc.), due to process characteristics (e.g. intensity, area affected, temporal persistence, etc.) and type of element at risk, in our case households and individuals. Our methodological choice was dictate by data availability.

The starting point of our research is a recently developed theoretical framework that includes explanatory factors at the household, sub-national regional and national level (Webbink et al, 2013). To test the hypotheses derived from this framework, we use a unique database containing information on 4,175 children aged 10-17 years living in Haiti. There is a consensus on the upper bounds of this age bracket as the UNICEF Convention on the rights of the child defines a 'child' as a person below the age of 18, which is also the legal age for adulthood in Haiti. For practical reasons, we restricted our study on 10 years old children and older because younger children were not interviewed directly, and the information provided by the household head is less detailed for them.

Several issues arise in using household survey data to examine child labour supply. First, there is the general question about who to ask about the child's labour supply. It seems likely that measurement error in hours worked is a first order problem with this data (a fortiori when interviewers asked household representatives) while participation is perhaps less difficult to gauge (Edmonds 2007). Second, most household surveys of children capture a large number of children that neither work nor attend school. (Biggeri et al. 2003) show that the measurement error in activities, especially mis-measurement of domestic work, unemployment and unobserved health issues are responsible for a significant part of the "idleness" status. The uniqueness of the ECVMAS data is that it includes information not only on the children's work and school attendance, but also on their studies at home and chores activities. Moreover, interviewers asked directly to every children from 10 years old, how many hours they spend working (market and in the household business, separately), studying or doing some house chores (asking for different types of common chores activities) during the reference week, which potentially reduces measurement errors. Even if the ECVMAS survey does not include an health specific module, several questions were also asked about physical or mental handicap suffered before or after the earthquake.

The ECVMAS survey includes also key retrospective questions corresponding to the period just before the 2010 earthquake, allowing us to account for changes in household' and child's characteristic between the 2010 earthquake and the time of interview (2012). The data quality literature stresses that when a phenomenon of large magnitude happens, the risk of measurement error associated to recall is reduced (De Nicola and Giné 2014, Dex 1995). According to Brown and Kulik (1977), "flashbulb" memories theory, a highly surprising and consequential event, like the 2010 earthquake, give rise to memories that show little forgetting (Winograd and Neisser 2006). Moreover, the literature which claims to test the reliability and validity of recall in households surveys advice to include landmark events to improve respondents' recall ability, as "the salience of the event" appear to have had the largest effects on data quality (?). For instance, Dex (1995) show that "Keeping to important events over a recall period of a few years, therefore, is one way of producing recall data of the same quality as concurrent data, for many subjects".

4.2 Earthquake Data

Additionally, we match at Primary Sampling Unit's level (using a geographic information system)[11] this rich data-set with the measures of the strength of ground motion, made available by the U.S Geological Survey. A common geological measure of local hazard that earthquakes cause is peak ground acceleration (PGA), or the maximum acceleration that is experienced by a physical body, e.g. a building, on the ground during the course of the earthquake motion. PGA is considered as a good measure of hazard to short buildings, up to about seven floors. These data allow us to distinguish between the natural hazard occurrence, which is the observed physical intensity of the 2010 earthquake, and the natural disaster impact (measured by an household damage score), which involve the interaction of natural hazard and social system.

The sample used in this paper is restricted to 4,175 children aged between 10 and 17 years old (18 percent of the population), with complete information in the relevant variables for this analysis, living in the capital, other urban and rural areas of Haiti. Table 1 below shows basic descriptive statistics (national averages and standard error) of the main variables used in the regression analysis for the selected sample.

The first two indicators shows low damage and intensity of the 2010 earthquake in an average national house, however, as it was mentioned above, the earthquake directly affect mainly the metropolitan region of Port-au-Prince. Although, most of children in our sample of 10-17 years old are son or daughter of the household head (67 percent), an important proportion (17 percent) are living with a household head with whom they are weakly biologically related (daughter/son in law, aunt/uncle, nephew/niece, cousin, or other relative). According to the Hamilton's rule (Hamilton 1964), a longer biological relationship with the decision-maker in the household put children at higher risk of receiving less resources. If this is the case, we might expect 2 of each 3 children in the sample to be less likely to attend school and more likely to work.

In our sample, 78 percent of children keep living in the house where they lived in January 2010 when the earthquake happened. Table 1 also shows the high incidence of aid to household in Haiti after the earthquake: 72 percent of the households where the children in our sample live received any type of assistance after earthquake. On top on the earthquake, the average number of negative economic shocks received by the household in the last 12 months is 2, which might also affect the current decision of the household about children's time use. Eight percent of the children in our sample have a household member that lives

[11] For each 500 PSUs of the ECVMAS sample, 16 households were randomly selected in the metropolitan area of Port-au-Prince and in the camps, 8 households for the rest of the country.

Table 1: Descriptive statistics

	2010		2012	
	mean	(Std. Err.)	mean	(Std. Err.)
Earthquake damage score (0-9)	-	-	1,5522	(0,0018)
Peak ground acceleration	-	-	0,1668	(0,0001)
Age	-	-	13,5592	(0,0016)
Sex (male=1)	-	-	0,5048	(0,0004)
Relation to hh head=son\daughter (yes=1)	-	-	0,6724	(0,0003)
Relation to hh head=close relative (yes=1)	-	-	0,1212	(0,0002)
Relation to hh head=other relative (yes=1)	-	-	0,1734	(0,0003)
Relation to hh head=domestic employee (yes=1)	-	-	0,0114	(0,0001)
Relation to hh head=other relationship (yes=1)	-	-	0,0217	(0,0001)
Live in the same house (yes=1)	-	-	0,7842	(0,0003)
Hh has received any type of assitance (yes=1)	-	-	0,7242	(0,0003)
Number of negative economic schock	-	-	2,0862	(0,0007)
Members living in a temporary camp (%)	-	-	0,0789	(0,0002)
Has any hh member suffered physical damage (yes=1)	-	-	0,0993	(0,0002)
Child was economically active (yes=1)	0,0792	(0,0002)	0,2311	(0,0003)
Household size	6,4746	(0,0019)	6,6337	(0,0019)
Durable goods	3,0487	(0,0015)	3,6909	(0,0015)
House ownership (yes=1)	0,7173	(0,0003)	0,7508	(0,0003)
Metropolitan area (yes=1)	-	-	0,1978	(0,0003)
Other urban area (yes=1)	-	-	0,2666	(0,0003)
Rural (yes=1)	-	-	0,5356	(0,0004)

Note: Sample weights used. The sample size corresponds to 4,175 children 10-17 years old

in one of the shelters built after the earthquake. This variable is considered in the analysis because living in a shelter might be a household strategy to keep receiving the additional services around them.

Table 1 shows that from January 2010 until mid-2012, the labour market participation of children increased in around 8 percentage points. This might be the simple effect of age but also the effect of the earthquake on household strategies for recovering their previous levels of welfare. Moreover, it is possible to see some improvements in the socioeconomic conditions of children in average households.

As the bottom variables in Table 1 show children in our sample are mainly located in rural areas (54 percent) and urban areas different to Port-au-Prince (27 percent). Given the geographical variation of the earthquake intensity and the distribution of our sample across regions, the regression analysis below incorporates regional controls.

5 Identification Strategy

There are several channels through which the 2010 earthquake in Haiti might have impacted children's opportunity cost of attending school and therefore households decision about children's time allocation. At the one hand, the earthquake represented a negative income shock for many households, affecting the production factors (labour, capital and infrastructure), increasing transportation and transaction costs and destroying markets. The earthquake might also have affected the demographic composition of the households (because of deaths, migration, incorporation of members to the household, etc.); children's physical (e.g. permanent injuries, handicap) and mental health (e.g. stress, depression); and, the infrastructure of services (e.g. roads, schools). On the other hand, the earthquake might have positively affected children's time allocation through the increase of international aid, which promptly arrived to the country after the earthquake.

The 2012 household survey of Haiti includes retrospective questions about the household and individuals conditions just before the 2010 earthquake occurred. The inclusion of variables accounting for initial conditions (before the earthquake) and their change over time (two years later, in 2012, when the decision about children's time allocation is taken) at child and household level is expected to wash away unobserved components that might have affected both the initial household vulnerability and the decision about children's time. This approach attempts to control for the indirect effects that the earthquake might have had in the channels discussed above. As mentioned in section 4, the risk of measurement error in the retrospective variables due to recall is negligible because of the importance of such event. Moreover, the use of the earthquake's intensity as an instrumental variable (IV) to deal with the potential endogeneity of household vulnerability, would be invalid given that the earthquake might also have affected the decision about children's time allocation through any (or all) of the mentioned channels.

The final damage impact of an earthquake might be decomposed into two components: (i) the intensity of the movement; and, (ii) how the house confront the movement. Our data allow us to control for the physical impact of the earthquake (i.e. peak ground acceleration) and the damaged caused by it. Conditional on the first one, the marginal effect of the second measure give us the additional effect of how the dwelling reacted to the intensity of the movement, i.e. vulnerability. We argue that dwellings with higher quality building materials are less vulnerable. That is, if two households faced the same peak ground acceleration but the damaged caused by the earthquake in household A is larger than in household B, we can say that household A was more vulnerable than B at the time of the earthquake.

We first estimate the following equation using a Linear Probability Model (LPM):

$$Y_{iht} = \alpha_0 + \beta v_h + \alpha_1 m_{iht-1} + \alpha_2 n_{iht} + \alpha_3 p_{ih} + \epsilon_{iht} \tag{1}$$

and then we add PSU fixed-effects (FE) to account for unobservable characteristics at PSU-level:

$$Y_{iht} = \alpha_0 + \beta v_h + \alpha_1 m_{iht-1} + \alpha_2 n_{iht} + \alpha_3 p_{ih} + \alpha_4 c + \epsilon_{iht} \tag{2}$$

In these specifications Y corresponds to the decision of household h, in time t (at the moment of the interview, in mid-2012, after the earthquake) about the participation of child i in any of the following activities: "neither school nor work" (idle), "school only", "work only" or "school and work together". Alternatively, Y corresponds to the number of hours children devote to studying, market work, domestic work or leisure. m and n correspond to time-variant child and household characteristics before (2010) and after the earthquake (2012), respectively; and, p corresponds to time-invariant child and household characteristics. The indicator of household's vulnerability, measured after the earthquake, is represented by v. Finally, the error term, ϵ, is assumed to be uncorrelated with v.

Equation (2) also includes PSU fixed-effects, c, to control for unobserved characteristics at PSU-level. Although both specifications seek to control for the change in variables reflecting the impact of the earthquake on the channels mentioned in the previous section, many other unobserved changes might have occurred. For instance, international aid targeted the larger hit areas of the country after the earthquake.

A main concern is that the categories for children's time allocation may have similar underlying determinants. In this case, error terms in the specifications regarding discrete choices for children's time and the one for number of hours to spend on each category are correlated. A straightforward way to improve OLS estimator efficiency is modeling them as a system of linear (for instance, using a seemingly unrelated regression model) and non-linear regressions (for instance, using a multivariate probit model with 4-equations probit models by maximum likelihood), respectively. However, we find an empirical trade-off between estimating these models and accounting for unobserved heterogeneity at PSU-level. The inclusion of FE in multivariate linear and non-linear models is not straightforward and therefore we end up estimating a LPM with PSU-FE. However, correlation between error terms is not particularly strong, therefore the efficiency gains relative to LMP estimation are not expected to be great.[12] Furthermore, as Edmonds (2007) mentions, using univariate models (instead of multivariate model) is the common practice in this literature and allows comparison with previous studies.

6 Results

This section includes two sets of regressions. The first set (Table 2) includes the household decision about children's time allocation in terms of "neither school nor work", "school only", "work only" and "school and work". The second set (Table 3) corresponds to the estimation of the number of hours for studying, work activities, household chores and leisure. For each regression, tables 2 and 3 show the estimates of equation (1) and (2) with PSU-FE. Tables A.1 and A.2 in Appendix show the LPM estimates of equation (1) and (2) (without FE).

Our main variable of interest is household vulnerability, measure as the residual of the total physical damage caused by the earthquake after controlling for the intensity of the earthquake movement.

[12] At the one hand, the correlation between the error terms of the equations of hours of study and of market work is -0.08; between the equation of hours of study and domestic work is -0.06; and, between the equations of market and domestic work is 0.11. At the other hand, the Wald test for a null correlation between the error terms, $\rho = 0$, in a bivariate probel model of an equation of school attendance (independently if combined with market work or not) and market work (independently if combined with school attendance or not) is not rejected.

The first column on each regression shows that if we do not account for unobserved heterogeneity at PSU-FE, the measure of earthquake intensity (PGA) show counter intuitive signs. For instance, the coefficient of PGA shows a positive relationship between the earthquake intensity and school attendance and the number of hours devoted to studying and a negative relationship with the probability of working, working and studying (simultaneously), and hours devoted to work (market and domestic work). After the 2010 earthquake the international community promptly react sending aid to the most affected areas of the country. As part of this help many schools were built in the country, which is likely to explain why children in most hit areas have larger access to schools. Therefore, the coefficient of PGA reflect not only the intensity of the earthquake but changes in conditions between the time of the earthquake and the interview.

Since we do not observe the level of aid arrived to communes, among other unobservable factors, it is essential to include PSU-FE. As mentioned in section 4, PGA are calculated at PSU level so the second column on each regression, which includes PSU-FE, compare children living in the same PSU and therefore were hit by the earthquake with the same intensity.

After accounting for time-variant and -invariant child and household characteristics and PSU-FE, we find lasting effects of household vulnerability on children's time allocation. First, table 2 shoes that more vulnerability at the time of the earthquake is associated to a larger probability of exclusively working and to a lower probability of exclusively attending school. These suggest that living in a more vulnerable household has long lasting negative effects on the investment in children's human capital. Similarly, table 3 shows that household vulnerability at the time of the 2010 earthquake increases the allocation of children's time to household chores (especially for girls).

Table 2: Fixed Effects model, School/Work decision

	Idle	School only	Work only	School &work
Earthquake damage score	0.002	-0.008*	0.004*	0.002
	(0.003)	(0.004)	(0.002)	(0.003)
Peak ground acceleration	.	.	.	.
	.	.	.	.
Age	0.008***	-0.017***	0.003	0.006*
	(0.003)	(0.004)	(0.002)	(0.004)
Sex (male=1)	0.062	0.072	-0.017	-0.116*
	(0.053)	(0.077)	(0.042)	(0.069)
Age*sex	-0.007*	-0.008	0.003	0.012**
	(0.004)	(0.006)	(0.003)	(0.005)
Relation to hh head=close relative (yes=1)	0.048***	-0.035	-0.004	-0.009
	(0.017)	(0.027)	(0.009)	(0.024)
Relation to hh head=other relative (yes=1)	0.044***	-0.020	0.008	-0.032*
	(0.014)	(0.021)	(0.009)	(0.019)
Relation to hh head=domestic employee (yes=1)	0.120**	-0.078	0.063	-0.105*
	(0.057)	(0.075)	(0.039)	(0.062)
Relation to hh head=other relationship (yes=1)	0.061	-0.097	0.068*	-0.031
	(0.040)	(0.060)	(0.036)	(0.048)
Child was economically active, 2010 (yes=1)	-0.009	-0.447***	0.140***	0.317***
	(0.019)	(0.030)	(0.027)	(0.035)
Live in the same house (yes=1)	0.014	-0.022	0.007	0.002
	(0.016)	(0.028)	(0.012)	(0.024)
Hh has received any type of assitance (yes=1)	-0.021*	0.023	0.000	-0.003
	(0.012)	(0.023)	(0.009)	(0.020)
Number of negative economic schock	-0.008	-0.018*	0.002	0.023***
	(0.006)	(0.010)	(0.003)	(0.009)
Members living in a temporary camp (%)	-0.008	-0.062	0.029*	0.041
	(0.022)	(0.038)	(0.016)	(0.029)
Has any hh member suffered physical damage (yes=1)	-0.020	0.014	0.017	-0.011
	(0.016)	(0.028)	(0.012)	(0.025)
Household size, 2010	-0.009*	-0.001	-0.003	0.013**
	(0.004)	(0.007)	(0.003)	(0.006)
Household size, 2012	0.011**	0.001	0.002	-0.014**
	(0.005)	(0.008)	(0.003)	(0.006)
Durable goods, 2010	-0.019	0.036	0.005	-0.022
	(0.017)	(0.024)	(0.008)	(0.020)
Durable goods, 2012	-0.045***	0.029	-0.020**	0.036
	(0.016)	(0.028)	(0.009)	(0.024)
House ownership, 2010 (yes=1)	-0.011	0.040	0.009	-0.038
	(0.019)	(0.033)	(0.016)	(0.030)
House ownership, 2012 (yes=1)	0.003	-0.049	-0.018	0.064**
	(0.018)	(0.034)	(0.017)	(0.028)
Constant	-0.003	1.041***	-0.029	-0.009
	(0.043)	(0.073)	(0.035)	(0.062)
Observations	4015	4015	4015	4015
R-squared	0.24	0.41	0.26	0.39

Note: PSU fixed-effects included in all regressions. Standard errors clustered at PSU level are in parentheses. *p<0.1, **p<0.05, ***p<0.01.

Table 3: Fixed Effects model, Number of hours

	Hours studying	Hours working	Hours hh chores	Hours leisure
Earthquake damage score	-0.170	0.064	0.275***	-0.169
	(0.131)	(0.059)	(0.094)	(0.188)
Peak ground acceleration	.	.	.	.
	.	.	.	.
Age	-0.077	0.234***	0.765***	-0.923***
	(0.101)	(0.082)	(0.108)	(0.164)
Sex (male=1)	-1.366	-3.264**	4.989***	-0.359
	(1.942)	(1.440)	(1.637)	(2.931)
Age*sex	0.095	0.327***	-0.705***	0.283
	(0.143)	(0.114)	(0.123)	(0.221)
Relation to hh head=close relative (yes=1)	-1.142*	-0.022	-0.322	1.486
	(0.646)	(0.458)	(0.500)	(0.916)
Relation to hh head=other relative (yes=1)	-1.381***	-0.319	1.373***	0.327
	(0.532)	(0.349)	(0.461)	(0.789)
Relation to hh head=domestic employee (yes=1)	-3.886***	0.689	7.234***	-4.037
	(1.354)	(1.187)	(1.913)	(2.656)
Relation to hh head=other relationship (yes=1)	-3.275***	0.811	3.096***	-0.632
	(1.174)	(1.377)	(1.056)	(1.793)
Child was economically active, 2010 (yes=1)	-1.586**	9.606***	1.863**	-9.882***
	(0.661)	(0.992)	(0.813)	(1.344)
Live in the same house (yes=1)	-0.916	0.026	0.453	0.436
	(0.770)	(0.472)	(0.620)	(1.064)
Hh has received any type of assistance (yes=1)	-0.506	-0.129	0.411	0.224
	(0.557)	(0.392)	(0.471)	(0.864)
Number of negative economic shock	0.487*	0.279*	0.554***	-1.320***
	(0.287)	(0.167)	(0.196)	(0.389)
Members living in a temporary camp (%)	-0.871	1.352**	0.098	-0.579
	(1.783)	(0.649)	(0.912)	(2.290)
Has any hh member suffered physical damage (yes=1)	0.801	-0.121	-0.016	-0.663
	(0.858)	(0.443)	(0.641)	(1.252)
Household size, 2010	0.103	0.041	-0.331**	0.187
	(0.182)	(0.118)	(0.165)	(0.288)
Household size, 2012	-0.289	-0.067	0.048	0.308
	(0.188)	(0.122)	(0.168)	(0.286)
Durable goods, 2010	2.106**	-0.168	-0.697	-1.241
	(0.909)	(0.419)	(0.570)	(1.251)
Durable goods, 2012	0.402	0.231	0.160	-0.793
	(0.950)	(0.495)	(0.585)	(1.272)
House ownership, 2010 (yes=1)	-1.701	-0.585	-0.190	2.476
	(1.249)	(0.451)	(0.651)	(1.529)
House ownership, 2012 (yes=1)	1.798	0.861**	-0.210	-2.449
	(1.278)	(0.415)	(0.647)	(1.519)
Constant	11.075***	-1.951	0.792	158.084***
	(1.744)	(1.285)	(1.694)	(2.737)
Observations	4015	4015	4015	4015
R-squared	0.57	0.38	0.36	0.39

Note: PSU fixed-effects included in all regressions. Standard errors clustered at PSU level are in parentheses. *p<0.1, **p<0.05, ***p<0.01.

Although our main variable of interest is household vulnerability, it is interesting to explore the relationship of the other control variables and children's time allocation. In general, older children are less likely to attend school and more likely to work. In addition, we find gender differences on the age effect: boys are less likely than girls to be idle and more likely to work and study simultaneously. Boys also spend more hours in market work and less in domestic work than girls. We also find evidence of the Hamilton's rule. Children who are less related biologically to the household head spend fewer hours studying and longer hours doing domestic work. We also find evidence of state-dependence in terms of past working experience. Children who were economically active at the time of the earthquake spend fewer hours studying and at leisure and more working for the market and domestically.

7 Conclusion

In January 2010, Haiti suffered a devastated earthquake that caused dramatic economic and personal losses. The total effect of the earthquake in people's lives happens through a natural factor (intensity), which is exogenous to people's behavior, and a vulnerability factor, which might be affected by individual's behavior, and therefore potentially affected by policy. This paper examines the lasting effect of household's vulnerability at the time of the earthquake on the decision about children's time allocation. Modifying children's time allocation might have been a coping strategy to overcome the effects of the earthquake.

It is well known in the literature that an investment in children's human capital has many positive effects on individuals' and nation lives. We find evidence that households' vulnerability is negatively associated to investments in children's human capital, which therefore, perpetuates household's poverty. For this reason, we believe that social policies should focus on attacking households' vulnerability. Moreover, we find evidence of differential household behavior in response to children's gender, age and degree of biologically relationship of the child and household head. We also bring evidence of the importance of disentangle activities related to domestic and market work. In particular, we find that according to children's age and gender they spend more or less time doing more work activities at home or for the market.

We use a rich and original dataset that with information about earthquake's intensity and damage, children answers about the use of their time, time devoted to domestic and market work and characteristics of individuals and households before the 2010 earthquake happened. Although the richness of our data, we are not able to disentangle whether the household decision about children's time reflects the household or child unobserved characteristics (e.g. household's preferences for schooling and child labour, child's depression, stress or ability to take advantage of school). The importance of the research question from a policy point of view and the lack of empirical evidence for Haiti make relevant the analysis.

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A Appendix

Table A.1: Linear Probability Model, School/Work decision

	Idle	School only	Work only	School &work
Earthquake damage score	0.002	-0.004	0.003*	-0.001
	(0.002)	(0.004)	(0.002)	(0.004)
Peak ground acceleration	-0.046	0.422***	-0.075***	-0.301***
	(0.044)	(0.074)	(0.022)	(0.060)
Age	0.009***	-0.017***	0.002	0.007**
	(0.003)	(0.004)	(0.002)	(0.003)
Sex (male=1)	0.071	0.010	-0.018	-0.062
	(0.052)	(0.075)	(0.035)	(0.067)
Age*sex	-0.008**	-0.003	0.003	0.008
	(0.004)	(0.005)	(0.003)	(0.005)
Relation to hh head=close relative (yes=1)	0.034**	0.011	-0.012	-0.033
	(0.014)	(0.024)	(0.009)	(0.021)
Relation to hh head=other relative (yes=1)	0.035***	0.007	0.001	-0.043**
	(0.013)	(0.020)	(0.008)	(0.018)
Relation to hh head=domestic employee (yes=1)	0.096*	-0.147**	0.043	0.008
	(0.053)	(0.069)	(0.037)	(0.059)
Relation to hh head=other relationship (yes=1)	0.036	-0.079	0.062*	-0.019
	(0.033)	(0.051)	(0.033)	(0.042)
Child was economically active, 2010 (yes=1)	-0.009	-0.511***	0.143***	0.377***
	(0.015)	(0.026)	(0.025)	(0.034)
Live in the same house (yes=1)	0.010	0.000	-0.001	-0.009
	(0.012)	(0.023)	(0.012)	(0.021)
Hh has received any type of assistance (yes=1)	-0.020*	-0.014	0.001	0.033*
	(0.011)	(0.020)	(0.007)	(0.017)
Number of negative economic shock	-0.011*	-0.018**	0.005*	0.024***
	(0.006)	(0.009)	(0.003)	(0.007)
Members living in a temporary camp (%)	0.005	0.005	0.020*	-0.030
	(0.016)	(0.033)	(0.012)	(0.027)
Has any hh member suffered physical damage (yes=1)	-0.012	0.015	0.007	-0.009
	(0.013)	(0.026)	(0.010)	(0.023)
Household size, 2010	-0.012***	-0.001	-0.007*	0.020***
	(0.004)	(0.007)	(0.004)	(0.007)
Household size, 2012	0.012***	0.003	0.005	-0.020***
	(0.004)	(0.007)	(0.004)	(0.007)
Durable goods, 2010	-0.011	0.044**	0.002	-0.035*
	(0.013)	(0.022)	(0.007)	(0.018)
Durable goods, 2012	-0.047***	0.067***	-0.023***	0.004
	(0.014)	(0.024)	(0.008)	(0.020)
House ownership, 2010 (yes=1)	-0.022	-0.007	0.023	0.006
	(0.015)	(0.027)	(0.017)	(0.026)
House ownership, 2012 (yes=1)	0.003	-0.055**	-0.014	0.067***
	(0.014)	(0.028)	(0.016)	(0.025)
Constant	0.034	0.957***	0.005	0.004
	(0.044)	(0.072)	(0.030)	(0.059)
Observations	4015	4015	4015	4015
R-squared	0.03	0.19	0.07	0.15

Note: Standard errors clustered at PSU level are in parentheses. *p<0.1, **p<0.05, ***p<0.01.

Table A.2: Linear Probability Model, Number of hours

	Hours studying	Hours working	Hours hh chores	Hours leisure
Earthquake damage score	-0.017	0.045	0.318***	-0.346**
	(0.116)	(0.058)	(0.098)	(0.174)
Peak ground acceleration	27.146***	-5.537***	-8.907***	-12.702***
	(2.854)	(1.027)	(1.609)	(3.395)
Age	-0.157	0.219***	0.749***	-0.811***
	(0.106)	(0.072)	(0.107)	(0.163)
Sex (male=1)	-2.778	-2.145	6.461***	-1.538
	(2.110)	(1.354)	(1.614)	(2.905)
Age*sex	0.194	0.248**	-0.799***	0.357
	(0.155)	(0.107)	(0.122)	(0.219)
Relation to hh head=close relative (yes=1)	-0.954	-0.444	-0.615	2.012**
	(0.627)	(0.398)	(0.465)	(0.859)
Relation to hh head=other relative (yes=1)	-0.861	-0.588*	1.257***	0.192
	(0.561)	(0.325)	(0.425)	(0.764)
Relation to hh head=domestic employee (yes=1)	-5.361***	1.399	6.947***	-2.985
	(1.475)	(1.285)	(1.968)	(2.736)
Relation to hh head=other relationship (yes=1)	-3.948**	0.966	2.142**	0.841
	(1.540)	(1.199)	(1.026)	(1.740)
Child was economically active, 2010 (yes=1)	-2.801***	10.307***	1.833**	-9.339***
	(0.674)	(0.881)	(0.715)	(1.259)
Live in the same house (yes=1)	-0.100	-0.084	0.237	-0.053
	(0.732)	(0.405)	(0.581)	(0.946)
Hh has received any type of assistance (yes=1)	-1.344**	0.146	0.059	1.139
	(0.607)	(0.312)	(0.399)	(0.790)
Number of negative economic shock	0.464*	0.451***	1.071***	-1.987***
	(0.272)	(0.132)	(0.169)	(0.340)
Members living in a temporary camp (%)	0.987	0.089	-1.149*	0.073
	(1.390)	(0.550)	(0.654)	(1.598)
Has any hh member suffered physical damage (yes=1)	1.012	-0.250	0.279	-1.040
	(0.820)	(0.390)	(0.542)	(1.098)
Household size, 2010	-0.133	0.156	-0.249*	0.226
	(0.174)	(0.121)	(0.144)	(0.252)
Household size, 2012	-0.208	-0.177	-0.075	0.460*
	(0.171)	(0.124)	(0.142)	(0.246)
Durable goods, 2010	2.932***	-0.453	-1.469***	-1.011
	(0.867)	(0.358)	(0.489)	(1.056)
Durable goods, 2012	1.327	-0.090	-0.151	-1.086
	(0.987)	(0.403)	(0.525)	(1.176)
House ownership, 2010 (yes=1)	-3.058***	0.067	0.126	2.865**
	(1.059)	(0.415)	(0.646)	(1.211)
House ownership, 2012 (yes=1)	1.163	1.186***	0.904	-3.253***
	(1.071)	(0.409)	(0.599)	(1.154)
Constant	8.351***	-1.435	1.729	159.354***
	(1.806)	(1.217)	(1.639)	(2.621)
Observations	4015	4015	4015	4015
R-squared	0.25	0.19	0.14	0.10

Note: Standard errors clustered at PSU level are in parentheses. *p<0.1, **p<0.05, ***p<0.01.

Table A.3: Bi-probit model

	School with or without work	Work with or without school
Earthquake damage score	-0.031*	0.005
	(0.016)	(0.017)

Table A.4: SUR model

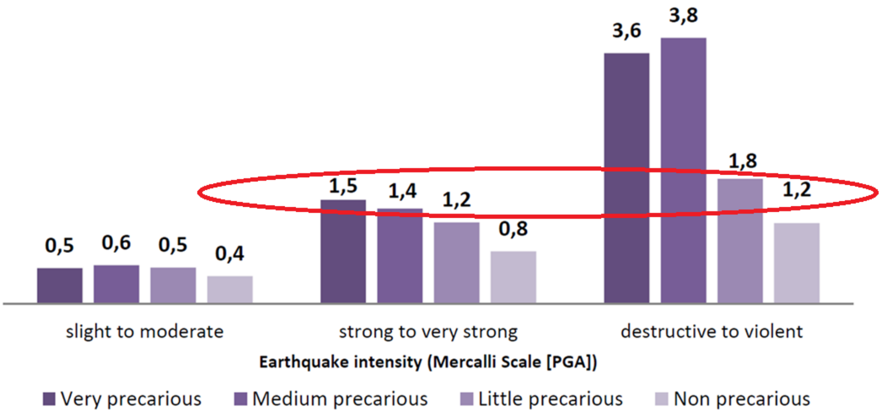
	Hours studying	Hours working	Hours hh chores
Earthquake damage score	-0.018	0.045	0.320***
	(0.082)	(0.054)	(0.067)

Table A.5: Probit model

	Idle	School only	Work only	School & work
Earthquake damage score	0.002	-0.003	0.003**	-0.001
	(0.002)	(0.004)	(0.001)	(0.004)

*Notes for A.3 A.4 and A.5: Additional controls in all regressions include: child's age, sex, relationship with the household head and a dummy for whether he (she) was economically active before the earthquake; a dummy variable for whether the household lives in the same house than at the time of the earthquake; a dummy for whether the household receives any type of assistance; the proportion of household members living in a temporary camp; a dummy for whether any member of the household suffered physical damage during the earthquake; variables for household size in 2010 and 2012; indexes of durable goods in 2010 and 2012; and, dummy variables for house ownership in 2010 and 2012. Standard errors clustered at the commune level are in parentheses. *Significant at 10 percent, **Significant at 5 percent, ***Significant at 1 percent.*

Figure A.1: Housing destruction score based on earthquake intensity and building vulnerability



Source: ECVMAS 2012; US Geological Survey; Authors' calculations

Note: Only covers households that have not changed housing since the earthquake.

Figure A.2: Haitian education system

Structure of the reformed Haitian education system			
19 years & +	**Superior**		
18 years	Final year - Philo	**Secondary**	
17 years	1^{st} year - Rheto		
16 years	2^{nd}year		
15 years	3^{rd}year		
14 years	9^{st}AF	**3^{rd} cycle**	**Primary**
13 years	8^{st}AF		
12 years	7^{st}AF		
11 years	6^{st}AF	**2^{nd} cycle**	
10 years	5^{st}AF		
9 years	4^{st}AF	**1^{st} cycle**	
8 years	3^{rd}AF		
7 years	2^{nd}AF		
6 years	1^{st} AF		
5 years	Upper	**Pre-school**	
4 years	Middle		
3 years	Lower		