This paper is a draft submission to the

WIDER Development Conference

Human capital and growth

6-7 June 2016 Helsinki, Finland

Build back better? Long-lasting impact of the 2010 Earthquake in Haiti.

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January 26, 2016

Abstract

This paper analyses the long-lasting effects of the 2010 Haiti earthquake on household well-being. Using original longitudinal data and objective geological measures, we provide strong evidence that in Haiti the immediate negative shock has been associated to persistent welfare losses over time. We rely on difference-in-difference estimations to evaluate the impact in the whole country and outside the Metropolitan area of Port-au-Prince. As the earthquake hit the country in a very specific area, its capital, we employ different strategies to address the possible violation of the parallel trend assumption. Our results also show that the earthquake has an overall negative long-lasting impact on labour market participation. When we exclude the more specific Metropolitan area, we observe a drop of 5 percentage points in the probability to participate to labour market, encumbering the resilient recovery. The disruption of household's livelihood system reduce the probability to recover from the shock without external aid. However, our findings suggest that the assistance program's coverage, even among the most impacted households has been highly variable.

JEL Codes: D1, I31, J22, O12, Q54.

Keywords: Natural Disasters, Impact Evaluation, Asset-Wealth, Labour Supply, Haiti

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1 Introduction

Up to 325 million extremely poor people will be living in the 49 most hazard-prone countries in 2030 according to the report "The geography of poverty, disasters and climate extremes in 2030" (Shepherd et al. 2013). Empirically, developing countries and poor areas are more exposed to natural disasters than the wealthy ones, meaning that similar shocks in Haiti, Chile or New Zealand can have vastly different impacts. This is exactly what happened in 2010. Haiti was smashed by one of the four most deadly disasters to occur worldwide for the last 30 years (the death toll as recorded in EM-DAT (2015) is estimated at 222,600) , the same year an earthquake of the same magnitude hit Christchurch (New Zealand's second-largest city) with no fatalities and an earthquake 500 times stronger (in terms of energy released, making it the fifth largest earthquake ever recorded by a seismograph) impacted Chile, killing 569 people (EM-DAT 2015). Natural hazards wind into human catastrophes when they worsen the poverty that already exists and drag more people down into poverty traps as their assets vanish, together with their means of securing the necessities of life. The risk of impoverishment is related to lack of access to markets, capital, assets and insurance mechanisms which contribute to make people able to cope and reconstruct.

As climate change is expected to cause more extreme events, and to exacerbate factors that make people less able to cope with shocks, the international community is showing a growing concern on natural hazard risk management. The "Build Back Better" concept was adopted as a priority of the "Sendai Framework for Disaster Risk Reduction 2015-2030", a guiding agreement for disaster risk reduction for the UN member countries. It is a concept of recovery, being defined as the restoration and improvement of facilities, livelihoods and living conditions of affected populations, including efforts to develop capacities that reduce disaster risk in the long term. Sendai 2015 Conference is only the latest international event showing the growing interest on this issue, several programs have been specially designed to reduce disaster risk factors in the last decade. However, these programs rely on weak empirical evidence, partly due to the lack of suitable data. That is why a much bigger body of empirical studies from specific disasters is required, helping us to understand exactly why some people are more vulnerable, and helping us to understand what can realistically be achieved in the aftermath of such extreme events.

The political authorities and multilateral organisations appear to share an optimistic view of the future of the post-earthquake population World Bank (2014). However, this paper, based on the first national socioeconomic survey to be taken since the earthquake (Herrera, Lamaute-Brisson, Milbin, Roubaud, Saint-Macary, Torelli and Zanuso 2014), provides strong evidence of a negative impact of the 2010 earthquake on household's wealth, 3 years after the shock. The 2010 recall data included in the 2012 ECVMAS survey allows us to take advantage of a longitudinal dimension and, by such, to overcome most of cross-sectional studies' limitations, such as failing to control for household and individual ex-ante characteristics and unobserved heterogeneity. Our identification strategy relies on difference-in-differences approach. Additionally to a drop of private assets, our results suggest that people living in 2010 in areas affected by the extreme event experienced a long-lasting decrease of their means to generate income. On average, we show a drop of about 2 percentage points in the probability to participate to the labour market, 3 years after the shock, for individuals incurring strong physical intensity in 2010. Excluding the quite specific Metropolitan Area (MA) of Port-au-Prince, even though this area experienced the strongest ground tremors, the negative impact is even stronger (about 4 p.p.). Yet, for logistical reasons and efficiency considerations, the external assistance has been concentrated in Port-au-Prince or in camps, and consequently, a large part of the earthquake victims (40% of destroyed dwellings were located outside the MA) may not have been reached (Herrera, Lamaute-Brisson, Milbin, Roubaud, Saint-Macary, Torelli and Zanuso 2014).

In order to delve into the different channels at play explaining why some households cope and recover better than other from the initially negative shocks, we analyse the heterogeneity of the impact according to gender, education and the initial level of wealth. Moreover, we intend in this paper to properly address the impact of the earthquake outside the MA, as part of our identification strategy, but also in an informative objective (as quite little is known about the effects of the earthquake outside this area, given less media and institutions coverage).

The paper is organized in 5 sections. Section 2 reviews the existing literature on natural disasters impact evaluation and presents the Haitian context. Section 3 describes the data used in the analysis and the empirical strategies to identify the mentioned effects. This is followed by a presentation of the results in Section 4. Finally, section 5 concludes the paper and discusses policy options.

2 Background

2.1 Previous Findings

The existing literature related to the impact of natural disasters on welfare is mainly empirical. Some studies focus on the short run estimation of the overall damages and financial costs of these extreme events. Strobl (2012) underlines some reasons to be skeptical about the actual quantitative size of macroeconomic estimates of damages. First, almost all these studies tend to treat natural disasters as a homogeneous group of extreme events affecting an assumed homogeneous group of countries. Yet, in a cross-country study Noy (2009) finds that any macroeconomic costs is almost entirely due the developing country group of his sample (Toya and Skidmore 2007). Second, current studies essentially have all relied on aggregate damage estimates (such as those provided by the widely used EM-DAT database) coming from different sources, whose nature and quality of reporting may change over time, the costs may be inflated to attract international emergency relief (Lundahl 2013, Schuller and Morales 2012), and identified events are generally subject to some threshold level for inclusion.

If the aggregated first-order effects of natural disasters are quite obvious, encompassing human fatalities and injuries, destruction of critical infrastructure, and disturbance of economic activities, quantifying the direct and indirect medium and long effects of extreme event on the well-being of households and assessing how they cope with these risk factors is more challenging. This long-lasting assessment is essential to more fully understand the mechanisms at play and to estimate their economic impacts in order to design effective risk management strategies (World Bank 2010, Gitay et al. 2013, Baez et al. 2015). (Hallegatte 2014) show that depending on the ability of the economy to cope, recover and reconstruct, the reconstruction will be more or less difficult, and its welfare effects limited or extended. This ability, which can be referred as the resilience of the economy to natural disasters, is an important dimension to estimate the vulnerability of a population.

It is not clear to what extent the immediate negative shock on production and welfare, persist over time or whether affected households recover, or even benefit at some point from some post-disaster reconstruction. On the one hand, in a situation of incomplete financial markets, immediate asset losses may push households into poverty traps that can persist over time (Alderman et al. 2006). On the other hand, it has been argued that disasters may act as "creative destruction" mechanism, triggering some investment and upgrading of capital (Crespo Cuaresma et al. 2008, Skidmore and Toya 2002). For instance, an upgrading could be the reconstruction of private and public buildings with reinforced structures, more efficient or better adapted infrastructures. Other positive effects could also come from the development of new activities, the reallocation of labour supply or migration.

A growing literature explores whether natural disasters lead to poverty persistence (see De la Fuente (2010) for a review). For instance, Bustelo et al. (2012) provide evidence that natural disasters may contribute to poverty and its intergenerational transmission if households decrease their investment in children's human capital, inducing children to fail to reach their growth and educational potential (Skoufias 2003, Baez and Santos 2007). Their results show a strong negative impact of the 1999 Colombian earthquake on child nutrition and schooling in the short-term. They also provide evidence of the persistence of adverse effects, with lesser degree in the medium-term, particularly for boys, in the most affected department.

Only other few studies address the impact of a high-magnitude earthquake due to a lack of suitable data (see Doocy et al. (2013) for a review, Yang (2008) for China, and Halliday (2006), Baez and Santos (2008), for El Savador), and even less their long-lasting impact. Gignoux and Menendez (2014) examine the long-term effects on individual economic outcomes of a set of earthquakes in Indonesia and provide strong evidence that the long-run economic consequences for affected households might not always be negative. They show that after going through short-term losses, households were able to recover in the medium run, and even exhibit income and welfare gains over 6 to 12 years.

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 recognize. Herrera, Lamaute-Brisson, Milbin, Roubaud, Saint-Macary, Torelli and Zanuso (2014), based on ECVMAS 2012 data, present the most up-to-date image of the labour market situation in Haiti and a systematic and comparative analysis with the EEEI 2007 data is conducted. They calculate comparable indicators and describe the evolution of the labour market in a five year interval (before and after the earthquake), but they highlight that the observed dynamic cannot be attributed to the earthquake only, as so many large scale events have intervened in the meantime (floods, hurricanes, epidemics, etc.). This paper, based on biographical record of the individuals, intend to complete these results on the general economic trends by isolating the specific role of this major shock.

2.2 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. Three years after the 2010 earthquake, poverty is still high, particularly in rural areas, just over one-third of the population barely managed to make ends meet (Herrera, Lamaute-Brisson, Milbin, Roubaud, Saint-Macary, Torelli and Zanuso 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, Lamaute-Brisson, Milbin, Roubaud, Saint-Macary, Torelli and Zanuso 2014). With a population of 10.4 million people,[1] 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 (Zanuso et al. 2014).

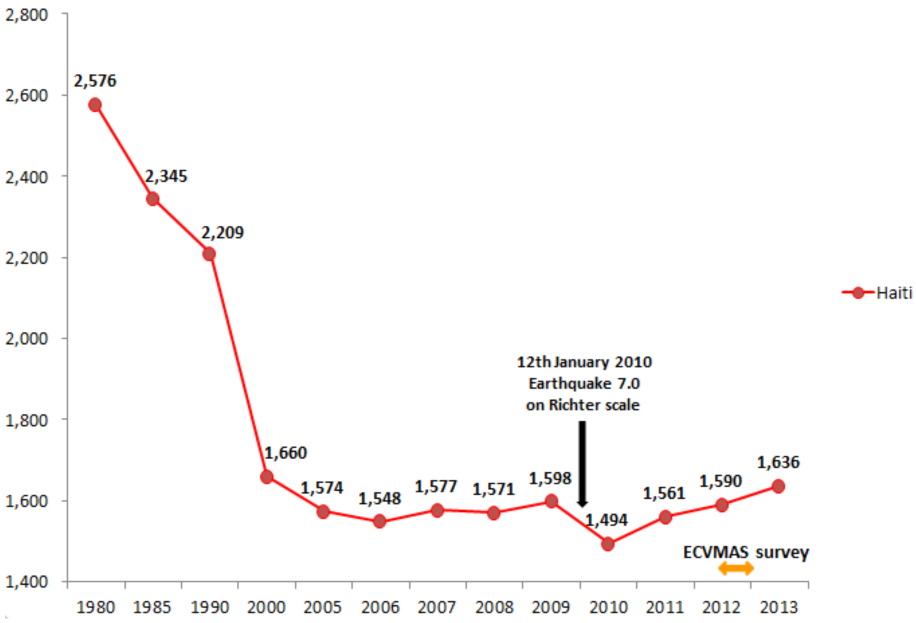
2.3 The 2010 Earthquake

The earthquake measuring 7.3 on the Richter scale smacked headlong into the Metropolitan area of Port−au−Prince, the country’s economic centre and home to nearly one in five Haitians, and swept on through the rest of the country. In addition to the loss of human life, devastated buildings (an estimated 105,000 dwellings and infrastructures totally destroyed and over 208,000 damaged, according to the 2010 Action Plan for National Recovery and Development of Haiti (PDNA), caused the displacement of millions of people to displaced persons camps and other arrangements nationwide. Seven months after the disaster, one and a half million people were living in 1,555 temporary camps. In September 2013, three and a half years after the earthquake, the latest IOM census (CCCM 2013) found that 172,000 people were still living in 306 camps and that those who had left the camps had not necessarily found a permanent housing solution. The World Bank estimated the damage and loss at around eight billion dollars or 120% of GDP. This disaster on a rare scale hit an already fragile country subject to extreme weather events and high political instability. It prompted an immediate response from the international community, which

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

sent in rescue teams and pledged financial assistance and support for reconstruction. Yet despite this and the billions of dollars committed, things are still far from back to normal. Per capita GDP nosedived 7% in 2010 and picked up 3% the following year. However, although the shock was limited in macroeconomic terms, it came at a time of long-term economic decline. In 2013, the UNDP Human Development Report (Malik 2013) found that per capita gross national income (GNI) had been falling steadily for over 20 years, sliding 41% in value from 1980 to 2012 (see figures 2 and 1).

Figure 1: GNI per capita in PPP terms in Haiti 1980-2013 (constant 2011 PPP$)

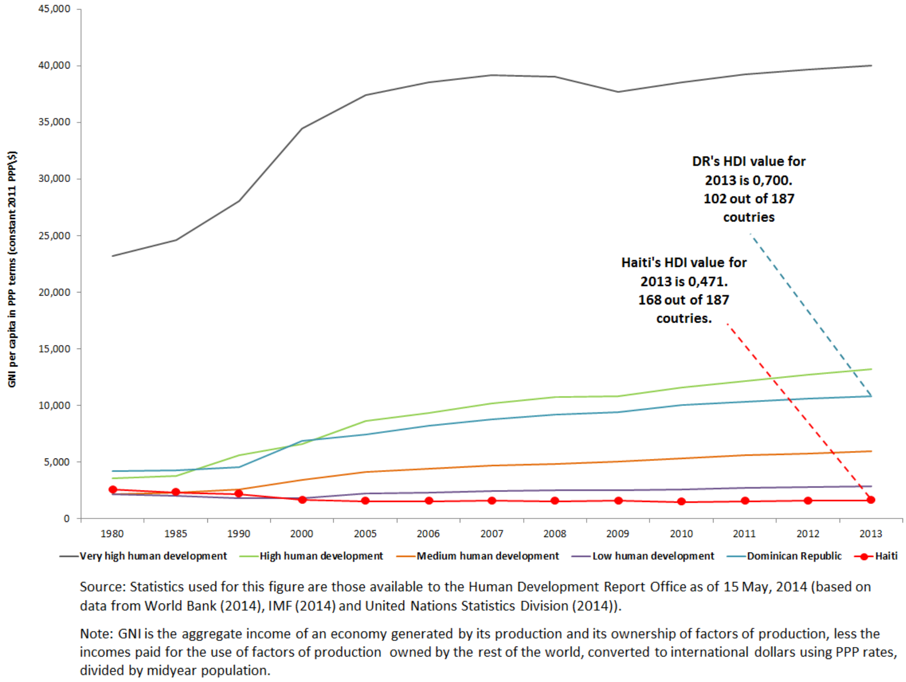


2.4 Fatal assistance?

Despite having received considerable foreign aid in the last decades, Haiti remains one of poorest country in the world and an extremely fragile state. Many experts bemoan the apparent inability of the international assistance to implement aid programs that achieve sustainable economic and democratic progress in Haiti [2]. For instance, Buss et al. (2009) deplores that from 1990 to 2003, U.S. authorities spent over $4 billion in aid to Haiti, donors pledged $707.3 million in new funding during the 2006 International Conference on the Economic and Social Development of Haiti in Port-au-Prince, yet the average Haitian still must survive on one dollar a day. Before the 2010 earthquake, although large amounts of aid have always flowed to Haiti, substantial amounts of money have never been spent, and sometimes a significant part was reallocated to other countries (Buss et al. 2009, IADB 2007). Since the earthquake, the delivery

[2] See Buss et al. (2009) for a detailed analysis of causes and drivers of foreign assistance failure attributable both to Haitian governance problems and to poor practices of multilateral and bilateral donors.

Figure 2: Haiti's GNI lower that the mean of the low human development countries



and the efficiency of international assistance to Haiti is even a more recurrent and thorny issue. From 2009 and 2012 the United Nations Office of the Special Envoy for Haiti conducted research on the delivery of international assistance to Haiti. According to data collected, multilateral and bilateral institutions have allocated more than $13 billion to relief and recovery efforts in the island nation, and an estimated 48% has been disbursed between 2010 and 2012. An additional estimated $3 billion was contributed to UN agencies and NGOs by private donors. The total in aid represented 3 times the revenue of the Government of Haiti during the same period. The Office of the Special Envoy revealed that an estimated 80 percent of all aid from bilateral and multilateral donors in 2010 bypassed national systems, and less than 1% of the $2.4 billion in humanitarian aid disbursed by bilaterals and multilaterals from 2010-2012 was channeled to the Government of Haiti [3] (Quigley and Ramanauskas 2012). Herrera, Lamaute-Brisson, Milbin, Roubaud, Saint-Macary, Torelli and Zanuso (2014) report than two years after the earthquake most of the assistance to the Haitian population has drastically decreased. Late 2012, more than 80% of the recipient households declared that they did not receive assistance for at least 3 months. Only health assistance and information programs were still active, as respectively 30% and 40% of the recipients declared some assistance in May 2012.

In such a context, estimating rigorously the long-run impact of earthquake

[3] See OECD (2011) for a discussion on the challenges of investing in national and local institutions in fragile settings

on the Haitian population is particularly relevant, from a policy point of view but also from a more academic perspective. As we shall see in the coming sections, such an evaluation poses a number methodological challenges, in the data collection and in the identification of the shock effect.

3 Empirical strategy

3.1 Data sources

This study combines data from three different sources, matched at primary section unit-level and communal section level (the lowest administrative unit in Haiti). The national representative Post Earthquake Living Conditions Survey (ECVMAS) conducted in late 2012, with the scientific support of the authors, was the first national socioeconomic survey to be taken since the earthquake, which consists of a sample of 4,951 households including 23,775 individuals (Herrera, Lamaute-Brisson, Milbin, Roubaud, Saint-Macary, Torelli and Zanuso 2014). The 2012 original data covers the entire country and is representative at department level and Metropolitan area, other urban area and rural level. Among the 500 primary section units (PSUs) covered by ECVMAS, 30 PSUs are representative of temporary camps population at mid-2012 (almost 370 thousands individuals). We also exploit the 2010 retrospective data available in the ECVMAS survey to benefit from the longitudinal dimension. [4]

Using a Geographic Information System (GIS) software in the WGS 1984 UTM Zone 48N coordinate system, we match ECVMAS PSU to a second source of data, the U.S Geological Survey, a data source for natural disasters, including seismic data obtained from seismographic instruments located around the world and mapping techniques (Zhao et al. 2006).

Finally, we use the 2009 Rural Census (RGA) communal section-level data. The RGA conducted between March and November 2009 was part of the World Programme for the Census of Agriculture of the FAO. The survey consists of an exhaustive sample of rural communal sections (570). Topic covered by the RGA include: migration, infrastructure, services, food security and violence issues.

3.2 Identification strategy

Our empirical strategy relies on difference-in-difference method. We make use for this purpose of recall data from the ECVMAS survey that enable us to sketch households' situation just before the earthquake occurred in 2010 and to construct a panel of households (as well as individuals) on the outcome variables described below (section 3.3). The impact of the earthquake can be estimated

[4] ECVMAS design is based on 1-2-3 survey methodology to measure informal economy and poverty. We add some specific earthquake-related questions, as well as residential and employment pathways in order to assess the impact of the earthquake. Several methodological issues have been resolved to collect good quality data in this post-disaster context (see Herrera, Lamaute-Brisson, Milbin, Roubaud, Saint-Macary, Torelli and Zanuso (2014), Herrera, Roubaud, Saint-Macary, Torelli and Zanuso (2014) for more details on the methodological challenges).

non-parametrically, simply by comparing the differnce of outcome before and after the earthquake of households living in strongly affected areas (i.e. which we refer to as '*treated*' households – see section 3.3.1 for a detailed definition of our '*treatment*' variable) to the before/after difference in outcome of households that were not affected (the '*untreated*'). Under some assumptions which we discuss later, this method provides an unbiased estimate of the impact of the event on the affected households:

$$\beta^{DID} = E[Y_{i1} - Y_{i0}|D = 1] - E[Y_{i1} - Y_{i0}|D = 0] \quad (1)$$

where Y_{it} is the outcome measured at time $t \in [0, 1]$ and D indicates the treatment, in our case, the fact of living in 2010 in an communal section strongly affected by the 2010 earthquake.

This is equivalent to estimating parametrically the following equation :

$$Y_{it} = \alpha t + \beta^{DID} D_i \cdot t + \eta_i + \epsilon_{it} \quad (2)$$

where t is a time variable, D_i is a dummy variable indicating whether household belongs to the treatment group and η_i are household fixed effects.

The main identifying condition is that the treated and untreated units, while not necessarily sharing the same characteristics, should have followed a similar trend in outcome if the earthquake had not occurred. This is referred to as the parallel trend assumption. In the ECVMAS we do observe households at two points in time only, and consequently, are not able to test whether treated and untreated households followed a similar trend before the earthquake occurred to test this assumption. We have some reasons however to doubt that the parallel trend assumption holds in our case.

While an earthquake is by definition exogenous in the sense that affected units are not selected along variables that also affect the outcome, it affects households in a delimited geographical zone, which may be characterized by specific attributes, which may be confounded with the earthquake impact (as they correlate with the shock). As detailed in section 2 the 2010 Haitian earthquake had its epicenter located about 20km away from Port-au-Prince, the country's capital and economic center. Damages were particularly heavy in the city and a large part of the earthquake victims lived in Port-au-Prince. It can easily be argued that Port-au-Prince and its inhabitants are quite specific and differ significantly from the rest of the country on many characteristics. See (Herrera, Lamaute-Brisson, Milbin, Roubaud, Saint-Macary, Torelli and Zanuso 2014) for detailed descriptive statistics on the living conditions and labour market in the Metropolitan Area and in the rest of the country. Under such condition, it is hard to believe that the treated households would have followed the same trend as the untreated ones, and that the parallel trend assumption holds. In other word, we lack good control units for the metropolitan households.

In order to address this issue we proceed to several adjustments. First, we restrict the estimation sample to households that lived in 2010 outside the Metropolitan Area of Port-au-Prince. We indeed believe that affected households outside this area are more comparable to the rest of the population, and that we are more likely to find good matches among the rest of the population. In addition to homogenising the estimation sample, this sample reduction brings another valuable contribution in that it informs about the impact of the earthquake outside Port-au-Prince. Little is known indeed about how has the population been affected outside the capital. The ECVMAS survey report shows that other areas than Port-au-Prince were also heavily affected (Herrera, Lamaute-Brisson, Milbin, Roubaud, Saint-Macary, Torelli and Zanuso 2014) : 40% of the totally destroyed dwellings were located outside the metropolitan area; 30% of the recorded death occurred outside the metropolitan area. Yet, for logistical reasons and for the sake of targeting efficiency, much of the international assistance has been concentrated in the city or in camps. Consequently, as the report shows, a large part of impacted households may not have benefited from this help.

Table 1 displays statistics on various types of assistance received by *impacted* households [5], as well as some information on visits to camps after the earthquake, and relates these statistics to the distance to the center of Port-au-Prince. In the first two columns, we compare households living in the Metropolitan area to others living outside, the last column reports correlation coefficient between access to assistance and the distance to the capital in kilometers. Let us first observe that coverage rates are particularly low when it comes to assistance other than information campaign[6]. Less than 5% of households that experienced heavy damages received assistance to clear rubbles around their house, less than 10% in total got reconstruction help and the more long term economic assistance concerned also a very little proportion of the impacted population. A part from reconstruction assistance, we observe that injured households located outside the Metropolitan area have received significantly less assistance than those coming from there. Correlations are also significant and negative. We also observe significant differences in camp frequenting, which is probably due to the fact that and indeed most camps where established very close to the metropolitan area [7].

This sample reduction however may not be sufficient to fully address the parallel trend condition. We thus resort to a second strategy to address the possible violation of the parallel trend hypothesis. We match our treated and untreated households on their probability of treatment exposure, following a methodology exposed in detail by Abadie (2005). This method basically extends the difference-in-difference methodology by modifying the parallel trend assumption into a conditional assumption.

If conditionally on a set of observed covariates X, treated and untreated units evolve on a same trend, and if we have $0 < P(D = 1|X) < 1$, that is that for each value of X there is a fraction of untreated households that can be used as control, then an unbaised estimator of the impact of a treatment on the treated can be obtained using a two-step weighted difference-in-difference:

[5] We make a distinction between *affected* (or treated) and *impacted* households, in this table we focus on households that saw their house strongly damaged or destroyed after the earthquake.
[6] These campaigns were aimed at preventing cholera epidemic
[7] cf. see the statistics on camp frequentation on the IOM website : http://iomhaitidataportal.info/dtm;

Table 1: Assistance and visits in camps by impacted* households

	Households that experienced heavy damages on their house			
	Metropolitan Area mean(sd) **(n=563)**	Outside MA mean(sd) **(n=263)**	Difference	Correlation with distance to Port-au-Prince
Assistance				
Any type of assistance	0.85 (0.37)	0.79 (0.41)	*	-0.093***
Any type but information	0.72 (0.46)	0.58 (0.49)	***	-0.176***
Clearing rubble	0.03 (0.16)	0.02 (0.14)	ns	-0.008
Reconstruction	0.07 (0.24)	0.11 (0.31)	**	-0.042
Food	0.47 (0.50)	0.17 (0.38)	***	-0.234***
Material	0.27 (0.44)	0.11 (0.31)	***	-0.169***
Health	0.58 (0.50)	0.41 (0.49)	***	-0.135***
Economic activity	0.04 (0.18)	0.04 (0.19)	ns	-0.043
Rehousing	0.44 (0.50)	0.16 (0.37)	***	-0.266***
Information	0.68 (0.47)	0.62 (0.49)	*	-0.067*
Camp				
Lived in a camp in 10/2012	0.37 (0.48)	0.22 (0.41)	***	-0.270***
At least one member passed by a camp between 01/2010 and 10/2012	0.61 (0.49)	0.28 (0.45)	***	-0.373***
Average number of days spent in camp by household members	438.8 (460.3)	179.1 (355.7)	***	-0.321***

*Note : this table only includes households living in 'treated' areas at the time the earthquake occurred

$$\beta^{wDID} = E[Y_1^1 - Y_1^0 | D = 1] = \frac{Y_1 - Y_0}{P(D = 1)} \cdot \frac{D - P(D = 1|X)}{1 - P(D = 1|X)} \tag{3}$$

where $P(D = 1|X)$ is estimated in a first stage, and weights derived from this first estimation are used into the non-parametric calculation of the estimator. This method builds on the propensity score matching method (Heckman et al. 1998) and leads to weight control observations in order to obtain a counterfactual that resembles our treated sample along observed characteristics.

We rely on this second strategy to estimate the impact of the treatment on our two main outcomes and to assess the heterogeneity of effects on wealth. However, as '*absdid*', the Stata package available online and created by Houngbedji (2015), for Abadie's semiparametric difference-in-difference estimator, does not estimate specification including interaction variables when the outcome is a binary variable, we thus proceed to an alternative parametric strategy suggested by Abadie (2005) to assess the heterogeneity of effects on the labour market outcome. We select a set of baseline observable characteristics X_{i0} believed to be related to the outcome dynamics of treated and untreated units and whose distribution differ between the two groups. Interacting those variables with our time variable enables us to introduce these variables linearly in equation 4 :

$$Y_{it} = \alpha t + \beta^{DID} D_i \cdot t + \gamma X_{i0} \cdot t + \eta_i + \epsilon_{it} \tag{4}$$

We introduce as baseline control both individual and communal section

(CS) characteristics (see section 3.4). As Abadie's semiparametric difference-in-difference estimator, this method extends the difference-in-difference methodology by modifying the parallel trend hypothesis into a conditional assumption :

$$E[Y_{i1}^0 - Y_0^0 | X_i, D_i = 1] = E[Y_{i1}^0 - Y_{i0}^0 | X_i, D_i = 0] \tag{5}$$

where Y_{i1}^0 denotes the outcome of individual i at time 1 had it not received the treatment and Y_{i0}^0 his belongs to the treatment group. If conditionally on these baseline observables, treated and untreated have the same outcome dynamic, equation 4 provides a valid estimate of the earthquake impact. With only two points in time we are not able to formally test this hypothesis, we realize a 'falsification' test by estimating the effect of the future earthquake on individuals' baseline outcome.

3.3 Definition and measures of variables of interest

3.3.1 Treatment variable

One of the additional reason explaining why it is not straightforward to estimate the impact of disasters arises from the fact that it is complicated to measure disaster intensity. ECVMAS survey includes different information about damages, but since the vulnerability prior to the disaster partly determines the extent of damages, these variables pose problems of endogeneity. The distance to the epicenter is a fully exogenous proxy for the intensity, but as earthquake intensity also depends on the geology and topography of the affected area, this measure is partial. [8]

In this article, we use the peak ground acceleration (PGA) of the 2010 Earthquake to construct our treatment variable. PGA is a common geological measure of local hazard that earthquakes cause, 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 storeys, which is the case of most buildings in Haiti (USGS online metadata). [9]

For each communal section in Haiti, we thus compute the PGA sustained and assign to each household the intensity experienced in the communal section

[8] We test alternative specifications with distance instead of PGA as treatment variable and our results are robust.

[9] Local measures of the ground motions induced by earthquakes are available only where stand seismographic stations, the mapping of the felt ground shaking and potential damage can be imputed from the characteristics of earthquakes and the geography of impacted areas, based on attenuation relations created by seismologists and engineers. PGA is a log-linear function of the distance to the epicenter among other terms, as well as estimated parameters using data from past earthquakes In the specific case of Haiti, even if the PGA is a more complete measure of earthquake intensity than the distance, it is not a perfect measure of it. Eberhard et al. (2010) mention in his technical report that the lack of seismographs and detailed knowledge of the physical conditions of the soils (e.g. lithology, stiffness, density, thickness) limit the precision of USGS assessment of ground-motion amplification in the widespread damage.

where it was living when the disaster occurred. [10] As the 2010 quake was a landmark event for the haitian population, the mis-location probability is very low, we thus argue that measurement error in the treatment variable is very limited, even for households staying in camps at the time of the survey[11].

We test different thresholds but relying on seismologic studies, we consider as '*treated*', the households who were living in 2010 in a communal section impacted by a PGA >= 18%g ('*g*' as the acceleration due to Earth's gravity, equivalent to g-force. In sections 4.1 and 4.2, we also test our results for a tri-level treatment). This limit also corresponds to the low bound of a very strong perceived shaking on a instrumental intensity scale (VII out of XII range of intensity, see Wald et al. (1999) for the conversion rule). If instrumentally derived seismic intensity alone is non sufficient to estimate the impact of an earthquake, the Modified Mercalli Intensities (MMI) scale [12] is more readily interpreted and more intuitive in terms of loss estimation. Eberhard et al. (2010) highlight that the VII range and greater intensity on MMI scale are associated with heavy damage, until earthquake intensity level XII which would correspond to total destruction. Table 2 displays for each level of MMI scale the distribution of the household damage score in the national sample. Up to the sixth level of intensity, from 67% to 76% of the household did not suffer damage and a very low proportion of households exposed to this relatively low intensity suffered extended damage. However, 43% of households exposed to a PGA >= 18%g, corresponding to level VII on MMI scale, did not suffer any damage, and more than 10% had their house completely destructed (damage score higher than 8).

3.3.2 Asset index

Our proxy measure for household well-being before and 3 years after the earthquake is based on households' possession of durable goods. [13] There are several

[10] Following a geographical matching approach we use a spatial join in ArcGIS to match USGS mapping data with ECVMAS survey's primary unit section polygons. 3 questions were asked in the 2012 ECVMAS questionnaire to accurately locate where people were living when the earthquake stroke. First question asked to each individual aged 10 and over: "Were you living in the same dwelling ?". If the answer is negative we asked if they were living in the same neighbourhood and finally if they moved further, we asked them the name of the commune and the communal section where they were living in Haiti at the time the earthquake stroke (the name of the country otherwise). For the analysis at household level, we consider that the households were located in 2010 where the household head was living.

[11] We find that 99% of households in camps were living in the "Ouest" department when the quake stroke. As the epicenter was in the middle of this department it makes sense that people remaining in camps almost 3 years after the disaster, likely the ones most affected by the earthquake, were living in this department.

[12] Unlike conventional MMI, the USGS estimated intensities are not based directly on observations of earthquake effects on people or structures but on historical events in the country.

[13] It would have been interesting to include more variables (e.g. housing features, type of sanitation, water source or access to education and wealth services) in our index, unfortunately the set of variables available for this analysis is relatively limited due to the inclusion of only few retrospective questions in the questionnaire. The ECVMAS, first nationwide representative survey related to living conditions and livelihoods after the earthquake, was highly expected as the need of updated statistics after the earthquake was such urgent in many aspects. Therefore, in partnership with IHSI and the World Bank, we had to make complicated trade-off to reduce the questionnaire and follow best practices in terms of interviews'

Table 2: Shaking intensity and damage score of the dwelling

MMI scale	Damage score of the dwelling										
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**Total**
I	13	0	0	1	1	1	0	0	1	0	17
PGA <0.0017	**76.47**	**0**	**0**	**5.88**	**5.88**	**5.88**	**0**	**0**	**5.88**	**0**	**100**
IV	944	67	84	36	23	8	19	5	3	16	1205
0.014≤ PGA <0.039	**78.34**	**5.56**	**6.97**	**2.99**	**1.91**	**0.66**	**1.58**	**0.41**	**0.25**	**1.33**	**100**
V	23	4	3	0	1	0	1	0	0	0	32
0.039≤ PGA <0.092	**71.88**	**12.5**	**9.38**	**0**	**3.13**	**0**	**3.13**	**0**	**0**	**0**	**100**
VI	782	111	117	57	36	12	22	6	4	12	1159
0.092≤ PGA <0.18	**67.47**	**9.58**	**10.09**	**4.92**	**3.11**	**1.04**	**1.9**	**0.52**	**0.35**	**1.04**	**100**
VII	292	55	83	55	46	25	38	14	25	53	686
0.18≤ PGA <0.34	**42.57**	**8.02**	**12.1**	**8.02**	**6.71**	**3.64**	**5.54**	**2.04**	**3.64**	**7.73**	**100**
VIII	640	156	195	116	163	83	136	40	55	217	1801
0.34≤ PGA <0.65	**35.54**	**8.66**	**10.83**	**6.44**	**9.05**	**4.61**	**7.55**	**2.22**	**3.05**	**12.05**	**100**
XI	7	3	1	2	0	0	3	0	1	7	24
0.65≤ PGA <1.24	**29.17**	**12.5**	**4.17**	**8.33**	**0**	**0**	**12.5**	**0**	**4.17**	**29.17**	**100**
Total	2,701	396	483	267	270	129	219	65	89	305	4,924
	54.85	**8.04**	**9.81**	**5.42**	**5.48**	**2.62**	**4.45**	**1.32**	**1.81**	**6.19**	**100**

Note: Zero observation for level II, III and X+ of Mercalli Instrumental Intensity.

arguments in favour of an asset-based approach compared to the more conventional income or expenditures measures. Firstly, Sahn and Stifel (2003) show that the asset index measures long-term wealth with less error than expenditures. Secondly, since vulnerability and resilience to natural disaster are dynamic concepts, we argue that consumption or income measures are limited in capturing response to economic difficulty. Owning durable goods helps people to insure themselves against falling into poverty and to cope with shocks (Dercon 1998, Zimmerman and Carter 2003). If conventional money-metric poverty measures rely on per capita household expenditure and per capita household income data, the asset index method is a more popular application of the multidimensional approach (Booysen et al. 2008). Finally, asset indices are also used to simulate income or expenditure poverty measures in the absence of more accurate monetary information (Filmer and Pritchett 2001). In developing countries, good quality data on consumption or income are scarce, a fortiori in comparable surveys over time. In Haiti consumption and/or income surveys were conducted in 1986, 1999, 2001 and 2012, but based on different designs, so that reliable monetary data are lacking in order to trace poverty and vulnerability trends before and after the earthquake.

We thus use the recall data on owned assets in the 2012 ECVMAS survey to create an alternative metric of households' welfare in 2010, just before the earthquake, and in 2012. We argue that in the specific case of Haiti, the measurement errors due to recall data, corresponding to the period just before the 2010 earthquake, is limited as the data quality literature stresses that when a phenomenon of large magnitude happens, the risk of measurement error asso-

duration.

ciated to recall is reduced (De Nicola and Giné 2014, Dex 1995). Dex (1995) highlight 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".

As all variables in our asset index are dummy variables, we rely on multiple correspondence analysis (MCA) methodology, more suited to analyse categorical variables (Benzecri et al. 1973, Asselin and Anh 2008, Asselin 2009, Booysen et al. 2008), to create our composite asset index. MCA provides information similar to those produced by factor analysis (FA) (used by Sahn and Stifel (2000)). This method however is less restrictive than the principal components analysis (PCA) (used by (Filmer and Pritchett 2001, Sahn and Stifel 2003)), essentially designed for continuous variables (Blasius and Greenacre 2006). Following (Asselin and Anh 2008), we created an asset index as a linear combination of categorical variables obtained from a MCA. The construction of the asset index was based on binary indicators on 12 private household assets.

Table 3 provides descriptive statistics about asset ownership in 2010 (with and without the Metropolitan area, respectively column 1 and 2) and in 2012 (with and without the Metropolitan area, respectively column (3) and (4)) and ACM weights for each index component (column (5)). Differences between the two samples confirm that households in the Metropolitan area are better off and the relative deprivation of other regions. To make our asset index comparable over time, it needs constant weights. We can use either "pooled" weights, estimated across the two periods (e.g. 2010, 2012) in order to have stable weights in time, or "baseline" weights obtained from the first period (e.g. 2010, before the earthquake). One could argue that "pooled" weights may introduce some endogeneity, as the distribution of durable goods might be affected by the earthquake. We thus opted for "baseline" weights, by definition not affected by the earthquake. Moreover, the asset index calculated based on "pooled" weights was extremely highly correlated with the one based on "baseline" weights (ρ=0.999, p-value<0.01).

In column (5), those components that reflect the relative higher standards of living, being owning an asset, contribute positively to the household's asset index score, while not owning one decreases it. All the primary components monotonically increase, our index is thus globally consistent. Less than 3% of the households owned a computer in 2010, they were still less than 4% in 2012, hence owning a computer contributes a lot in increasing the asset index (weight = 6.36). On the contrary, 60% of the households held at least one mobile phone in 2010, the proportion jumped to 76% in 2012. As owning a mobile phone is quite widespread, not owning one contributes more than the other components to decrease the household's asset index score, that is, measured of relative welfare. The first dimension explained 89% of inertia.

Although the limited set of variables constrains the interpretation of the resulting index as a complete measure of well-being, private assets tend to be closely associated with money-metric well-being (Booysen et al. 2008). Using the consumption data available for 2012, we assessed the robustness of this asset index as a poverty measure by comparing it to household per capita expenditure (deflated to October 2012). The index has a significant and positive correlation coefficient (ρ=-0.589) and Spearman rank correlation with household per capita

Table 3: Assets ownership and weights obtained from MCA

Variable	% households who own the asset				Categories	Baseline Weights
	2010		2012			
	with MA	without MA	with MA	without MA		
	(1)	(2)	(3)	(4)		(5)
Oven	5.65	2.30	5.44	2.09	**0**	-0.29
					1	4.78
Television	28.30	15.65	28.20	17.31	**0**	-0.74
					1	1.88
Radio	44.04	37.97	42.01	37.77	**0**	-0.79
					1	1.01
Mobile phone	59.93	53.41	75.58	70.33	**0**	-0.94
					1	0.63
Fridge	9.32	4.26	8.76	4.01	**0**	-0.41
					1	3.95
Generator	1.93	1.40	2.25	1.58	**0**	-0.14
					1	6.86
Inverter	3.58	2.29	3.42	2.35	**0**	-0.22
					1	5.84
Computer	2.84	1.34	3.91	1.77	**0**	-0.19
					1	6.36
Ventilator	13.54	6.48	13.05	7.75	**0**	-0.48
					1	3.09
Car	2.77	1.43	2.82	1.59	**0**	-0.19
					1	6.55
Motorcycle	3.68	4.33	4.74	5.60	**0**	-0.06
					1	1.62
Sewing machine	3.07	2.68	3.04	2.81	**0**	-0.04
					1	1.23

Note: Dummy variables 1= own the asset, 0= does not own the asset.

expenditure (ρ=-0.551). World Bank (2003) reported that is not unusual to have a relatively weak relationship with consumption, with correlation coefficients between 0.2 and 0.4. In part, this may be due to a restricted selection of private assets but also because asset indices are slow-moving compared to expenditure (or income), short term changes in economic situation of many households may leave the asset indices unchanged (Booysen et al. 2008). Our findings here are thus in line with these findings, and slightly at the upper end of the scale.

The minimum of the asset index at national level for 2010 and 2012 is -0.69, the maximum is 6.24. The mean is sightly higher in 2012 (0.08) than in 2010 (0.06). Tables 5 and 7 provide the mean (and standard deviation) of the asset index for the different sub-samples.

3.3.3 Labour market variables

To complete our assessment of the impact of the 2010 earthquake on economic activity and to better understand the potential coping strategies and barriers to resilience, we complete our analysis by evaluating the impact on labour market outcomes. The measurement of the active population is an indicator of the number of individuals involved in the labour market, whether they have a job (employed), or are searching for one (unemployed). According to the international definition from the International Labour Office (ILO), is considered an unemployed person anyone of working age (10 years and more in this study) who fills these three conditions: (1) without any work, (2) seeking work (has taken specific steps to obtain paid employment), (3) currently available for work.

Even though in developing countries, deprived of institutionalised mechanisms of protection for the unemployed, the notion of unemployment is not the most appropriate to measure the tensions on the labour market, it remains one of the forms of under-employment of the workforce.

Table 4 displays individual characteristics before and after the earthquake respectively, within the whole Haitian population, and among '*treated*', that is haitian individuals living in 2010 in an area strongly affected by the earthquake, and '*untreated*' groups. As we explain later in section 3.2, we consider two groups of treated individuals, one that includes individuals living in 2010 in the Metropolitan area (T1) and another one that excludes them (T2). The full sample includes a balanced panel of 18 024 individuals, that got two years older between both years. In 2012, on average, almost 57% of the population aged 10 or over is active. If we restrict our sample to the population aged 15 or over the labour force participation rate gains more than 6 points in 2012, exceeding 63%.

Three major findings emerge from this table. First, in 2010, there are no significant differences between the population living in areas strongly affected by the earthquake and the others in term of employment or labour market participation (except when we exclude the MA, the difference on labor market participation is significant at 10% level of error probability). When we keep the MA, there are no significant differences between inactive populations in the two groups. Second, the job structure is significantly different in 2010 and 2012, which can be partly explained by a specific evolution in the Metropolitan Area. This is confirmed by non significant differences between treated (without MA) and untreated zones, for self-employed and family workers, internship, apprentice status. Finally, in 2012, all the labour market characteristics are significantly different between the two groups, whether it includes the MA or not. This table thus suggests that individuals are less likely to participate in the labour market or to be employed when they were strongly affected by the 2010 earthquake.

Table 4: Individual characteristics before and after the 2010 Earthquake

	Total with MA	NT	T1 with MA	T2 without MA	NT-T1	NT-T2
	(1)	(2)	(3)	(4)	(5)	(6)
	mean (sd)	mean (sd)	mean (sd)	mean (sd)		
	(n=18024)	**(n=9133)**	**(n=8891)**	**(n=2155)**		
Baseline characteristics						
Age	32.05 (17.71)	32.83 (18.92)	31.24 (16.34)	32.67 (18.54)	***	ns
Sex (male=1)	0.48 (0.50)	0.50 (0.50)	0.46 (0.50)	0.48 (0.50)	***	*
No education	0.21 (0.41)	0.29 (0.45)	0.13 (0.34)	0.22 (0.41)	***	***
Pre-school education	0.01 (0.11)	0.02 (0.13)	0.01 (0.08)	0.01 (0.10)	***	*
Primary education	0.36 (0.48)	0.40 (0.49)	0.31 (0.46)	0.38 (0.48)	***	**
Secondary education	0.37 (0.48)	0.28 (0.45)	0.47 (0.50)	0.37 (0.48)	***	***
Superior education	0.05 (0.22)	0.02 (0.13)	0.08 (0.27)	0.02 (0.15)	***	*
Employed (yes=1)	0.49 (0.5)	0.5 (0.5)	0.49 (0.5)	0.51 (0.5)	ns	ns
Active (yes=1)	0.57 (0.5)	0.56 (0.5)	0.57 (0.5)	0.59 (0.49)	ns	*
Unemployed (yes=1)	0.08 (0.26)	0.07 (0.25)	0.08 (0.28)	0.08 (0.27)	***	**
Inactive (yes=1)	0.42 (0.49)	0.42 (0.49)	0.41 (0.49)	0.39 (0.49)	ns	**
Wage workers	0.14 (0.34)	0.08 (0.28)	0.19 (0.39)	0.12 (0.32)	***	***
Self-employed	0.31 (0.46)	0.35 (0.48)	0.27 (0.44)	0.34 (0.47)	***	ns
Family workers, internship	0.05 (0.21)	0.06 (0.25)	0.03 (0.16)	0.06 (0.23)	***	ns
2012 characteristics						
Employed (yes=1)	0.48 (0.50)	0.54 (0.50)	0.41 (0.49)	0.49 (0.50)	***	***
Active (yes=1)	0.57 (0.50)	0.60 (0.49)	0.53 (0.50)	0.57 (0.49)	***	**
Unemployed (yes=1)	0.09 (0.28)	0.05 (0.22)	0.12 (0.32)	0.08 (0.28)	***	***
Inactive (yes=1)	0.43 (0.50)	0.40 (0.49)	0.46 (0.50)	0.42 (0.49)	***	**
Wage workers	0.12 (0.32)	0.07 (0.26)	0.16 (0.37)	0.10 (0.30)	***	***
Self-employed	0.23 (0.42)	0.28 (0.45)	0.17 (0.38)	0.24 (0.43)	***	***
Family workers, internship	0.13 (0.34)	0.19 (0.39)	0.08 (0.26)	0.15 (0.36)	***	***

Note : Column (1) to (4) present means and standard deviation in parentheses. Column (1) corresponds to the full sample including the Metropolitan Area (MA) and column (2) to the Non-Treated group (NT). All the hhs living in MA in 2010 are part of the treated group. Column (3) and (4) present respectively the descriptive statistics for treated group (T_1) including MA and (T_2) excluding MA. Column (5) and (6) present the result of Ttest and Chi2 test, with *p<0.1, **p<0.05, ***p<0.01, to test differences between T1 group, column (3), and NT group column (2), and T2 group, column (4) and NT group column (2), excluding MA.

Thus, these figures provide a first insight into the impact of the 2010 earthquake on the labour market. However, they do not account of the different trends between the 2 years considered, the impact of the many other shocks that affected the population (e.g. hurricanes, floods, pandemics) or effects of any other observable or unobservable individual and household characteristics. Identifying this impact requires a specific identification strategy (see sections 3.2 and 4.2).

3.4 Descriptive statistics

Tables 5 and 7 provide descriptive statistics on household and commune characteristics before and after the earthquake respectively.

The first column reports variable means over the whole ECVMAS sample, and column (2) to (4) report statistics for sub-samples of 'untreated' (NT), and 'treated' households, including the Metropolitan area (T1) and excluding (T2) it respectively. Following the previous sections, we employ here an impact evaluation terminology, and refer 'treated' to households that lived in January 2010 in a PSU strongly affected by the earthquake (cf. section 3.3.1). Columns (5) and (6) test the differences of means between untreated households and the two subsamples of treated ones.

The asset index, one of our main outcome variables, is a composite index of various assets possessed by the household in 2010, and a good proxy of relative households' wealth (see section 3.3.2). As expected, we observe a sharp difference between the untreated group and the treated one, when it encompasses the Metropolitan Area. Restricting our sample reduces this difference by two-third, but it remains nevertheless significant. Untreated and treated groups also differ in household size, and this difference remains after taking out the metropolitan households. We observe no large differences in household composition. And finally, restricting our sample helps to get rid of some important differences on the employment of household heads.

Turning to commune characteristics[14]. Not surprisingly, we observe a strong relation between the treatment and the distance to Port-au-Prince and to the epicenter. Treated communes from the restricted sample are still located quite close to the epicenter (39km on average) and to Port-au-Prince (50km on average).

[14] As the treatment variable is defined at a lower level than communes, we need to reclassify communes and use the same threshold than we use at the communal section level : communes are considered treated if the average PGA recorded is greater or equal to 0.18%g (see section 3.3.1.

Table 5: Baseline descriptive statistics

	Total with MA (1)	**NT** (2)	**T1 with MA** (3)	**T2 without MA** (4)	**NT-T1** (5)	**NT-T2** (6)
	mean (sd)	mean (sd)	mean (sd)	mean (sd)		
Household characteristics	**(n=4941)**	**(n=2414)**	**(n=2527)**	**(n=608)**		
Treat : PGA>=0.18 (yes=1)	0.51	0	1	1		
PGA	0.21 (0.16)	0.06 (0.05)	0.35 (0.08)	0.26 (0.05)	***	***
Asset Index	0.06 (1.06)	-0.33 (0.65)	0.44 (1.23)	-0.08 (0.82)	***	***
Household size	4.65 (2.46)	4.99 (2.65)	4.33 (2.21)	4.49 (2.40)	***	***
Single person household (yes=1)	0.06 (0.23)	0.06 (0.23)	0.06 (0.24)	0.06 (0.25)	ns	ns
Couple without children (yes=1)	0.05 (0.22)	0.05 (0.21)	0.06 (0.23)	0.06 (0.24)	ns	ns
Couple with children (yes=1)	0.25 (0.43)	0.27 (0.45)	0.23 (0.42)	0.25 (0.43)	***	ns
Single-parent nuclear (yes=1)	0.10 (0.31)	0.09 (0.29)	0.12 (0.32)	0.12 (0.33)	***	**
Extended single-parent fam. (yes=1)	0.13 (0.34)	0.13 (0.33)	0.14 (0.35)	0.13 (0.34)	ns	ns
Extended household (yes=1)	0.40 (0.49)	0.41 (0.49)	0.40 (0.49)	0.38 (0.48)	ns	ns
HH head variables						
Age	45.95 (15.22)	48.79 (15.53)	43.24 (14.41)	47.28 (15.70)	***	**
Sex (male=1)	0.57 (0.50)	0.61 (0.49)	0.52 (0.50)	0.56 (0.50)	***	**
No education	0.34 (0.47)	0.47 (0.50)	0.22 (0.41)	0.38 (0.49)	***	***
Pre-school education	0.02 (0.12)	0.02 (0.14)	0.01 (0.10)	0.02 (0.14)	***	ns
Primary education	0.30 (0.46)	0.31 (0.46)	0.30 (0.46)	0.33 (0.47)	ns	ns
Secondary education	0.28 (0.45)	0.17 (0.38)	0.39 (0.49)	0.24 (0.43)	***	***
Superior education	0.06 (0.23)	0.02 (0.15)	0.09 (0.28)	0.03 (0.16)	***	ns
Employed (yes=1)	0.84 (0.37)	0.85 (0.36)	0.83 (0.37)	0.87 (0.34)	*	ns
Unemployed (yes=1)	0.05 (0.21)	0.04 (0.19)	0.06 (0.24)	0.04 (0.19)	***	ns
Inactive (yes=1)	0.09 (0.28)	0.10 (0.29)	0.08 (0.27)	0.07 (0.26)	*	*
Communal section characteristics	**(n=271)**	**(n=210)**	**(n=61)**	**(n=48)**		
Communal section density	2759.96 (4481.21)	2041.07 (3021.49)	6354.39 (7851.13)	2921.8 (3506.11)	***	ns
Commune characteristics	**(n=132)**	**(n=110)**	**(n=22)**	**(n=14)**		
Commune distance to epicenter (km)	106.89 (48.88)	121.68 (38.56)	32.89 (17.41)	38.76 (18.65)	***	***
Commune distance to PaP (km)	106.78 (55.33)	121.11 (47.90)	35.08 (26.90)	49.72 (22.83)	***	***

Note : Column (1) to (4) present means and standard deviation in parentheses. Column (1) corresponds to the full sample including the Metropolitan Area (MA) and column (2) to the Non-Treated group (NT). All the hhs living in MA in 2010 are part of the treated group. Column (3) and (4) present respectively the descriptive statistics for treated group (T1) including MA and (T2) excluding MA. Column (5) and (6) present the result of Ttest and Chi2 test, with *p<0.1, **p<0.05, ***p<0.01, to test differences between T1 group, column (3), and NT group column (2), and T2 group, column (4) and NT group column (2), excluding MA.

Population density, however decreases sharply as we exit the Metropolitan Area, and is no longer different between the untreated the restricted treated sample[15]. Table 6 complete the analysis on communal section baseline characteristics with data from the 2009 rural census. In both full and restricted sample, we observe significant differences regarding electricity, health, education and communication infrastructures between treated and non treated communal

[15] We use the figures from the demographic projection made by IHSI in 2012 based on the last available population census (2003), not corrected for the earthquake fatalities. We also have the figures for 2003 but for an incomplete set of communes. The density of both years are nevertheless highly correlated (with a correlation coefficient equal to 0.97). Furthermore, Herrera, Lamaute-Brisson, Milbin, Roubaud, Saint-Macary, Torelli and Zanuso (2014) show that the main population moves due to the earthquake were mostly restricted in the very short term.

section. Overall, it is quite clear nevertheless that taking out the thirteen communal sections of the Metropolitan Area strongly leads to homogenizing the sample.

Table 6: Communal sections' characteristics – RGA 2009

	Ensemble **(n=271)**	NT **(n=210)**	T1 **(n=61)**	NT-T1	T2 **(n=48)**	NT-T2
	(1)	(2)	(3)	(4)	(5)	(6)
In Migration important (1=yes)	0.16	0.14	0.23	n.s.	0.17	n.s.
	(0.37)	(0.35)	(0.42)		(0.38)	
25% population with electricity (1=yes)	0.08	0.03	0.27	***	0.17	***
	(0.28)	(0.17)	(0.45)		(0.38)	
75% population with drinking water (1=yes)	0.02	0.00	0.07	***	0.02	n.s.
	(0.14)	(0.07)	(0.25)		(0.15)	
Sanitation unit operational in SC (1=yes)	0.48	0.47	0.53	n.s.	0.49	n.s.
	(0.50)	(0.50)	(0.50)		(0.51)	
Pharmacy operational in SC (1=yes)	0.26	0.22	0.40	***	0.36	**
	(0.44)	(0.42)	(0.49)		(0.49)	
Secondary school operational in SC (1=yes)	0.52	0.46	0.75	***	0.74	***
	(0.50)	(0.50)	(0.44)		(0.44)	
Post office operational in SC (1=yes)	0.05	0.03	0.12	***	0.13	***
	(0.22)	(0.18)	(0.33)		(0.34)	
Registry office operational in SC (1=yes)	0.13	0.11	0.17	n.s.	0.19	n.s.
	(0.33)	(0.32)	(0.38)		(0.40)	
Court operational in SC (1=yes)	0.11	0.10	0.17	n.s.	0.19	*
	(0.31)	(0.29)	(0.38)		(0.40)	
Gas station operational in SC (1=yes)	0.10	0.07	0.22	***	0.17	**
	(0.31)	(0.26)	(0.42)		(0.38)	
Fixed phone operational in SC (1=yes)	0.18	0.13	0.35	***	0.30	***
	(0.39)	(0.34)	(0.48)		(0.46)	
Sport facility operational in SC (1=yes)	0.12	0.11	0.17	n.s.	0.17	n.s.
	(0.33)	(0.31)	(0.38)		(0.38)	
Severity of food insecurity	0.28	0.27	0.33	n.s.	0.31	n.s.
	(0.27)	(0.26)	(0.30)		(0.28)	
Physical violence growing (1=yes)	0.31	0.33	0.25	n.s.	0.24	n.s.
	(0.46)	(0.47)	(0.44)		(0.43)	
Violence on resource sharing growing (1=yes)	0.38	0.36	0.43	n.s.	0.38	n.s.
	(0.49)	(0.48)	(0.50)		(0.49)	

Table 7 reports post-earthquake household characteristics. The asset index stayed stable on average for the whole haitian population between 2010 and 2012. Splitting it in different treatment groups shows different dynamics, between households living in zones not directly affected by the earthquake and households living in strongly affected areas. The index increased significantly within the non-treated group, gaining an average of 0.06 points. It decreased in the first treated group (that includes the MA) and remained stable in the second treated group. Taking the Metropolitan Area alone, this index score decreased on average by 0.05 points. Those figures indicate that the earthquake has probably had an impact on households' durables, and that this impact has been particularly strong in Port-au-Prince. Outside the MA and within affected zone, the decline is not significant, but this dynamic should be compared to a control group in order to evaluate what the trend should have been had the earthquake not occurred.

Households became significantly larger (+3% on average for the whole country, and at a similar rate in treated and untreated groups), an evolution that may be, at least partly, attributable to the earthquake. Indeed as reported by Herrera, Lamaute-Brisson, Milbin, Roubaud, Saint-Macary, Torelli and Zanuso (2014), the catastrophe has forced individuals to join new households or form new ones with further family members. The phenomenon is non negligible as we estimated that 160,000 individuals got relocated in new households after the earthquake, most of them being located outside of Port-au-Prince. This increase in household size may also be the result of degraded economic conditions that have discouraged young adults to leave their parents' households and to form new households. Regarding the employment status of household heads, we observe as for individual-level figures (see section 3.3.3, table 4) that it reduced on average over the whole country , and that more household heads became inactive in 2012 in treated zones than in untreated ones. This evolution seems to be partly due to the earthquake as explained in section 3.3.3. We examine the impact of the earthquake on employment in more detail in section 4.2.

The last part of table 7 reports descriptive statistics on the outreach of post-earthquake assistance programs. In table 1, we looked at the difference of outreach among impacted households living in and out the MA and found significant differences. Here we see that households from treated zones have received significantly greater help than those from untreated zones. We also see that some programs, related to information campaigns in particular have reached many households outside the affected areas.

Table 7: 2012 descriptive statistics

	Total with MA	NT	T1 with MA	T2 without MA	NT-T1	NT-T2
	(1) mean (sd)	(2) mean (sd)	(3) mean (sd)	(4) mean (sd)	(5) mean (sd)	(6) mean (sd)
Household characteristics	**(n=4941)**	**(n=2414)**	**(n=2527)**	**(n=608)**		
Treat : PGA>=0.18 (yes=1)	0.51	0	1	1		
PGA	0.21 (0.16)	0.06 (0.05)	0.35 (0.08)	0.26 (0.05)	***	***
Asset Index	0.08 (1.05)	-0.27 (0.67)	0.40 (1.24)	-0.07 (0.84)	***	***
Household size	4.80 (2.44)	5.14 (2.62)	4.47 (2.20)	4.59 (2.36)	***	***
Single person household (yes=1)	0.06 (0.24)	0.06 (0.24)	0.07 (0.25)	0.08 (0.27)	ns	*
Couple without children (yes=1)	0.03 (0.17)	0.03 (0.18)	0.03 (0.17)	0.03 (0.18)	ns	ns
Couple with children (yes=1)	0.26 (0.44)	0.27 (0.45)	0.25 (0.43)	0.24 (0.43)	**	ns
Single-parent nuclear (yes=1)	0.11 (0.31)	0.09 (0.29)	0.12 (0.32)	0.13 (0.33)	***	***
Extended single-parent fam. (yes=1)	0.15 (0.36)	0.14 (0.35)	0.16 (0.36)	0.14 (0.35)	ns	ns
Extended household (yes=1)	0.39 (0.49)	0.40 (0.49)	0.38 (0.49)	0.38 (0.49)	ns	ns
HH head variables						
Employed (yes=1)	0.72 (0.45)	0.78 (0.41)	0.65 (0.48)	0.71 (0.45)	***	***
Unemployed (yes=1)	0.09 (0.29)	0.05 (0.21)	0.13 (0.34)	0.07 (0.26)	***	**
Inactive (yes=1)	0.19 (0.39)	0.17 (0.37)	0.22 (0.41)	0.22 (0.41)	***	***
Assistance						
Any type of assistance (yes=1)	0.71 (0.45)	0.65 (0.48)	0.76 (0.43)	0.77 (0.42)	***	***
Any type but information (yes=1)	0.48 (0.50)	0.40 (0.49)	0.56 (0.50)	0.52 (0.50)	***	***
Clearing rubble (yes=1)	0.01 (0.09)	0.00 (0.04)	0.01 (0.12)	0.01 (0.09)	***	***
Reconstruction (yes=1)	0.03 (0.16)	0.00 (0.06)	0.05 (0.21)	0.08 (0.26)	***	***
Food (yes=1)	0.22 (0.41)	0.09 (0.29)	0.33 (0.47)	0.18 (0.39)	***	***
Material (yes=1)	0.11 (0.31)	0.05 (0.22)	0.16 (0.37)	0.10 (0.30)	***	***
Health (yes=1)	0.38 (0.48)	0.34 (0.47)	0.41 (0.49)	0.39 (0.49)	***	**
Economic activity (yes=1)	0.02 (0.15)	0.01 (0.11)	0.03 (0.18)	0.03 (0.17)	***	***
Rehousing (yes=1)	0.15 (0.35)	0.02 (0.14)	0.27 (0.44)	0.16 (0.37)	***	***
Information (yes=1)	0.58 (0.49)	0.55 (0.50)	0.60 (0.49)	0.59 (0.49)	***	*
Other (yes=1)	0.00 (0.06)	0.00 (0.06)	0.00 (0.07)	0.01 (0.10)	ns	**

Note : Column (1) to (4) present means and standard deviation in parentheses. Column (1) corresponds to the full sample including the Metropolitan Area (MA) and column (2) to the Non-Treated group (NT). All the hhs living in MA in 2010 are part of the treated group. Column (3) and (4) present respectively the descriptive statistics for treated group (T1) including MA and (T2) excluding MA. Column (5) and (6) present the result of Ttest and Chi2 test, with *p<0.1, **p<0.05, ***p<0.01, to test differences between T1 group, column (3), and NT group column (2), and T2 group, column (4) and NT group column (2), excluding MA.

4 Results

4.1 Long-lasting impact on household asset index

Tables 8 and 9 report results from the estimation of equation 2 in witch the outcome is our asset index variable. Table 8 shows the estimates over the whole sample and table 9 displays it on the sample excluding the MA. For both tables, column (1) show the results of the baseline specification. Column (2) includes the set of baseline household characteristics (e.g. sex, age and education level of the household head). Column (3) additionally includes the set of baseline communal section characteristics (e.g. density, a dummy variable for the importance of in migration, a severity index of food security, two dummies variables related to the level of violence and eleven infrastructure and facilities variables (see tables **??** and **??** in appendix detailed results including controls variables)). In column (4) we include household fixed effects that control for all unobserved heterogeneity between households. Column (5) show the results for the same specification as column (4) but on the restricted sample of column (3) (resulting from the inclusion of RGA variables that lead us to exclude all urban communal sections. Note that in the sample including MA this results in halving the estimation sample).

Results exhibit a negative and significant impact of the earthquake on households' asset index, indicating that three years after the event, families from affected areas were still strongly suffering from the shock and had not yet recovered. This result is quite stable across the different specifications and estimation sample. Note also that models that include households fixed effects produce very similar results to those including household and CS baseline control variables, indicating that those last capture quite well the heterogeneity between units. The impact is not statistically significant in the sample excluding the MA (table 9), a result that is stable across different specifications and estimation samples. Thus, results from households living in the MA in 2010, close to the epicenter, appear to be the main driving force of these results.

Independently of the statistical significance, the impact is in magnitude twice as large in the full sample than in the restricted sample. Standardized coefficients show that living in an affected communal section in 2010 leads 0.09 standard deviation decrease in predicted wealth index, with the other variables held constant (Tables **??** and table **??** in appendix provide standardized effects). The coefficient estimated being the average treatment effect on the treated (ATT), the presence of metropolitan households, among the most severely impacted, in the first sample is likely to inflate the figure.

As seen earlier in section 3.2, the validity of such estimates hinges on a strong identifying assumption, which states that wealth trajectories of households living in areas which did not experience strong ground tremors, are the right conterfactual. According to descriptive statistics (Tables 4 and 5 described respectively in sections 2.4 and 3.4), we suspect that 'treated' and 'non treated' groups would have not followed parallel paths in terms of wealth, as the extreme event affects a delimited zone which may be characterized by specific attributes, which may be confounded with the shock (section 3.2). A first strategy is thus

Table 8: Asset index DID - With MA

	(1)	(2)	(3)	(4)	(5)
Time	0.06***	0.06***	0.05***	0.06***	0.05***
	(0.02)	(0.01)	(0.01)	(0.01)	(0.00)
Treat	0.75***	0.49***	0.17***		
	(0.07)	(0.05)	(0.05)		
Time x Treat	-0.10**	-0.10**	-0.15***	-0.10***	-0.15***
	(0.05)	(0.04)	(0.05)	(0.02)	(0.04)
Household baseline controls	NO	YES	YES	NO	NO
CS baseline controls	NO	NO	YES	NO	NO
Household FE	NO	NO	NO	YES	YES
Constant	-0.30***	-1.01***	-0.79***	0.08***	-0.27***
	(0.02)	(0.10)	(0.06)	(0.01)	(0.01)
Observations	9,732	9,722	4,818	9,732	4,818
Number of idmen_panel	4,927	4,922	2,428	4,927	2,428
R2-within	0.006	0.006	0.024	0.006	0.024
R2-between	0.121	0.348	0.312	0.117	0.096
R2-overall	0.112	0.319	0.282	0.048	0.030

Note: Clustered standard errors in parentheses at communal section and year level
*** p<0.01, ** p<0.05, * p<0.1

Table 9: Asset index DID - Without MA

	(1)	(2)	(3)	(4)	(5)
Time	0.06***	0.06***	0.05***	0.06***	0.05***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)
Treat	0.24**	0.19**	0.12**		
	(0.10)	(0.09)	(0.05)		
Time x Treat	-0.05	-0.05	-0.06	-0.05	-0.06
	(0.05)	(0.05)	(0.05)	(0.04)	(0.05)
Household baseline controls	NO	YES	YES	NO	NO
CS baseline controls	NO	NO	YES	NO	NO
Household FE	NO	NO	NO	YES	YES
Constant	-0.30***	-0.68***	-0.76***	-0.26***	-0.35***
	(0.02)	(0.05)	(0.05)	(0.01)	(0.01)
Observations	5,969	5,965	4,240	5,969	4,240
Number of idmen_panel	3,017	3,015	2,135	3,017	2,135
R2-within	0.015	0.016	0.017	0.015	0.017
R2-between	0.018	0.206	0.260	0.012	0.054
R2-overall	0.017	0.188	0.239	0.000	0.006

Note: Clustered standard errors in parentheses at communal section and year level
*** p<0.01, ** p<0.05, * p<0.1

to exclude from the estimation sample households that lived in the Metropolitan Area of Port-au-Prince, arguing that in this sub-sample strongly affected areas are more comparable to the control group. Table 5 suggests that this strategy help to reduce the baseline differences between 'treated' and 'non treated' groups at households level.

The ideal would be to test the parallel trend hypothesis over two periods before the occurrence of the earthquake, unfortunately we don't have the panel data required to implement this "placebo" test. Yet, we can still estimate the impact of a "future" earthquake (t=1) on baseline wealth, following this equation:

$$Y_{i0} = \alpha + \beta D_i + \epsilon_i \tag{6}$$

where, Y_{i0} is the household (or individual) outcome in 2010, and D_i is a dummy equal to 1 if the household (or the individual) i is living in a area that is going to be hit by the extreme hazard in 2010. The significance of the coefficient β is not a direct test for the parallel trend but provides a good indication of whether the hypothesis plausibly holds. By adding baseline characteristics X_{i0} to equation 6, we can further get an intuition of whether conditionally on this set of observables, treated and non treated households would follow the same trend. Formally, the test is written :

$$Y_{i0} = \alpha + \beta D_i + \gamma X_{i0} + \epsilon_i \tag{7}$$

Table 10: "Falsification" test on asset index

Dependent variable: asset index 2010	**With MA**			**Without MA**		
	(1)	(2)	(3)	(4)	(5)	(6)
Treat	0.76***	0.43***	0.09***	0.24**	0.21***	0.07*
	(0.10)	(0.07)	(0.03)	(0.10)	(0.08)	(0.04)
Household baseline controls	NO	YES	YES	NO	YES	YES
CS baseline controls	NO	NO	YES	NO	NO	YES
Observations	4,805	4,787	2,390	2,952	2,937	2,105
R-squared	0.13	0.32	0.32	0.02	0.19	0.25

Note: Standard errors clustered at the communal section level in parentheses *** p<0.01, ** p<0.05, * p<0.1

Results of the falsification test are reported in Table 10. We run the test over the two estimation samples. Results show first that without baseline control, the future earthquake has a strong and positive impact on households initial wealth level, providing a strong evidence of the presence of confounding factors, implying a selection bias in basic estimates. Comparing columns (1) and (4) we see that the exclusion of MA households in the estimation sample considerably helps in reducing the bias, yet it remains significant. In column (2) and (5) we include baseline household-level controls, that may capture some heterogeneity in outcome dynamic between the treated and non treated groups. The reduction in the size of the coefficients indicate that these variables do capture heterogeneity but that they are not sufficient for ensuring the conditional assumption. The last columns (3) and (6) displays results of this falsification test after controlling for communal section baseline characteristics. If we are able to reduce a lot the differences between 'treated' and 'non treated' groups, we are not able to capture all heterogeneity and to satisfy the conditional identifying the country. The earthquake indeed hit the country in a very specific zone, affecting specific households and individuals and limited data availability on the pre-earthquake period does not allow us to fully address this issue [16]

Yet, as Table 10 shows, the inclusion of baseline control variables enable to correct for a substantial share of the selection bias. Therefore, to finally strengthen the robustness of our previous results, we compute semi-parametric DID estimates, following Abadie (2005). He suggests a two-step weighting procedure 3.2, which combines DID and matching estimators to relax the somehow strong DID identifying assumption which, in this method, has to hold conditional on covariates. Intuitively, it works by weighting down the temporal difference in the wealth index for the non-treated households for those values of covariates which are over-represented among them and weighting-up this difference for those values of covariates under-represented.

Results from the first stage, that is estimation of the propensity score, are shown in the appendix (table A.4)[17].

Results of equation 3 are reported in first line of table 11. As previously, we find a negative and significant long-lasting impact of the earthquake on households' asset index. This result however becomes significant when we take out MA households from the estimation sample. Note that with these weights, results are slightly lower but nevertheless quite similar in magnitude to those obtained previously with the parametric DID estimates including baseline controls or household fixed effects. We are thus quite confident in their robustness.

These non significant result in the second sub-sample is likely to be due to the presence of heterogeneous impacts across the affected population. We thus explore in the following parts of table 11 potential sources of heterogeneity : were initially poorer households more impacted than the richer ones or on the contrary could they recover better from the shock? Could women-headed households recover as much as men-headed households ?

The first source of heterogeneity we look at is households' initial wealth. The first estimation including an interaction of the treatment with baseline wealth

[16] A previous version of this paper included some covariates at commune level, from the 2007 Enquête sur l'Emploi et l'Economie Informelle (EEEI) survey instead of the set of 2009 communal section variables. The access to the general agricultural census, conducted in 2009, allowed us to improve our estimates by adding more and better covariates but potentially add a selection issue related to the restriction of the sample. In table A.1 in appendix, we also show estimates of models (2) and (5) on the restricted RGA sample to check whether this reduction in significativity is not only due to sample restrictions. Results are quite similar to those shown in table 10 which make us confident that it is indeed the inclusion of variables, rather than the restriction of the sample, that helps to reduce significativity. We are currently working on the possibility to use intensity of light at night data for improving our parallel trend test.

[17] Note that this table displays the simple logit estimates, while the command *absdid* created by Houngbedji (2015) we use estimates the propensity score non-parametrically.

Table 11: Semi-parametric DID and heterogeneity of the effect

	With MA n=2375		Without MA n=2105	
ATT	Coef.	Std error	Coef.	Std error
Treat	-0.103***	(0.035)	-0.032	(0.028)
Treat	-0.095***	(0.033)	-0.045	(0.033)
Treat x wealth 2010	-0.213***	(0.063)	-0.111*	(0.064)
Treat	0.036	(0.025)	0.031	(0.020)
Treat x tercile 2	0.000	(0.054)	-0.012	(0.044)
Treat x tercile 3	-0.419***	(0.093)	-0.262***	(0.102)
Treat	-0.192***	(0.037)	-0.117	(0.039)
Treat x Male-headed HH	0.161**	(0.067)	0.151***	(0.055)
Treat	-0.112**	(0.047)	-0.034	(0.037)
Treat x Head has pre-school educ.	-0.221	(0.148)	-0.303*	(0.157)
Treat x Head has primary educ.	0.072	(0.090)	-0.014	(0.056)
Treat x Head has secondary educ.	-0.038	(0.079)	-0.012**	(0.084)
Treat x Head has superior educ.	0.032	(0.193)	0.659***	(0.319)

show that the richest were relatively more affected. We then divide the whole population into wealth terciles (based on the 2010 asset index). Results indicate that the richest tercile seems to record, three years after the catastrophe, the greatest losses. Such a result is implied by our choice of dependent variable. Our index is only based on the possession of physical goods, and does not account for many other dimensions of well-being (which would encompass human or social capital for instance). In the Haitian context the poorest hold very little and have sadly not much to loose when looking at durables. Unfortunately, we lack the baseline data that would enable us to account for other sources of well-being and help us better measure the losses experienced by the poor (for instance psychological measures). Nevertheless, from an economic perspective the main adverse effects of an earthquake are caused by the destruction of physical capital, held in large parts by the richer parts of the population, who inevitably face a negative shock.

We then find significant differences between male and female-headed households, the former one having recovered better than the later ones. While this effect may be due at least in part to the fact that we identify households head in 2012, and that part of female-headed households are so because of human loss due to the earthquake, it is important to note that in Haiti in normal time, an important share of households (43% according to the 2007 EEEI survey) are headed by women. Female-headed households thus appear more vulnerable, and less armed to face and cope with such a shock than the male-headed households.

Finally, the decomposition by education level shows that the least educated household heads experienced greater losses than the more educated ones three years after the earthquake. Access to information on earthquake prevention and adaptation strategies, may play a role here, as well as households' ability to use post-earthquake coping strategies.

4.2 Impact on labour market participation

If the previous results provide some evidence that the earthquake have a long-lasting impact on household well-being and not only the one in Metropolitan area who received the strongest physical intensity, one additional question seems crucial for policy intervention: the differential vulnerability of individuals to this unexpected shock. In order to delve into the different mechanisms at play that help to explain how some individuals cope and recover better from the initially negative shocks, we also estimate the effect of the 2010 earthquake on individual labour market participation. We thus estimate the equation 2 on a balanced panel of 17 520 individuals aged 10 years and above in 2012 for the full sample and 10 985 individuals for the restricted sample, taking out of the estimation sample households that lived in 2010 in the Metropolitan Area. As already mentioned, in addition to homogenising the estimation sample, this sample reduction brings another valuable contribution in that it informs about the impact of the earthquake outside Port-au-Prince, given less media and institutions coverage.

Tables 12 and 13 provide the regression results from equation 2 at individual level for respectively sample with and without Metropolitan Area. Individual fixed effect captures the effect of any unobservable time-invariant individual characteristics. We estimate these specifications with a linear probability model (LPM), with robust standard errors. Although logit models are more appropriate to binary dependent variables, identification in conditional (fixed-effects) logit models only relies on observations which exhibit time variation regarding the dependent variable (around 20% in both full and restricted samples), as the others have no effect on the estimation (their individual's contribution to the log-likelihood is zero). Additionally, deriving marginal effects from conditional (fixed-effects) logit estimations including interaction terms remains quite tricky (Ai and Norton 2003). Thus, we rely on LPM to investigate the effects on the whole sample and the heterogeneity of effects and estimate a conditional (fixed-effects) logit models to corroborate the robustness of our results.

Results in table 12 suggest that the earthquake has an overall negative long-lasting impact on subsequent labour market participation. The LPM coefficients including individual fixed effects indicate an average drop of about 7 percentage points (column (4)) in the probability to participate to the labour market, 3 years after the shock, for individuals incurring a strong physical intensity in 2010 (8 p.p. in the RGA restricted sample, column (5)). According to table 13, the probability to participate to the labour market decrease (-5 p.p, column (4)) also for people living outside the strongly affected areas in 2010 (- 6 p.p. in the RGA restricted sample, table 13, column (5)). Unfortunately the level of education was not measured at the baseline, assuming that between 2010 and 2012 the level of education of an adult is very unlikely to change. [18].

The decrease of the probability to participate to the labour market for the

[18] Considering that a change in the last level of education reached is more likely to have changed for young people, we also estimate the regression for equation 2 only on individuals aged from 25 to 54 and find that our result are robust (negative, same size of effects and strongly significant). The coefficient on the treatment dummy is significantly negative and strongly significant in all specifications, which is also consistent with the results of the conditional (fixed-effects) logit model . Results are available upon request.

Table 12: Labour market participation DID - With MA

	(1)	(2)	(3)	(4)	(5)
Time	0.03***	0.03***	0.05***	0.03***	0.05***
	(0.01)	(0.01)	(0.01)	(0.00)	(0.01)
Treat	0.01	-0.01	0.04***		
	(0.01)	(0.01)	(0.01)		
Time x Treat	-0.07***	-0.07***	-0.08***	-0.07***	-0.08***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Ind & hh baseline controls	NO	YES	YES	NO	NO
CS baseline controls	NO	NO	YES	NO	NO
Individual FE	NO	NO	NO	YES	YES
Constant	0.56***	-0.54***	-0.46***	0.57***	0.58***
	(0.01)	(0.02)	(0.02)	(0.00)	(0.00)
Observations	36,048	35,882	17,568	36,048	17,568
Number of idmen_panel	18,024	17,941	8,784	18,024	8,784
R2-within	0.006	0.006	0.011	0.006	0.011
R2-between	0.001	0.447	0.436	0.001	0.000
R2-overall	0.002	0.356	0.344	0.002	0.002

Note: Clustered standard errors in parentheses at communale section and year level
*** p<0.01, ** p<0.05, * p<0.1

individual living in affected areas might be partly explained by the significant decrease of self-employed between 2010 and 2012, especially for individuals of the 'treated' sample, where people lost some productive assets in the aftermath of the earthquake. According to ECVMAS data, 15% of the households declare that at least one member stop economic activities because of the damages occurred to their dwellings, almost one household out of four in the 'treated' group.

As in the previous section, the validity of these findings depend on whether the identifying condition is verified. We run the same 'falsification' test we did in the previous section at household-level. Results are presented in Table 14 and are much more encouraging than in the previous section. Here indeed we find that there is no significant difference between individuals living in area affected by strong ground motions and the one living outside regarding baseline labour market participation in the full sample estimation (except column (2), when we control for age squared and household size). We find some significant difference between the treated ad the untreated in the restricted sample estimation. However, after controlling for a complete set of baseline observable communal section, household (except household size) and individual characteristics (except age squared), differences vanish, providing evidence that conditionally on this set of variables, treated and untreated individuals would have evolved on a same trend if the earthquake had not occurred.

Yet, as table 14 shows, the selection bias is reduced. The inclusion of baseline

Table 13: Labour market participation DID - Without MA

	(1)	(2)	(3)	(4)	(5)
Time	0.03***	0.03***	0.05***	0.03***	0.05***
	(0.01)	(0.01)	(0.01)	(0.00)	(0.01)
Treat	0.02	0.02**	0.03**		
	(0.01)	(0.01)	(0.02)		
Time x Treat	-0.05***	-0.05***	-0.06***	-0.05***	-0.06***
	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)
Ind & hh baseline controls	NO	YES	YES	NO	NO
CS baseline controls	NO	NO	YES	NO	NO
Individual FE	NO	NO	NO	YES	YES
Constant	0.56***	-0.47***	-0.44***	0.57***	0.58***
	(0.01)	(0.02)	(0.02)	(0.00)	(0.00)
Observations	22,576	22,454	15,740	22,576	15,740
Number of idmen_panel	11,288	11,227	7,870	11,288	7,870
R2-within	0.004	0.004	0.011	0.004	0.011
R2-between	0.000	0.431	0.429	0.000	0.000
R2-overall	0.001	0.339	0.336	0.001	0.002

Note: Clustered standard errors in parentheses at communale section and year level
*** p<0.01, ** p<0.05, * p<0.1

Table 14: "Falsification" test on labour market participation

	With MA				Without MA			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Treat	0.02	0.03**	-0.00	0.02	0.01	0.02*	0.02*	0.02*
	(0.02)	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)
Individual baseline controls								
Sex	0.10***	0.10***	0.08***	0.10***	0.11***	0.11***	0.10***	0.11***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Age	0.01***	0.06***	0.06***	0.06***	0.01***	0.06***	0.06***	0.06***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Age2		-0.00***	-0.00***	-0.00***		-0.00***	-0.00***	-0.00***
		(0.00)	(0.00)	(0.00)		(0.00)	(0.00)	(0.00)
Educ = Preschool	-0.02	0.03	0.03	0.03	-0.03	0.03	0.03	0.03
	(0.03)	(0.03)	(0.02)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Educ = Primary	-0.04***	0.03**	0.03***	0.02**	-0.05***	0.03**	0.02**	0.03**
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Educ = Secondary	-0.00	-0.03**	-0.04***	-0.04**	-0.02	-0.04**	-0.04***	-0.04**
	(0.02)	(0.02)	(0.01)	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)
Educ = Superior	0.18***	0.05*	-0.01	0.05	0.20***	0.05*	0.00	0.05*
	(0.03)	(0.03)	(0.02)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Household baseline controls								
Household size		-0.01***	-0.01***	-0.01***		-0.01***	-0.01***	-0.01***
		(0.00)	(0.00)	(0.00)		(0.00)	(0.00)	(0.00)
Densité section communale 2012	-0.00	-0.00	-0.00**	-0.00*	-0.00	-0.00	-0.00	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Communal section baseline controls	YES	YES	NO	NO	YES	YES	NO	NO
Constant	0.16***	-0.45***	-0.50***	-0.46***	0.17***	-0.44***	-0.48***	-0.45***
	(0.02)	(0.03)	(0.02)	(0.02)	(0.02)	(0.03)	(0.02)	(0.03)
Observations	8,784	8,784	17,884	8,784	7,870	7,870	11,172	7,870
R-squared	0.25	0.45	0.46	0.45	0.24	0.45	0.45	0.45

Note:Standard errors clustered at the section communale level in parentheses

control variables enable to correct the remaining part in the sample without MA.

Therefore, to strengthen the robustness of our results, we compute at individual level semi-parametric DID estimates (Abadie 2005), following the same two-step weighting procedure presented in section 3.2 and applied at household-level in section 4.1. Results from the first stage, that is the propensity score estimation are shown in the appendix (table A.6). [19] Results of the second step confirm the previous parametric results: a drop of around 5 p.p. of the individual labour participation in average in all the country and a slightly lower drop (- 4 p.p.) for individuals outside the MA. When we restrict our sample to adult aged from 25 to 54, we find a drop of 7 p.p. for both sample, which is also quite similar in magnitude to those obtained previously, which confirms their robustness.

If the previous results provide strong evidence that the earthquake has a long-lasting impact on labour market participation, it seems important to explore more accurately the heterogeneity of the effects. To investigate it, we estimate equation 4, the 'augmented' specifications of the DID labour market participation model with individual fixed effects and the 3 levels of baseline controls on the restricted sample. Table 15 displays the results of LPM estimations.

The first important finding is that there is a significant wealth effect driving the decline of the labour market participation, independently of the earthquake, since the dummy for the second tercile is significant in specification (3) and (4), but the coefficients of the interactions between wealth terciles and treatment are not significant (column (4)). The most plausible interpretation might be attributed to the country's economic degradation reducing job opportunities for a large part of the population, except for the wealthiest over-represented in the public (68%) and private formal (66%) sectors. Specification (5) suggests that, independently of the earthquake, and as expected, men have a higher probability to participate to the labour market than women. Regarding education, we only find a positive and significant effect of preschool education on the probability to participate to the labour market. It might be explain by the greater level of deprivation and even more restricted social network for people who never attend school, the baseline category in this specification.

5 Conclusion

Using original longitudinal data and objective geological measures, we test the long-lasting impact of the earthquake that hit Haiti in 2010. Assessing the economic consequences of such extreme shocks, and the fall in owning assets, is essential to understand to what extent affected population recover by herself and whether post-disaster external intervention can help to limit long-term economic disruption. We provide strong evidence that the immediate negative shock has been associated to persistent disruption of livelihoods over time and to persistent welfare losses for a significant part of the population.

At national level, we find strong evidence of a negative and significant impact of the earthquake on households' asset index, indicating that three years after the event, families from affected areas were not yet recovered from the

[19] As in the previous section, this table here is just informative as the command *absdid* created by Houngbedji (2015) we use estimates the propensity score non-parametrically.

Table 15: Labour Market Participation DID with interactions - Without MA -

	(1)	(2)	(3)	(4)	(5)	(6)
Time	0.03***	0.03***	0.33***	0.33***	0.32***	0.32***
	(0.01)	(0.00)	(0.02)	(0.02)	(0.02)	(0.02)
Treat	0.02					
	(0.01)					
Time x Treat	-0.05***	-0.05***	-0.04***	-0.01	-0.04*	0.10**
	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.05)
Wealth2010 x Time					-0.00	
					(0.01)	
Wealth2010 x Time x Treat						
Q2 x Time			-0.04***	-0.03**		
			(0.01)	(0.01)		
Q3 x Time			-0.02	-0.02		
			(0.02)	(0.02)		
Q2 x Time x Treat				-0.05*		
				(0.03)		
Q3 x Time x Treat				-0.02		
				(0.04)		
Sex x Time			0.10***	0.10***	0.10***	0.10***
			(0.01)	(0.01)	(0.01)	(0.01)
Sex x Time x Treat					-0.01	
					(0.02)	
Preschool educ. x Time			0.00	0.00	0.00	-0.02
			(0.03)	(0.03)	(0.03)	(0.03)
Primary educ. x Time			0.01	0.00	0.00	0.00
			(0.01)	(0.01)	(0.01)	(0.01)
Secondary educ. x Time			-0.01	-0.01	-0.02	-0.03**
			(0.01)	(0.01)	(0.01)	(0.01)
Superior educ. x Time			0.02	0.02	0.02	0.03
			(0.04)	(0.04)	(0.04)	(0.05)
Preschool educ. x Time x Treat						0.13***
						(0.05)
Primary educ. x Time x Treat						-0.03
						(0.02)
Secondary educ. x Time x Treat						0.01
						(0.03)
Superior educ. x Time x Treat						-0.04
						(0.07)
Constant	0.56***	0.57***	0.58***	0.58***	0.58***	0.58***
	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Individual baseline controls	NO	NO	YES	YES	YES	YES
Household baseline controls	NO	NO	YES	YES	YES	YES
SC baseline controls	NO	NO	YES	YES	YES	YES
Individual FE	NO	YES	YES	YES	YES	YES
Observations	22,576	22,576	15,572	15,572	15,572	15,740
Number of idind_panel	11,288	11,288	7,786	7,786	7,786	7,870
R2-within	0.004	0.004	0.097	0.097	0.096	0.096
R2-between	0.000	0.000	0.179	0.178	0.182	0.176
R2-overall	0.001	0.001	0.023	0.023	0.024	0.023

Note: Clustered standard errors in parentheses at communale section and year level
*** p<0.01, ** p<0.05, * p<0.1

shock. This result is quite stable across different specifications. Standardized coefficient show that living in an affected communal section in 2010 leads 0.1 standard deviation decrease in predicted wealth index, with the other variables held constant.

The impact appears to be more mitigated in a restricted sample that excludes the metropolitan households. There, the negative impact of the earthquake is significant only among specific group, evidencing heterogeneous impacts across the affected population. Results indicate the richest tercile seems to record, three years after the quake, the greatest losses. Such a result is implied by our choice of dependent variable, constrained by baseline data availability, the index does not account for many other dimensions of well-being (which would encompass human or social capital for instance). In Haiti, the poorest hold very little and have sadly not much durables to loose. Nevertheless, from an economic perspective the main adverse effects of an earthquake are caused by the destruction of physical capital, held in large parts by the wealthiest, who inevitably face a strong adverse shock. If the richest invest less in the economy because of this adverse shock, it will imply additional disruption in the future livelihoods for the poorer. Moreover, results clearly indicate that in both samples, male-headed households recovered better than the female-headed ones and that least educated household heads experienced greater losses that the more educated ones. Therefore, these more vulnerable groups should be a priority in the design of future risk-management programs.

We provide also strong evidence that the earthquake has an overall negative long-lasting impact on labour market participation. When we exclude the more specific Metropolitan area, we still observe a drop of 5 percentage point in the probability to participate to labour market, encumbering the resilient recovery. The heterogenous effect appears even clearer for women, they experienced the largest losses of durable goods and, probably because more vulnerable ex-ante and with less labour market opportunities, they were also more likely to decrease their labour force participation, independently of the earthquake, making them more prone to becoming trapped in poverty. These results lead us to the conclusion that the disruption of household's livelihood system reduce the probability to recover from the shock without external aid. However, statistics suggest that the assistance program's coverage, even among the most impacted households has been highly variable, often low and negatively correlated with the distance to Port-au-Prince.

Although our results help to better understand the persistence and heterogeneity of effects, they are clearly limited by the nature of the data available. If the 2012 ECVMAS survey was an important first step, there is an urgent demand for quality longitudinal data in Haiti (and other developing countries highly vulnerable to natural disasters), in order to assess more accurately long-run consequences of extreme shocks and thus designing effective risk management strategies.

References

Abadie, A.: 2005, Semiparametric difference-in-differences estimators, *The Review of Economic Studies* **72**(1), 1–19.

Ai, C. and Norton, E. C.: 2003, Interaction terms in logit and probit models, *Economics Letters* **80**(1), 123–129.

Alderman, H., Hoddinott, J. and Kinsey, B.: 2006, Long term consequences of early childhood malnutrition, *Oxford Economic Papers* **58**(3), 450–474.

Asselin, L.-M.: 2009, *Analysis of multidimensional poverty: Theory and case studies*, Vol. 7, Springer Science & Business Media.

Asselin, L.-M. and Anh, V. T.: 2008, Multidimensional poverty and multiple correspondence analysis, *in* N. Kakwani and J. Silber (eds), *Quantitative Approaches to Multidimensional Poverty Measurement*, Palgrave Macmillan, London, pp. 80–103.

Baez, J. E., Lucchetti, L., Genoni, M. E. and Salazar, M.: 2015, Gone with the storm: Rainfall shocks and household well-being in Guatemala, *World Bank Policy Research Working Paper* (7177).

Baez, J. E. and Santos, I. V.: 2007, Children's vulnerability to weather shocks: A natural disaster as a natural experiment, *Social Science Research Network, New York* .

Baez, J. E. and Santos, I. V.: 2008, On shaky ground: The effects of earthquakes on household income and poverty, *Working paper UNDP RPP LAC 02/2008* .

Benzecri, J.-P. et al.: 1973, *L'analyse des données, Tome 2*, Dunod, Paris.

Blasius, J. and Greenacre, M.: 2006, Correspondence analysis and related methods in practice, *Multiple Correspondence Analysis and Related Methods* pp. 3–40.

Booysen, F., Van Der Berg, S., Burger, R., Von Maltitz, M. and Du Rand, G.: 2008, Using an asset index to assess trends in poverty in seven Sub-Saharan african countries, *World Development* **36**(6), 1113–1130.

Buss, T. F. et al.: 2009, *Haiti in the balance: Why foreign aid has failed and what we can do about it*, Brookings Institution Press.

Bustelo, M., Arends-Kuenning, M. P. and Lucchetti, L.: 2012, Persistent impact of natural disasters on child nutrition and schooling: Evidence from the 1999 Colombian earthquake, *IZA Discussion Papier IZA No. 6354* .

Cavallo, E., Powell, A. and Becerra, O.: 2010, Estimating the direct economic damages of the earthquake in Haiti, *The Economic Journal* **120**(546), F298–F312.

CCCM: 2013, Cluster Haiti: Updated list of IDP sites of the DTM, october 2013, *Technical report*, Camp Coordination and Camp Management, OIM.

Crespo Cuaresma, J., Hlouskova, J. and Obersteiner, M.: 2008, Natural disasters as creative destruction? Evidence from developing countries, *Economic Inquiry* **46**(2), 214–226.

De la Fuente, A.: 2010, Natural disasters and poverty in latin america: Welfare impacts and social protection solutions, *Well-Being and Social Policy* **6**(1), 1–15.

De Nicola, F. and Giné, X.: 2014, How accurate are recall data? Evidence from coastal India, *Journal of Development Economics* **106**, 52–65.

Dercon, S.: 1998, Wealth, risk and activity choice: Cattle in Western Tanzania, *Journal of Development Economics* **55**(1), 1–42.

Dex, S.: 1995, The reliability of recall data: A literature review, *Bulletin de Methodologie Sociologique* **49**(1), 58–89.

Doocy, S., Daniels, A., Packer, C., Dick, A. and Kirsch, T. D.: 2013, The human impact of earthquakes: A historical review of events 1980-2009 and systematic literature review, *PLoS currents* **5**.

Eberhard, M. O., Baldridge, S., Marshall, J., Mooney, W. and Rix, G. J.: 2010, The mw 7.0 Haiti earthquake of January 12, 2010: USGS/EERI advance reconnaissance team report, *Technical report*, USGS.

EM-DAT, E. E. D.: 2015, The OFDA/CRED international disaster database.

Filmer, D. and Pritchett, L. H.: 2001, Estimating wealth effects without expenditure data –or tears: An application to educational enrollments in states of India, *Demography* **38**(1), 115–132.

Gignoux, J. and Menendez, M.: 2014, Benefit in the wake disaster: Long-run effects of earthqueakes on welfare in rural indonesia, *Document de Travail DIAL DT/2014-15* .

Gitay, H., Bettencourt, S., Kull, D., Reid, R., McCall, K., Simpson, A. and Fay, M.: 2013, Building resilience: Integrating climate and disaster risk into development, *Technical report*, World Bank, Washington.

Hallegatte, S.: 2014, *Natural disasters and climate change*, Springer.

Halliday, T.: 2006, Migration, risk, and liquidity constraints in El Salvador, *Economic Development and Cultural Change* **54**(4), 893–925.

Heckman, J. J., Ichimura, H. and Todd, P.: 1998, Matching as an econometric evaluation estimator, *The Review of Economic Studies* **65**(2), 261–294.

Herrera, J., Lamaute-Brisson, N., Milbin, D., Roubaud, F., Saint-Macary, C., Torelli, C. and Zanuso, C.: 2014, L'évolution des conditions de vie en Haïti entre 2007 et 2012. La réplique sociale du séisme., *Technical report*, IHSI, IRD, DIAL.

Herrera, J., Roubaud, F., Saint-Macary, C., Torelli, C. and Zanuso, C.: 2014, Les conditions de vie de la population haïtienne après le séisme: Un diagnostic nécessaire, *Dialogue* (38), 2–10.

Houngbedji, K.: 2015, Abadie's semi-parametric difference-in-difference estimator, *mimeo Paris School of Economics* .

IADB: 2007, Country program evaluation: Haiti 2001-2006.RE-327., *Technical report*, Washington: Inter-American Development Bank.

Lundahl, M.: 2013, *The political economy of disaster. Destitution, plunder and earthquake in Haiti.*, Routledge, London.

Malik, K.: 2013, *Human development report 2013. The rise of the South: Human progress in a diverse world*, UNDP-HDRO Human Development Reports.

Noy, I.: 2009, The macroeconomic consequences of disasters, *Journal of Development Economics* **88**(2), 221–231.

OECD: 2011, Managing risks in fragile and transitional contexts. The price of success?, *Technical report*, Organisation for Economic Co-operation and Development.

Quigley, B. and Ramanauskas, A.: 2012, Haiti after the quake, *CounterPunch. Available at http://www.counterpunch.org/2012/01/03/haiti-after-the-quake* .

Sahn, D. E. and Stifel, D.: 2003, Exploring alternative measures of welfare in the absence of expenditure data, *Review of Income and Wealth* **49**(4), 463–489.

Sahn, D. E. and Stifel, D. C.: 2000, Poverty comparisons over time and across countries in Africa, *World Development* **28**(12), 2123–2155.

Schuller, M. and Morales, P.: 2012, *Tectonic shifts: Haiti since the earthquake*, Kumarian Press.

Shepherd, A., Mitchell, T., Lewis, K., Lenhardt, A., Jones, L., Scott, L. and Muir-Wood, R.: 2013, *The geography of poverty, disasters and climate extremes in 2030*, ODI London, UK.

Skidmore, M. and Toya, H.: 2002, Do natural disasters promote long-run growth?, *Economic Inquiry* **40**(4), 664–687.
URL: *http://ideas.repec.org/a/oup/ecinqu/v40y2002i4p664-687.html*

Skoufias, E.: 2003, Economic crises and natural disasters: Coping strategies and policy implications, *World Development* **31**(7), 1087–1102.

Strobl, E.: 2012, The economic growth impact of natural disasters in developing countries: Evidence from hurricane strikes in the Central American and Caribbean regions, *Journal of Development Economics* **97**(1), 130–141.

Toya, H. and Skidmore, M.: 2007, Economic development and the impacts of natural disasters, *Economics Letters* **94**(1), 20–25.

Wald, D. J., Quitoriano, V., Heaton, T. H. and Kanamori, H.: 1999, Relationships between peak ground acceleration, peak ground velocity, and modified Mercalli intensity in California, *Earthquake Spectra* **15**(3), 557–564.

World Bank: 2003, Measuring living standards: Household consumption and wealth indices. Quantitative techniques for health equity analysis. Technical note 4., *Technical report*, World Bank, Washington.

World Bank: 2010, *Natural Hazards, UnNatural Disasters: The Economics of Effective Prevention*, The World Bank.

World Bank: 2014, Investing in people to fight poverty in Haiti, *Technical report*, World Bank, Washington.

Yang, D.: 2008, Risk, migration, and rural financial markets: Evidence from earthquakes in El Salvador, *Social Research: An International Quarterly* **75**(3), 955–992.

Zanuso, C., Torelli, C. and Roubaud, F.: 2014, Le marché du travail en Haïti après le séisme: Quelle place pour les jeunes?, *Autrepart* **71**, 135–156.

Zhao, J. X., Zhang, J., Asano, A., Ohno, Y., Oouchi, T., Takahashi, T., Ogawa, H., Irikura, K., Thio, H. K., Somerville, P. G. et al.: 2006, Attenuation relations of strong ground motion in Japan using site classification based on predominant period, *Bulletin of the Seismological Society of America* **96**(3), 898–913.

Zimmerman, F. J. and Carter, M. R.: 2003, Asset smoothing, consumption smoothing and the reproduction of inequality under risk and subsistence constraints, *Journal of Development Economics* **71**(2), 233–260.

A Appendix

Table A.1: Wealth 2010 - falsification test - selection issue with RGA sample

	With MA		Without MA	
	Full sample	RGA sample	Full sample	RGA sample
Treat	0.43***	0.31***	0.21***	0.24***
	(0.07)	(0.07)	(0.08)	(0.08)
Sex HH	-0.07***	-0.03	-0.04	-0.02
	(0.02)	(0.03)	(0.03)	(0.03)
Age HH	0.01***	0.00***	0.00***	0.00***
	(0.00)	(0.00)	(0.00)	(0.00)
Educ HH = Preschool	0.13*	0.09**	0.08	0.08**
	(0.08)	(0.04)	(0.06)	(0.04)
Educ HH = Primary	0.29***	0.17***	0.21***	0.16***
	(0.03)	(0.03)	(0.03)	(0.03)
Educ HH = Secondary	0.77***	0.56***	0.61***	0.55***
	(0.07)	(0.05)	(0.05)	(0.06)
Educ HH = Superior	2.03***	1.59***	1.16***	1.45***
	(0.27)	(0.22)	(0.18)	(0.33)
Density SC 2012	0.00**	0.00***	0.00***	0.00***
	(0.00)	(0.00)	(0.00)	(0.00)
Constant	-1.02***	-0.69***	-0.74***	-0.68***
	(0.13)	(0.06)	(0.06)	(0.05)
Observations	4,787	2,390	2,937	2,105
R-squared	0.32	0.28	0.19	0.21

Standard errors clustered at the CS level in parentheses*** p<0.01, ** p<0.05, * p<0.1

Table A.2: Asset index DID - With MA - Three level treatment

	(1)	(2)	(3)	(4)	(5)
Time	0.06***	0.06***	0.05***	0.06***	0.05***
	(0.02)	(0.01)	(0.01)	(0.01)	(0.00)
Treat 1 (= 1 if 0.18¡= PGA ¡0.34)	0.31***	0.21***	0.13***	0.10	-0.14
	(0.09)	(0.07)	(0.05)	(0.14)	(0.30)
Treat 2 (= 1 if PGA ¿ = 0.34)	0.81***	0.54***	0.25**	0.10	0.32***
	(0.07)	(0.05)	(0.10)	(0.10)	(0.11)
Time x Treat 1	-0.10*	-0.10**	-0.08	-0.09**	-0.08
	(0.05)	(0.05)	(0.06)	(0.04)	(0.05)
Time x Treat 2	-0.09*	-0.10**	-0.24***	-0.10***	-0.23***
	(0.05)	(0.04)	(0.07)	(0.02)	(0.06)
Time x household baseline controls					
Sex (male=1)		-0.08***	0.01		
		(0.02)	(0.02)		
Age		0.01***	0.00***		
		(0.00)	(0.00)		
Pre-school education (yes=1)		0.09	0.03		
		(0.07)	(0.04)		
Primary education (yes=1)		0.31***	0.16***		
		(0.03)	(0.02)		
Secondary education (yes=1)		0.80***	0.50***		
		(0.04)	(0.05)		
Superior education (yes=1)		2.14***	1.60***		
		(0.20)	(0.18)		
Time x communal section baseline controls					
Section communale density			0.00		
			(0.00)		
In Migration important (1=yes)			-0.00		
			(0.04)		
25% population with electricity (1=yes)			0.16*		
			(0.09)		
75% population with drinking water (1=yes)			0.03		
			(0.05)		
Sanitation unit operational (1=yes)			-0.08**		
			(0.04)		
Pharmacy operational (1=yes)			0.04		
			(0.04)		
Secondary school operational (1=yes)			-0.03		
			(0.07)		
Post office operational (1=yes)			0.06		
			(0.08)		
Registry office operational (1=yes)			0.02		
			(0.06)		
Court operational (1=yes)			0.09***		
			(0.03)		
Gas station operational (1=yes)			0.02		
			(0.11)		
Fixed phone operational (1=yes)			0.01		
			(0.07)		
Sport grounds operational (1=yes)			0.06		
			(0.05)		
Severity of food insecurity			0.04		
			(0.05)		
Physical violence growing (1=yes)			-0.00		
			(0.04)		
Violence on resource sharing growing (1=yes)			0.02		
			(0.04)		
Household FE	NO	NO	NO	YES	YES
Constant	-0.27***	-0.99***	-0.79***	0.03	-0.29***
	(0.03)	(0.10)	(0.05)	(0.05)	(0.07)
Observations	9732	9722	4818	9732	4818
Number of idmen_panel	4927	4922	2428	4927	2428
R2-within	0.00209	0.00339	0.0339	0.00623	0.0348
R2-between	0.154	0.359	0.313	0.118	0.005
R2-overall	0.142	0.330	0.283	0.067	0.008

Note: Clustered standard errors in parentheses at communale section and year level
*** p<0.01, ** p<0.05, * p<0.1

Table A.3: Asset index DID - Without MA - Three level treatment

	(1)	(2)	(3)	(4)	(5)
Time	0.06***	0.06***	0.05***	0.06***	0.05***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)
Treat 1 (= 1 if 0.18¡= PGA ¡0.34)	0.25**	0.19**	0.13**	-0.05	
	(0.12)	(0.10)	(0.06)	(0.11)	
Treat 2 (= 1 if PGA ¿ = 0.34)	0.22**	0.19**	0.07	0.08	
	(0.10)	(0.08)	(0.09)	(0.27)	
Time x Treat 1	-0.06	-0.06	-0.07	-0.06	-0.07
	(0.06)	(0.06)	(0.06)	(0.05)	(0.06)
Time x Treat 2	0.02	0.01	-0.02	-0.00	-0.02
	(0.05)	(0.05)	(0.05)	(0.03)	(0.03)
Time x household baseline controls					
Sex (male=1)		-0.06**	0.01		
		(0.03)	(0.03)		
Age		0.00***	0.00***		
		(0.00)	(0.00)		
Pre-school education (yes=1)		0.06	0.01		
		(0.06)	(0.05)		
Primary education (yes=1)		0.24***	0.15***		
		(0.03)	(0.02)		
Secondary education (yes=1)		0.68***	0.51***		
		(0.05)	(0.05)		
Superior education (yes=1)		1.46***	1.61***		
		(0.16)	(0.29)		
Time x communal section baseline controls					
Section communale density			0.00**		
			(0.00)		
In Migration important (1=yes)			-0.01		
			(0.05)		
25% population with electricity (1=yes)			0.16		
			(0.11)		
75% population with drinking water (1=yes)			0.01		
			(0.05)		
Sanitation unit operational (1=yes)			-0.08**		
			(0.04)		
Pharmacy operational (1=yes)			0.03		
			(0.04)		
Secondary school operational (1=yes)			-0.01		
			(0.07)		
Post office operational (1=yes)			0.06		
			(0.07)		
Registry office operational (1=yes)			0.02		
			(0.04)		
Court operational (1=yes)			0.06***		
			(0.02)		
Gas station operational (1=yes)			0.07		
			(0.11)		
Fixed phone operational (1=yes)			0.02		
			(0.06)		
Sport grounds operational (1=yes)			0.05		
			(0.05)		
Severity of food insecurity			0.04		
			(0.05)		
Physical violence growing (1=yes)			-0.05		
			(0.03)		
Violence on resource sharing growing (1=yes)			0.04		
			(0.03)		
Household FE	NO	NO	NO	YES	YES
Constant	-0.30***	-0.68***	-0.76***	-0.25***	-0.35***
	(0.02)	(0.05)	(0.05)	(0.02)	(0.01)
Observations	5969	5965	4240	5969	4240
Number of idmen_panel	3017	3015	2135	3017	2135
R2-within	0.0145	0.0152	0.0182	0.0165	0.0182
R2-between	0.022	0.208	0.261	0.005	0.053
R2-overall	0.020	0.189	0.239	0.001	0.006

Note: Clustered standard errors in parentheses at communale section and year level
*** p<0.01, ** p<0.05, * p<0.1

Table A.4: Treat - Propensity score estimation - logit

	With MA		Without MA	
	(1)		(2)	
Sex HH	-0.37**	(0.16)	-0.29*	(0.17)
Age HH	-0.00	(0.00)	0.00	(0.00)
Educ HH = Preschool	-0.22	(0.45)	-0.07	(0.43)
Educ HH = Primary	0.29*	(0.17)	0.35*	(0.18)
Educ HH = Secondary	0.72***	(0.23)	0.44*	(0.24)
Educ HH = Superior	1.45***	(0.48)	0.97*	(0.49)
Densité section communale 2012	0.00*	(0.00)	0.00*	(0.00)
In Migration important (1=yes)	-0.11	(0.47)	-0.22	(0.52)
25% population with electricity (1=yes)	2.95***	(0.75)	2.06***	(0.66)
75% population with drinking water (1=yes)	-0.60	(0.53)	-0.39	(0.55)
Sanitation unit operational in SC (1=yes)	-1.09**	(0.45)	-1.10**	(0.47)
Pharmacy operational in SC (1=yes)	0.56	(0.50)	0.67	(0.50)
Registry office operational in SC (1=yes)	0.37	(0.96)	0.53	(1.06)
Court operational in SC (1=yes)	-0.33	(0.96)	-0.29	(1.07)
Sport grounds operational in SC (1=yes)	-0.12	(0.49)	0.02	(0.50)
Secondary school operational in SC (1=yes)	0.98**	(0.42)	1.14***	(0.43)
Post office operational in SC (1=yes)	1.28	(0.87)	1.34*	(0.81)
Gas station operational in SC (1=yes)	-0.08	(0.56)	-0.25	(0.63)
Fixed phone operational in SC (1=yes)	0.49	(0.45)	0.43	(0.47)
Severity of food insecurity	0.99	(0.68)	0.44	(0.75)
Physical violence growing (1=yes)	-1.13**	(0.45)	-1.11**	(0.46)
Violence on resource sharing growing (1=yes)	0.94**	(0.41)	0.63	(0.38)
Constant	-2.51***	(0.54)	-2.71***	(0.63)
Observations	2,431		2,138	
pseudo-R2	0.397		0.295	

Note: Clustered standard errors in parentheses at communal section and year level
*** p<0.01, ** p<0.05, * p<0.1

Table A.5: Labour participation DID - With MA - Detailed controls

	(1)	(2)	(3)	(4)	(5)
Time	0.03***	0.03***	0.05***	0.03***	0.05***
	(0.01)	(0.01)	(0.01)	(0.00)	(0.01)
Treat	0.01	-0.01	0.04***		
	(0.01)	(0.01)	(0.01)		
Time x Treat	-0.07***	-0.07***	-0.08***	-0.07***	-0.08***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Time x individual baseline controls					
Sex (male=1)		0.13***	0.15***		
		(0.01)	(0.01)		
Age		0.06***	0.05***		
		(0.00)	(0.00)		
Age$\hat{2}$		-0.00***	-0.00***		
		(0.00)	(0.00)		
Pre-school education (yes=1)		0.04*	0.03		
		(0.02)	(0.03)		
Primary education (yes=1)		0.03***	0.03***		
		(0.01)	(0.01)		
Secondary education (yes=1)		-0.04***	-0.04***		
		(0.01)	(0.01)		
Superior education (yes=1)		0.01	0.07**		
		(0.01)	(0.03)		
Time x household baseline controls					
Household size		-0.01***	-0.01***		
		(0.00)	(0.00)		
Time x communal section baseline controls					
Section communale density			-0.00*		
			(0.00)		
In Migration important (1=yes)			-0.02		
			(0.01)		
25% population with electricity (1=yes)			-0.04**		
			(0.02)		
75% population with drinking water (1=yes)			-0.01		
			(0.01)		
Sanitation unit operational (1=yes)			-0.02*		
			(0.01)		
Pharmacy operational (1=yes)			-0.02		
			(0.01)		
Secondary school operational (1=yes)			0.03		
			(0.03)		
Post office operational (1=yes)			-0.05		
			(0.03)		
Registry office operational (1=yes)			-0.01		
			(0.01)		
Court operational (1=yes)			0.03***		
			(0.01)		
Gas station operational (1=yes)			0.02		
			(0.02)		
Fixed phone operational (1=yes)			-0.00		
			(0.02)		
Sport grounds operational (1=yes)			0.00		
			(0.01)		
Severity of food insecurity			0.01		
			(0.02)		
Physical violence growing (1=yes)			0.00		
			(0.01)		
Violence on resource sharing growing (1=yes)			-0.01		
			(0.01)		
Individual FE	NO	NO	NO	YES	YES
Constant	0.56***	-0.54***	-0.46***	0.57***	0.58***
	(0.01)	(0.02)	(0.02)	(0.00)	(0.00)
Observations	36,048	35,882	17,568	36,048	17,568
Number of idmen_panel	18,024	17,941	8,784	18,024	8,784
R2-within	0.006	0.006	0.011	0.006	0.011
R2-between	0.001	0.447	0.436	0.001	0.000
R2-overall	0.002	0.356	0.344	0.002	0.002

Note: Clustered standard errors in parentheses at section communale and year level
*** p<0.01, ** p<0.05, * p<0.1

Table A.6: Treat - Propensity score estimation at individual level - logit

	With MA (1)	With MA (2)
Sex	-0.08	-0.10*
	(0.05)	(0.06)
Age	-0.00	-0.01
	(0.01)	(0.01)
Age squared	0.00	0.00**
	(0.00)	(0.00)
Educ = Preschool	-0.06	0.02
	(0.33)	(0.33)
Educ = Primary	0.35**	0.37**
	(0.15)	(0.16)
Educ = Secondary	0.78***	0.65***
	(0.20)	(0.21)
Educ = Superior	1.25***	0.80***
	(0.38)	(0.30)
Household size	-0.06**	-0.04*
	(0.03)	(0.03)
Densité section communale 2012	0.00**	0.00*
	(0.00)	(0.00)
In Migration important (1=yes)	-0.13	-0.23
	(0.48)	(0.53)
25% population with electricity (1=yes)	2.81***	2.02***
	(0.72)	(0.64)
75% population with drinking water (1=yes)	-0.39	-0.19
	(0.52)	(0.55)
Sanitation unit operational in SC (1=yes)	-1.07**	-1.06**
	(0.44)	(0.47)
Pharmacy operational in SC (1=yes)	0.43	0.51
	(0.48)	(0.50)
Registry office operational in SC (1=yes)	-0.06	0.07
	(1.00)	(1.13)
Court operational in SC (1=yes)	0.05	0.10
	(0.99)	(1.12)
Sport grounds operational in SC (1=yes)	-0.01	0.13
	(0.46)	(0.48)
Secondary school operational in SC (1=yes)	0.95**	1.15***
	(0.42)	(0.43)
Post office operational in SC (1=yes)	1.43*	1.46*
	(0.84)	(0.79)
Gas station operational in SC (1=yes)	0.09	-0.04
	(0.56)	(0.61)
Fixed phone operational in SC (1=yes)	0.51	0.45
	(0.45)	(0.47)
Severity of food insecurity	1.17*	0.71
	(0.67)	(0.75)
Physical violence growing (1=yes)	-1.19***	-1.08**
	(0.45)	(0.47)
Violence on resource sharing growing (1=yes)	0.94**	0.62
	(0.41)	(0.39)
Constant	-2.77***	-2.78***
	(0.50)	(0.59)
Observations	8,784	7,870
pseudo-R2	0.395	0.307

Note: Clustered standard errors in parentheses at communale section and year level
*** p<0.01, ** p<0.05, * p<0.1