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DOCUMENT DE TRAVAIL DT/2015-15

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BUILD BACK BETTER?
LONG-LASTING IMPACT OF THE 2010 EARTHQUAKE IN HAITI.

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Document de travail UMR DIAL
Septembre 2015

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 estimate the impact over the whole country, and outside the Metropolitan Area of Port-au-Prince with difference-in-difference estimations. As the earthquake hit the country in a very specific area, its capital city, we employ different strategies to address the possible violation of the parallel trend assumption. We provide strong evidence that in Haiti the immediate negative shock has been associated to persistent welfare losses over timeOur 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 3.9 p.p. 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.

Key words: Natural Disasters, Impact Evaluation, Asset-Wealth, Labour Supply, Haiti.

JEL Code : D1, I31, J22, O12, Q54

Résumé

Cet article estime l'impact à moyen terme du tremblement de terre qui a frappé Haïti en 2010 sur le bien-être des ménages. Grâce à des données longitudinales de première main, ainsi que des données objectives géo-référencées de l'intensité du séisme, nous estimons l'impact au niveau national et pour un échantillon plus restreint excluant l'aire métropolitaine de Port-au-Prince à l'aide d'une estimation en doubles différences. Parce que l'épicentre du séisme se situe dans cette zone spécifique qui est la capitale, nous mobilisons plusieurs stratégies pour répondre à la violation potentielle de l'hypothèse d'évolution parallèle en absence de choc. Nos résultats montrent que le choc négatif a provoqué une perte de richesse durable dans le temps pour les ménages haïtiens. Nos résultats suggèrent également un impact négatif durable sur l'offre de travail. Plus précisément, lorsque nous excluons l'aire métropolitaine, nous observons une diminution de 3.9 points de pourcentage de la probabilité de participer au marché du travail, constituant un obstacle important au processus de résilience. Le dérèglement des différents moyens de subsistance réduit la probabilité pour les ménages de se remettre du choc dans aide extérieure. Pourtant, nos résultats montrent des limites dans le ciblage des populations affectées.

Mots Clés : Désastres Naturels, Evaluation d'impact, Richesse, Offre de travail, Haïti.

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 Bank (2014). However, this paper, based on the first national socio-economic survey to be taken since the earthquake (Herrera et al., 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 et al., 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 the receipt of assistance, the transit in a temporary camp 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).

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 (Bank and Nations, 2010; Gitay et al., 2013; Baez et al., 2015). Furthermore, 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.

Few papers 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 Menéndez (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 et al. (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 et al., 2014). According to the new national poverty line produced by the government of Haiti and based on the ECVMAS 2012, more than one in two Haitians was poor, living on less than $2.41, and one person in four was living below the national extreme poverty line of $1.23 a day. A comparison of household earnings with the level of income deemed by households to be the minimum required to live finds that nearly eight in ten households can be classified as "subjective poor" (Herrera et al., 2014). With a population of 10.4 million people,[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 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.

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,

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

[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.

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 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 et al. (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 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

The data used for this study come from two cross sections of national representative household-level survey data collected before (Enquête sur l'Emploi et l'Économie Informelle (EEEI), 2007) and after the earthquake. 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 et al., 2014). As the 2007 EEEI survey, the 2012 data covers the entire country and is representative at department level and Metropolitan area, other urban area

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

and rural level. We also exploit the 2010 retrospective data available in the ECVMAS survey to benefit from the longitudinal dimension. Then, using a Geographic Information System (GIS) software in the WGS 1984 UTM Zone 48N coordinate system, we match ECVMAS primary section units (PSUs) to our third 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).

3.2 Definition and measures of variables of interest

3.2.1 Treatment variable

One of the 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. 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 floors, which is the case of most buildings in Haiti 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 [4].

For each PSU in Haiti, we thus compute the PGAs of the 2010 earthquake and assign to each household the intensity experienced in the PSU where it was living when the disaster occurred. We test different thresholds but relying on seismologic studies, we decide to consider as treated, the households who were living in 2010 in a PSU impacted by a PGA >= 18%g (g as the acceleration due to Earth's gravity, equivalent to g-force). 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 [5]) scale is more

[4] 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

[5] 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.

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 moderate/heavy damage, until earthquake intensity level XII which would correspond to total destruction.

3.2.2 Asset index

Our proxy measure for household well-being before and 3 years after the earthquake is based on households' possession of durable goods. There are several 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 associated 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[6]. Table 1 provides descriptive statistics about asset ownership in 2010 and in 2012 (columns (3) and (4) and ACM weights for each index component (column (5)). To make our asset index comparable over time, we constructed it using "pooled" weights, estimated across the three periods (e.g. 2007, 2010, 2012) in order to have stable weights in time. Those components that reflect higher standards of living, being owning an asset, contribute positively to the household's asset index score, while not owning one decreases it. 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 = 6.16). 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 contribute more than the other components to decrease the household's asset index score. The first dimension explained 90.8% of inertia.

Table 1: Assets ownership and weights obtained from MCA

Assets	Ownership	% households (2010)	% households (2012)	Weights
Oven	**0**	94.35	94.56	-0.28
	1	5.65	5.44	5.03
Television	**0**	71.7	71.8	-0.75
	1	28.3	28.2	2.01
Radio	**0**	55.96	57.99	-0.69
	1	44.04	42.01	0.88
Mobile phone	**0**	40.07	24.42	-1.04
	1	59.93	75.58	0.56
Fridge	**0**	90.68	91.24	-0.41
	1	9.32	8.76	4.16
Generator	**0**	98.07	97.75	-0.15
	1	1.93	2.25	6.16
Inverter	**0**	96.42	96.58	-0.22
	1	3.58	3.42	5.53
Computer	**0**	97.16	96.09	-0.19
	1	2.84	3.91	6.16
Ventilator	**0**	86.46	86.95	-0.49
	1	13.54	13.05	3.09
Car	**0**	97.23	97.18	-0.20
	1	2.77	2.82	6.03
Motorcycle	**0**	96.32	95.26	-0.06
	1	3.68	4.74	1.55
Sewing machine	**0**	96.93	96.96	-0.06
	1	3.07	3.04	1.59

The limited set of variables included (due to the inclusion of limited retro-

[6]To ensure comparability, only variables that appear in the retrospective questionnaire and in 2007 were included.

spective questions) and the discrete nature of the underlying assets constrain the well-being analysis. However, relying on a fair proportion of the variables measuring private assets, it can be expected to properly assess the long-term wealth and to respond to modification in money-metric well-being (Booysen et al., 2008). The correlation between per capita consumption and the asset index is quite high, 0.59 in the full sample and 0.61 in the Metropolitan Area. The index is less correlated (0.44) in other urban and rural areas. 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 4 and 5 provide the mean (and standard deviation) of the asset index for different sub samples.

3.2.3 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 2 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 3.3, 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.

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 3.3 and 4.2).

Table 2: Individual characteristics before and after the 2010 Earthquake

	Total with MA	**NT**	**T1 with MA**	**T2 without MA**	**NT-T1**	**NT-T2**
	(1) mean (sd) **(n=18024)**	(2) mean (sd) **(n=9133)**	(3) mean (sd) **(n=8891)**	(4) mean (sd) **(n=2155)**	(5)	(6)
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.

3.3 Identification strategy

Our empirical strategy relies on difference-in-difference method. We make use for this purpose of recall data in 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 above. The impact of the earthquake can be estimated non-parametrically, simply by comparing the outcomes before and after the earthquake of households living in strongly affected areas (i.e. which we refer to as '*treated*' households – see section 3.2.1 for a definition of our '*treatment*' variable) and comparing this difference 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} are outcomes measured at time $t \in [0, 1]$ and D indicates the treatment, in our case, the fact of living in 2010 in an area 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, we are not able to test whether treated and untreated households followed a similar trend before the earthquake occurred to test this asumption. 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 in regards of the country, and differ significantly from the rest of the country on many characteristics. See (Herrera et al., 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 homogeneizing 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 Port-au-Prince. The ECVMAS survey report shows that other areas than Port-au-Prince were also heavily affected (Herrera et al., 2014) : 40% of the totally destroyed habitations 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 have benefited from this help.

Table 3 displays statistics on various types of assistance received by *impacted* households[7], 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 Port-au-Prince in kilometers. Let us first observe that coverage rates are particularly low when it comes to assistance other than information campaign[8]. 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 frequentation, which is probably due to the fact that and indeed most camps where established very close to the metropolitan area [9]. Looking at the impact of the earthquake outside the metropolitan area thus makes sense not only from the identification perspective, it, also makes sense from an informative point of view.

This sample reduction however may not be sufficient to fully address the parallel trend condition as households located close to the epicentre and thus affected by the centre may live that are relatively close to Port-au-Prince and experience different conditions that may also affect their outcome dynamics. We thus proceed as suggested by Abadie (2005), by selecting a set of baseline

[7] 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.

[8] These campaigns were aimed at preventing cholera epidemic

[9] cf. see the statistics on camp frequentation on the IOM website : http://iomhaitidataportal.info/dtm;

Table 3: 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 occured

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 2 :

$$Y_{it} = \alpha t + \beta^{DID} D_i \cdot t + \gamma X_{i0} \cdot t + \eta_i + \epsilon_{it} \tag{3}$$

We introduce as baseline control both household (individual) and commune characteristics, such the sex and age of the household head, his/her education level, composition of the household in 2010, and commune-level controls such as the population density in the origin district[10], and proportion of households equipped in 2007 with evolved water and electricity facilities as measured in the 2007 EEEI. We finally account for the labour market structure in the origin commune by including the activity and unemployment rates in the commune in 2007.

This method extends the difference-in-difference methodology by modifying the parallel trend hypothesis into a conditional assumption :

[10] We use the figures from the demographic projection made by IHSI in 2012 based on the last available population census (2003). 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), showing either that the population moves due to the earthquake were not that important – this is also what the descriptive analyses on post-earthquake-mobility show (see Herrera et al. (2014)), or that they were not taken into account when the projections were made.

$$E[Y_{i1}^0 - Y_0^0 | X_i, D_i = 1] = E[Y_{i1}^0 - Y_{i0}^0 | X_i, D_i = 0] \quad (4)$$

where Y_{i1}^0 denotes the outcome of household 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 3 provides a valid estimate of the earthquake impact. While 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 households' baseline outcome.

3.4 Descriptive statistics

Tables 4 and 5 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 3.2.1). 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 variable, is a composite index of various assets possessed by the household in 2010, and a good proxy of households' wealth (see section 3.2.2). 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[11]. 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). Population density, however decreases sharply as we exit the Metropolitan Area, and is no longer different between the untreated the restricted treated sample. Differences in the labour market are also observed between affected and non-affected communes, but all these differences vanish when we take out the communes in the Metropolitan Areas. We should remain cautious as the number of communes in the second treated group is quite low. It is quite clear nevertheless

[11] 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 PSU level : communes are considered treated if the average PGA recorded is greater or equal to 0.18%g (see section 3.2.1.

that taking out the six communes of the Metropolitan Area strongly leads to homogenizing the sample.

Table 5 reports post-earthquake household characteristics. The asset index stayed stable on average for the whole haitian population between 2010 and 2012. Splitting it in treatment groups shows different dynamics across groups, between households living in zones not directly affected by the earthquake and households living in strongly affected areas. It 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 the 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 et al. (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 3.2.3, table 2) 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 3.2.3. We examine the impact of the earthquake on employment in more detail in section 4.2.

The last part of table 5 reports descriptive statistics on the outreach of post-earthquake assistance programs. In table 3, 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 4: 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)	*	*
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)	***	***
Section communale density	2759.96 (4481.21)	2041.07 (3021.49)	6354.39 (7851.13)	2921.8 (3506.11)	***	ns
Mean 2007 variables						
Primary sector	0.41 (0.21)	0.44 (0.19)	0.26 (0.24)	0.37 (0.19)	***	ns
Private informal sector	0.54 (0.19)	0.52 (0.18)	0.66 (0.19)	0.58 (0.17)	***	ns
Private formal sector	0.01 (0.02)	0.01 (0.02)	0.03 (0.03)	0.01 (0.02)	***	ns
Public sector	0.04 (0.05)	0.03 (0.05)	0.05 (0.03)	0.03 (0.03)	ns	ns
Active	0.42 (0.10)	0.42 (0.10)	0.40 (0.09)	0.43 (0.09)	ns	ns
Unemployed	0.05 (0.05)	0.05 (0.04)	0.08 (0.07)	0.04 (0.04)	***	ns
Discouraged unemployed	0.20 (0.10)	0.20 (0.11)	0.20 (0.08)	0.18 (0.07)	ns	ns
Inactive	0.33 (0.12)	0.33 (0.11)	0.32 (0.12)	0.34 (0.14)	ns	ns
Wage workers	0.17 (0.13)	0.15 (0.13)	0.24 (0.13)	0.17 (0.08)	***	ns
Self-employed	0.76 (0.16)	0.77 (0.17)	0.70 (0.13)	0.76 (0.08)	*	ns
Family workers, internship	0.07 (0.11)	0.08 (0.11)	0.06 (0.04)	0.06 (0.04)	ns	ns
Electricity evolved equipment	0.02 (0.04)	0.01 (0.03)	0.07 (0.08)	0.02 (0.02)	***	ns
Water evolved equipment	0.58 (0.34)	0.58 (0.34)	0.61 (0.38)	0.46 (0.33)	ns	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.

Table 5: 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)	***	***
Mat (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

Table 6 reports results from the estimation of equation 2 in witch the outcome is our asset index variable. Column (1) shows the estimate over the whole sample and column (2) displays it on the restricted sample. In both models we include household fixed effects that control fr all unobserved heterogeneity between households. Results exhibit a negative an 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. The impact is in magnitude twice as large in the full sample than in the restricted sample. 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.

Table 6: Asset index DID

	Full sample	**Restricted sample**
	(1)	(2)
Time	0.061***	0.061***
	(0.007)	(0.007)
Time x Treat	-0.100***	-0.051**
	(0.017)	(0.024)
Household FE	YES	YES
Constant	0.062***	-0.282***
	(0.004)	(0.004)
Observations	9,574	5,874
R-squared	0.007	0.018
Number of idmen_panel	4,787	2,937

Note: Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

As seen earlier in section 3.3, 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 2 and 4 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 3.3). Excluding from the estimation sample households that lived in the Metropolitan Area of Port-au-Prince, arguing that in this restricted sample strongly affected areas are more comparable to the control group. Table 4 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 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:

$$Y_{i0} = \alpha + \beta D_i + \epsilon_i \qquad (5)$$

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 5, we can further test whether conditionally on this set of observables households would follow the same trend. Formally, the test is written :

$$Y_{i0} = \alpha + \beta D_i + \gamma X_{i0} + \epsilon_i \qquad (6)$$

Results of the falsification test are reported in Table 7. 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 restriction of the estimation sample considerably helps in reducing the bias, yet it remains significant also when excluding the MA. 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 some commune-level 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[12]

Yet, as Table 7 shows, the inclusion of baseline control variables enable to correct for a substantial share of the selection bias. We thus include those variables interacted with time, in the impact estimation model (Abadie, 2005). Results of the estimation of equation 3 are reported in Table 8. Columns (1) and (4) display results from the basic equation estimated over the full and restricted samples respectively, to which we add sets of household and commune characteristics, in the columns that follow.

The introduction of household baseline characteristics does not have a strong incidence on the estimated impact coefficient in both the full and restricted samples, however the inclusion of commune baseline characteristics has stronger

[12]The general agricultural census, conducted in 2009, collected a large number of district-level (section communale) variables and could provide good covariates for improving our estimates.

Table 7: "Falsification" test on asset index

	Full sample			Restricted sample		
Dependent variable : asset index 2010	(1)	(2)	(3)	(4)	(5)	(6)
Treatment (PGA >=0.18)	0.773***	0.527***	0.295***	0.251***	0.209***	0.166***
	(0.029)	(0.026)	(0.037)	(0.031)	(0.033)	(0.036)
Household head characteristics						
Sexe (male=1)		-0.066**	-0.034		-0.050*	-0.011
		(0.028)	(0.028)		(0.027)	(0.026)
Age		0.009***	0.009***		0.003***	0.004***
		(0.001)	(0.001)		(0.001)	(0.001)
Pre-school education (yes=1)		0.135*	0.101		0.090	0.062
		(0.069)	(0.067)		(0.063)	(0.060)
Primary education (yes=1)		0.314***	0.267***		0.246***	0.203***
		(0.024)	(0.023)		(0.023)	(0.022)
Secondary education (yes=1)		0.817***	0.722***		0.667***	0.560***
		(0.039)	(0.039)		(0.049)	(0.048)
Superior education (yes=1)		2.079***	1.963***		1.234***	1.110***
		(0.118)	(0.117)		(0.163)	(0.166)
Household characteristics (2010)						
Household size		0.026***	0.027***		0.017***	0.017***
		(0.006)	(0.006)		(0.006)	(0.006)
Couple without children (yes=1)		0.124*	0.129*		0.232***	0.237***
		(0.073)	(0.073)		(0.062)	(0.061)
Couple with children (yes=1)		0.058	0.048		0.046	0.042
		(0.066)	(0.065)		(0.047)	(0.046)
Single-parent nuclear (yes=1)		0.104	0.091		0.084*	0.075*
		(0.066)	(0.065)		(0.045)	(0.044)
Extended single-parent family (yes=1)		0.252***	0.218***		0.242***	0.225***
		(0.071)	(0.071)		(0.059)	(0.058)
Extended household (yes=1)		0.153**	0.142**		0.173***	0.166***
		(0.065)	(0.065)		(0.049)	(0.048)
Commune characteristics						
Section communale density			0.000***			0.000***
			(0.000)			(0.000)
Electricity evolved equipment			-0.238			1.208**
			(0.300)			(0.547)
Water evolved equipment			0.055			-0.002
			(0.042)			(0.039)
% Workers employed in primary sector			-0.665***			-0.392***
			(0.083)			(0.073)
Constant	-0.333***	-1.274***	-1.036***	-0.333***	-0.969***	-1.337***
	(0.020)	(0.080)	(0.095)	(0.014)	(0.071)	(0.116)
Observations	4,787	4,787	4,787	2,937	2,937	2,937
R-squared	0.133	0.331	0.350	0.021	0.213	0.231

Note: Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

consequences. The impact coefficient in the full sample estimation, is strongly reduced, and becomes even insignificant. Thus, this tends to indicate that on average, and once controlled for baseline characteristics, the earthquake may not have had long -lasting effects. Impacted households may thus have recovered, on average, from the losses of the earthquake, reaching the same trend than of the unaffected households. However, if we exclude the MA, the impact is reduced but remains significantly different from zero. We should remain cautious in interpreting those results because of remaining selection issues.

The results presented above may also well be due to the presence of erogeneous impacts accross the affected population. Is the impact stronger in the non MA area because of the lack of assistance or access to camps? Were initially poorer households more impacted than the richer ones or on the contrary could they recover better from the shock? We explore these questions in table 9, by

Table 8: Asset index DID with baseline controls

	Full sample			Restricted sample		
	(1)	(2)	(3)	(4)	(5)	(6)
Time	0.061***	0.074	0.121**	0.061***	0.059*	0.045
	(0.007)	(0.050)	(0.061)	(0.007)	(0.035)	(0.045)
Time x Treat	-0.100***	-0.113***	-0.038	-0.051**	-0.050**	-0.043*
	(0.017)	(0.018)	(0.024)	(0.024)	(0.024)	(0.025)
Time x household head characteristics	NO	YES	YES	NO	YES	YES
Time x household characteristics	NO	YES	YES	NO	YES	YES
Time x commune characteristics	NO	NO	YES	NO	NO	YES
Household FE	YES	YES	YES	YES	YES	YES
Constant	0.062***	0.062***	0.062***	-0.282***	-0.282***	-0.282***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Observations	9,574	9,574	9,574	5,874	5,874	5,874
R-squared	0.007	0.014	0.025	0.018	0.031	0.042
Number of idmen_panel	4,787	4,787	4,787	2,937	2,937	2,937

Note: Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

decomposing it into various groups of households.

Table 9: Asset index DID with interactions

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Time	0.045	0.043	0.043	0.056	0.060	0.074*	0.085*
	(0.045)	(0.044)	(0.044)	(0.045)	(0.045)	(0.045)	(0.044)
Time x Treat	-0.043*	0.002	0.023	-0.035	0.026	0.009	0.041
	(0.025)	(0.023)	(0.024)	(0.025)	(0.035)	(0.024)	(0.025)
Wealth second tercile (Q2) x Time		-0.149***	-0.153***				
		(0.013)	(0.013)				
Wealth third tercile (Q3) x Time		-0.413***	-0.373***				
		(0.038)	(0.045)				
Q2 x Time x Treat			0.015				
			(0.034)				
Q3 x Time x Treat			-0.119				
			(0.079)				
Material assistance x Time				-0.043***	-0.016		
				(0.014)	(0.014)		
Material assistance x Time x Treat					-0.126***		
					(0.046)		
Transit camp x Time						-0.285***	-0.012
						(0.049)	(0.069)
Transit camp x Time x Treat							-0.406***
							(0.093)
Constant	-0.282***	-0.282***	-0.282***	-0.282***	-0.282***	-0.282***	-0.282***
	(0.004)	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)
Time x Household baseline controls	YES	YES	YES	YES	YES	YES	YES
Time x Commune baseline controls	YES	YES	YES	YES	YES	YES	YES
Household FE	YES	YES	YES	YES	YES	YES	YES
Observations	5,874	5,874	5,874	5,874	5,874	5,874	5,874
R-squared	0.044	0.133	0.135	0.046	0.050	0.067	0.078
Number of idmen_panel	2,937	2,937	2,937	2,937	2,937	2,937	2,937

Note: Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

The first source of heterogeneity we look at is households' initial wealth. We divide the whole population into wealth terciles (based on the 2010 asset index), and include those terciles in column (2) and interact with the treatment in column (3). Results indicate that, regardless of the earthquake, households from the second and third terciles have experienced a larger negative growth in their asset holding, than the poorest ones. The experience of the earthquake does not significantly accentuate these effects, but it deepens the negative effect experienced by the richest tercile which 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 look at the long-lasting effects of the earthquake on households that benefited from assistance and those who did not. In section 3.3 we described some statistics on assistance programs and showed that even among the most impacted households coverage has been highly variable, often low and negatively correlated with the distance to Port-au-Prince. We test here whether households that have benefited from assistance have recovered better from the direct losses of the earthquake than others. We focus here only on material assistance, that is from all types except from information campaigns conducted throughout the country to prevent cholera epidemics. Results indicate otherwise : those who benefited from material assistance also experienced on average larger losses three years after the earthquake than those who did not. First it may indeed be true that assistance programs which were foremost aimed to respond to the emergency, failed to engage the reconstruction phase (see section 3.3, 3 and Herrera et al. (2014) who show that most assistance programs were stopped after two years) and were not sufficient to help impacted households. Furthermore, this negative impact compared to the insignificant coefficient estimated on affected households that did not receive assistance, may indicate a rather good targeting of the programs who attained the most impacted households, but yet did not help them to recover. Another and rather pessimistic interpretation is that assisted households because of the promise of future help did not look themselves for self-coping strategies, and remained behind in the recovery process. This argument has been pronounced in the case of refugee camps accused to attract mostly unimpacted poor households to keep them into a dependency situation. However, descriptive statistics in the ECVMAS report shows that this was not the case and in fact those that stayed in those sites were those that experienced the most severe destruction. Nevertheless the camps may have had for those who stayed long a poverty trap effect rather than a pushing influence by cutting households from their immediate social and working networks and from their access to working capital 4.2.

In columns (6) and (7) we interact our treatment effect with a dummy variable indicating whether at least one of the household members stayed for more than a day in one of these camps after the earthquake. The heterogeneity of this effect appears even clearer than in the case of assistance : households that passed even for a short period in one of these sites are the one who experienced the largest losses in terms durable goods. This is first explained by a strong selection effect: those who left their home to say in refugee camps if they did not loose their house in the earthquake had to abandon it (although many households sent only part of their members into camps). Beyond this selection issue, there might also an impoverishment effect in staying in camps which may not offer the conditions for households to engage in income generating activities. We explore this question in the next section when looking at the effect of the earthquake on labor market participation.

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 the 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 homogeneizing 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.

Table 10 provides the regression results from equation 2 at individual level for both samples. 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 10 suggest that the earthquake has an overall negative long-lasting impact on subsequent labour market participation. According to the result in column (1), the probability to participate to the labour market increase for people living outside the strongly affected areas in 2010. For individuals living in the strongly shaking areas, the coefficient on the treatment dummy is significantly negative and significant in all specifications, which is consistent with the results of the conditional (fixed-effects) logit model (table A.2 in appendix).

Table 10: Labour participation DID

	Full sample	Restricted sample
	(1)	(2)
Time	0.035***	0.035***
	(0.005)	(0.005)
Time x Treat	-0.071***	-0.048***
	(0.007)	(0.011)
Individual FE	YES	YES
Constant	0.567***	0.570***
	(0.002)	(0.002)
Observations	35,040	21,970
R-squared	0.006	0.005
Number of idind_panel	17,520	10,985

Note: Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

The decrease of the probability to participate to the labour market for the individual living in affected areas is consistent with 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 was we did in the previous section at the household-level. Results are presented in Table 11 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 (column (1)). We find however some significant difference between the treated ad the untreated in the restricted sample estimation, in column (5). However, after controlling for a complete set of baseline observable commune, household and individual characteristics (columns (4) and (8)), 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.

Based on this finding, we estimate the impact of the earthquake on labour market participation following equation 3, i.e. including baseline controls interacted with time. Results are presented in Table 12. First, we control for a set of baseline individual characteristics (column (2)): sex, age and education dummies (equal to 1 for each level of education, 'no education' being the base category). 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. 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 (table A.1 in appendix). Second, we include the set of baseline household characteristics (column (3)): household size and household composition dummies in 2010. We

Table 11: "Falsification" test on labour market participation

	Full sample				Restricted sample			
labour market participation in 2010	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Treatment (PGA ¿=0.18)	0.004	0.015**	0.013*	0.005	0.021*	0.023**	0.020*	0.016
	(0.007)	(0.007)	(0.008)	(0.011)	(0.012)	(0.011)	(0.011)	(0.012)
Individual characteristics								
Sexe (male=1)		0.078***	0.074***	0.074***		0.100***	0.098***	0.098***
		(0.007)	(0.007)	(0.007)		(0.008)	(0.008)	(0.008)
Age		0.013***	0.013***	0.013***		0.012***	0.012***	0.012***
		(0.000)	(0.000)	(0.000)		(0.000)	(0.000)	(0.000)
Pre-school education (yes=1)		-0.005	-0.006	-0.004		-0.029	-0.031	-0.029
		(0.031)	(0.031)	(0.031)		(0.034)	(0.034)	(0.034)
Primary education (yes=1)		-0.013	-0.010	-0.010		-0.042***	-0.041***	-0.040***
		(0.010)	(0.010)	(0.010)		(0.012)	(0.012)	(0.012)
Secondary education (yes=1)		0.017*	0.023**	0.020*		-0.009	-0.004	-0.004
		(0.010)	(0.010)	(0.011)		(0.013)	(0.013)	(0.013)
Superior education (yes=1)		0.140***	0.144***	0.141***		0.178***	0.182***	0.182***
		(0.017)	(0.017)	(0.017)		(0.031)	(0.032)	(0.032)
Household characteristics (2010)								
Household size			-0.011***	-0.011***			-0.008***	-0.008***
			(0.001)	(0.001)			(0.002)	(0.002)
Couple without children (yes=1)			0.074**	0.074**			0.060	0.059
			(0.029)	(0.029)			(0.039)	(0.039)
Couple with children (yes=1)			0.010	0.010			0.040	0.039
			(0.024)	(0.024)			(0.033)	(0.033)
Single-parent nuclear (yes=1)			-0.055**	-0.056**			-0.028	-0.030
			(0.026)	(0.026)			(0.035)	(0.035)
Extended single-parent family (yes=1)			-0.052**	-0.053**			-0.023	-0.026
			(0.025)	(0.025)			(0.034)	(0.034)
Extended household (yes=1)			-0.012	-0.013			-0.002	-0.004
			(0.024)	(0.024)			(0.033)	(0.033)
Section communale density			-0.000**	-0.000*			-0.000	-0.000
			(0.000)	(0.000)			(0.000)	(0.000)
Commune characteristics (mean 2007)								
Electricity evolved equipment				-0.008				-0.304*
				(0.079)				(0.178)
Water evolved equipment				0.007				0.005
				(0.020)				(0.020)
Labour force participation				-0.058				-0.077
				(0.058)				(0.061)
% unemployed (extended definition)				-0.021				-0.019
				(0.040)				(0.042)
Informal sector				0.030				0.047
				(0.034)				(0.036)
Private formal sector				0.169				0.226
				(0.188)				(0.213)
Public sector				-0.224**				-0.184*
				(0.101)				(0.103)
Constant	0.565***	0.108***	0.200***	0.215***	0.565***	0.157***	0.203***	0.222***
	(0.005)	(0.013)	(0.026)	(0.045)	(0.005)	(0.015)	(0.035)	(0.051)
Observations	17,520	17,520	17,520	17,520	10,985	10,985	10,985	10,985
R-squared	0.000	0.242	0.250	0.251	0.000	0.239	0.244	0.245

Note: Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

also include the density of the communale section (smaller geographical entity than a commune) where the household was living in 2010, as it will control for the disparities between urban and rural households (see section 3.3, footnote 5). Then, we add a set of baseline commune characteristics (column (4)), to control for facilities and various services include the mean of households with electricity, generator or solar panels, the mean of households with water-tap tap system in 2007. We also control for a set of baseline controls specific to the labour market: labour force participation, mean of unemployed individuals (including discouraged workers) and mean of employed individual in institutional sector (agricultural sector being the base category) at commune level in 2007.

The inclusion of baseline characteristics alters the magnitude of the coefficients of the earthquake on labor participation, but it does not change their sign and significance. The LPM coefficients of the most complete specification point

Table 12: Labour market participation DID with baseline controls

	Full sample				Restricted sample			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Time	0.035***	0.140***	0.115***	0.106**	0.035***	0.160***	0.175***	0.139***
	(0.005)	(0.013)	(0.028)	(0.047)	(0.005)	(0.015)	(0.036)	(0.053)
Time x Treat	-0.071***	-0.074***	-0.059***	-0.022**	-0.048***	-0.043***	-0.048***	-0.039***
	(0.007)	(0.007)	(0.008)	(0.011)	(0.011)	(0.011)	(0.011)	(0.012)
Time x individual characteristics	NO	YES	YES	YES	NO	YES	YES	YES
Time x household characteristics	NO	NO	YES	YES	NO	NO	YES	YES
Time x commune characteristics	NO	NO	NO	YES	NO	NO	NO	YES
Individual FE	YES	YES	YES	YES	YES	YES	YES	YES
Constant	0.567***	0.567***	0.567***	0.567***	0.570***	0.570***	0.570***	0.570***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Observations	35,040	35,040	35,040	35,040	21,970	21,970	21,970	21,970
R-squared	0.006	0.058	0.059	0.064	0.005	0.063	0.070	0.075
Number of idind_panel	17,520	17,520	17,520	17,520	10,985	10,985	10,985	10,985

Note: Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

out an average drop of about 2.2 percentage points in the probability to participate to the labour market, 3 years after the shock, for individuals incurring a strong physical intensity in 2010. The long-lasting effect is even stronger (3.9 percentage points) when we exclude individuals living in the Metropolitan area at the time of the earthquake. This result is robust (negative and strongly significant) when we restrict our sample to adult aged from 25 to 54, respectively a drop of 2.8 and 5.3 percentage points (columns (1) and (5) in Table A.1, in appendix).

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 '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 13 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 (2) and (3), but the coefficients of the interactions between wealth terciles and treatment are not significant (column (3)). 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. In addition, the coefficient of the assistance (all kind of assistance, excluding information program) interacted with treatment suggests that members of recipient households have a higher probability to decrease their labour force participation, suggesting that there is a part of substitution between the different coping mechanisms (column (5)). As for the individuals who passed by a camp, results show no significant difference associated with the treatment (column (7)). However, specification (6) suggests that, independently of the earthquake, passing through a camp decreases even more the probability to participate to the labour market, which might be partly explained by their ex-ante greater vulnerability.

Table 13: Labour market participation DID with interactions

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Time	0.139***	0.142***	0.136**	0.147***	0.137***	0.129**	0.130**
	(0.053)	(0.053)	(0.054)	(0.053)	(0.053)	(0.053)	(0.053)
Time x Treat	-0.039***	-0.038***	-0.014	-0.036***	0.001	-0.031**	-0.032**
	(0.012)	(0.012)	(0.020)	(0.012)	(0.016)	(0.012)	(0.013)
Wealth second tercile (Q2) x Time		-0.033***	-0.028***				
		(0.010)	(0.011)				
Wealth third tercile (Q3) x Time		-0.011	-0.003				
		(0.014)	(0.015)				
Q2 x Time x Treat			-0.036				
			(0.026)				
Q3 x Time x Treat			-0.037				
			(0.029)				
Material assistance x Time				-0.018**	-0.004		
				(0.009)	(0.010)		
Material assistance x Time x Treat					-0.075***		
					(0.022)		
Transit camp x Time						-0.049**	-0.057
						(0.024)	(0.055)
Transit camp x Time x Treat							0.010
							(0.061)
Constant	0.570***	0.570***	0.570***	0.570***	0.570***	0.570***	0.570***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Time x Individual baseline controls	YES	YES	YES	YES	YES	YES	YES
Time x Household baseline controls	YES	YES	YES	YES	YES	YES	YES
Time x Commune baseline controls	YES	YES	YES	YES	YES	YES	YES
Individual FE	YES	YES	YES	YES	YES	YES	YES
Observations	21,970	21,970	21,970	21,970	21,970	21,970	21,970
R-squared	0.075	0.076	0.076	0.075	0.076	0.075	0.075
Number of idmen_panel	10,985	10,985	10,985	10,985	10,985	10,985	10,985

Note: Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

5 Conclusion

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. Assessing the long-lasting economic consequences of 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.

Although mitigated at the national level, results clearly indicate in the restricted sample that excludes the Metropolitan area of Port-au-Prince, more homogeneous in pre-earthquake characteristics, a negative and significant impact of the earthquake in treated households' asset index (around -0.05). These results suggest that almost three years after the shock, households that lived in strongly affected areas in 2010 remained strongly and negatively impacted. Furthermore, there is evidence 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 3.9 p.p. in the probability to participate to labour market, encumbering the resilient recovery. 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. Pushing further the analysis we observe that those who benefited from material assistance also experienced on average larger losses three years after the earthquake than those who did not. However, it might be true that assistance programs, which were aimed at first to respond to the emergency, failed to engage the reconstruction and to stop the disruption of the livelihoods system of affected households. The heterogenous effect appears even clearer for households and individuals who passed through a camp. They experienced the largest losses of durable goods and, probably because more vulnerable ex-ante, they were also more likely to decrease their labour force participation, independently of the earthquake, making them more prone to becoming trapped in poverty.

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.

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A Appendix

Table A.1: Parametric DID on labour market participation on individuals aged from 25 to 54

	Full sample				Restricted sample			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Time	-0.059***	-0.128***	-0.129***	-0.164**	-0.059***	-0.151***	-0.112*	-0.190**
	(0.007)	(0.028)	(0.044)	(0.073)	(0.007)	(0.035)	(0.063)	(0.088)
Time x Treat	-0.030***	-0.039***	-0.037***	-0.028*	-0.048***	-0.046***	-0.052***	-0.053***
	(0.010)	(0.011)	(0.012)	(0.016)	(0.017)	(0.016)	(0.017)	(0.018)
Time x individual characteristics								
Sexe (male=1)		0.114***	0.117***	0.116***		0.111***	0.107***	0.107***
		(0.010)	(0.010)	(0.010)		(0.012)	(0.013)	(0.013)
Age		0.000	0.000	0.000		0.001	0.001	0.001
		(0.001)	(0.001)	(0.001)		(0.001)	(0.001)	(0.001)
Pre-school education (yes=1)		0.027	0.026	0.026		0.014	0.014	0.015
		(0.041)	(0.041)	(0.041)		(0.041)	(0.041)	(0.040)
Primary education (yes=1)		0.009	0.008	0.010		0.002	0.006	0.007
		(0.014)	(0.014)	(0.014)		(0.015)	(0.015)	(0.015)
Secondary education (yes=1)		0.023	0.023	0.026*		0.006	0.021	0.021
		(0.014)	(0.015)	(0.015)		(0.017)	(0.018)	(0.018)
Superior education (yes=1)		0.086***	0.087***	0.093***		0.055	0.080**	0.077**
		(0.020)	(0.020)	(0.021)		(0.035)	(0.036)	(0.036)
Time x household characteristics (2010)								
Household size			0.001	0.001			-0.003	-0.002
			(0.002)	(0.002)			(0.003)	(0.003)
Couple without children (yes=1)			-0.039	-0.040			-0.071	-0.075
			(0.041)	(0.041)			(0.060)	(0.060)
Couple with children (yes=1)			-0.010	-0.009			-0.015	-0.016
			(0.035)	(0.035)			(0.051)	(0.051)
Single-parent nuclear (yes=1)			0.018	0.020			-0.006	-0.004
			(0.037)	(0.037)			(0.055)	(0.055)
Extended single-parent family (yes=1)			0.014	0.014			-0.003	-0.001
			(0.037)	(0.037)			(0.054)	(0.054)
Extended household (yes=1)			-0.009	-0.008			-0.013	-0.012
			(0.035)	(0.035)			(0.051)	(0.052)
Section communale density			-0.000	-0.000			-0.000***	-0.000***
			(0.000)	(0.000)			(0.000)	(0.000)
Time x commune characteristics (mean 2007)								
Electricity evolved equipment				0.221*				0.560**
				(0.120)				(0.275)
Water evolved equipment				0.026				0.038
				(0.030)				(0.031)
Labour force participation				0.119				0.201**
				(0.092)				(0.097)
% unemployed (extended definition)				-0.008				-0.028
				(0.063)				(0.066)
Informal sector				-0.045				-0.041
				(0.053)				(0.056)
Private formal sector				-0.566**				-0.307
				(0.287)				(0.329)
Public sector				0.037				-0.060
				(0.140)				(0.141)
Constant	0.859***	0.859***	0.859***	0.859***	0.862***	0.862***	0.862***	0.862***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)
Individual FE	YES	YES	YES	YES	YES	YES	YES	YES
Observations	15,130	15,130	15,130	15,130	8,786	8,786	8,786	8,786
R-squared	0.031	0.052	0.052	0.054	0.028	0.047	0.051	0.053
Number of idind_panel	7,565	7,565	7,565	7,565	4,393	4,393	4,393	4,393

Note: Robust standard errors in parentheses: *** $p<0.01$, ** $p<0.05$, * $p<0.1$. Section communale density variable is the density of the section communale (smaller geographical entity than a commune) where the household was living in 2010 (see section 3.3, footnote 5).

Table A.2: Parametric DID on labour market participation: clogit model

	Full sample				Restricted sample			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Time	0.337***	1.804***	1.373***	0.972*	0.337***	1.913***	2.113***	1.480**
	(0.047)	(0.161)	(0.357)	(0.543)	(0.047)	(0.196)	(0.527)	(0.672)
Time x Treat	-0.711***	-0.518***	-0.394***	-0.144	-0.467***	-0.339***	-0.407***	-0.365***
	(0.068)	(0.082)	(0.089)	(0.126)	(0.106)	(0.119)	(0.122)	(0.140)
Time x individual characteristics								
Sexe (male=1)		0.843***	0.835***	0.830***		0.863***	0.834***	0.838***
		(0.080)	(0.080)	(0.081)		(0.100)	(0.101)	(0.102)
Age		-0.063***	-0.061***	-0.060***		-0.064***	-0.061***	-0.060***
		(0.004)	(0.004)	(0.004)		(0.005)	(0.005)	(0.005)
Pre-school education (yes=1)		-0.023	0.017	-0.018		-0.191	-0.185	-0.223
		(0.386)	(0.391)	(0.399)		(0.389)	(0.390)	(0.395)
Primary education (yes=1)		0.144	0.157	0.166		0.114	0.192	0.189
		(0.126)	(0.126)	(0.127)		(0.150)	(0.151)	(0.152)
Secondary education (yes=1)		-0.125	-0.067	-0.018		-0.332**	-0.126	-0.101
		(0.124)	(0.125)	(0.127)		(0.148)	(0.153)	(0.155)
Superior education (yes=1)		0.171	0.262	0.331		-0.278	0.111	0.099
		(0.202)	(0.206)	(0.209)		(0.351)	(0.366)	(0.374)
Time x household characteristics (2010)								
Household size			0.041***	0.039**			0.006	0.006
			(0.015)	(0.015)			(0.018)	(0.018)
Couple without children (yes=1)			-0.245	-0.303			-0.752	-0.809
			(0.390)	(0.389)			(0.563)	(0.567)
Couple with children (yes=1)			0.207	0.156			-0.113	-0.139
			(0.330)	(0.327)			(0.491)	(0.493)
Single-parent nuclear (yes=1)			0.213	0.193			-0.249	-0.241
			(0.347)	(0.345)			(0.510)	(0.512)
Extended single-parent family (yes=1)			0.136	0.112			-0.342	-0.342
			(0.338)	(0.335)			(0.503)	(0.505)
Extended household (yes=1)			0.046	0.027			-0.268	-0.257
			(0.330)	(0.327)			(0.493)	(0.494)
Section communale density			-0.000**	-0.000			-0.000***	-0.000***
			(0.000)	(0.000)			(0.000)	(0.000)
Time x commune characteristics (mean 2007)								
Electricity evolved equipment				0.856				2.405
				(0.888)				(2.209)
Water evolved equipment				0.172				0.223
				(0.248)				(0.254)
Labour force participation				1.566**				1.835**
				(0.712)				(0.758)
% unemployed (extended definition)				-0.660				-0.841
				(0.501)				(0.519)
Informal sector				-0.274				-0.066
				(0.423)				(0.447)
Private formal sector				-8.067***				-7.675***
				(2.262)				(2.523)
Public sector				1.876				1.064
				(1.333)				(1.340)
Individual FE	YES	YES	YES	YES	YES	YES	YES	YES
Observations	7068	7068	7068	7068	4572	4572	4572	4572
Number of idind_panel	3534	3534	3534	3534	2286	2286	2286	2286

Note: Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1. Section communale density variable is the density of the section communale (smaller geographical entity than a commune) where the household was living in 2010 (see section 3.3, footnote 5).