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IZA DP No. 12475

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ISSN: 2365-9793

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ABSTRACT

Repeated Shocks and Preferences for Redistribution*

A society that believes wealth to be determined by random "luck", rather than by merit, demands more redistribution. We present evidence of this behavior by exploiting a natural experiment provided by the L'Aquila earthquake in 2009, which hit a large area of Central Italy through a series of destructive shakes over eight days. Matching detailed information on the ground acceleration registered during each shock with survey data about individual opinions on redistribution we show that the average intensity of the shakes is associated with subsequent stronger beliefs that, for a society to be fair, income inequalities should be levelled by redistribution. The shocks, however, are not all alike. We find that only the last three shakes - occurred on the fourth and the eighth day of the earthquake - have a statistically significant impact. Overall, we find that the timing and repetition of the shocks play a role in informing redistributive preferences.

JEL Classification: H10, H53, D63, D69, Z1

Keywords: redistribution, inequality, natural disasters, earthquakes, multiple shocks

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* A previous version of this paper circulated under the title "Natural disasters and demand for redistribution: Lessons from an earthquake". We are indebted to Marianna Belloc, Elena Esposito, Stefano Gagliarducci, Veronica Grembi, Luigi Guiso and Andrea Pozzi for helpful comments and suggestions. Usual caveats apply.

1 Introduction

Redistributive policies rely on the prevailing beliefs about the fairness of social competition. Previous research suggests that if a society believes that socioeconomic success only depends on merit, and that everyone should fully enjoy the fruits of her work, it will demand low redistribution. If, instead, the belief prevails that wealth is mostly determined by random "luck", such as the fortune of being born in the right place into the right family, society will support higher redistribution thus levying heavier taxes (Alesina and Angeletos, 2005; Bénabou and Tirole, 2006). Empirical studies provide individual-level evidence that economic self-interest explains only a part of the variation in attitudes towards redistribution, whether across (Betchel et al., 2014) or within countries (Dahlberg et al., 2012), and that a stronger belief that luck matters in determining one's position in the social ladder is associated to higher support for welfare spending (see Alesina and Giuliano, 2011, for a review). Even if agents largely inherit their beliefs from ancestors (Guiso et al., 2006), individual perceptions about the competing roles of luck and merit also are the outcome of a life-long learning process. Unfortunate experiences can support the belief that random luck, instead of merit, plays a key role in income distribution, thereby raising aversion to inequality and consensus for redistributive policies (Piketty, 1995; Alesina and Angeletos, 2005).

By exploiting a natural experiment given by the 2009 L'Aquila earthquake, we provide empirical evidence that a prior experience of the impact of pure random luck is associated to a stronger willingness to reduce inequality through redistribution. The earthquake, one of the strongest and most destructive seismic events registered in Italy in the last 40 years, consisted of an initial shock occurred on April 6, 2009 and dozens of aftershocks, seven of which had a moment magnitude larger than or equal to 5, over the following days until April 13, 2009. A natural disaster is a manifestation of luck, in this case the misfortune of living in the wrong place at the wrong time, which randomly strikes the population revealing the volatility of material wealth and how exogenous events can destroy the outcomes achieved with merit.

We build a novel dataset that matches the peak ground acceleration (PGA) of each shock recorded throughout the National Strong Motion Network during the earthquake with nationally representative survey data about individual opinions and beliefs collected almost two years later, at the beginning of 2011, by the Italian National Election Studies (ItaNES). The empirical analysis illustrates how, consistently with the literature, the average intensity of the shakes registered throughout the L'Aquila earthquake is associated with a subsequent stronger belief that, for a society to be fair, income inequalities should be levelled by redistribution. The analysis of the single shocks occurred between April 6 and 13, however, reveals that this result is driven by the impact of the last three shakes, suggesting that the timing and repetition of the shock also play a role in informing redistributive preferences. Despite having been destructive, the first five shakes show no statistically significant impact. The PGA of the three final shocks occurred between April 9 and 13, instead, is significantly correlated with preferences for redistribution, as if a cumulative effect of the shocks has been at stake. Though new in the economics literature, this result is consistent with the commonly accepted finding in psychology that repeated shocks prompt stronger emotional and behavioral responses (Turner and Lloyd, 1995; Williams et al., 2007).

The natural experiment provided by the earthquake allows circumventing the endogeneity problems that are usually at stake in the analysis of individual preferences and opinions. There are several reasons to safely rule out population self-selection into the province of L'Aquila along specific personal characteristics such as risk attitudes. First, no seismic event was registered in the area over the previous 24 years, when the province of L'Aquila was hit by a non-destructive earthquake that did not cause fatalities or injuries in 1985. Second, according to the National Institute of Geophysics and Volcanology (*Istituto Nazionale di Geofisica e Vulcanologia*, INGV), the 1985 earthquake did not alter the seismic classification of the epicentral area that was first assessed in 1927, when L'Aquila and the surrounding municipalities were classified as "zone 2" areas, a very broad category comprising 27% of Italian municipalities. The demographic balance and the migration balance of the epicentral area and the surrounding provinces have proved stable over the following two decades, suggesting that the event did not prompt any precautionary emigration (Istat, 2013a; 2013b). Third, data clearly show that no significant emigration flows occurred over the years following the 2009 earthquake: the crude rate of net migration (plus statistical adjustment) for the province of L'Aquila is equal to -0.3 and 1.0 per 1000 inhabitants in 2009 and 2010, respectively. These rates are smaller than the national rate for the same years (3.6 and 3.4, respectively). As it will be explained in detail in Section 2.3, comparable figures hold for the municipalities inside the most hit area (the so called *cratere sismico,* "seismic crater"), whose emigration and immigration flows did not significantly change after the 2009 earthquake.[1]

The omission of relevant variables may also prevent a correct identification of the impact of the

[1] Data are sourced from https://ec.europa.eu/eurostat/web/population-demography-migration-projections/data/database.

shocks. Since preferences for redistribution can be affected by personal traits, we control for demographic characteristics, socio-economic status, political opinions, religious beliefs, and situations of economic hardship of the family. Moreover, we control for cultural differences across provinces by adding province dummies, and city-level geomorphological variables, including the seismicity of the municipality.

To rule out the possibility that our results capture spurious correlations, we then develop a series of counterfactuals by generating placebo earthquakes with the same intensity and propagation pattern of the last three L'Aquila main shakes but having their epicenter in the centroid of each of the 6,685, 6,915, and 6,846 municipalities outside the actual epicentral areas. We then estimate the relationship of these shakes with support for redistribution. Given the relevance of repeated exposure to traumatic shocks, we replicate the placebo procedure excluding from the sample of counterfeit epicenters also those municipalities where at least one of the previous five main shakes was felt (5,917, 5,916 and 5,920 respectively). The different placebo tests support our results. To further inspect the diverse outcomes associated to single versus multiple shocks, we exploit a natural counterfactual provided by an earthquake occurred in the province of Parma approximately 3.5 months before the L'Aquila earthquake, on December 23, 2008, which consisted of a single shake. Though being comparable in magnitude to the shakes registered over the L'Aquila event, the PGA of the Parma shake was smaller and we do not find any significant relationship with preferences for redistribution in our sample.

Our contribution bridges three strands of literature. The first investigates the determinants of the individual demand for redistribution by analyzing the role of the macroeconomic environment (Giuliano and Spilimbergo, 2014), experiences about inequality (Betchel et al., 2018; Roth and Wohlfart, 2018; Pellicer et al., 2019), mobility prospects (Piketty, 1995; Bénabou and Ok, 2001), concerns regarding the fairness of social competition and the roots of inequality (Alesina et al., 2001; Alesina and Angeletos, 2005; Alesina and La Ferrara, 2005; Isaksson and Lindskog, 2009; Jiménez-Jiménez et al., 2018), culture and religion (Luttmer and Singhal, 2011; Dills and Hérnandez-Julian, 2014; Kirchmaier et al., 2018), immigration (Dahlberg et al., 2012), risk preferences (Gärtner et al., 2017), altruism and cosmopolitanism (Betchel et al., 2014) and social capital (Algan et al., 2016; Cerqueti et al., 2019). In a paper that is close in spirit to ours, Esarey et al. (2012) show through a laboratory experiment that subjects treated with a chance of random and catastrophic loss of income vote for higher taxes to reduce inequality. This behavior is intended to make society fairer inasmuch as redistribution "strengthens the link between effort and outcome by mitigating the effect of random events that can drastically impact income, like natural disasters" (Esarey et al., 2012, p. 686)". We add to this field by exploiting a natural experiment to study the role of exogenous unfortunate events in support for redistribution.

The second strand studies the effect of natural disasters on macroeconomic and behavioral outcomes such as institutional change (Belloc et al., 2016), growth (Skidmore and Toya, 2002), trust (Toya and Skidmore, 2014), risk attitudes (Eckel et al., 2009; Said et al., 2015; Hanaoka et al., 2018), well-being (Rehdanz et al., 2015; Kim et al., 2017), and time preferences (Callen, 2015; Cassar et al., 2017).We contribute to this literature in several substantive ways. We suggest that natural disasters can trigger a change in the perceived role of luck that affects redistributive preferences . In addition, we exploit the peculiar timing of the natural experiment provided by the L'Aquila earthquake - which lasted eight days in the form of a first strong shake and a series of equally destructive aftershocks - to study the possible role of repeated shocks. Finally, we differentiate from previous studies by operationalizing a continuous measure of the intensity of the shocks that captures exactly how hardly the shakes are felt by inhabitants. With a few exceptions (e.g., Hanaoka et al., 2018), economics studies measure the exposure to natural disasters through dichotomic or categorical indicators.

Finally, some authors analyze how natural disasters prompt a change in the agenda of political elites and assess the impact of relief programs on voters' support for incumbent parties (Betchel and Hainmueller, 2011; Gagliarducci et al., 2019). This perspective on the outcomes of catastrophes has the advantage of relying on the actual behaviors of policy makers. Our approach of using survey data collected in a representative sample of the population adds to these studies by shedding light on the sources of those social preferences that affect the response of voters to relief programs. Previous studies found that voters react differently to relief programs in countries with different attitudes towards redistribution (Alesina et al., 2001). While redistributive policies in the wake of disasters seem to have a positive electoral return across German districts (Betchel and Hainmueller, 2011), the change in the policy agenda of U.S. congress members dictated by hurricanes is associated with a penalty in the following elections (Gagliarducci et al., 2019).

The rest of the paper is organized as follows: Section 2 describes the dataset we assembled by matching the information on the L'Aquila earthquake with survey data and the empirical strategy. Section 3 presents the econometric analysis and discusses the robustness and interpretation of results. In section 4 we draw some concluding remarks.

2 Data and empirical strategy

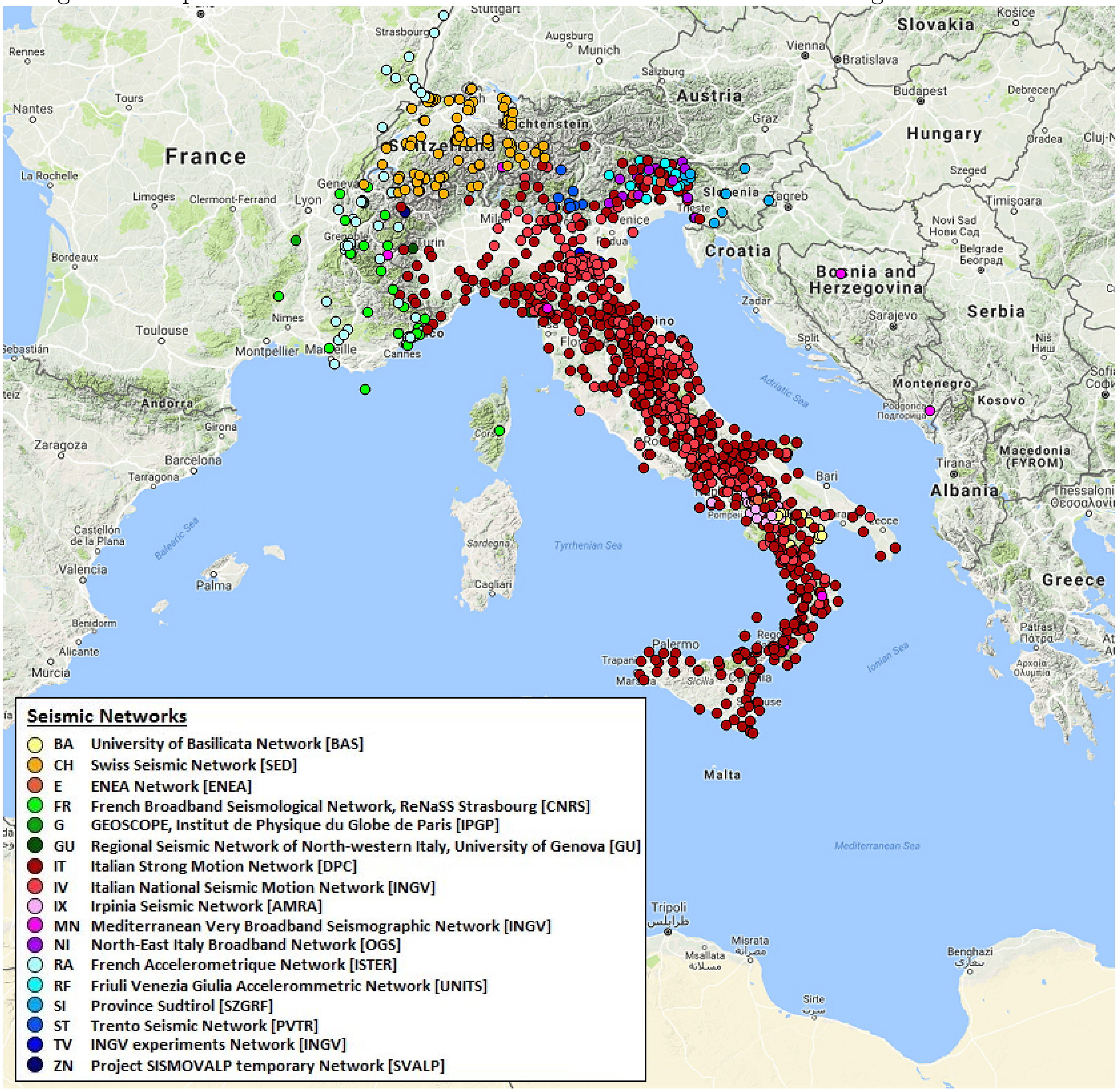
2.1 The Italian strong motion database and the L'Aquila earthquake

Data on the L'Aquila earthquake are drawn from the Italian strong motion database ITACA (ITalian ACcelerometric Archive), which was developed during different projects in the framework of an agreement between the Italian Department of Civil Protection (*Dipartimento della Protezione Civile*, DPC) and the INGV. The current release of the database (v. 2.3, January 2018) contains 36,714 three-component accelerometric waveforms generated by 1,640 earthquakes with magnitude greater than 3.0 occurred in Italy between February 1972 and December 2017 (Luzi et al., 2017). ITACA collects strong motion data recorded by the major Italian networks as well as, for events occurred at the Italian borders, by neighboring networks abroad. As shown in Figure 1, a total of 1,337 accelerometric stations are currently in operation, with an average spacing between stations of approximately 20 km (Gorini et al., 2010). Most stations (673) belong to the Italian Strong Motion Network (IT) – also known as *Rete Accelerometrica Nazionale* (RAN) – operated by DPC, and 259 belong to the Italian National Seismic Motion Network (IV), operated by INGV.

For each seismic event the accelerometric stations record the peak ground acceleration (PGA, cm/s^2) of the shake. PGA is the largest peak acceleration recorded at a site during a seismic event. Unlike the Richter and moment magnitude scales, it is not a measure of the total energy of the earthquake, but rather of how hard the earth shakes on the surface at a given geographic point (Douglas, 2003). It thus provides an objective indicator of the intensity with which the shakes are perceived by residents.

On April 6 2009, 01:32:40 UTC, an earthquake of moment magnitude $M_W = 6.3$ occurred close to L'Aquila, a town of 68,500 inhabitants in Central Italy. The hypocenter was located at a depth of 8.3 km along a NW-SW normal fault with SW dip (i.e. the angle formed by the fault plane and the horizontal direction). About 300 people died because of the collapse of residential and public buildings, and damage was widespread in L'Aquila and its neighboring municipalities (Ameri et al., 2009).

Figure 1: Map of the seismic networks included in the ITACA v. 2.3 strong motion database.



Source: Authors' elaboration on data described in the text.

This first earthquake was followed by seven aftershocks of moment magnitude larger than or equal to 5, the strongest of which occurred on April 7 ($M_W = 5.6$) and April 9 ($M_W = 5.6; M_W = 5.4$) (Ameri et al., 2009). Table 6 in the Appendix reports the metadata of the L'Aquila earthquake and its main aftershocks.[2]

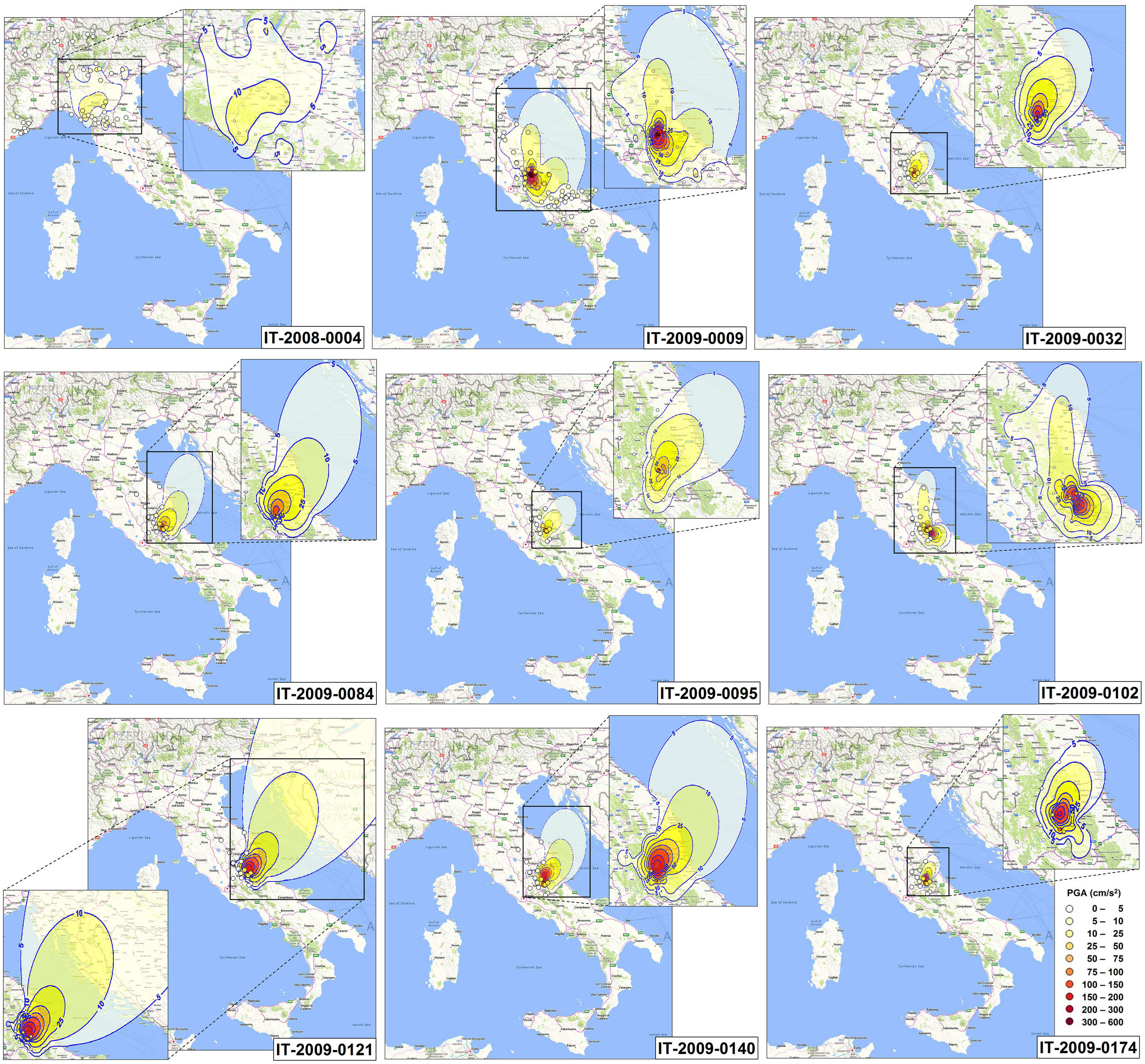
A total of 19 weaker (M_L between 4.0 and 5.4) yet again surface (H $\leq$ 17.1 km) shocks were

[2] Table 6 also includes the metadata of the earthquake occurred in the province of Parma approximately three months before, which will be used to compare the impact of single and multiple shocks in Section 3.4

recorded by a radius of 15-20 km around the mainshock's epicenter during the same day and the following three days (Luzi et al., 2017). The effects of the L'Aquila event were recorded by a total of 62 ITACA accelerometric stations. The event represents the fourth largest earthquake recorded by strong motion instruments in Italy (i.e. since 1972), after the 23/11/1980 $M_W = 6.9$ Irpinia, the 30/10/2016 $M_W = 6.5$ Norcia, and the 06/05/1976 $M_W = 6.4$ Friuli earthquakes, and it is the only big earthquake whose information can be matched with subsequent survey data concerning preferences for redistribution.

In our empirical analysis, we first use the average PGA recorded across these different shakes to measure the intensity with which the earthquake was felt at each geographic location between the first (IT-2009-0009) and the last (IT-2009-0174) shake, which occurred on April 6 and 13, 2009, respectively. Figure 2 shows the PGA values locally recorded by the 62 stations over the whole Italian territory sorted by date. The maximum PGA value of the first shake (IT-2009-0009) – representing one of the highest values ever recorded in Italy (Ameri et al., 2009) – was measured at a distance of 4.9 km from the epicenter. The minimum positive PGA value (0.94 cm/s^2) was recorded at a distance of 275.2 km from the epicenter. To trace the spatial variability of the ground motion in the epicentral area, we spatially interpolate the PGA values recorded by each station. Data interpolation is performed using the Kriging algorithm (Davis and Sampson, 1986), which predicts unknown values using variograms to express the spatial variation and minimizes the error of predicted values. For municipalities covered by more than one station, we average the value of the PGA recorded across them. This allows to impute one and only one PGA value to each municipality.

Figure 2: PGA spatially interpolated contours based on PGA values recorded by the ITACA accelerometric stations during the Parma earthquake (IT-2008-0004) and the L'Aquila earthquake's main shakes (IT-2009-0009 onwards)



Source: Authors' elaboration on data described in the text.

As shown in the close-up maps of Figure 2, a PGA minimum threshold of 5 cm$/s^2$ was graphically set to filter out those areas affected to a marginal extent by the event. The effects of the shakes do not propagate uniformly across the ground, but are strongly influenced by the geomorphological structures encountered along their path. The area of maximum PGA occurs inside the surface projection of the fault. Note that, for the L'Aquila shakes, the PGA contours are elongated in the north–south direction. The attenuation of PGA with distance from the epicenter looks strongly asymmetric, with higher decay rate towards the west (Ameri et al., 2009). The spatial interpolation allows us to accurately reconstruct the ground acceleration felt in each municipality of the epicentral area during each shake.

2.2 The ItaNES survey

The survey data employed in this paper are provided by the Italian National Election Studies (ItaNES), an inter-university consortium promoting research on voting behavior in Italy. In this analysis we employ the "2011-2013 Inter-electoral panel study" released in 2014. Even if the study provides longitudinal data covering the 2011-13 period, questions concerning the tax system were only asked in the first wave. We thus only consider telephonic interviews administered in the first wave that took place around two years after the L'Aquila earthquake, between February 9 and May 3, 2011, to a sample stratified by gender, age, education, region, and the demographic size of municipalities, as partitioned into 5 classes. ItaNES also administered similar surveys over the period 2001-2006. However the questions differ among surveys, and are posed to different samples, with a minimum overlap at the municipality level. This prevents us from exploiting a difference in differences strategy.

As for our dependent variable, individual preferences about redistribution are measured by recoding responses to the question: "Tell me to what extent do you agree with the statement: "For a society to be fair, the government should reduce differences in the socio-economic conditions of people", possible responses being "Strongly agree", "Agree", "Not agree nor disagree", "Disagree" and "Strongly disagree". "Strongly agree" and "Agree" responses were coded as 1 to obtain a dummy variable capturing support for redistribution. This indicator is standardly used, with slight differences, to measure the individuals' demand for redistribution. For example, Algan et al. (2016) measure the individual demand for redistribution through the score given by World Values Survey (WVS) respondents to the following statements: "Incomes should be made more equal" versus "We need larger income differences as incentives". Guiso et al. (2006) derive an indicator of demand for redistribution from the 7 points-scale degree to which respondents of the U.S. General Social Survey (GSS) feel close to the statements "Some people think the government ought to reduce the income differences between the rich and the poor" versus "Others think that the government should not concern itself with reducing income differences". Alesina and La Ferrara (2005) model the extent of redistribution desired by individuals as their optimal tax rate, and measure it via the score given by GSS respondents to the question: "Should the government reduce income differences between rich and poor?". Similar indicators were used to measure support for redistribution by Corneo and Gruner (2002), Luttmer and Singhal (2011) and Dahlberg et al. (2012), to name just a few.

The survey also includes information on demographic characteristics, socio-economic status, political opinions, and possible downturns in the economic well-being of the household, which we consider as additional controls in our econometric model. Since PGA is measured at the level of the municipality, we also add a battery of municipality-level geomorphological controls such as seismicity, altitude, latitude and longitude. Table 2 reports the descriptive statistics on the estimation sample, while Table 7 in the Appendix presents the definitions of the explanatory variables.

We then match survey data with the information on the average PGA registered throughout the eight major shakes (section 3.1) and with the PGA level of each single shake (section 3.2). Survey respondents are attributed the PGA felt in their municipality of residence. There is a temporal lag of approximately two years between the earthquake (April 2009) and the collection of the survey data we employ in the analysis (February-May 2011). Nonetheless, it is a common approach in this literature to investigate how the exposure to natural disasters is associated to individual attitudes a few years after the shock, the underlying assumption being that the cognitive and behavioral impact of traumas, or more in general of adverse environmental circumstances, is persistent and stable over time.[3]

2.3 Empirical strategy

To study the impact of repeated shocks, e.g. the L'Aquila earthquake, on demand for redistribution, we consider a linear probability model in which our dependent variable is the dummy described in Section 2.2. Given a random sample, the OLS regression produces consistent and unbiased estimators of the coefficients. Heteroskedasticity is accounted for by robust standard errors clustered at the municipality level. Preferences for redistribution are thus related to individual characteristics, such as age, educational attainment, political and religious preferences, that are widely acknowledged in the literature to explain attitudes towards redistribution.

[3] Callen (2015) provides evidence that exposure to the 2004 tsunami increased patience in a sample of Sri Lankan workers as measured two years and half later. Hanaoka et al. (2018) show that the effect of the exposure to the 2011 Great East Japan Earthquake on men's risk preferences is persistent a few years after the Earthquake.

Table 1: Descriptive statistics

Variable	Mean	Std. Dev.	Min	Max
Redistribution	0.780	0.414	0	1
Age	49.503	17.890	18	98
Male	0.488	0.500	0	1
Education	2.478	0.859	0	4
Right wing	5.004	2.880	0	10
Religion	0.924	0.265	0	1
Country's econ appraisal	1.850	0.829	1	5
Family's econ appraisal	2.517	0.746	1	5
Sismicity	2.233	0.834	1	4
Latitude	42.988	2.922	9.276	46.947
Longitude	12.119	2.635	7.180	18.414
Altitude	3.873	1.326	1	5
Urban	1.891	0.734	1	3
Seaside	0.274	0.446	0	1
Mountain	1.494	0.751	1	3
Area	3.992	1.377	0.535	7.160
IT-2009-0009	6.950	20.551	0	370.64
IT-2009-0032	2.672	9.155	0	91.83
IT-2009-0084	2.087	6.618	0	107.84
IT-2009-0095	2.135	6.767	0	81.66
IT-2009-0102	4.708	13.402	0	135.94
IT-2009-0121	3.520	11.826	0	190.98
IT-2009-0140	2.322	8.222	0	172.83
IT-2009-0174	1.532	6.180	0	180.19
IT-2008-0004	1.949	2.764	0	14.66

Notes: Statistics are reported for the estimation sample (N=1,608).

With respect to our variable of interest, the exogeneity of the earthquake allows to circumvent the endogeneity issues that are commonly at stake in the analysis of individual beliefs. We are aware that exposure to natural disasters may also be affected by individual choices. There is evidence that people move from areas frequently struck by recurrent events, such as tornados in the United States, to reduce risk (Boustan et al., 2012). However, no such evidence has ever been found in Europe and with respect to earthquakes, which have a remarkably lower frequency and predictability.

Looking at the last decades, we can safely rule out the possibility that individuals self-selected into the epicentral area. First, no seismic event was registered in the area from May 1985, 24 years before the earthquake we consider in this paper. The 1985 event had $M_L = 4.2$ and did not cause fatalities or injuries. The INGV did not update the seismic classification of L'Aquila after this episode; the city kept the classification given in 1927 as a "Zone 2" area, a very broad category comprising 27% of Italian municipalities. Second, official statistics clearly show that no significant change occurred in the population of the area over the following years. After 1992, census data rather registered a slight increase in the population living in L'Aquila and the surrounding municipalities (Istat, 2013a; 2013b). Overall, the demographic balance and the migration balance of the epicentral area and the surrounding provinces have proved stable over the two decades preceding 2009.

Migration patterns after the 2009 earthquake confirm this tendency: official statistics on migration flows for the province of L'Aquila are close to zero and even smaller than the national rates for 2009 and 2010. The crude rates of net migration (plus statistical adjustment) per 1,000 inhabitants are equal to -0.3 and 1.0 for the province of L'Aquila in 2009 and 2010, respectively. These rates are smaller than those for the whole country, equal to 3.6 and 3.4 in 2009 and 2010, as reported by Eurostat. If we focus on the most hit area, the so called *cratere sismico* ("seismic crater"),[4] where emigration is most likely, the total population of around 145,000 decreased by 278 units in 2009 (-0.19%) and increased by 342 units in 2010 (+0.24%). Migration rates in the seismic crater have been quite volatile in those years but always positive: rates in 2009 and 2010 were positive, albeit smaller than in 2008 and 2007. While this can be read as a consequence of the post-earthquake difficulties, it could simply reflect natural fluctuations in migration flows, as the rate for 2006 was even lower (Pesaresi, 2012). Overall, these figures suggest that our 2011 sample of the population is not biased by selection issues related to the 2009 earthquake.

Geographical factors, however, could prevent an accurate identification of the effect of the earthquake on individual beliefs. Support for redistribution has been found to be significantly correlated with aspects of social capital such as civicness (Algan et al., 2016), prosocial behavior (Cerqueti et al., 2019), trust (Guiso et al., 2016), and religious participation (Alesina and La Ferrara, 2005) whose levels vary remarkably across Italian provinces. To tackle these issues, we include province dummies.

We include controls for the geomorphological characteristics at the municipality level (e.g., official seismic classification, mountain area, latitude and longitude) to account for factors that could be correlated with the intensity of the earthquake and also have an independent effect on preferences

[4] The area has been officially defined by DPC and INGV in 2009 (Galli and Camassi, 2009). It covers around 20 kms along the NW-SE direction and comprises 57 municipalities and suburban areas (*frazioni*), of which 16 have been severily hit: Castelnuovo (in the municipality of San Pio delle Camere); Onna (L'Aquila); San Gregorio (L'Aquila); Sant'Eusanio Forconese; Tempera (L'Aquila); Villa Sant'Angelo; L'Aquila centre; Poggio di Roio (L'Aquila); Poggio Picenze; Bazzano (L'Aquila); Casentino (Sant'Eusanio Forconese); Colle di Roio (L'Aquila); Paganica (L'Aquila); Roio Piano (L'Aquila); Santa Rufina (L'Aquila); Tussillo (Villa Sant'Angelo).

for redistribution. Thus, we first estimate the following equation to assess how preferences for redistribution relate to the average intensity of the eight main shakes occurred over the eight days of the L'Aquila earthquake between April 6 and 13, 2009.

$$redistribution_i = \alpha + \beta L'AquilaPGA_m + \gamma X_i + \delta Y_i + d_p + \varepsilon_i \quad (1)$$

where $L'AquilaPGA$ is the average peak ground acceleration registered throughout the eight main shocks of the L'Aquila earthquake at the centroid of the respondent's municipality of residence m. X is a vector of individual-specific characteristics collected in the ItaNES survey, Y is a vector of municipality-level controls, and d_p is a set of province dummies.

To study the possible role of the repetition and timing of the shocks, we then assess the relationship between the PGA of each shake and redistributive preferences by estimating eight further versions of the same econometric model in which we replace the average intensity of the shakes with the PGA of each of the main eight shakes (see Table 1 and Figure 2).

Unfortunately our data do not allow to observe individual preferences before and after the shocks. To rule out the possibility that our results capture spurious correlations driven by a coincidence we develop a series of counterfactuals. We first generate three placebo earthquakes in all similar to each of the L'Aquila shakes that proved being significantly correlated with preferences for redistribution in our sample. We randomly assign the epicenter of the placebo shakes to the municipalities in which the accelerometric stations registered a null PGA during the actual earthquake (6,685, 6,915, and 6,846 for the sixth, the seventh and eighth shake respectively). By replicating the propagation pattern of the actual shakes, we are able to reconstruct how the shock would have been felt in each municipality laying in the counterfeit epicentral area. We then assess how the placebo shakes correlate with preferences for redistribution. We additionally repeat the placebo tests on a reduced sample from which we exclude, in addition to those municipalities in which the PGA of the shake being simulated was positive, also those municipalities in which at least one of the previous five shakes had a $PGA > 0$ (5,917, 5,916 and 5,920 for the sixth, the seventh and the eighth shake respectively). We finally exploit information obtained from the placebo tests to conduct additional robustness checks on the estimations of the econometric model in Section 3.3.

To further test the role of multiple vs. single shocks, we exploit a natural counterfactual provided by an earthquake occurred 3.5 months before in the province of Parma on December 23, 2008. Differently from the L'Aquila earthquake, this seismic event consisted of one single shock of significant magnitude ($M_L = 5.2$ and $M_W = 5.5$) with magnitude, acceleration and propagation pattern comparable to those of the main shakes registered throughout the 2009 event. The results of this test, however, must be handled with caution, given that the Parma earthquake had a deeper hypocenter, resulting in small damages and no fatalities.

3 Results

In this section we present the results of the econometric analysis. We start by analyzing how the average intensity of the shakes occurred over the L'Aquila earthquake between April 6 and 13 relates to preferences for redistribution (Section 3.1). We then present results for each single shake (3.2). In the following subsections, we first present the results of the placebo analysis (3.3). Then, we use a natural counterfactual to test the different effects of single vs. multiple shocks (3.4). Finally, we briefly discuss our results (3.5).

3.1 The average intensity of the shock and support for redistribution

The baseline estimation in column 1 of Table 2 shows that preferences for redistribution are positively and significantly correlated at 10% level with the average PGA registered throughout the eight main shakes of the L'Aquila earthquake. The standard errors are clustered at the municipality level.[5] We report the results with the standardized value of $L'AquilaPGA$ for a more straightforward interpretation of the results. In column 2 we consider a number of personal traits that are likely to be correlated with preferences for redistribution. In line with standard predictions, right wing-biased respondents are less inclined to support redistribution (e.g., Gelman et al., 2007). Christians are also less likely to support redistribution, consistently with previous findings (e.g., Guiso et al., 2006). Column 3 presents the results with both $L'AquilaPGA$ and the individual traits, finding that coefficient estimates are unchanged. In column 4 we also control for perceived variations in the business cycle. Individuals believing that the economic situation of the country has generally improved support redistribution less. The self-reported level of the household economic welfare, on the other hand, is not significantly correlated with support for redistribution.

Column 5 shows that results are robust to the addition of province dummies. Notice that the

[5]Results are robust with clustering of standard errors at the province level. Estimates available upon request.

province dummies are jointly statistically different from zero and we reject the null hypothesis of equality of their coefficients, thus suggesting that the dummies do indeed capture some unmeasured time-invariant province-specific feature that is related to preferences for redistribution.[6] The coefficient for average PGA rises from 0.13 to 0.31. The increase reflects the fact that the provinces more severely hit by the earthquake were likely less in favor of redistribution due to cultural characteristics that are unevenly distributed across the Italian territory. Controlling for province dummies nets out these unmeasured negative effects and leads to a larger coefficient for the PGA. In column 6, in addition to controlling for province dummies, we add a battery of municipality-level controls. Results still hold and we do not observe any systematic relationship of municipal covariates with support for redistribution. We also include the classification of seismicity at the municipality level provided by the INGV. In further robustness checks we also control for news consumption through television and the Internet to test for the possible role of information, for the use of other types of media and contents, the work status of respondents and their self-reported interest in politics. In all cases the additional controls are not statistically significant while our main finding on L'Aquila earthquake is not affected.[7]

The size of the effect of the average PGA is economically relevant. The magnitude of the coefficient implies that a one standard deviation increase in the average peak ground acceleration of the shakes implies an increase in the likelihood of supporting redistribution by 3.1 percentage points. The standardized beta coefficients for the other explanatory variables, which are not reported for the sake of brevity, suggest that the effect of the average PGA is comparable to that of the other statistically significant covariates, such as political orientation (whose effect is 3.5 percentage points).

3.2 Multiple shocks and support for redistribution

In this section we assess the possible role of repeated shocks by estimating equation (1) for each of the eight main shakes occurred during the L'Aquila earthquake. Results are reported in Table 3. Shakes are labelled with their ID in the ITACA database and are reported in chronological order from April 6 to 13, 2009. We observe that the first five shakes, occurred between the 6th and the 7h of April, are not significantly correlated with our dependent variable. The sixth shake, occurred

[6] The test statistic for the joint significance of the province dummies is $F(109, 1023) = 82.43$, while the test statistic for the equality of the province dummies is $F(108, 1023) = 82.69$; both are significant at 1% level.

[7] Results are available upon request.

Table 2: L'Aquila earthquake and support for redistribution

	(1)	(2)	(3)	(4)	(5)	(6)
L'Aquila PGA	0.016*		0.013*	0.013*	0.031*	0.031*
	(0.009)		(0.008)	(0.007)	(0.016)	(0.018)
Age		0.074***	0.074***	0.072***	0.055**	0.054**
		(0.027)	(0.027)	(0.026)	(0.027)	(0.027)
Male		0.043**	0.042**	0.033*	0.023	0.023
		(0.020)	(0.020)	(0.020)	(0.020)	(0.020)
Education		0.025**	0.024*	0.030**	0.028**	0.028**
		(0.012)	(0.012)	(0.012)	(0.013)	(0.013)
Right wing		-0.018***	-0.018***	-0.013***	-0.012***	-0.012***
		(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Christian		-0.088***	-0.088***	-0.084***	-0.070**	-0.071**
		(0.031)	(0.031)	(0.031)	(0.032)	(0.032)
Country's econ. sit				-0.059***	-0.062***	-0.062***
				(0.014)	(0.014)	(0.014)
Household's econ. sit.				-0.001	-0.010	-0.009
				(0.015)	(0.016)	(0.016)
Seismicity						-0.045
						(0.031)
Latitude						0.003
						(0.002)
Longitude						-0.004
						(0.061)
Altitude						-0.011
						(0.014)
Urban						-0.005
						(0.019)
Coastal						-0.030
						(0.036)
Mountain						-0.014
						(0.023)
Area						0.009
						(0.013)
Constant	0.780***	0.587***	0.589***	0.672***	0.756***	0.812
	(0.011)	(0.123)	(0.122)	(0.125)	(0.127)	(0.768)
Province dummies	NO	NO	NO	NO	YES	YES
Observations	1,608	1,608	1,608	1,608	1,608	1,608
R-squared	0.001	0.029	0.030	0.043	0.115	0.117

Notes: Standard errors clustered at the municipality level in parentheses, number of clusters is 1,024. *, **, *** significant at 10%, 5%, and 1% respectively.

on April 9, is statistically significant at 10% level. Statistical significance increases for the last two shocks, occurred on April 9 and 13 respectively. Notice that the first and strongest shake (IT-2009-0009) hit a much wider area, which includes the areas that have been later struck by the last three shakes, namely IT-2009-0121, IT-2009-0140, and IT-2009-0174, as evident from Figure 2. This means that all individuals that felt these last shakes had experienced at least the first earthquake.

The effect is sizeable and economically relevant. Considering for example the sixth shock, the magnitude of the coefficient implies that a one standard deviation increase in the peak ground acceleration implies an increase in the likelihood of supporting redistribution of 3 percentage points. Looking at the standardized beta coefficients also for the other explanatory variables, we find, similarly to the results with the average PGA reported in Table 2, that the effect is comparable to that of the other statistically significant explanatory variables. In all regressions we control for personal traits, the various geomorphological city-level variables, and province dummies. All covariates maintain the same sign and significance throughout the eight shocks.

3.3 Placebo tests

To further check the robustness of our results, we implement a placebo test in the spirit of Abadie and Hainmueller (2010) and Belloc et al. (2016). For each of the three statistically significant shakes (IT-2009-0121, IT-2009-0140, and IT-2009-0174), we generate a series of placebo earthquakes with the same intensity and propagation pattern but having their epicenter in the centroid of each of the 6,685, 6,915, and 6,846 Italian municipalities outside the actual epicentral areas of the sixth, the seventh and the eighth shake respectively, i.e., those municipalities in which the strong motion network registered a null PGA during the actual shakes. For each placebo event, we reconstruct a propagation pattern by calculating the PGA of the shakes striking each municipality that lay in the counterfeit epicentral area based on the relationship between the distance from the epicenter and the ground acceleration observed during each of the actually significant shakes.

For each of the three significant shakes, we then randomly assign the epicenter of the relative placebo shocks to the municipalities that were not hit by the shock. This allows us to estimate the reaction of the individuals in the sample to three swarms of placebo earthquakes. More specifically, the test is developed along the following steps for each of the significant shakes.

First, the PGA values recorded by the accelerometric stations during the shake are averaged

Table 3: Multiple shocks and support for redistribution

	(1) April 6	(2) April 6	(3) April 6	(4) April 7	(5) April 7	(6) April 9	(7) April 9	(8) April 13
Age	0.054**	0.053*	0.053**	0.053**	0.054**	0.054**	0.054**	0.054**
	(0.027)	(0.027)	(0.027)	(0.027)	(0.027)	(0.027)	(0.027)	(0.027)
Male	0.024	0.023	0.023	0.024	0.024	0.023	0.023	0.023
	(0.021)	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)
Education	0.029**	0.028**	0.028**	0.028**	0.028**	0.028**	0.028**	0.028**
	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)
Right wing	-0.012***	-0.012***	-0.012***	-0.012***	-0.012***	-0.012***	-0.012***	-0.012***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Christian	-0.072**	-0.071**	-0.071**	-0.071**	-0.071**	-0.071**	-0.072**	-0.072**
	(0.032)	(0.032)	(0.032)	(0.032)	(0.032)	(0.032)	(0.032)	(0.032)
Country's econ. sit	-0.062***	-0.063***	-0.062***	-0.062***	-0.062***	-0.062***	-0.063***	-0.063***
	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)
Household's econ. sit.	-0.009	-0.009	-0.009	-0.009	-0.009	-0.009	-0.009	-0.009
	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)
Seismicity	-0.043	-0.044	-0.044	-0.044	-0.045	-0.044	-0.045	-0.045
	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)
Latitude	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Longitude	-0.003	-0.006	-0.007	-0.005	-0.006	-0.003	-0.003	-0.003
	(0.061)	(0.061)	(0.061)	(0.061)	(0.061)	(0.061)	(0.061)	(0.062)
Altitude	-0.010	-0.010	-0.010	-0.010	-0.012	-0.010	-0.010	-0.010
	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)
Urban	-0.005	-0.005	-0.005	-0.005	-0.004	-0.005	-0.005	-0.005
	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)
Coastal	-0.032	-0.030	-0.031	-0.032	-0.029	-0.030	-0.033	-0.032
	(0.036)	(0.036)	(0.036)	(0.036)	(0.036)	(0.036)	(0.035)	(0.036)
Mountain	-0.014	-0.013	-0.013	-0.013	-0.015	-0.014	-0.014	-0.014
	(0.023)	(0.023)	(0.023)	(0.023)	(0.023)	(0.023)	(0.023)	(0.023)
Area	0.010	0.010	0.010	0.010	0.009	0.010	0.011	0.011
	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)
IT-2009-0009	0.020							
	(0.016)							
IT-2009-0032		0.016						
		(0.019)						
IT-2009-0084			0.023					
			(0.015)					
IT-2009-0095				0.017				
				(0.019)				
IT-2009-0102					0.035			
					(0.022)			
IT-2009-0121						0.030*		
						(0.015)		
IT-2009-0140							0.025**	
							(0.011)	
IT-2009-0174								0.016**
								(0.008)
Constant	0.791	0.820	0.845	0.816	0.837	0.798	0.802	0.785
	(0.770)	(0.768)	(0.767)	(0.769)	(0.767)	(0.769)	(0.770)	(0.772)
Province dummies	YES	YES	YES	YES	YES	YES	YES	YES
Observations	1,608	1,608	1,608	1,608	1,608	1,608	1,608	1,608
R-squared	0.117	0.116	0.117	0.116	0.117	0.117	0.117	0.117

Notes: Standard errors clustered at the municipality level in parentheses, number of clusters is 1,024. *, **, *** significant at 10%, 5%, and 1% respectively.

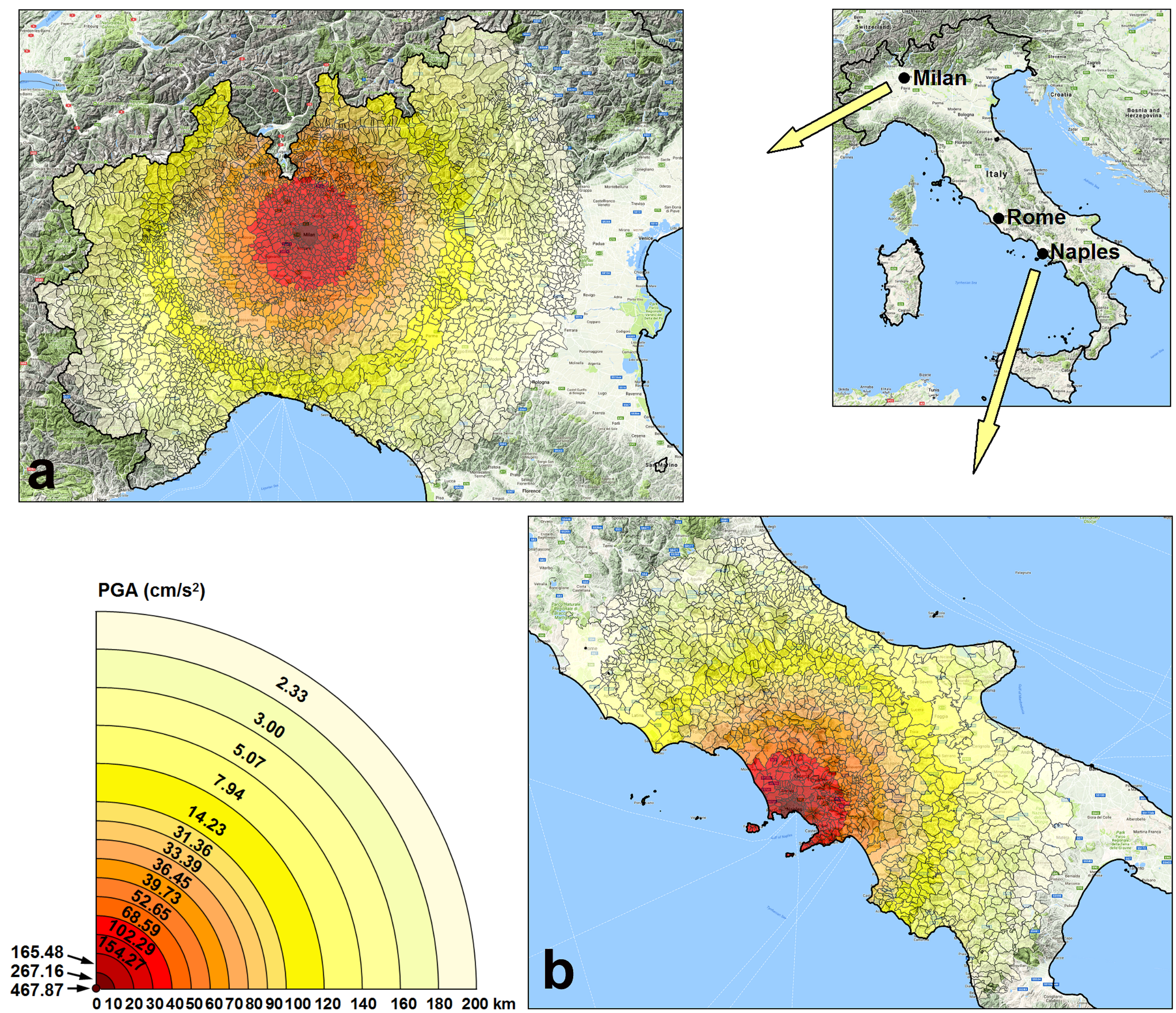
for each municipality. This allows to impute to those municipalities covered by more than one accelerometric station one and only one PGA value. Second, we build a stylized version of the actual shock by assuming that the shakes propagate across the ground with the same intensity they did during the actual shakes, so that the related PGA values change as a sole function of the radial distance from the epicenter. As a result, the false epicentral areas have a circular geometry and are partitioned into 12 circular sectors, each one with a specific value of PGA according to the distance from the placebo epicenter. The PGA mean values calculated by radial distance from the earthquake's epicenters are reported in Tables 8-10 in the Appendix for the sixth, seventh and eighth shake respectively.

Then, after imputing to the m municipality the PGA value of the epicenter's municipality (L'Aquila, in all the three cases), the PGA values of each circular sector have been calculated by averaging the PGA values of all municipalities comprised in that specific radial bin, i.e., by considering the radial distance of the centroid of those municipalities from the centroid of the epicenter municipality. Figure 3 provides an example by illustrating the propagation pattern of two placebo earthquakes having their epicenters in Milan (Panel A) and Naples (Panel B) respectively.

Following Belloc et al. (2016), the purpose of the tests is to check how many times the randomly generated placebo deliver an effect similar to the true estimates. If in our results we were erroneously rejecting the null hypothesis that the coefficients of interest are equal to 0 in columns (6), (7) and (8) of Table 3 (i.e., we were attributing to the shocks an effect that does not exist in reality), we should observe placebo coefficients close to our true estimate, represented by the vertical line in Figure 4, which reports the probability density function of the estimates of the coefficients of the placebo shocks for the sixth shake - i.e., first of the three significant shakes, which occurred on April 9, 2009.

The top panel of Figure 4 shows that the estimates generated in the test are almost always to the left (meaning smaller in value than) the true estimated coefficients, equal to 0.03. Coefficients of the 6,685 counterfeit earthquakes are distributed around zero. The fake estimated coefficient is statistically significant at the 5% (10%) level in the 4.68% (7.58%) of cases. We then conduct a second test by dropping from the sample of imputed epicenters not only the municipalities in the epicentral area of the sixth shake but also those municipalities in which at least one of the previous five shakes was felt (i.e. where a $PGA > 0$ was registered). The purpose of this test is to exclude from the placebo also those municipalities that, while not being struck by the sixth shake, were

Figure 3: Examples of the application of the placebo test based on the IT-2009-0121 shake to the municipalities of: (a) Milan; (b) Naples.



exposed to one of the of the preceding five shakes and could therefore possibly have experienced a repeated shock were they to be hit by the placebo shake. The number of counterfeit epicenters then becomes 5,917. The bottom panel of Figure 4 shows that, also in this case, the estimates generated in the test are almost always to the left (meaning smaller in value than) the true estimated coefficients. The coefficient of the PGA attributed to the placebo shakes is larger than the true coefficient and statistically significant at the 5% (10%) level in the 4.56% (7.16%) of cases. We get comparable results for the other two significant shakes.[8]

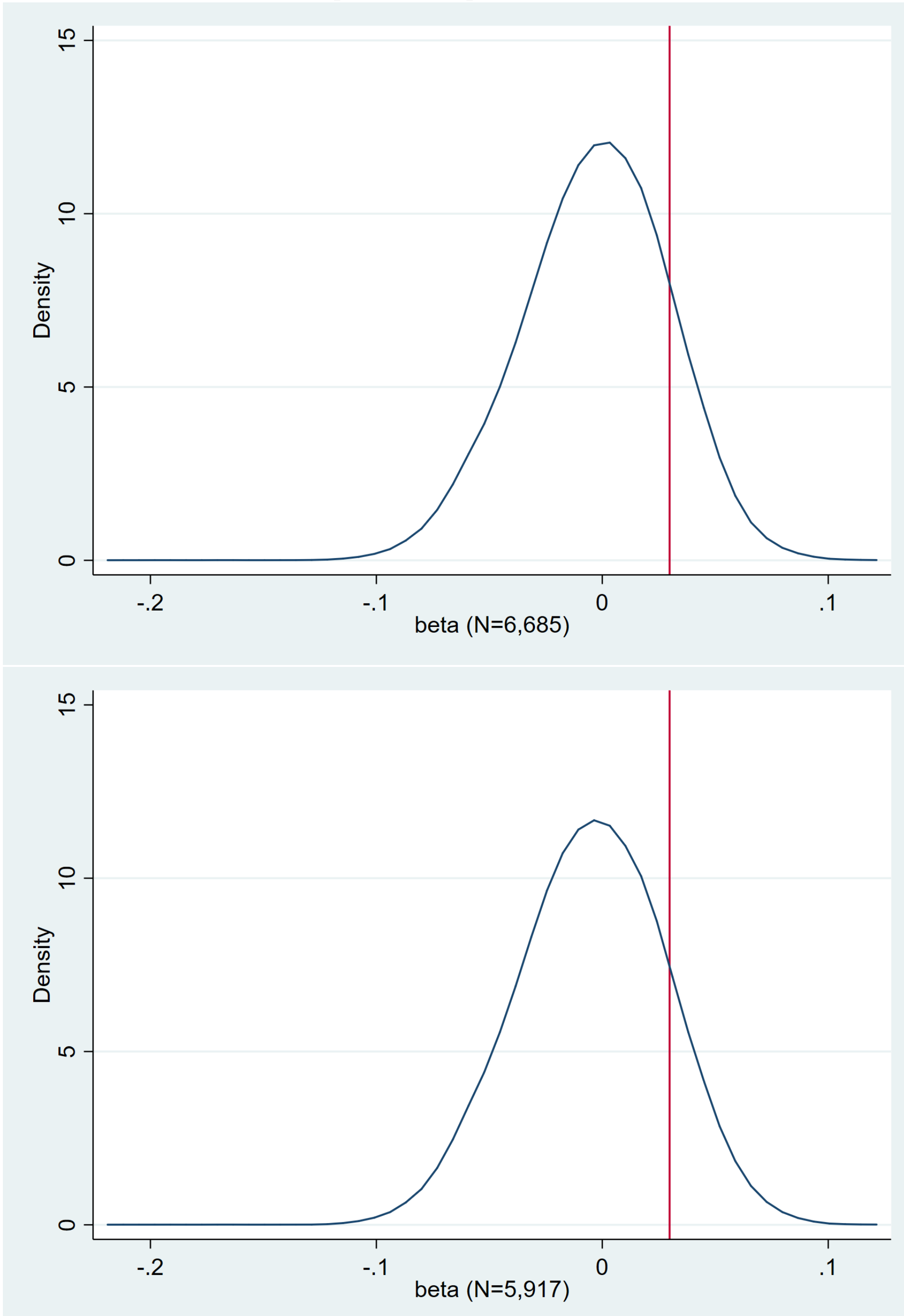
We then exploit the findings of the placebo tests to run a further robustness check: we drop from the estimation sample those "suspect" municipalities for which the placebo shocks have a statistically significant and large coefficient and estimate our model again for the last three shakes. Results do not change and are reported in Table 4. Results also hold if we keep the full sample and include a dummy for the same municipalities.

Table 4: Multiple shocks and support for redistribution - Reduced sample

	(1) April 9	(2) April 9	(3) April 13
Age	0.047*	0.053*	0.065**
	(0.028)	(0.027)	(0.028)
Male	0.025	0.023	0.025
	(0.021)	(0.021)	(0.021)
Education	0.026*	0.027**	0.032**
	(0.013)	(0.013)	(0.013)
Right wing	-0.013***	-0.012***	-0.013***
	(0.004)	(0.004)	(0.004)
Christian	-0.074**	-0.078**	-0.081**
	(0.032)	(0.032)	(0.032)
Country's econ. sit	-0.065***	-0.067***	-0.071***
	(0.015)	(0.014)	(0.015)
Household's econ. sit.	-0.011	-0.010	-0.009
	(0.016)	(0.016)	(0.016)
Seismicity	-0.043	-0.048	-0.025
	(0.032)	(0.031)	(0.031)
Latitude	0.002	0.002	0.002
	(0.002)	(0.002)	(0.003)
Longitude	-0.018	0.002	-0.003
	(0.065)	(0.063)	(0.061)
Altitude	-0.010	-0.006	-0.005
	(0.014)	(0.014)	(0.014)
Urban	-0.010	-0.005	-0.012
	(0.020)	(0.019)	(0.019)
Coastal	-0.031	-0.039	-0.024
	(0.036)	(0.036)	(0.036)
Mountain	-0.011	-0.011	-0.005
	(0.023)	(0.023)	(0.023)
Area	0.007	0.010	0.005
	(0.013)	(0.013)	(0.013)
IT-2009-0121	0.031*		
	(0.016)		
IT-2009-0140		0.025**	
		(0.012)	
IT-2009-0174			0.016**
			(0.008)
Constant	1.070	0.781	0.746
	(0.814)	(0.799)	(0.764)
Province dummies	YES	YES	YES
Observations	1,567	1,580	1,536
# clusters	995	1,004	973
R-squared	0.131	0.130	0.151

Notes: Standard errors clustered at the municipality level in parentheses. *, **, *** significant at 10%, 5%, and 1% respectively.

Figure 4: Kernel density function of the placebo point estimates obtained based on the placebo geometry of the sixth shake of the L'Aquila earthquake



3.4 An isolated shock and support for redistribution: The Parma earthquake

To assess the different impact of single versus multiple shocks, we exploit a natural counterfactual provided by an earthquake occurred in the province of Parma, approximately 500 km North of

[8] The probability density functions of placebo tests for IT-2009-0140 and IT-2009-0174 are not reported for the sake of brevity but are available upon request.

L'Aquila, just 3.5 months before the L'Aquila events. The Parma earthquake took the form of only one main shock occurred on December 23, 2008, with $M_M = 5.5$ (which was stronger than that of seven of the eight shakes occurred during the L'Aquila earthquake). The metadata of the seismic event are reported in Table 6 (column 1) in the Appendix, and the propagation pattern of the shake is illustrated in the top-left panel of Figure 2. The shake is comparable in terms of energy and acceleration to those registered during the L'Aquila earthquake. Still, with a deeper hypocenter (H = 22.9 km) it was less destructive, it did not cause fatalities, and therefore received limited media coverage. These differences between the two earthquakes suggest caution in the interpretation of this comparison. However, given that the Parma earthquake took place only a few months before the L'Aquila events, assessing its relation with redistributive preferences provides some evidence on the possibly diverse outcomes of single vs. multiple events.

Results are reported in Table 5. The peak ground acceleration perceived during the earthquake (event IT-2008-0004 in the ITACA database) is positively but not significantly correlated with support for redistribution. The sign, magnitude, and significance level of the covariates' coefficients do not differ from those reported in Tables 2 and 3. The joint evidence reported in Tables 3 and 5 supports the intuition that the repetition of the traumatic shock plays a role in informing social preferences.

3.5 Discussion

In section 3.1 we illustrated a positive and significant relationship between the average intensity of the shakes registered throughout the L'Aquila earthquake and individuals' support for redistribution. The analysis of the single shocks carried out in section 3.2 revealed a complex picture, showing that the average result was driven by the effect of the last three shakes occurred between April 9 and 13, 2009. Individuals that were repeatedly subjected to the trauma of the earthquake exhibited a significant support for redistribution as the last shocks they experienced were stronger. A possible interpretation is that a cumulative effect of the shocks has been at stake, as if the repetition of the shock had increased its saliency in respondents' perception, thereby strengthening their behavioral response.

This result recalls evidence from psychiatry and psychology that single and multiple shocks have different outcomes, with most studies suggesting that repeated shocks prompt stronger emotional and behavioral responses. Distinct outcomes have been found for single versus multiple traumas -

Table 5: The Parma shock and support for redistribution

Date	2008, Dec 23
Age	0.054**
	(0.027)
Male	0.024
	(0.020)
Education	0.029**
	(0.013)
Right wing	-0.012***
	(0.004)
Christian	-0.072**
	(0.032)
Country's econ. sit	-0.062***
	(0.014)
Household's econ. sit.	-0.009
	(0.016)
Seismicity	-0.045
	(0.031)
Latitude	0.003
	(0.002)
Longitude	-0.002
	(0.062)
Altitude	-0.009
	(0.014)
Urban	-0.005
	(0.019)
Coastal	-0.033
	(0.036)
Mountain	-0.011
	(0.023)
Area	0.011
	(0.013)
IT-2008-0004	0.030
	(0.030)
Constant	0.734
	(0.775)
Province dummies	YES
Observations	1,608
R-squared	0.117

Notes: Standard errors clustered at the municipality level in parentheses, number of clusters is 1,024. *, **, *** significant at 10%, 5%, and 1% respectively.

generally defined as emotional responses to terrible events like an accident, an assault or a natural disaster[9] - in terms of distress (Williams et al., 2007), recurrent headache (Stesland et al., 2013), self-confidence (Allen and Lauterbach, 2007), coping abilities (Dale et al., 2009), vagal regulation (Dale et al., 2009), automatic freezing-like responses (Hagenaars et al., 2012), interpersonal sensitivity (Hagenaars et al., 2011), post-traumatic stress disorder and distress tolerance difficulties (Gerber et al., 2018), and depression (Rytwinski et al., 2013). In all cases there is evidence that the magnitude of the behavioral reactions to the shocks is a function of the exposure to the stimuli (Turner and Lloyd, 1995).

A similar mechanism also seems to fit our results. In our sample, the significant and positive relationship between redistributive preferences and the intensity of the L'Aquila shakes seems to have been "triggered" only after a few shocks. After the first five shakes, support for redistribution becomes significantly and positively related to the ground acceleration experienced by respondents in any of the last three episodes.

Most of the existing studies on the behavioral and macroeconomic consequences of natural disasters like earthquakes and tornados view the shocks in isolation (e.g., Callen, 2015; Belloc et al., 2016) or as aggregated events (e.g., Toya and Skidmore, 2014; Skidmore and Toya, 2002). The analysis of the single events occurred throughout the L'Aquila earthquake suggests that future research should scrutinize the possibly different effect of the "accumulation" of the shocks in individuals' experience. As it is not easy to retrieve a natural experiment allowing to directly test for the existence of a cumulative effect, it may be useful to turn to laboratory experiments in the spirit of Esarey et al. (2012).

Overall, our findings extend the results of a small but growing amount of studies suggesting that concerns about the source of inequality (whether it is determined by merit or random luck) play a role in shaping the public's support for redistributive policies (Alesina and Angeletos, 2005; Alesina and La Ferrara, 2005; Drenik and Perez-Truglia, 2018). Our approach of exploring the impact of the earthquake on social preferences by using representative survey data also complements the literature on how catastrophes affect the actual behavior of political elites in terms of the deployment of relief programs and environmental policies. As some empirical studies suggest, the longevity of a political elite also depends on how voters react to the policy actions implemented in the wake of a natural disaster (Betchel and Hainmueller, 2011; Gagliarducci et al., 2019). Such a reaction mirrors

[9] American Psychological Association, https://www.apa.org/helpcenter/recovering-disasters.aspx, last accessed on June 20, 2019.

individual preferences for redistribution. If a society believes that random luck, rather than merit, determines income distribution, then redistributive programs might play a key role in the survival of a political elite in the wake of a natural disaster. How beliefs about income distribution change across cultural, economic and institutional backgrounds is a relevant issue to be addressed in future research.

Finally, even if the placebo tests support our results, findings must be taken with caution, given the impossibility to exploit a difference in differences strategy due to the cross-sectional nature of the data. In addition, our test of the effect of the shocks is based on the relationship between the ground acceleration registered at a site and residents' opinions measured approximately two years later. Despite these limitations, our findings and measurement approach add a contribution to the literature on the impact of natural disasters on social preferences that calls for further investigations about the concurring roles of intensity, repetition, and timing of the shocks.

4 Conclusions

In this paper we document that individuals who experienced one of the major earthquakes occurred in Italy in the last three decades exhibit on average a significantly stronger preference for redistribution. Unfortunate exogenous shocks like natural disasters can raise the belief that luck matters more than merit in determining one's position in the social ladder. Other studies previously documented, theoretically and empirically, that beliefs about the importance of luck are a good predictor of the individual support for redistribution (e.g., Alesina and Angeletos, 2005; Alesina and La Ferrara, 2005; Bénabou and Tirole, 2006). The natural experiment provided by the L'Aquila earthquake allows us to bring evidence that the demand for redistribution is associated with the exposure to an exogenous and randomly distributed traumatic shock.

The first part of the empirical analysis shows that the individual support for redistribution is increasing with the average peak ground acceleration - i.e., the intensity of the shock - experienced during the several main shakes occurred over the eight days of the L'Aquila earthquake. We then show that the shocks are not all alike. We rather observe that only the last three shocks are significantly related to support for redistribution, suggesting that the social preferences change ensuing from repeated exposure.

Despite the exogeneity of the earthquake, the cross-sectional nature of the data could prevent a correct identification of its impact on preferences for redistribution. To deal with identification concerns, we develop three counterfactuals and use them to perform placebo tests. Results of the tests suggest an interpretation of our findings consistent with the hypothesis that any increase in the role of "pure random luck" implies a higher preference for redistribution (Piketty, 1995; Alesina and Angeletos, 2005; Alesina and La Ferrara, 2005).

Although this work has focused on a specific natural disaster, the impact of pure random luck may prove important in other contexts, even in light of its policy implications. Alesina and Glaeser (2004) and Guiso et al. (2006), in fact, document a relationship between the proportion of people supporting redistribution and the share of GDP spent on social welfare across countries and American states respectively. Given the role that consensus for redistribution has on the actual implementation of redistributive policies, our findings call for further investigations on the relationships connecting natural disasters, individuals' opinions and beliefs, and public policies.

References

Abadie, A. and Hainmueller, J. (2010). Synthetic control methods for comparative case studies: Estimating the effect of california's tobacco control program. *Journal of the American Statistical Association*, 105(490):493–505.

Alesina, A. and Angeletos, G. M. (2005). Fairness and redistribution. *American Economic Review*, 95(4):960–980.

Alesina, A. and Giuliano, P. (2011). Preferences for redistribution. In Benhabib, J., Bisin, A., and Jackson, M. O., editors, *Handbook of Social Economics*, pages 92–133. Elsevier, Amsterdam.

Alesina, A. and Glaeser, E. (2004). *Fighting Poverty in the US and Europe*. Oxford University Press, Oxford.

Alesina, A. and La Ferrara, E. (2005). Preferences for redistribution in the land of opportunities. *Journal of Public Economics*, 89:897–931.

Alesina, A., Sacerdote, B., and Glaeser, E. (2001). Why doesn't the United States have a European-style welfare state? *Brookings Papers on Economic Activity*, (2):187–277.

Algan, Y., Cahuc, P., and Sangnier, M. (2016). Trust and the welfare state: The Twin Peaks curve. *The Economic Journal*, 126(593):861–883.

Allen, B. and Lauterbach, D. (2007). Personality characteristics of adult survivors of childhood trauma. *Journal of Traumatic Stress*, 20(4):587–595.

Ameri, G., Massa, M., Bindi, D., D'Alema, E., Gorini, A., Luzi, L., Marzorati, S., Pacor, F., Paolucci, R., R., P., and Smerzini, C. (2009). The 6 April 2009, Mw 6.3, L'Aquila (central Italy) earthquake: strong-motion observations. *Seismological Research Letters*, 80(6):951–966.

Belloc, M., Drago, F., and Galbiati, R. (2016). Earthquakes, religion, and transition to self-government in italian cities. *Quarterly Journal of Economics*, 131(4):1875–1926.

Bénabou, R. and Ok, E. A. (2001). Social mobility and the demand for redistribution: The POUM hypothesis. *Quarterly Journal of Economics*, 116(2):447–487.

Bénabou, R. and Tirole, J. (2006). Belief in a just world and redistributive politics. *Quarterly Journal of Economics*, 121(2):699–746.

Betchel, M. M. and Hainmueller, J. (2011). How lasting is voter gratitude? An analysis of the short- and long-term electoral returns to beneficial policy. *American Journal of Political Science*, 55(4):852–868.

Betchel, M. M., Hainmueller, J., and Margalit, Y. (2014). Preferences for international redistribution: The divide over the eurozone bailouts. *American Journal of Political Science*, 58(4):835–856.

Betchel, M. M., Liesch, R., and Scheve, K. S. (2018). Inequality and redistribution behavior in a give-or-take game. *Proceedings of the National Academy of Science of the United States of America*, 115(14):3611–3616.

Boustan, L. P., Kahn, M. E., and Rhode, P. W. (2012). Moving to higher ground: Migration response to natural disasters in the early twentieth century. *American Economic Review: Papers & Proceedings*, 102(3):238–244.

Callen, M. (2015). Catastrophes and time preference: Evidence from the Indian Ocean earthquake. *Journal of Economic Behavior & Organization*, 118:199–214.

Cassar, A., Healy, A., and Von Kessler, C. (2017). Trust, risk, and time preferences after a natural disaster: Experimental evidence from Thailand. *World Development*, 94:90–105.

Cerqueti, R., Sabatini, F., and Ventura, M. (2019). Civic capital and support for the welfare state. *Social Choice and Welfare*, https://doi.org/10.1007/s00355-019-01185-7.

Corneo, G. and Gruner, H. P. (2002). Individual preferences for political redistribution. *Journal of Public Economics*, 83:83–107.

Dahlberg, M., Edmark, K., and Lundqist, H. (2012). Ethnic diversity and preferences for redistribution. *Journal of Political Economy*, 120(1):41–76.

Dale, L. P., Carroll, L. E., Galen, G., Hayes, J. A., Webb, K. W., and Porges, S. W. (2009). Abuse history is related to autonomic regulation to mild exercise and psychological wellbeing. *Applied Psychophysiology and Biofeedback*, 34:299–308.

Davis, J. C. and Sampson, R. J. (1986). *Statistics and data analysis in Geology*. Wiley, New York.

Dills, A. K. and Hérnandez-Julian, R. (2014). Religiosity and state welfare. *Journal of Economic Behavior and Organization*, 104:37–51.

Douglas, J. (2003). Earthquake ground motion estimation using strong-motion records: A review of equations for the estimation of peak ground acceleration and response spectral ordinates. *Earth-Science Reviews*, 61:43–104.

Drenik, A. and Perez-Truglia, R. (2018). Sympathy for the diligent and the demand for workfare. *Journal of Economic Behavior and Organization*, 153:77–102.

Eckel, C. C., El-Gamal, M. A., and Wilson, R. K. (2009). Risk loving after the storm: A bayesian-network study of hurricane katrina evacuees. *Journal of Economic Behavior & Organization*, 69:110–124.

Esarey, J., Salmon, T., and Barilleaux, C. (2012). Social insurance and income redistribution in a laboratory experiment. *Political Research Quarterly*, 65(3):685–698.

Gagliarducci, S., Paserman, D., and Patacchini, E. (2019). Hurricanes, climate change policies and electoral accountability. NBER Working Paper No. 25835.

Galli, P. and Camassi, R. (2009). Rapporto sugli effetti del terremoto aquilano del 6 aprile 2009. *Rapporto congiunto DPC-INGV*.

Gärtner, M., Mollerstrom, J., and Seim, D. (2017). Individual risk preferences and the demand for redistribution. *Journal of Public Economics*, 153:49–55.

Gelman, A. E., Shor, B., Bafumi, J., and Park, D. K. (2007). Rich state, poor state, red state, blue state: What's the matter with Connecticut? *Quarterly Journal of Political Science*, 2(4):345–367.

Gerber, M. M., Frankfurt, S. B., Contractor, A. A., Oudshoorn, K., Dranger, P., and Brown, L. A. (2018). Influence of multiple traumatic event types on mental health outcomes: Does count matter? *Journal of Psychopathology and Behavioral Assessment*, pages https://doi.org/10.1007/s10862–018–9682–6.

Giuliano, P. and Spilimbergo, A. (2014). Growing up in a recession. *Review of Economic Studies*, 81:787–817.

Gorini, A., Nicoletti, M., Marsan, P., Bianconi, R., De Nardis, R., Filippi, L., Marcucci, S., Palma, F., and Zambonelli, E. (2010). The italian strong motion network. *Bulletin of Earthquake Engineering*, 8:1075–1090.

Guiso, L., Sapienza, P., and Zingales, L. (2006). Does culture affect economic outcomes? *Journal of Economic Perspectives*, 20(2):23–48.

Guiso, L., Sapienza, P., and Zingales, L. (2016). Long-term persistence. *Journal of the European Economic Association*, 14(6):1401–1436.

Hagenaars, M. A., Fisch, I., and van Minnen, A. (2011). The effect of trauma onset and frequency on ptsd-associated symptoms. *Journal of Affective Disorders*, 132:192–199.

Hagenaars, M. A., Stins, J. F., and Roelofs, K. (2012). Aversive life events enhance human freezing responses. *Journal of Experimental Psychology*, 141(1):98–105.

Hanaoka, C., Shigeoka, H., and Watanabe, Y. (2018). Do risk preferences change? Evidence from the great East Japan earthquake. *American Economic Journal: Applied*, 10(2):298–330.

Isaksson, A. S. and Lindskog, A. (2009). Preferences for redistribution—a country comparison of fairness judgements. *Journal of Economic Behavior and Organization*, 72(3):884–902.

Istat (2013a). 15 ° censimento della popolazione e delle abitazioni 2011. Technical report, Istat, Rome.

Istat (2013b). L'italia del censimento. struttura demografica e processo di rilevazione: Abruzzo. Technical report, Istat, Rome.

Jiménez-Jiménez, N., Molis, E., and Solano-Garcia, A. (2018). The effect of initial inequality on meritocracy: A voting experiment on tax redistribution. *Journal of Economic Behavior & Organization*, https://doi.org/10.1016/j.jebo.2018.09.019.

Kim, B., Carruthers, C. K., and Harriss, M. C. (2017). Maternal stress and birth outcomes: Evidence from the 1994 northridge earthquake. *Journal of Economic Behavior & Organization*, 140:354–373.

Kirchmaier, I., Prüfer, J., and Trautmann, S. T. (2018). Religion, moral attitudes and economic behavior. *Journal of Economic Behavior and Organization*, 148:282–300.

Luttmer, E. F. P. and Singhal, M. (2011). Culture, context and the taste for redistribution. *American Economic Journal: Economic Policy*, 3:157–179.

Luzi, L., Pacor, F., and R., P. (2017). Italian accelerometric archive v 2.3. Istituto Nazionale di Geofisica e Vulcanologia, Dipartimento della Protezione Civile Nazionale. doi: 10.13127/ITACA.2.3.

Pellicer, M., Piraino, P., and Wegner, E. (2019). Perceptions of inevitability and demand for redistribution: Evidence from a survey experiment. *Journal of Economic Behavior & Organization*, 159:274–288.

Pesaresi, C. (2012). I comuni del cratere sismico, prima e dopo il terremoto del 2009. Considerazioni sui movimenti demografici in atto. *Semestrale di Studi e Ricerche di Geografia*, 24(1):69–84.

Piketty, T. (1995). Social mobility and redistributive politics. *Quarterly Journal of Economics*, CX(3):551–584.

Rehdanz, K., Welsch, H., Narita, D., and Okubo, T. (2015). Well-being effects of a major natural disaster: The case of Fukushima. *Journal of Economic Behavior and Organization*, 116:500–517.

Roth, C. and Wohlfart, J. (2018). Experienced inequality and preferences for redistribution. *Journal of Public Economics*, 167:251–262.

Rytwinski, N. K., Scur, M. D., Feeny, N. C., and Youngstrom, E. A. (2013). The co-occurrence of major depressive disorder among individuals with posttraumatic stress disorder: A meta-analysis. *Journal of Traumatic Stress*, 26:299–309.

Said, F., Afzal, U., and Turner, G. (2015). Risk taking and risk learning after a rare event: Evidence from a field experiment in Pakistan. *Journal of Economic Behavior and Organization*, 118:167–183.

Skidmore, M. and Toya, H. (2002). Do natural disasters promote long-run growth? *Economic Inquiry*, 40(4):664–687.

Stesland, S. Ø., Dyb, G., Thoresen, S., Wentzel-Larsen, T., and Zwart, J. A. (2013). Potentially traumatic interpersonal events, psychological distress and recurrent headache in a population based cohort of adolescents: The HUNT study. *BMJ Open*, 13(e002997).

Toya, H. and Skidmore, M. (2014). Do natural disasters enhance societal trust? *Kyklos*, 67(2):255–279.

Turner, R. J. and Lloyd, D. A. (1995). Lifetime traumas and mental health: The significance of cumulative adversity. *Journal of Health and Social Behavior*, 36(4):360–376.

Williams, S. L., Williams, D. R., Stein, D. J., Seedat, S., Jackson, P. B., and Moomal, H. (2007). Multiple traumatic events and psychological distress : The South Africa stress and health study. *Journal of Traumatic Stress*, 20(5):845–855.

Appendix

Table 6: Metadata of the shakes as reported in the ITACA database

ID	IT-2008-0004	IT-2009-0009	IT-2009-0032	IT-2009-0084	IT-2009-0095	IT-2009-0102	IT-2009-0121	IT-2009-0140	IT-2009-0174
Date-Time	23/12/2008, 00:00	06/04/2009, 01:32	06/04/09, 2:37	06/04/09, 23:15	07/04/09, 9:26	07/04/09, 17:47	09/04/09, 00:52	09/04/09, 19:38	13/04/09, 21:14
Nation	Italy	Italy	Italy	Italy	Italy	Italy	Italy	Italy	Italy
Region	Emilia-Romagna	Abruzzo	Abruzzo	Abruzzo	Abruzzo	Abruzzo	Abruzzo	Abruzzo	Abruzzo
Province	Parma	L'Aquila	L'Aquila	L'Aquila	L'Aquila	L'Aquila	L'Aquila	L'Aquila	L'Aquila
Municipality	Neviano degli Arduini	L'Aquila	L'Aquila	L'Aquila	L'Aquila	Fossa	L'Aquila	L'Aquila	L'Aquila
Latitude (decimal degrees N)	44.544	42.342	42.36	42.463	42.336	42.303	42.489	42.504	42.498
Longitude (decimal degrees E)	10.345	13.380	13.328	13.385	13.387	13.486	13.351	13.35	13.337
Hypocentral depth, H (km)	22.9	8.3	8.7	9.7	9.6	17.1	11.0	9.3	9.0
Local magnitude, M_L	5.2	5.9	4.6	5.0	4.8	5.4	5.1	5.0	5.0
Moment Magnitude, M_W	5.5	6.3	5.1	5.1	5.1	5.5	5.4	5.2	5.0
Number of recording stations	60	62	19	25	30	59	52	43	46

Notes: All times are UTC

Table 7: Variables description

Age	Log of age
Male	Dummy equal to 1 if respondent is male
Education	Ordinal variable coded as follows: 0=No education; 1=Primary school; 2=Junior high school; 3=High school; 4=University
Right wing	Ordinal variable ranging from 0 to 10, where 0 is extreme left and 10 is extreme right
Christian	Dummy equal to 1 for Christians and Jews, and 0 for other religions, atheists and agnostics, as in Guiso et al. (2006)
Country's econ. situation	Ordinal variable ranging from 1 to 5 that codes the response to the question: "In your opinion, the economic situation of Italy in the last year is:" 1= greatly worse; 2= partially worse; 3=unchanged; 4=partially improved; 5=greatly improved
Household econ. situation	Ordinal variable ranging from 1 to 5 that codes the response to the question: "In your opinion, the economic situation of your family in the last year is:" 1= greatly worse; 2= partially worse; 3=unchanged; 4=partially improved; 5=greatly improved
L'Aquila PGA	standardized transformation of the average PGA (in cm/s^2) recorded in the municipality of residence out of the eight main shakes occurred on L'Aquila earthquake
Seismicity	Ordinal variable ranging from 1 to 4 that reports the ISTAT official classification of municipalities according to their seismic risk
Latitude	Municipality latitude defined in decimal degrees
Longitude	Municipality longitude defined in decimal degrees
Altitude	Ordinal variable ranging from 1 to 5 that reports the ISTAT official classification of municipalities according to their altitude class
Urban	Ordinal variable ranging from 1 to 3 that reports the ISTAT official classification of municipalities according to their urbanization class
Coastal	Dummy equal to 1 for coastal municipalities
Mountain	Ordinal variable ranging from 1 to 3 that reports the ISTAT official classification of municipalities according to their mountain status
Area	Log of Municipality area in square km

Table 8: PGA mean values calculated by radial distance from sixth shake's actual epicenter (IT-2009-0121)

Circular sector id	Radial distance from earthquake's epicenter (km)		Mean PGA (cm/s^2)	Involved municipalities
	Min	Max		
0	0	0	292.58	1
1	0	10	153.74	3
2	10	20	126.42	13
3	20	30	72.8	18
4	30	40	54.64	44
5	40	50	42.68	74
6	50	60	28.89	102
7	60	70	15.79	114
8	70	80	17.37	99
9	80	90	20.58	100
10	90	100	20	91
11	100	125	9.09	257
12	125	150	1.79	207

Table 9: PGA mean values calculated by radial distance from seventh shake's actual epicenter (IT-2009-0140)

Circular sector id	Radial distance from earthquake's epicenter (km)		Mean PGA (cm/s^2)	Involved municipalities
	Min	Max		
0	0	0	337.69	1
1	0	10	145.21	2
2	10	20	93.36	13
3	20	30	42.55	18
4	30	40	29.34	44
5	40	50	25.35	74
6	50	60	17.16	102
7	60	70	9.92	114
8	70	80	10.13	99
9	80	90	12.87	100
10	90	100	13.53	91
11	100	125	8.11	257
12	125	150	3.55	207

Table 10: PGA mean values calculated by radial distance from eighth shake's actual epicenter (IT-2009-0174)

Circular sector id	Radial distance from earthquake's epicenter (km)		Mean PGA (cm/s^2)	Involved municipalities
	Min	Max		
0	0	0	261.84	1
1	0	10	106.29	2
2	10	20	47.35	13
3	20	30	25.61	18
4	30	40	18.44	44
5	40	50	12.59	74
6	50	60	8.88	102
7	60	70	7.75	114
8	70	80	7.77	99
9	80	90	8.97	100
10	90	100	8.45	91
11	100	125	4.33	257
12	125	150	1.25	207