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Natural disasters and demand for redistribution: lessons from an earthquake*

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Abstract

The literature shows that when a society believes that wealth is determined by random "luck" rather than by merit, it demands more redistribution. Adverse shocks, like earthquakes, strengthen the belief that random "bad luck" can frustrate the outcomes achieved with merit. We theoretically illustrate that individuals react to such shocks by raising support for redistribution. We then present evidence of this behavior by exploiting a natural experiment provided by one of the strongest seismic events that occurred in Italy in the last three decades, the L'Aquila earthquake in 2009. We assemble a novel dataset by matching information on the ground acceleration registered throughout the National Strong Motion Network during the earthquake with survey data about individual opinions on redistribution collected a few months later. The empirical analysis illustrates that the intensity of the shakes is associated with subsequent stronger beliefs that, for a society to be fair, income inequalities should be levelled by redistribution.

Keywords: fairness, redistribution, inequality, natural disasters, earthquakes.

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

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1 Introduction

Redistributive policies rely on the prevalent 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). Fong (2001) and Alesina and La Ferrara (2005) provide individual-level evidence that a stronger belief that luck matters in determining one's position in the social ladder is associated to higher support for redistribution.

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. Piketty (1995), for example, theoretically shows that unfortunate experiences can support the belief that luck, instead of merit, plays a decisive role in income distribution, thereby raising aversion to inequality and consensus for redistributive policies.

To study the relationship between adverse shocks and demand for redistribution, we exploit a natural experiment provided by one of the strongest seismic events that occurred in Italy in the last decades, the L'Aquila earthquake in 2009. A natural disaster can be seen as a manifestation of random "bad luck", i.e. the misfortune of living in the wrong place at the wrong time, which demonstrates how exogenous events can frustrate the outcomes achieved with merit.

Borrowing the theoretical set-up of Alesina and Angeletos (2005), we first illustrate how the average support for redistribution reacts to an adverse shock that strengthens the perceived role of fate in the distribution of income. In this framework people derive disutility from social injustice, defined as welfare allocations that result from random luck instead of merit. We model the adverse shock as the increase in the expected volatility of income due to factors that are not under the agent's control. We show that the shock leads to increasing the demand for redistribution aimed at counteracting the effect of luck.

To test this relation, we then assemble a novel dataset by matching the peak ground acceleration (PGA) recorded throughout the National Strong Motion Network during the L'Aquila earthquake with nationally representative survey data about individual opinions and beliefs that were collected 18 months after the shock. 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. Data on PGA are drawn from the strong motion database ITACA (ITalian ACcelerometric Archive), which relies on 1337 accelerometric stations installed in the most active seismic areas of Italy, with an average spacing between stations of approximately 20 km (Gorini et al., 2010).

The empirical analysis illustrates how, consistently with theoretical results, the 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 natural experiment provided by the earthquake allows circumventing the endogeneity problems that are usually at stake in the analysis of individual preferences and opinions. However, other issues may prevent a correct identification of the effect of the shock. Since preferences for redistribution can be biased by unobserved local factors and personal traits, we control for province fixed effects and for a series of individual traits including demographic characteristics, socio-economic status, political opinions, religious beliefs, news consumption, and possible downturns in the economic well-being of the household.

The damages and the emotional impact of an earthquake can be endogenously limited, for example through the strengthening of anti-seismic measures (Kahn, 2005). In addition, people evacuated from damaged buildings could selfishly demand redistribution for alleviating their personal state of need, rather than because of a change in their beliefs. To address this issue, we run robustness checks considering only those areas where the earthquake did not cause any damage.

Finally, to rule out the possibility that our results capture a spurious correlation, we develop a counterfactual by generating 5,921 placebo earthquakes with the same intensity and a similar propagation pattern of the L'Aquila event, one for each Italian municipality outside of the actual epicentral area. We repeat the procedure 20,000 times to observe how the counterfeit shakes relate to preferences for redistribution. For the sake of robustness, we also repeat the test by assuming a different geometry of propagation. Placebo tests support our results.

Our contribution bridges two strands of the literature. The first investigates the determinants of the individual demand for redistribution by analyzing the role of mobility prospects (Piketty, 1995; Bénabou and Ok, 2001), fairness (Alesina and Angeletos, 2005;Isaksson and Lindskog, 2009), beliefs about equality of opportunities (Fong, 2001; Alesina and La Ferrara, 2005), religion (Dills and Hérnandez-Julian, 2014; Kirchmaier et al., 2018) empathy and altruism (Dahlberg et al., 2012; Yamamura, 2012), and aspects of social capital (Algan et al., 2016; Cerqueti et al., 2016). We add to this field by showing how the desire for fairness leads those who witnessed the potential role of exogenous unfortunate events to more strongly dislike inequalities thus supporting redistribution. Such a mechanism was only implicitly hypothesized in Piketty (1995) and Alesina and Angeletos (2005) but, to the best of our knowledge, it was never empirically tested in the literature.

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; Calo-Blanco et al., 2017), risk attitudes (Eckel et al., 2009; Said et al., 2015), well-being (Rehdanz et al., 2015), and time preferences (Callen, 2015; Cassar et al., 2017). We add to this literature by revealing that natural disasters can trigger an unexpected chain of reactions possibly influencing redistributive policies. Methodologically, we differentiate from previous studies by implementing a continuous measure of seismic shocks in the empirical analysis. For example, Belloc et al. (2016) capture the intensity of the shock through a binary measure of whether the earthquake was 'destructive' or 'felt'. Skidmore and Toya (2002) and Toya and Skidmore (2014) assess a country's exposure to disasters as the number of significant events occurred in a certain period. Barrot and Sauvagnat (2016), Hosono et al. (2016) and Calo-Blanco et al. (2017) use a dummy variable capturing the individual exposure to earthquakes. To overcome measurement errors, we employ a continuous indicator exactly capturing how hard the shakes were felt by inhabitants.

The rest of the paper is organized as follows: section 2 presents the theoretical framework. Section 3 describes the dataset we assembled by matching the information concerning L'Aquila earthquake with survey data. Section 4 presents the empirical analysis and discusses the robustness of results. In section 5 we draw some concluding remarks.

2 Theoretical framework

To analyze how adverse shocks such as natural disasters affect demand for redistribution, we build on a simplified version of the theoretical framework proposed by Alesina and Angeletos (2005).

Let us assume a continuum of agents indexed by $i \in [0,1]$. Individual income (y_i) depends on merit (A_i) and random luck (η_i):

$$y_i = A_i + \eta_i,$$

where η_i is an i.i.d. shock with zero mean and σ_η variance. This shock represents all factors of socioeconomic success that are not under the voluntary control of i such as, for example, the fortune of being born in the right place into the right family or the misfortune of experiencing an adverse shock like an earthquake. Individual features and luck are uncorrelated, so that $Cov(A_i, \eta_i) = 0$. Agents live for one period and consume their whole income.

Following Meltzer and Richard (1981) and similarly to Sabatini et al. (2017), we assume that the public sector implements a redistributive scheme such that incomes are taxed at rate t, and tax revenues are redistributed evenly among agents. Disposable income is given by

$$c_i = (1-t)y_i + G, \tag{1}$$

where $G = t\overline{y}$, and $\overline{y} = \int_0^1 y_i di$.

In line with Alesina and Angeletos (2005) individual preferences are given by

$$U_i = c_i - \gamma\Omega,$$

where Ω measures the disutility caused by "social injustice", i.e. welfare allocations that are perceived as unfair because they result from random luck instead of merit. The parameter γ can be interpreted as a measure of the aversion to 'social injustice'. A social allocation is unfair when it deviates from what agents should get based on their merit $\hat{y}_i = A_i$. We assume

$$\Omega = \int_0^1 (c_i - \hat{y}_i)^2 \, di.$$

Given the definition of G, and $Cov(A_i, \eta_i) = 0$, after some manipulation we find

$$\Omega = (1-t)^2\sigma_\eta + t^2\sigma_A,$$

where $\sigma_A \equiv Var(A)$.

The individual agent's expected utility is

$$E[U_i] = E(c_i) - \gamma\Omega = (1-t)A_i + t\overline{y} - \gamma\left((1-t)^2\sigma_\eta + t^2\sigma_A\right). \tag{2}$$

An analysis of equation (2) shows that agents may demand redistribution, i.e. a positive tax rate, for two reasons. First, there is a 'selfish' motive for desiring redistribution since agents gain from a positive tax rate as long as their expected income is lower than the mean income. Second, if individuals care about social outcomes they demand a positive tax rate to reduce the 'unfairness' of the market allocation. This is the altruistic or fairness motive for redistribution. The disutility generated by unfair allocations, Ω, is minimized by $t_\Omega = \sigma_\eta/(\sigma_\eta + \sigma_A)$, which is an increasing function of the variability of 'luck'. Redistribution reduces unfairness when luck is more relevant in determining income and consumption distributions.

Individual agents choose their desired tax rate (t_i^*) by maximizing (2) with respect to t so that:

$$t_i^* = \frac{2\gamma\sigma_\eta + \overline{y} - A_i}{2\gamma(\sigma_\eta + \sigma_A)}. \tag{3}$$

Individual demand for redistribution is positive ($t^* > 0$) if (and only if) $2\gamma\sigma_\eta + \overline{y} - A_i > 0$. As long as luck affects individual income ($\sigma_\eta > 0$), there is always a positive demand for redistribution due to the fairness motive; on the other hand, selfish demand for redistribution is a negative linear function of expected income A_i, and it is positive only for agents with below-average expected income ($A_i < \overline{y}$). Agents with above-average expected income will demand a positive tax rate if their altruistic motive for redistribution is stronger than their (negative) selfish one.

Now, assume that an adverse shock such as a natural disaster affects agents' perception of the relevance that 'luck' plays in economic outcomes. If the exact distribution of η_i, and in particular its variance σ_η, is unknown to the agents, it is reasonable to represent the effect of the shock as an increase in σ_η. The individual response to a higher variability of luck is:

$$\frac{dt_i^*}{d\sigma_\eta} = \frac{2\gamma\sigma_A - (\overline{y} - A_i)}{2\gamma(\sigma_\eta + \sigma_A)^2}. \tag{4}$$

The net result on the individual desired tax rate depends on two effects. The first one is positive and common to all agents because the tax rate that minimizes the disutility of social unfairness, $t_\Omega = \sigma_\eta/(\sigma_\eta + \sigma_A)$, is an increasing function of σ_η. The second influence is positive for people with above average expected income, while it is negative for agents who expect to be in the lower half of income distribution. The result may at first look counterintuitive. What happens is that higher variability of income due to pure luck raises Ω, the disutility due to unfair allocations. Agents in both classes, in deciding their demand for redistribution, place a stronger emphasis on the altruistic rather than on the selfish motive. The high income individuals have zero selfish demand for redistribution; therefore attaching a higher weight to the altruistic motive raises the optimal tax rate. On the contrary, the desired tax rate for relatively low income agents would be 100% if they acted based on the selfish motive only. If social unfairness is higher they move their optimal tax rate closer to the social unfairness minimizing one, t_Ω; against their own interest they demand lower redistribution. A similar mechanism is explored in more detail in Sabatini et al. (2017).

In our empirical investigation, we assess how the average support for redistribution, corresponding to the average tax rate $\bar{t}^* = \int_0^1 t_i^* di$, is affected by the L'Aquila earthquake[1]. The model's prediction is that the response is unambiguously positive:

$$\frac{d}{d\sigma_\eta}\bar{t}^* = \frac{d\int_0^1 t_i^* di}{d\sigma_\eta} = \frac{\sigma_A}{(\sigma_\eta + \sigma_A)^2} > 0. \tag{5}$$

The rationale is the following. Changes in the individual desired tax rate due to the selfish motive for redistribution are linear in the difference between average and individual expected income (see equation 4); therefore they cancel out on average. The response of the desired tax rate to the shock is driven by the fairness motive only, which demands higher redistribution following an increase in the variability of luck.

3 Data and empirical strategy

3.1 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). ITACA was developed during different projects in the framework of an agreement between the Italian Department of Civil Protection (DPC) and the National Institute of

[1]Several authors model support for redistribution as the desired tax rate through which redistribution is financed. In addition to Alesina and Angeletos (2005), see among others Bénabou and Tirole (2006) and Algan et al. (2016).

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The current release of the database (v. 2.2, June 2017) contains 32,271 three-component accelerometric waveforms generated by 1,524 earthquakes with magnitude greater than 3.0 occurred in Italy between February 1972 and December 2016. ITACA contains 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 the most (673) belonging to the Italian Strong Motion Network (IT) – also known as *Rete Accelerometrica Nazionale* (RAN) – operated by DPC, and 259 belonging to the Italian National Seismic Motion Network (IV), operated by INGV.

For each seismic event recorded, main parameters provided by the accelerometric stations include: station's distance from the epicenter (R_{epi}, km); station's subsoil category according to the Eurocode 8 (EC8) classification; peak ground acceleration (PGA, cm/s^2), peak ground velocity (PGV, cm/s) and peak ground displacement (PGD, km) recorded during the seismic shaking.

On 6 April 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 8.3 km depth 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). Table 1 reports the metadata of the L'Aquila earthquake. 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.

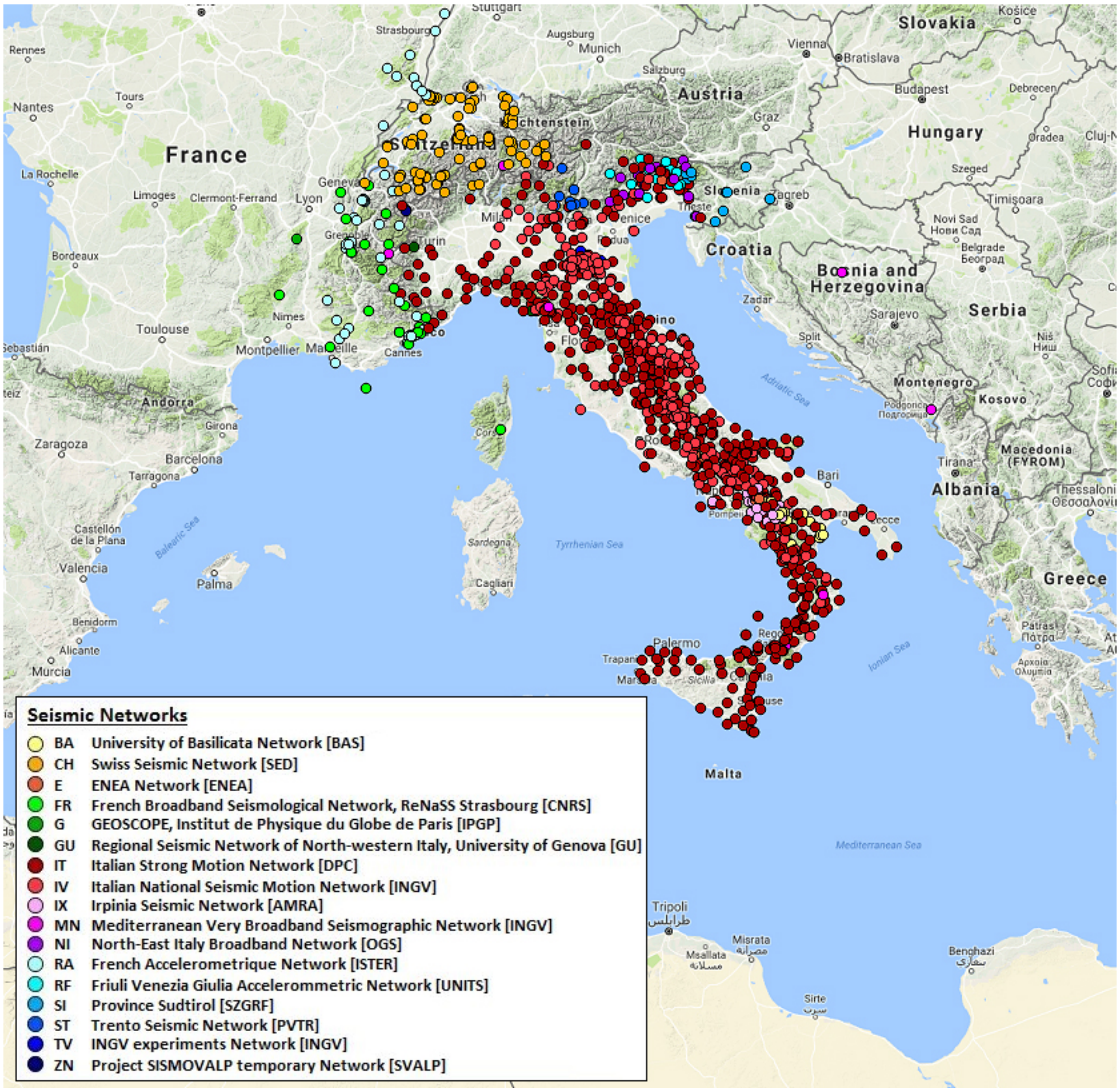


Figure 1: Map of the seismic networks included in the ITACA v. 2.2 strong motion database. Source: authors' elaboration on data described in the text.

Table 1: Metadata of the L'Aquila first shake as reported in the ITACA database

ID	IT-2009-0009
Date-Time	06/04/2009, 01:32:40 UTC
Name	L_AQUILA
Nation	Italy
Region	Abruzzo
Municipality	L'Aquila
Latitude (decimal degrees)	42.342 N
Longitude (decimal degrees)	13.380 E
Hypocentral depth, H (km)	8.3
Local magnitude, M_L	5.9
Moment Magnitude, M_W	6.3
Style of faulting	Normal faulting
Number of recording stations	62

This event comprises the first and strongest shock and several aftershocks. We observe 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). A total of 19 weaker (M_L between 4.0 and 5.4) yet again surface (H $\leq$ 17.1 km) shocks were 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 event were recorded by a total of 62 ITACA accelerometric stations. In our empirical analysis, we use the maximum PGA recorded across these different shake and aftershakes to measure the intensity with which the earthquakes were felt at each geographic location. Figure 2 shows the PGA locally recorded by the 62 stations over the whole Italian territory.

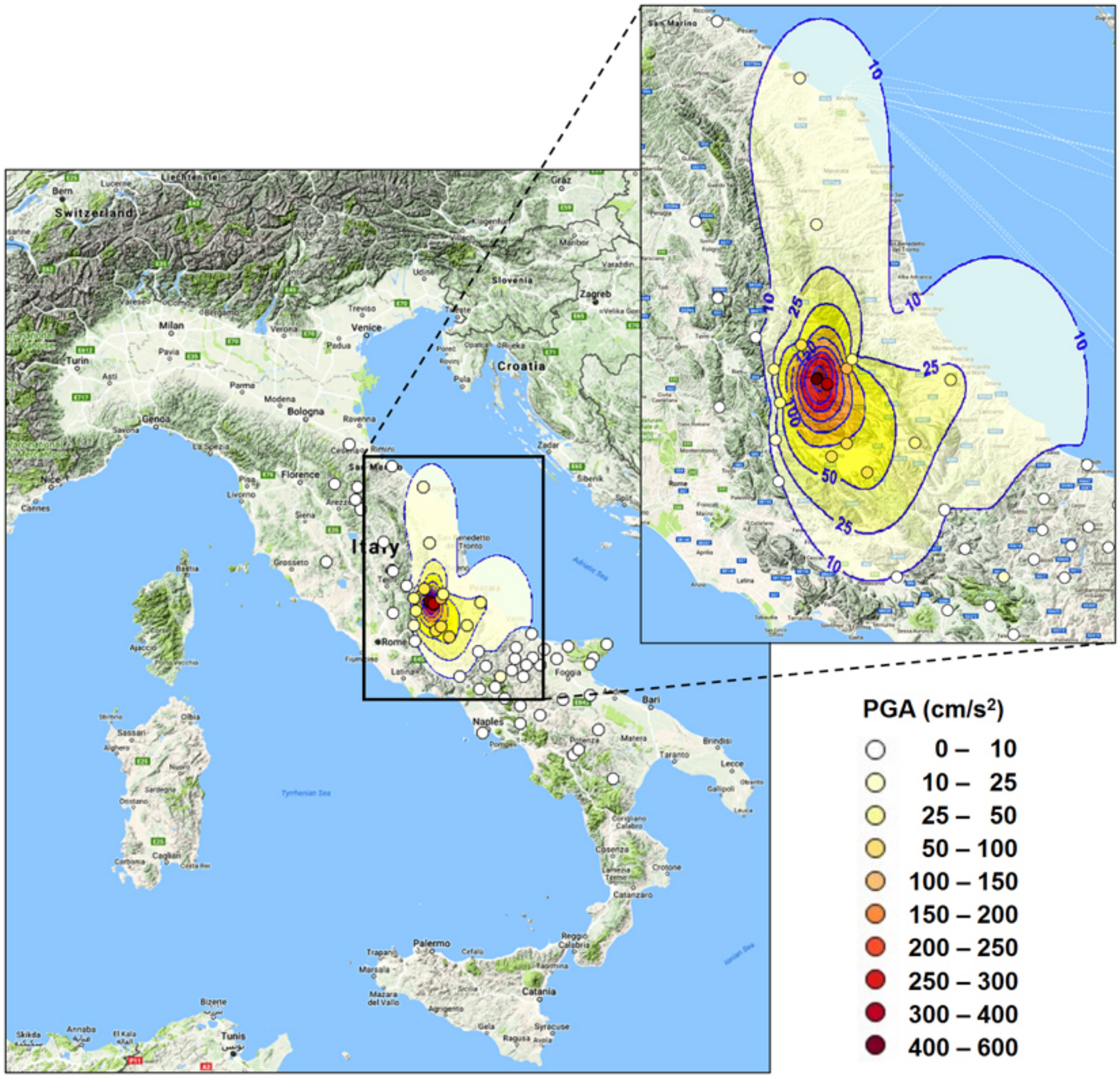


Figure 2: PGA values recorded by the ITACA accelerometric stations during the L'Aquila first shake (IT-2009-0009) and PGA spatially interpolated contours. Source: authors' elaboration on data described in the text.

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. Noteworthy, two stations closer to the epicenter (1.8 and 2.2 km) recorded lower PGA values

(355.46 and 306.43 cm/s^2, respectively). Conversely, 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 interpolated the PGA values recorded by each station. Data interpolation was 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.

As shown in the close-up map of Figure 2, a PGA minimum threshold of 10 cm/s^2 was graphically set to filter out those areas affected to a marginal extent by the event. As apparent, the effects of the earthquake do not propagate uniformly across the ground, but are rather strongly influenced by the geomorphological structures encountered along its path. The area of maximum PGA occurs inside the surface projection of the fault. Note that 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 the earthquake.

3.2 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, making it impossible to exploit the panel dimension of the data for studying support for redistribution. We thus only consider interviews administered in the first wave that took place18 months after the earthquake, in February 2011, to a sample stratified by gender, age, education, region, and the demographic size of municipalities, as partitioned into 5 classes.

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 has been often used, with slight differences, to measure the individuals' demand for redistribution (e.g. Alesina and La Ferrara, 2005; Guiso et al., 2006; Algan et al., 2016).

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 US 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, news consumption, and possible downturns in the economic well-being of the household which we consider as additional controls in our econometric model. Table 2 reports the descriptive statistics, while Table 5 in the Appendix presents the definitions of the explanatory variables.

We then match survey data with the information on the ground acceleration registered throughout the National Strong Motion Network during the earthquake. Each survey respondent is attributed the PGA felt in her municipality of residence.

Table 2: Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Redistribution	2,248	0.778	0.416	0	1
L'Aquila PGA	2,248	7.452	21.290	0	370.64
Age	2,247	51.226	18.124	18	98
Male	2,248	0.537	0.499	0	1
Education	2,248	2.344	0.899	0	4
Father's education	2,248	1.372	1.100	0	4
Country's econ situation	2,225	1.819	0.826	1	5
Family's econ welfare	2,242	2.464	0.775	1	5
Political engagement	2,248	0.405	0.491	0	1
Right wing	1,641	5.018	2.884	0	10
Worker	2,248	0.317	0.465	0	1
Religion	1,893	0.925	0.263	0	1
TV news	2,248	0.673	0.469	0	1
Internet	2,248	0.257	0.437	0	1
Newspapers	1,893	0.588	0.492	0	1

3.3 Empirical strategy

To study the relationship between natural disasters, e.g. the L'Aquila earthquake, and demand for redistribution, we consider a linear probability model, where our dependent variable is the dummy described above. Indeed, 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 province level (Wooldridge, 2002).

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. 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. The latest seismic event registered in the Province of L'Aquila took place on 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. Census data provided by the Italian National Institute of Statistics clearly show that neither emigration took place from L'Aquila nor, more in general, any significant change occurred in the population of the area in the following years. After 1992, census data rather registered a slight increase in the population living in L'Aquila and the surrounding municipalities. These facts overall suggest that residents of the area did not select themselves in some way.

Other factors, however, can prevent an accurate identification of the effect of the earthquake on individual beliefs. Preferences for redistribution can be influenced by unobserved local factors and individual characteristics. To tackle this issue, we control for province fixed effects and for a battery of personal traits. Thus, the equation we estimate is:

$$redistribution_i = \alpha + \beta L'AquilaPGA_c + \gamma X_i + d_p + \varepsilon_i \tag{6}$$

where $L'AquilaPGA$ is the peak ground acceleration at the centroid of the respondent municipality of residence, X is a vector of individual-specific characteristics collected in the Itanes survey, and d_p is a set of province dummies.

People who personally suffered from the material damages caused by the earthquake may express a selfish demand for redistribution that does not necessarily reflect a change in their beliefs. To overcome this problem, we run a robustness check by excluding from the sample the areas where material damages were reported.

Even so, it is still conceivable that our results capture a spurious correlation driven by a coincidence. To rule out this possibility, we develop a counterfactual by generating a placebo earthquake in all similar to the L'Aquila event and randomly assigning its epicenter to the municipalities in which the accelerometric stations registered a null PGA during the actual earthquake. By replicating the propagation pattern of the L'Aquila event, we are able to reconstruct how the shakes would have been felt in each municipality laying in the counterfeit epicentral area. We randomly repeat this procedure 20,000 times for the sake of robustness. In a further check, we repeat the procedure assuming a different propagation pattern of the shakes.

4 Results

4.1 Main results

Table 3 reports the main results. The baseline estimation reported in column 1 shows a positive and statistically significant coefficient for coefficient *L'AquilaPGA*, thus suggesting that larger PGA values for the L'Aquila event are associated with a stronger preference for redistribution. This finding still holds after controlling for age, sex, education. In column 2 we include an indicator of the family background given by the educational qualification of the respondent's father, the perceived economic situation of the country and the self-reported level of the household economic welfare. As expected, as the household welfare is perceived to improve, individuals are less likely to support redistributive policies. On the other hand, the perceived economic situation of the country is not a significant predictor of the individual demand for redistribution, consistently with previous literature on the selfish motives for redistribution (e.g. Meltzer and Richard, 1981). In column 3 we control for the political orientation of respondents. In line with standard predictions, right wing oriented individuals are less likely to support redistribution, consistently with findings from the political science literature (e.g. Brooks and Brady, 1999 and Gelman et al., 2007). As inherited moral values may play a role in the individual attitudes towards social justice and redistribution, we follow Guiso et al. (2006) and test how our dependent variable relates to religious beliefs. As in Guiso et al. (2006), we use a binary variable equal to 1 in case respondents are Christians or Jews and 0 otherwise. Differently from them we find no significant results (column 4). The two findings, however, are not inconsistent, as Guiso et al. (2006) carried out their analysis at the cross-country level, where larger variability is observed. As reported in Table 1, roughly 92% of the Itanes sample declared to be Christian or Jew. In columns 5 and 6 we control for news consumption through television and the Internet to test for the possible role of information (see for example Kuzmienko et al., 2015). In either cases coefficients are not significant. We also control for the use of other types of media and contents, the work status of respondents and their self-reported interest in politics, with no significant results.[2]

[2]There results are not shown in tables for the sake of brevity but are available upon request.

Table 3: L'Aquila earthquake and support for redistribution

	(1)	(2)	(3)	(4)	(5)	(6)
L'Aquila PGA	0.286***	0.212***	0.162***	0.190***	0.212***	0.211***
	(0.014)	(0.033)	(0.045)	(0.039)	(0.033)	(0.033)
Age	0.009	0.019	0.014	0.048	0.014	0.023
	(0.050)	(0.051)	(0.070)	(0.057)	(0.053)	(0.054)
Male	0.023	0.025	0.007	0.027	0.026	0.027
	(0.038)	(0.038)	(0.047)	(0.043)	(0.038)	(0.038)
Education	0.028	0.027	0.026	0.027	0.026	0.026
	(0.023)	(0.025)	(0.031)	(0.028)	(0.024)	(0.024)
Father's education		0.021	0.010	0.023	0.020	0.020
		(0.018)	(0.026)	(0.024)	(0.018)	(0.018)
Country econ. situation		-0.021	-0.019	-0.029	-0.020	-0.021
		(0.028)	(0.032)	(0.030)	(0.028)	(0.028)
Household econ. welfare		-.061**	-.069*	-.072*	-.062**	-.061**
		(0.027)	(0.040)	(0.038)	(0.027)	(0.027)
Right wing			-.017*			
			(0.009)			
Religion				-0.082		
				(0.056)		
TV news consumption					0.031	
					(0.046)	
Internet consumption						0.014
						(0.046)
Constant	0.385*	0.557**	0.746**	0.570*	0.551**	0.544**
	(0.216)	(0.246)	(0.349)	(0.295)	(0.247)	(0.252)
Observations	2,247	2,220	1,627	1,875	2,220	2,220
R-squared	0.597	0.606	0.684	0.649	0.607	0.606

Robust standard errors in parentheses; *, **, *** significant at 10%, 5% and 1% level respectively.

In a further robustness check aimed at disentangling the selfish need for public aid possibly caused by the earthquake damages from changes in the individuals concerns about redistribution, we test whether our results still hold after excluding from the sample the area that was most hit by the seismic event. As reported in Table 4, the coefficient estimates obtained on this subsample are comparable in terms of magnitude and statistical significance to the ones observed on the full sample. Thus, the finding that experiencing an earthquake is positively related to stronger preferences for redistribution is confirmed even dropping the observations where the demand for redistributive policies for selfish motives is likely to be stronger.

Table 4: L'Aquila earthquake and support for redistribution outside of the epicentral area

	(1)	(2)	(3)	(4)	(5)	(6)
L'Aquila PGA	0.288***	0.213***	0.166***	0.193***	0.213***	0.212***
	(0.014)	(0.033)	(0.045)	(0.039)	(0.033)	(0.033)
Age	0.000	0.014	0.006	0.042	0.009	0.020
	(0.049)	(0.051)	(0.070)	(0.056)	(0.052)	(0.053)
Male	0.027	0.029	0.007	0.028	0.030	0.031
	(0.038)	(0.038)	(0.047)	(0.043)	(0.038)	(0.038)
Education	0.026	0.023	0.022	0.023	0.022	0.020
	(0.023)	(0.025)	(0.031)	(0.028)	(0.024)	(0.024)
Father's education		0.025	0.012	0.025	0.024	0.024
		(0.018)	(0.026)	(0.024)	(0.018)	(0.018)
Country econ. situation		-.023	-.019	-.029	-.022	-.023
		(0.028)	(0.032)	(0.030)	(0.028)	(0.028)
Household econ. welfare		-.061**	-.068*	-.071*	-.062**	-.061**
		(0.027)	(0.041)	(0.038)	(0.027)	(0.027)
Right wing			-.016*			
			(0.009)			
Religion				-.080		
				(0.056)		
TV news consumption					0.030	
					(0.045)	
Internet consumption						0.023
						(0.045)
Constant	0.420**	0.580**	0.776**	0.595**	0.574**	0.559**
	(0.213)	(0.244)	(0.350)	(0.294)	(0.245)	(0.251)
Observations	2,192	2,165	1,583	1,830	2,165	2,165
R-squared	0.594	0.604	0.681	0.646	0.605	0.604

Robust standard errors in parentheses; *, **, *** significant at 10%, 5% and 1% level respectively.

4.2 Placebo test

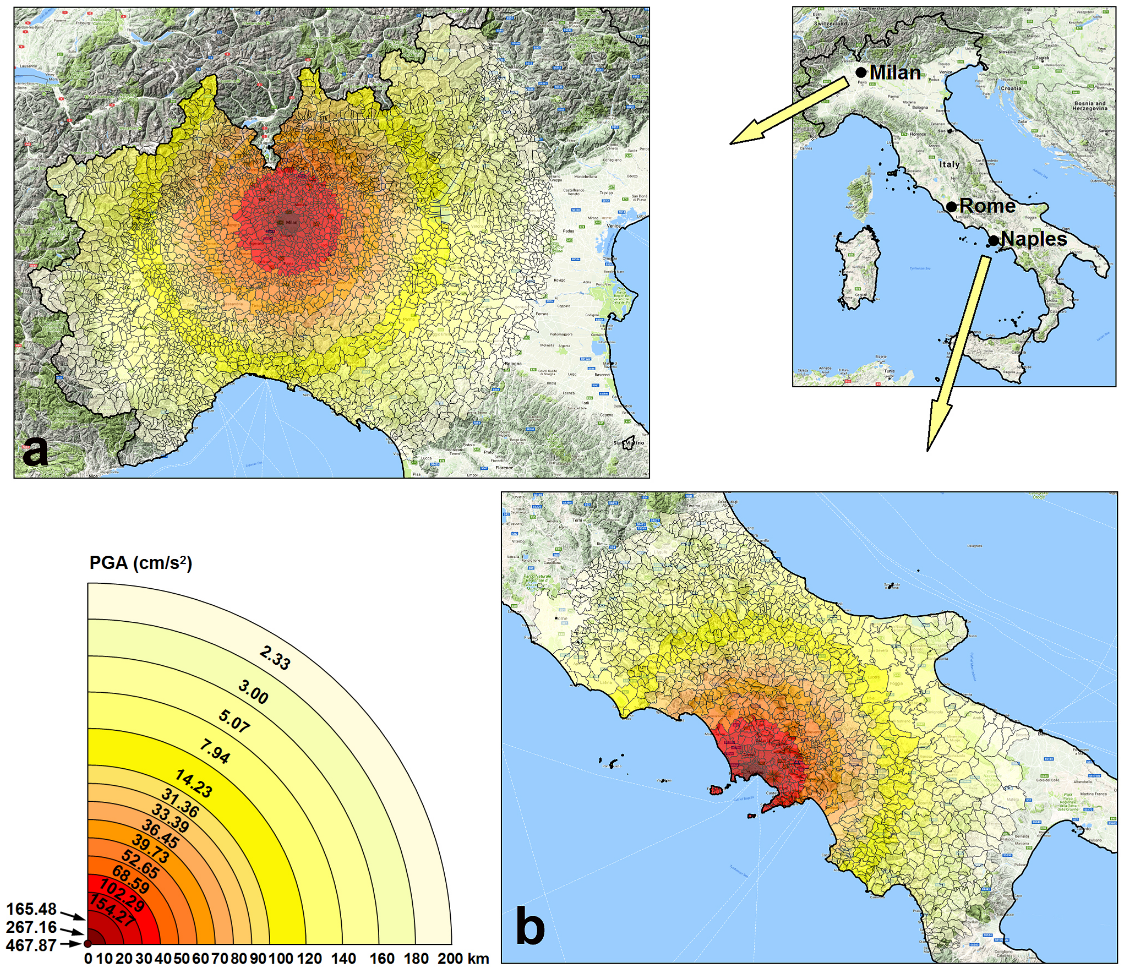
To further check the robustness of our results, we implement a placebo test in the spirit of Abadie and Hainmueller (2010) and Belloc et al. (2016). We generate a series of placebo earthquakes with the same maximum intensity of the L'Aquila event but having their epicenter in the centroid of any of the 5,921 municipalities falling outside the actual epicentral area, i.e. those municipalities in which the strong motion network registered a null PGA during the earthquake. For each placebo event, we reconstruct a propagation pattern by calculating the PGA of the shakes striking each municipality laying in the counterfeit epicentral area based on the relationship between the distance from the epicenter and the ground acceleration observed in the L'Aquila event. We then randomly assign the epicenter of the placebo shake to the municipalities not hit by the L'Aquila event, and repeat this procedure 20,000 times. This allows us to estimate the reaction of the individuals in the sample to a swarm of placebo earthquakes with epicenter in any of the 5,921 Italian municipalities outside of the L'Aquila epicentral area. More specifically, the test is developed along the following steps.

First, the PGA values recorded by the accelerometric stations during the actual earthquake are averaged for each municipality; for the epicenter's municipality (L'Aquila), for example, a mean PGA value of 467.87 cm/s2 was achieved. 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 L'Aquila event by assuming that the shakes propagate uniformly across the ground, so that the related PGA values decrease uniformly from the epicenter as a sole function of the radial distance. As a result, the false epicentral areas have a circular geometry and are partitioned into a number of circular sectors, each one with a decreasing value of PGA according to the distance from the placebo epicenter. For the sake of robustness, we implement the simulation of the propagation pattern according to two different criteria: we produce two partitions of the false epicentral areas into 15 and 22 zones and develop accordingly two separated placebo tests relative to each partition. The size and PGA values of the two partitions are exemplified in detail in Tables 6 and 7 in the Appendix.

Then, after imputing to the i municipality the maximum mean PGA value of the epicenter's municipality (467.87 cm/s2), 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.

Eventually, two placebo tests have been applied to Itanes respondents, corresponding to two placebo earthquakes, "placebo1" and "placebo2", for each municipality outside the epicentral area. Figure 3 provides an example of the application of the "placebo1" event, whose geometry is described in detail in Table 6 in the Appendix, to the municipalities of Milan (3a) and Naples (3b). The geometry of the "placebo2" earthquake is described in detail in Table 7 in the Appendix.

Figure 3: Example of the application of the placebo test based on the "placebo1" geometry (see Table 6) on the IT-2009-0009 shake to the municipalities of: (a) Milan; (b) Naples.



Following Belloc et al. (2016), the purpose of the tests is to check how many times the randomly generated placebo estimates happen to be too close to our true estimate. If in our main results we were erroneously rejecting the null hypothesis that our coefficient of interest is equal to 0 (i.e., we were attributing to earthquakes an effect that does not exist in reality), we should observe placebo coefficients close to our true estimate. We run 20,000 simulations of the baseline specification reported in column (1) of Table 3. As can be seen from Figure 4, the estimates generated in the placebo1 test are almost always to the left (meaning smaller in value than) the true estimated coefficient, equal to 0.286. Coefficients of the counterfeit earthquakes are distributed around zero.

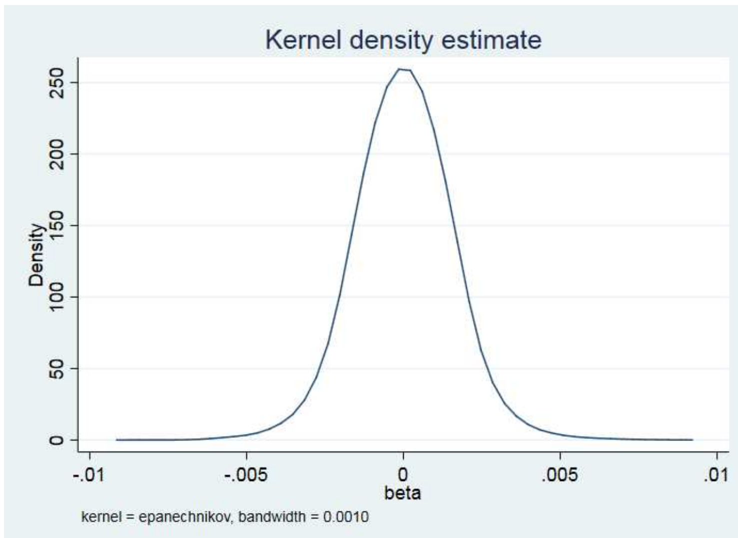


Figure 4: Kernel density function of the 20,000 placebo point estimates obtained based on the "placebo1" geometry as randomly assigned to the 5,921 municipalities falling outside the actual epicentral area.

5 Conclusion

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. This finding supports the theory that demand for redistribution also depends on individual concerns about the fairness of social competition. 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 to the intensity with which individuals objectively experienced an exogenous and randomly distributed shock.

Despite the exogeneity of the earthquake, several issues related to the cross-sectional nature of the data can prevent a correct identification of its impact on preferences for redistribution. To deal with identification concerns, we developed a counterfactual and used it to perform placebo tests. Results of the tests suggest an interpretation of our findings consistent with the theoretical predictions.

Although this work has focused on a specific natural disaster, the mechanism illustrated in the theoretical model and documented empirically 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 relation between the proportion of people supporting redistribution and the share of GDP spent on social welfare across countries and American states respectively. Given the implications 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.

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Appendix

Table 5: Description of variables

L'Aquila PGA	Maximum PGA recorded in the municipality of residence out of the 8 events occurred on 6/4/2009
Age	Log of age
Gender	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
Father's education	Ordinal variable for the educational attainment of respondents' father
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
Interest in politics	Dummy equal to 1 if the interviewed declares being interested in politics
Political orientation	Ordinal variable ranging from 0 to 10, where 0 is extreme left and 10 is extreme right
Work status	Dummy equal to one if the interviewed has a paid job at the time of interview
Religion	Dummy equal to 1 for Christians and Jews, and 0 for other religions, atheists and agnostics, as in Guiso et al. (2006)
TV news consumption	Dummy equal to 1 is respondent watches TV news every day
Internet news consumption	Dummy equal to 1 if respondent searches for news on the Internet
Newspapers	Dummy equal to 1 if respondent reads a newspaper at least once a week (excluding sport newspapers)

Table 6: PGA mean values calculated by radial distance from the L'Aquila earthquake's epicenter according to the "placebo1" earthquake geometry: 15 circular sectors

Circular sector id	Radial distance from earthquake's epicenter (km)		Mean PGA (cm/s2)	Involved municipalities
	Min	Max		
0	0	0	467.87	1
1	0	10	267.16	3
2	10	20	165.48	29
3	20	30	154.27	10
4	30	40	102.29	44
5	40	50	68.59	72
6	50	60	52.65	111
7	60	70	39.73	110
8	70	80	36.45	108
9	80	90	33.39	108
10	90	100	31.36	108
11	100	120	14.23	184
12	120	140	7.94	174
13	140	160	5.07	137
14	160	180	3	172
15	180	200	2.33	178

Table 7: PGA mean values calculated by radial distance from the L'Aquila earthquake's epicenter according to the "placebo2" earthquake geometry: 22 circular sectors

Circular sector id	Radial distance from earthquake's epicenter (km)		Mean PGA (cm/s2)	Involved municipalities
	Min	Max		
0	0	0	467.87	1
1	0	5	360.47	1
2	5	10	220.50	2
3	10	15	195.16	4
4	15	20	178.05	13
5	20	25	155.26	16
6	25	30	127.00	6
7	30	40	102.29	44
8	40	50	68.59	72
9	50	60	52.65	1115
10	60	70	39.73	110
11	70	80	36.45	108
12	80	90	33.39	108
13	90	100	31.36	108
14	100	120	14.23	184
15	120	140	7.94	174
16	140	160	5.07	137
17	160	180	3.00	172
18	180	200	2.33	178
19	200	250	1.54	353
20	250	300	0.92	294
21	300	350	0.55	421
22	350	380	0.19	413