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Understanding post disaster prosociality: Comparing post earthquake cooperation and fairness in two Italian regions

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ABSTRACT

Natural disasters put an enormous strain on communities' ability to cooperate. Community resilience, which heavily depends on individuals' prosocial attitudes, reduces the effects of disasters, determining completely different dynamics even in neighboring regions. We designed an exploratory empirical study in which we collected empirical data on behavior in two games together with survey data in seven municipalities located in two Italian regions affected by two major earthquakes. We measured contributions in the Public Goods Game and fairness in a modified Dictator Game, with the aim of testing for the effects of damage suffered, and embeddedness in the community on prosociality. We compared two different explanations, damage suffered and embeddedness, and we concluded that, in our sample, embeddedness was not related to differences in contributions, while damage suffered by the individuals was. This study contributes to the literature on post-disaster prosociality by presenting a unique lab–in-the-field experiment, and showing the differential impact of the same disaster in neighboring regions.

1. Introduction

The literature on the motives behind cooperation, in economics and other social sciences, is vast. The question of 'why humans pay a cost to benefit an unrelated stranger' has been asked time and again, and different kinds of experimental and observational approaches have been used to answer this question. A slightly different version of this question has become more prominent in the last 20 years, when the world has witnessed a constant increase in crises, triggered by natural and technical hazards, urbanization and forced migration. The UN Global Assessment Report on Disaster Risk Reduction reports a significant increase in the number of disasters occurring worldwide between 1970 and 2020, with a projected increase of 40 per cent until 2030, calling for urgent action towards improving preparedness and resilience [1].

Given the constant rise in disasters, it is important to understand what motivates individuals to help each other when a hazard disrupts their lives. Being prosocial, sharing material resources with your neighbours, providing affective or material support to strangers can be tremendously important to survive emergencies and to rebuild after a disaster. On the contrary, competition for scarce resources and the unwillingness to help others can worsen the negative impact of the situation. Empirical studies of post-disaster behavior find that in some contexts people affected by disasters respond with increases in prosociality [2–5], while in others they do not [6,7]. Is it possible to identify some factors associated with post-disaster prosociality? What is the relationship between

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individual willingness to contribute and community resilience?

In a resilient community, its members actively contribute to (re)build the tangible and intangible environment after an external shock or a crisis [8]. Investing time and resources in helping others, volunteering, and participating in community life are individual choices that can definitely benefit one's community. In the social sciences, these behaviors are usually framed as social dilemmas, in which individuals' benefit is at odds with collective welfare [9]. As defined by Magis [10] community resilience is the *"existence, development and engagement of community resources by community members to thrive in an environment characterized by change, uncertainty, unpredictability and sur-prise (p.401)"*. Similarly, the United Nations International Strategy for Disaster Reduction UNISDR [11], has defined community resilience as "*the ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions*." Resilience is a multi-faceted concept, meaning that there are several dimensions of resilience, from individual - including psychological and physical well-being [12]- to governmental and institutional resilience [13].

In this study, we explore the relationship between individual prosociality, i.e., the willingness to invest resources to benefit others without a guarantee of reciprocity, and resilience in two Italian regions hit by earthquakes. Prosociality can be broadly understood as a "set of voluntary actions one may adopt to help, take care of, assist, or comfort others" ([14], p. 77) and in the post-disaster context there are three aspects that are especially relevant: cooperation, redistribution and civic capital. By means of a lab in the field behavioral experiment and survey questions, we investigated how cooperation in a Public Good Game (PGG) and redistributive choices in a Distribution Game (DisG) varied across different communities in two neighboring Italian regions hit by two separate earthquakes a few years apart. Emilia Romagna was hit by an earthquake in 2012 [15,16] while Marche (together with three other regions, Abruzzo, Lazio and Umbria) was hit in 2016 [17,18].

Our contribution to the literature on post-disaster behavioral choices is threefold. First, by looking at differences in contributions from people who directly suffered from the earth-quake and people who lived in close areas but did not suffer any property damage, we aim to explore which factors are related to resilience in the mid-term, i.e., between one and three years after the disaster. Second, we study cooperative behavior and fairness both compar-ing between affected and not affected communities as well as between Regions, and at the individual level, with the aim to explore the extent to which exposure to earthquakes might correlate with behavioral changes. We will not only look at prosocial choices in a PGG, but also at two possible explanations for the preference for redistribution, an aspect that has been usually underestimated in the economic literature on post-disaster resilience [19]. Third, we can contribute to the literature on the changing effects of disasters on individual preferences and community resilience [4,6]. The rest of the paper is organized as follows. First, we review the literature on coopera-tion, fairness and civic capital. Second, we delineate the context, describing the territories, their characteristics and briefly sketching their histories. Third, we describe the experimen-tal setup and procedure. We then present the results of the study and, finally, we discuss conclusions and future work.

2. Literature review

Given the many methodological challenges of performing controlled experiments in the aftermath of disasters, the evidence of changes in prosocial behaviors linked to the disaster are limited and, somewhat, contradictory. A significant body of work focuses on donations to disaster victims, identifying different psychological factors that might induce people to send money to strangers in dire need after a disaster [20]. However, this literature often reports studies about prosociality in people not directly affected by a crisis, but who want to support others by donating money Evangelidis and Van den Bergh [21]. Studies on prosociality in people directly affected by a disaster are more difficult to conduct, due to the ethical and methodological difficulties of running behavioral studies with people in distress. Therefore, the evidence about post-disaster prosociality in people immediately affected by a disaster is still limited and scattered, also because it is often impossible to conduct studies with a pre/post design, therefore causally identifying the effect and magnitude of the crisis on the individuals affected.

However, there is an empirical literature on disasters that shows that individuals affected by disasters exhibit significantly less trustworthy behavior [7], but they have greater levels of trust in both experiments [2] and survey studies with hypothetical scenarios [4,22]. Another important factor to explain the variations reported seems to be the time passed between the event and the data collection: prosociality increases in the aftermath of a disaster [23–25], but enhanced prosocial preferences can fade away, together with the observed amount of support available in the community. Given this lack of conclusive results, our contribution to the literature is in testing whether the experience of an earthquake was correlated with prosocial behaviors in two Italian regions. When threatened by imminent danger and facing material losses due to the hazards, human beings come to each other's aid [26,27], and the common experience of a disaster can shape a shared identity and feelings of mutual support that will make individuals more willing to help each other. Here, we propose to explore two alternative mechanisms that can influence behavioural change: the damage experienced and the feeling of embeddedness in the community.

The first mechanism builds on the idea that people who have been in need of help are more inclined to help others in a similar situation, and that the amount of help needed could be related to their generosity. According to Rao et al. [4], being at disadvantage be-cause of the disaster increases individuals' propensity to exhibit prosocial behavior. In their survey study of prosocial choices of people residing in Wenchuan (China) and affected by an 8.0-magnitude (Richter scale) earthquake, that occurred in May 2008, residents in more devastated areas demonstrated more prosocial behavior. This relationship indicates that having experienced significant material losses can motivate people to become more generous towards others. This is also in line with the increase in post-disaster prosociality reported by several studies across the world [23–25], suggesting that after a catastrophe humans can exhibit their best behavior. Several case studies in histories and from very different locations witness to the fact that, in times of needs, humans become more altruistic and other-regarding [28].

Witnessing suffering in other people can invoke empathy and concern for their well-being [29,30], and shared painful experiences can facilitate a feel-ing of emotional closeness [31]. Taken together, this literature suggests the hypothesis that it is the common experience of a disaster, regardless of its ma-terial consequences on the single individuals, that creates a shared identity. We thus expect people living in the affected areas to be more generous in their contributions, regardless of the material consequences of the disaster for themselves. The feeling of *being in this to-gether* Drury [32] motivates people to be more compassionate and caring toward others, therefore increasing their prosociality. Psychologists refer to prosocial behavior under ex-treme circumstances as 'catastrophe compassion' [33], and suggest that emotional connections and the feeling of 'being in this together' could explain why, under dire circum-stances, most of the people take care of each other, instead of focusing on themselves only. As described by Drury [32], an elevated sense of shared identity is indeed common to disaster survivors, and is a potent source of cooperative behavior.

Contributing to the public good is one dimension of prosociality. Another one is the request for redistribution of resources, which is especially relevant in those contexts in which the external shock might change significantly the distribution of resources across individuals, increasing or decreasing inequalities. In societies in which wealth is predomi-nantly attributed to merit and individual willpower, the demand for redistribution is lower [34]. On the contrary, when people believe that luck plays a major role in determining people's outcomes, then there is a more positive attitude, and a request for redistributive policies (e.g. Ref. [34–36]). Fairness has been studied in relation to disasters because the desire to equalize the unfair outcomes caused by the crisis can result in cooperative choices and less inequalities, and it can also lead to support for policies that aim to help people. Gualtieri et al. [37] investigated the relationship between a sequence of shocks following the L'Aquila earthquake, one of the more disruptive earthquakes that occurred in Italy since 1980, and the following demand for redistribution in the citizens. Their results show that multiple shocks have cumulative effects and that individuals who experienced the earthquake have a significantly stronger preference for redistributive policies. Preferences for redistribution are shaped by the source of inequality (whether it is determined by merit or random luck), and they play a role in providing support for redistributive policies [34,38]. A recent study on the effect of be-ing reminded of the pandemic on solidarity and fairness in a representative sample of USA residents found evidence suggesting that the crisis, intended as an exogenous shock people have no control over, may shape inequality acceptance. Cappelen et al. [39] found that people become more accepting of inequality, which could be consistent with the idea that people may unconsciously want to maintain an 'belief in a just world', in which inequal-ity reflects controllable factors [36,40,41]. Believing that others' misfortunes are due to their lack of initiative can reduce the support for redistribution [42], with relevant consequences on social support and cooperation.

In order to explore whether and to what extent the exposure to a disaster is linked to a change in prosocial preferences, and limited by the impossibility to draw a before/after disas-ter comparison, we compare individual contributions in a behavioral experiment conducted in two areas. After major earthquakes, the Italian governments maps the total damage and distinguish between municipalities that are severely affected and will be the target of special measures and interventions ('cratere sismico', translated as locations Inside Seismic Area - ISA) from areas that are close by but not considered affected (Outside Seismic Area - OSA). Using this classification based on institutional differences between affected and unaffected areas, we can correlate differences in contributions with differences in damage experienced (disadvantage hypothesis) and in levels of embeddedness (social identity hypothesis).

In our study, we use social capital as a control. Studies on post-disaster recovery con-sistently show that the difference between communities that manage to rebuild themselves effectively and those that are unable to do so can be found in social capital [43,44].

By analyzing different kinds of data coming from communities hit by major disasters (the earthquakes in Tokyo in 1923 and Kobe in 1995, the Indian Ocean Tsunami in 2004 and the Hurricane Katrina in 2005), Aldrich [43] and Aldrich and Meyer [44] explained the differences in recovery by the role of social capital across diverse societies, cultures and economic backgrounds. Individual and community social capital networks provide access to various resources that are crucial to coping with disaster situations such as information, aid, financial resources, as well as emotional and psychological support [44]. Guiso et al. [45] propose the concept of 'civic capital' as the 'values and beliefs that help a group overcome the free-rider problem in the pursuit of socially valuable activities'. The concept of civic capital emphasizes the importance of individuals' values and beliefs, their sharing and persistence over time (because they are passed on to community members through inter-generational transmissions), formal education, or socialization.

In our paper, civic capital is measured by means of three survey questions (see the Experimental Design section for more details). Survey questions are used to collect data on damage suffered, embeddedness, age, gender, and occupation status. This means that it is possible to use observational data to measure and compare the decisions of citizens residing outside the seismic area with those of people directly affected by the disaster, both within and between regions [46,47].

2.1. Hypotheses

Following the consideration made while reviewing the literature, we now formulate four hypotheses. The first hypothesis that we will test is the null hypothesis that there is not any difference in contributions and preferences for redistribution between people living inside and outside the earthquake areas (H0). We will contrast H0 with the alternative hypothesis that individuals living in disaster areas are statistically speaking more cooperative. In this sense, comparing contributions and redistribution in the earthquake areas compared to the ones not affected, we expect the former to be higher on average (H1). Our second hypothesis states that the difference in prosociality and redistribution between locations can be influenced by differences in the amount of material damage experienced, in line with Rao et al.'s disadvantage hypothesis Rao et al. [4]. The third hypothesis, in line with the psychological literature on 'catastrophe compassion' [33] suggests that the extent to which the disaster increased giving and preference for redistribution varies as a function of participants' embeddedness in their own communities. The fourth and last hypothesis states that being affected by a disaster correlates positively with the propensity toward redistribution and fair outcomes.

3. The context

Because of its existing vulnerabilities, Italy offers an interesting test bed for the study of post-disaster resilience. Marche and Emilia Romagna are neighboring regions whose coastal areas run undivided (Costa Adriatica) whereas the Apennines creates a natural boundary between the Po plain (Pianura Padana) in Emilia and the mountain rural areas in the inner Marche. Although close to each other, these two regions were historically belonging to different realms until the country unification in 1861.

These different realms were also characterized by different institutional settings, with Marche being part of the highly centralized Stato Pontificio, ruled by the pope, and Emilia being divided into small state-cities with a strong civic tradition and an active aristocracy. Secondly, most of the territory in Marche is mountainous and rural, with only 10 per cent of flat land and many small villages scattered across the Apennines. On the contrary, Emilia is mostly flat, which means that villages and towns have always been much more connected to bigger centers and among themselves. There are substantial differences in population, too. Marche has 1.487.150 inhabitants, whereas Emilia Romagna has 4.425.366 which is almost three times bigger than Marche. The difference becomes even more striking if we look at the level of provinces, with density ranging between 261 inhabitants/km2 in Modena province and 110 inhabitants/Km2 in Macerata province. These geographical differences could partially explain the current economic divide between these regions. Emilia is a rich industrial area, with many small and medium-sized enterprises (GDP per capita in 2017 was 35,323.80 Euros), whereas Marche's inhabitants main source of income is tourism, especially on the coast (GDP per capita of Marche Region in 2017 was 26,597.17 Euros).

3.1. *Emilia Romagna and central Italy earthquakes*

As much of the Italian territory, both Emilia Romagna and Marche are seismic areas, and both regions were hit by major earthquakes in the last few years. Between May and June 2012 a total of seven strong and destructive earthquakes hit Emilia-Romagna (damage estimated at around 12 billion Euros, 27 victims). In August and October 2016 Central Italy, an area including Abruzzo, Lazio, Marche and Umbria, was hit by several major earthquakes, which caused total damages estimated at 27 billion euros and killed 299 people. Marche was one of the regions affected, and the number of people who were forced to leave their houses was 32000 (over a total of 39800 dislocated people in the four affected regions). After an earthquake, the Italian government makes an immediate estimation of the damages, upon which the territory is divided into two categories. Communities within the seismic area, *cratere sismico* in Italian, receive aid and structural funding for rebuilding private houses and public buildings, whereas communities outside the area are not considered affected and are not eligible for economic aid. This creates the condition for a comparison between damaged and undamaged communities within each of the two regions.

On the basis of this distinction, we identified seven locations where to conduct the experiments (see Fig. 1). In Emilia-Romagna, we chose Mirandola as a city belonging to the seismic area, whereas Reggio Emilia and Vignola were locations outside it. In Marche, we chose Tolentino, as larger town in the seismic area, and Fiastra, a small mountain village. To compare these two towns to analogous locations outside the seismic area, we selected Macerata, a larger town, and Petritoli, a smaller village in the hills. The comparison between locations in Marche is based on the number of inhabitants and size of towns, as can be seen from Table 8, although the locations within the seismic areas are smaller. This is due to the fact that the area most affected by the earthquake crater is rural and mountainous Frigerio et al. [18], and the closer the location is to the mountains, the lower the average population in the area. As reported above, Marche and Emilia-Romagna differ in terms of the size and distribution of the population, and this heterogeneity is

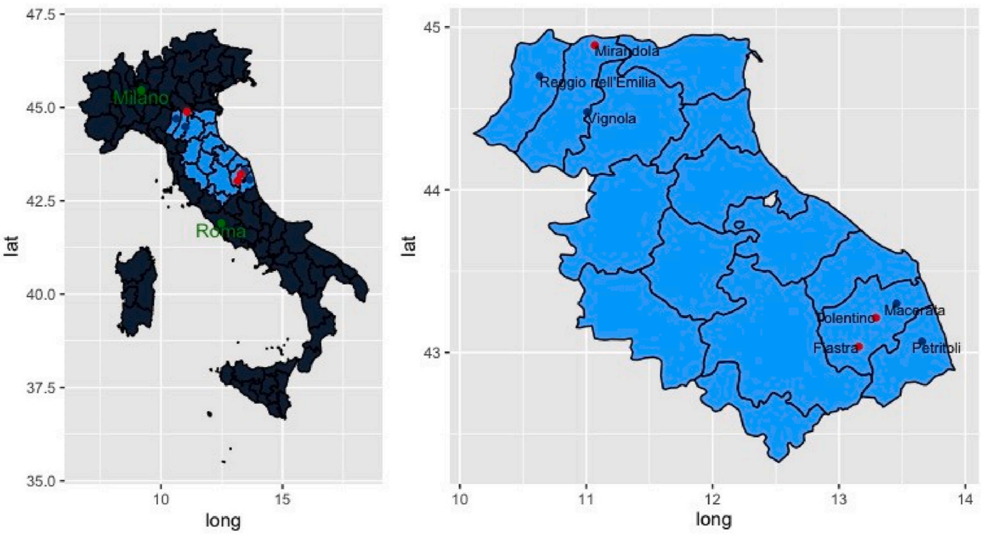

Fig. 1. Left: map of Italy, dots identify locations of the experiments. Right: focus on the center-east area with locations indicated with coloured dots. Red dots are cities inside the crater, blue dots are cities outside the crater. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

reflected also in the sample selection. For each municipality, we report in Table S1 (Supplementary Material) information concerning the population, socio-economic structure, geographical characteristics and effects of the recent earthquakes on the municipality. We further report data on the recent evolution of income and population change in Table S2 (Supplementary Material).

4. Experimental design

The planning of the experiment was conceived in response to the Emilia Earthquake in 2012. The initial experimental sessions commenced in 2015, reflecting the considerable time required for experiment design and - especially - participant recruitment. The latter involved sourcing individuals from affected regions, specifically targeting non-student populations, some of whom were directly or indirectly impacted by a natural disaster. In the same period, several earthquakes hit Marche, thus allowing us to use the same structural design to collect more data. This extension added a between-region comparison to the design, which required however to take into account regional-level elements that are potential confounding factors. Sessions were run between November 2015 and May 2018 (see Table 1 for a summary of the number of participants recruited for each location as well as of the time in which experimental sessions were held. More details are reported in Fig. S4 in supplementary material).

We report a general description of locations features in Supplementary Material (Tables S1 and S2) together with a more detailed description of procedures.

4.1. General sample of the population

We selected a sample of 252 individuals from the general national population at the time of the experiment, trying to maximize the heterogeneity of the sample and the randomness of the selection process. We aimed for a diverse sample of citizens living in the two regions: the composition of our sample in terms of demographics and working conditions is reported in Table 2, together with indications of any difference between the experimental sample and the general population (Table S4 of supplementary material reports the breakdown of demographics for each location in which the experiment was run). With respect to the Italian population as reported in the 2019 census, the actual sample over-represents females, students, and younger individuals while it under-represents retired, inactive, and older people. Even if our sample is not fully representative, it still provides a richer and more realistic picture of the population with respect to the traditional student sample used in the large majority of experimental studies. The remaining discrepancies were due to limitations in the pool of available subjects. The pool of participants recruited was distributed across locations as reported in Table S3 of Supplementary Material.

4.2. Recruitment

The recruitment procedure reflects the attempt to maximize the randomness and diver-sity of the sample, which was selected through a rigorous selection process of the participants. In order to reach potential participants, 1000 letters were sent to random households selected from the lists of residents in the municipalities involved. Moreover, written adver-tisements (flyers and posters) were posted in a large number of restaurants, bars, and shops, along with ads through the municipality's newsletters and a Facebook page. Finally, thanks to the administrative offices of the University, we had the opportunity to send emails to about 4000 alumni of the University of Modena and Reggio Emilia, inviting them to spread information about the experiment to their relatives and friends who could qualify to partic-ipate. We applied rigid selection criteria concerning the birth and residence of each subject in the selected location so that only residents of either the municipalities in which the session was run, or of the neighboring ones, could participate in an experiment run there (locations of the sessions, dates, times are reported in Table S4). We also verified whether participants had grown up in the municipality (or nearby areas) and controlled for the birthplaces and residences of their parents. This procedure makes us confident that the selected participants were embedded in their respective communities.

4.3. Experimental procedures

Participant were informed that no deception was involved and that they could withdraw their participation, deny consent for the use of data, and leave the sessions at any time obtaining the show-up fee, but no participant left any session. Participants were made aware of the fact that oral communication was forbidden during the experimental sessions. Moreover, mobile cubicles were used to make visual contact among participants impossible. All instructions were read aloud by the same experimenter at the beginning of every session. The instructions could be consulted during the experiment as well.

The experiment was conducted with the use of a mobile laboratory for experimental economics, using the Reggio Emilia Behavioural Economics Laboratory (REBEL).[2] The experimental software was developed in Python using the o-Tree platform [48]: experiments were run on tablets with touch screens and a web-based graphical user interface. These tools were specifically conceived to make the study more accessible to the general population by reducing issues related to the potential lack of computer proficiency. A small exercise to practice with the use of the tablet was requested to the participants before the beginning of the sessions.

Average session time was 1 h, and payoffs were expressed in experimental points (tokens), with each token corresponding to 4 euro cents. Subjects received a 5 Euros show-up fee and on average extra 15 Euros for the decisions made in the experiment. Payments were made privately and in cash at the end of each session. We used comprehension questions and in case of incorrect answers, the participants were informed by the software of the incorrect answer and given an explanation of the mistake, in order to help them to fully understand the game. No drop out selection was implemented as follow up to comprehension questions. This procedure was intended

[2] Details on the events with pictures are available on the web site of the lab: www.rebel.unimore.it.

Table 1
Summary of Sessions held, with location, region, # participants and month/year of the session.

Region	Location	Year Earth-quake	Participants	month/Year session
Emilia Romagna	Vignola	2012	32	nov-15
Emilia Romagna	Reggio Emilia	2012	16	mar-16
Emilia Romagna	Mirandola	2012	80	apr-16
Emilia Romagna	Reggio Emilia	2012	48	may-16
Marche	Macerata	2016	12	may-17
Marche	Petritoli	2016	24	aug-17
Marche	Petritoli	2016	12	oct-17
Marche	Fiastra	2016	12	dec-17
Marche	Tolentino	2016	16	may-18

Table 2
Sample (N = 252) demographics.

	Italy	Sample		Italy	Sample
Age Class			**Gender**		
18-25	10%	37%	Male	49%	37%
26-35	15%	21%	Female	51%	63%
36-45	19%	12%	**Occupational Status**		
46-55	18%	14%	Employed	57%	49%
56-65	15%	17%	Retired/Inactive	31%	19%
65+	25%	7%	Students	12%	33%

to overcome potential issues of understanding due to the variance of education levels and age of participants. The number of participants for each session was planned to be 16. In a few cases, due to last minute dropouts, we run sessions with 12 subjects. All sessions were run on Saturdays in order to favor participation of people working during the week. The experiment was conducted in accordance with regulations and relevant guidelines for experiments with human subjects of the REBEL (Reggio Emilia Behavioural Economics Laboratory) at the University of Modena and Reggio Emilia and therefore approved by the REBEL ethics committee. All participants received and signed an informed consent form explaining that data were anonymous in the collection and use.

4.4. *Measures*

The experiment consisted of a sequence of different experimental games, and a survey presented at the end (Fig. 2). In the current paper, we present data from a one-shot Public Good Game (PGG from now on) and the Distribution Game (DisG from now on)[3] that the participants played. The survey was presented at the end of the experiment.

Public Goods Game - PGG. Our PGG presents participants with a discrete choice: all group members receive an endowment of $e = 40$ experimental points and must decide simultaneously how much of their endowment to invest in a common project, choosing a contribution level among the following possible values, $c_i \in (0, 10, 20, 30, 40)$, knowing that the residual $(e - c_i)$ will remain in their private account. Every point invested in the group account is then doubled and shared equally among group members. Individual earnings are determined as follows:

$$\pi_i = e - c_i + \alpha \sum_{j=0}^{N} c_j,$$

where α is the marginal per capita return (MPCR) of the public good. Free-riding is the dominant strategy for rational self-interested individuals, when MPCR is above 1/N and below 1. Social welfare is instead maximized when everyone contributes the whole endowment. The discrete contributions framework, based on Rand and Nowak [49], is chosen with the aim of facilitating calculations and understanding of the decision structure.

Distribution Game. The second experimental task is a one-shot distribution game (DisG) [50], in which each participant must select one out of the three different allocations (reported in Fig. 3) of the same amount of experimental points to anonymous members of their group. The game can be regarded as a modified dictator game because, after all choices are made, the computer will randomly select only one participant per group - the dictator - whose choice will be used to determine the actual payoffs for every participant in the game. Participants are informed of the structure of the game and aware of the fact that only one of them, selected randomly, will determine with his/her choices the distribution of resources in the group. The choices are presented as an option between three cake graphs, each of which has the same size with a different distribution of payoffs. We propose alternative allocations of the total same income (always equals 96) among four participants in order to eliminate any potential confound related to efficiency motivations,

[3] The instructions for the entire experimental session are reported in the supplementary material, and results concerning tasks not studied here are reported in Pancotto and Righi [70] and in Pancotto et al. [71].

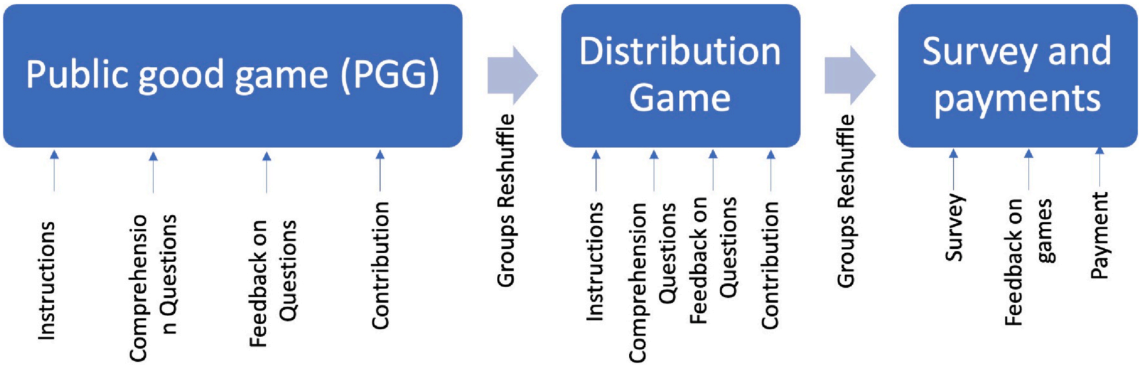

Fig. 2. Tasks carried out during the experiment.

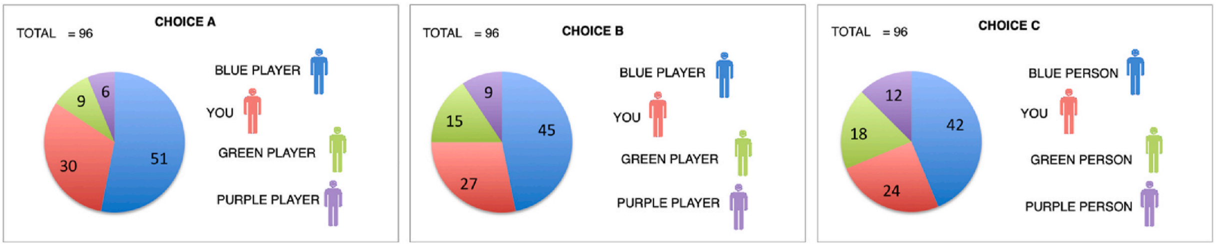

Fig. 3. Choices in the DisG as translated in English from the Italian original figure. The size of the pie chart is the same for the three choices because total income is constant and equal to 96. In the chart, the color of the share corresponds to the color of the person: for example, BLUE PERSON takes the blue share of the pie. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

which would involve options including different total income values, which are identified in the literature as highly salient [50] and thus could jeopardize our test of pure redistributive preference. Parameter values are reported in Table 3 while choice screens presented to subjects are shown in Fig. 3. Parameter values are chosen in order to stress the opposition between a selfish and a pro-social choice, keeping total income constant. The pro-social choice (Choice C in Table 3) is selected according to F&S (see Ref. [51]), ERC (see Ref. [52]) and the Minimax criterium, against the selfish one (Choice A) as codified in Engelmann and Strobel [50]. Participants were not informed of the outcome of the PGG before playing the DisG.

Survey. The full list of survey questions (translated from the original Italian survey) is reported in the Supplementary Material (Section S3). Survey questions in our design were especially important because they allowed us to complement the behavioral measures with self-reported measures of residence and family history, civic capital, trust, and information about their own experience during the earthquake. The survey contained a list of questions about the following topics:

- **Personal information**: citizenship, age, gender, composition of the household, prox-ies of income, number of siblings, work status.
- **Embeddedness**: Although all participants were selected with the restriction to be residents in the village, town, or city chosen in the design, at the time of the experi-ment, we also wanted to capture how rooted each participant and their families were in the region. To assess their embeddedness we asked them where they were born (within the region or elsewhere), where they attended primary school, and where their parents were born. The question about primary school was introduced because we considered it to be a reliable indicator of the fact that primary socialization happened within that community or elsewhere. We created an indicator of embeddedness that ranges between 4 - when the participant is born in the region, has gone to primary school in the region and both his mother and father are born in the region as well - and 0. This indicator generates a discrete variable that measures approximately the degree of embeddedness of the participant. The variable used in the analysis is *embeddedness.* Summary statistics about this variable are reported in SOM (Table S5 in Supplementary Material, together with a breakdown of its value by location).
- **Damage**: We asked participants about the amount of damage suffered by their houses, i.e., the habitability of their house at the time of the experiment. If the house was still inhabitable, serious damage usually resulted in displacement and relocation which is important for the individual perception of damage, but also for the disruption of social ties that emerge with displacement. The variable used in the analysis is damage, as we verified that other questions related to damage declared, are all correlated with it. For this reason, we use it as a proxy of damage, and define it as such from now on. Overall 19 of the subjects involved in the experiment had their primary house gravely damaged or destroyed. This reflects the fact that many individuals in these conditions had to leave the area altogether and therefore could not be reached for the experiment.
- **Trust** We used a sub-sample of questions from the World Value Survey to measure the participants' level of generalized trust [53]. In line with the cited survey, to measure trust in other people in the community, we asked people "Do you think that most people

Table 3
Parameters of the distribution game.

Player	Choice A	Choice B	Choice C
Person 1	51	45	42
DICTATOR	30	27	24
Person 3	9	15	18
Person 4	6	9	12
Total Income	96	96	96
Criteria			
Population Variance	328.5	189	126
Bolton-Ockenfels (ERC)	−6.25	−3.13	0
F&S Strict	−22	−16	−12
Minimax	6	9	12
Average Person 1-3-4	22	23	24

Notes: Population Variance is the variance of the pay-offs of each choice. Bolton & Ockenfels(ERC) is calculated as $ERC = -abs\left(\frac{DictatorPayoff}{96} - \frac{1}{4}\right)$. $F\&S\ Strict = -\frac{1}{4}\sum abs(Payoff_i - DictatorPayoff)$. Minimax is the value of the minimum payoff among the four components of the group in each presented possible choice. Average is the simple average of the payoffs ofthe group in each choice excluding the dictator.

would try to take advantage of you if they got a chance, or would they try to be fair?". Besides, to test trust in institutions, we asked participants about their degree of confidence in a wide range of different institutions.[4]

- **Civic capital - CK**: Building upon the work of Guiso et al. [54] and Cartocci [55], we measured civic capital by means of the answer to three different questions, each one related to a different form of solidarity. The three questions were about having donated blood in the previous year, having voted in the previous European elections (2014), and in the most recent Italian referendum (2014). We created a synthetic indicator of civic capital that takes value from 0 to 3, with higher values corresponding to higher levels of civic capital of the individual. We use this indicator instead of the single survey answers in an attempt to overcome the problem of missing values related to the potential inability to engage in one of the chosen behaviors (such for instance health issues making blood donation unsafe or impossible, or being underage at the time of the elections and referendum).[5] The variable used in the analysis is codified as *CK*.

5. Results

In the Hypotheses section, we built and discussed 4 different hypotheses based on the literature, which are summarized in Table 4.

To investigate H0 in contrast to H1 (the relationship between exposure to natural dis-asters and positive correlations with contributions in the PGG and preferences for redistri- bution in the DisG), Table 5 compares the mean values of PGG and DisG. Assessing the statistical significance of this difference, given the discrete nature of the original response variables and the varying sample sizes, we employ a test to determine whether the contri- bution frequencies of the response variables for participants inside the seismic area (ISA) significantly differ compared to those outside (OSA), which serves as the reference group. We conduct this analysis using a chi-square goodness of fit test [56].

We find that the average contribution (PGG) from people living inside the seismic area (mean PGG ISA = 25.55) is significantly higher than the contribution of those who live outside of it (mean PGG OSA = 25.34), with a chi-square significant at 95% ($\chi^2 = 11.746$, df = 4, p-value = 0.01935).[6]

To conduct a similar analysis for the DisG, we assign numerical values: selfish choices as 1, intermediate as 2, and fair choices as 3, where a higher value indicates greater fairness. Subsequently, we compute the average fairness indicator within each subgroup by segregating participants residing inside and outside the seismic area. Among participants inside the seismic area (ISA), the average fairness indicator stands at 2.42%, whereas it is 2.29% for those outside. To compare these means, we again utilize a chi-square test to assess the frequencies. The difference shows statistical significance at the 90% confidence level based on the chi-square test (χ -squared = 5.293, df = 2, p-value = 0.0709). Overall these analyses support the following:

Result 1. *There is a significant diflerence in participants' contributions between those living in the affected areas and those living outside. This allows us to reject the null hypothesis (H0). Average contribution in the PGG and frequency of fair allocations in the DisG is higher among participants living in the areas aflected by the earthquake, as predicted by H1.*

The second result that we find is that the amount of damage suffered positively correlates with both prosociality and preference for

[4] More specifically: (1)associations related to the churches, (2) Sport/leisure associations, (3) Artis-tic/music/educational associations, (4) Labor Unions, (5) Political Parties, (6)Environmental organizations, (7) Professional organizations, (8) Charitable or humanitarian organizations, (9) Consumers organizations, (10) the European Union.

[5] To treat these variables we use the following codification for example to blood donation: 1, the person has donated blood, 0 the person has not donated blood, NA, the participant could not donate for other reasons.

[6] The power of the χ^2 test of association between frequencies here represented, is 98% (w = 0.3297838, N = 252,df = 4, sig.level = 0.05).

Table 4
Summary of the main hypotheses.

H0	(Null hypothesis) people affected by the disaster show no differences in contri-butions and preferences for redistribution compared to non-affected population
H1	(Alternative hypothesis) exposure to natural disasters correlates positively with giving in the PGG and preferences for redistribution in the DisG
H2	The extent to which the disaster increased giving and preference for redistribu-tion correlates positively with having experienced damage in the earthquakes
H3	The extent to which the disaster increased giving and preference for redistri-bution correlates positively with the embeddedness of the individual
H4	Being affected by the disaster correlates positively with the propensity towards redistribution and for fair outcomes

Table 5
Comparison ISA (inside seismic crater) vs OSA (outside seismic crater) and damaged vs no damage.

ISA vs OSA				
task	ISA	χ^2, p-value	OSA	df
PGG	25.55	11.746, p = 0.019	25.34	df = 4
DisG	2.42	5.29, p = 0.07	2.29	df = 2
Damage vs no damage				
task	damage	χ^2, p-value	no-damage	df
PGG	31.05	8.738, p = 0.06799	24.91	df = 4
DisG	2.68	4.78, p = 0.09	2.31	df = 2

fairer outcomes, in support of H2. Ev-idence for this is reported in Table 6 and Table 7. The regression in Table 6 shows that there is a positive correlation between the severity of the damage suffered and the amount of contributions in PGG, thus supporting H2. The inclusion of controls such as age and the choice in the dictator, reduces the significance of the variable damage. We verify that this result is due to the correlation between these explanatory variables (see Table S6 in supplementary material). Indeed, damage is significantly correlated with age variable (*t*-test of correlations: −0.2, pval. 0.002) and with the dictator responses (−0.12, pval. 0.04). The only control variable that results significant in the complete model in Table 6 is age, which indicates that cooperation increases with the age of the participant. When including all controls, as in Model (7), civic capital and fairness do not correlate with contri-bution levels. Besides, the dummy variable *Region* (taking value 0 for people participating in ex-perimental sessions in Emilia Romagna and value 1 for people participating in experimental sessions in Marche) is not significant in all models.

Along similar lines, the regression in Table 7 shows that damage is positively correlated to fairness in the DisG in all models tested, controlling for all other variables included in the model. Other variables providing mild explanatory power are gender and age. When damage is included, neither civic capital nor contribution in the PGG are significant.

Overall we can summarize these findings as follows:

Result 2. *Average contribution in the PGG and fair allocations in the DisG is correlated with the amount of damage reported: participants who*

Table 6
Determinants of contributions in the PGG.

	Dependent variable:						
	pgg						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Damage	3.124**	3.141**	3.174**	2.445*	2.649*	2.485*	2.167
	(1.393)	(1.420)	(1.424)	(1.471)	(1.490)	(1.490)	(1.501)
embeddedness		0.082	−0.035	0.167	−0.391	−0.961	−0.892
		(1.273)	(1.279)	(1.277)	(1.428)	(1.473)	(1.470)
GenderMale			−0.488	−0.480	−0.393	−0.644	−0.418
			(1.515)	(1.530)	(1.535)	(1.540)	(1.543)
age				0.128***	0.136***	0.107**	0.115**
				(0.048)	(0.049)	(0.052)	(0.052)
Region					−1.653 (1.886)	−1.857 (1.886)	−1.697 (1.884)
ck						1.437	1.437
						(0.958)	(0.956)
DisG							1.391
							(0.926)
Constant	31.166***	31.132***	31.326***	25.174***	26.173***	25.212***	20.899***
	(2.679)	(2.734)	(2.776)	(3.599)	(3.777)	(3.821)	(4.770)
Observations	247	247	244	237	237	237	237
R^2	0.020	0.020	0.022	0.051	0.054	0.063	0.072
Adjusted R^2	0.016	0.012	0.010	0.034	0.033	0.039	0.044

Note: *p<0.1; **p<0.05; ***p<0.01.

Table 7
Determinants of contributions in the DisG.

	Dependent variable:						
	DisG						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
damage	0.197**	0.200**	0.187*	0.215**	0.229**	0.229**	0.211**
	(0.098)	(0.100)	(0.099)	(0.104)	(0.105)	(0.106)	(0.106)
embeddeddness		0.019	−0.002	−0.010	−0.049	−0.049	−0.042
		(0.090)	(0.089)	(0.090)	(0.101)	(0.105)	(0.104)
GenderMale			−0.199*	−0.168	−0.162	−0.162	−0.157
			(0.106)	(0.108)	(0.108)	(0.109)	(0.109)
age				−0.006*	−0.006	−0.006	−0.006*
				(0.003)	(0.003)	(0.004)	(0.004)
Region					−0.115	−0.115	−0.102
					(0.133)	(0.134)	(0.134)
ck						−0.0001	−0.010
						(0.068)	(0.068)
pgg	0.007						
	(0.005)						
Constant	2.708***	2.700***	2.768***	3.030***	3.100***	3.100***	2.923***
	(0.189)	(0.193)	(0.194)	(0.254)	(0.267)	(0.271)	(0.295)
Observations	247	247	244	237	237	237	237
R^2	0.016	0.016	0.031	0.042	0.045	0.045	0.054
Adjusted R^2	0.012	0.008	0.019	0.025	0.024	0.020	0.025

Note: *p<0.1; **p<0.05; ***p<0.01.

reported more damage were also more likely to invest more in both games, in accordance with the disadvantage hypothesis (H2).

Contrary to our expectations, we did not find any support for H3. Indeed, embeddedness, i.e., the degree to which the participant is rooted in a given community, does not have any significant positive correlation with the amount contributed. Again, this result stems from the analysis of the models presented in Table 6 for PGG and Table 7 for the DisG.

Result 3. *The average contribution in the PGG and frequency of fair allocations in the DisG are not significantly correlated with the embeddedness of the participants. We therefore reject H3.*

In order to understand this result, in Table 8 we further decompose the results by looking at the contribution levels of the participants in the seven municipalities. Looking at city-level data, we find that participants in cities affected by the earthquake in Marche contribute more on average than the others; the difference being even bigger for the DisG (Fiastra 2.58, and Tolentino 2.56 are the locations with the highest percentage of fair allocations).

The opposite is true for Emilia when it comes to PGG, where Vignola, outside of the seismic area, presents the highest average contribution (27.5) followed by Mirandola. For DisG, figures display a reversed pattern: the fairest location in Emilia is Reggio Emilia (ISA), while the least fair is Vignola (OSA). We test this difference at the level of the region, due to the heterogeneity of the number of observations per city, and report results in Table 9 (Table S7 in Supplementary materials reports the breakdown of the same variables for each city/town chosen for the experiment): in Marche, contributions are significantly larger than in Emilia Romagna (25.52 versus, 25.39; significant difference tested with a χ^2 test, p: 0.017), while for the DisG, the indicator for Emilia Romagna (2.36) is higher than the one of Marche (2.36, χ^2 p: 0.025). The two regions are heterogeneous in terms of the prosociality dimensions measured in the experiment. We surmise that the lack of effect of the variable embeddedness may be overcome by the different responses to the disaster that the two regions are showing.

Result 4. *In Marche people living inside the seismic area contribute more and have a stronger preference for fairness, while in Emilia we observe significantly higher contributions outside the disaster area.*

One possible explanation of this result emerges from the analysis of the literature on disasters, since the timing of the experiment with regard to the earthquake is different be-tween the two locations: in general, the earlier data collection, the higher the prosociality responses. In Marche, inhabitants participated in the experiment one year after the earth-quake, whereas in Emilia the data was collected three years after the event. Another possible explanation can be due to factors that belong to the characteristics of the region: in Fig. 4 we draw the average change in the population over the last 10 years of the towns included in the sample, divided by Region[7];

[7] Official statistics from ISTAT of the towns included in the sample, subdividing by region.

Table 8
City level data.

	N.Participants	Pop. at 2021	(N/POP)*1000	PGG mean (sd)	DisG
Fiastra	12	632	18.98	26.7 (8.88)	2.58 (0.66)
Petritoli	36	2307	15.60	24.7 (11.8)	2.08 (0.80)
Tolentino	16	19831	0.80	26.9 (8.73)	2.56 (0.72)
Vignola	32	25383	1.26	27.5 (13.7)	2.19 (0.85)
Mirandola	80	174849	0.45	25.1 (11.6)	2.38 (0.83)
Macerata	12	318921	0.03	25 (6.74)	2.42 (0.66)
Reggio Emilia	64	532483	0.12	24.7 (12.1)	2.44 (0.79)

Table 9
Comparison between regions.

Region	PGG mean (sd)	DisG mean (sd)	CK index mean (sd)	Embed. mean (sd)
Marche	25.52 (9.99)	2.32 (0.77)	1.67 (0.77)	0.34 (0.54)
Emilia Romagna	25.39 (12.1)	2.36 (0.82)	1.60 (0.91)	0.96 (0.50)
	PGG	DisG	CK index	Embed.
Marche vs E. Romagna	X-Sq test → 11.922 (0.01794)	7.3365 (0.025)	8.69 (0.03)	185 (2.2e-16)

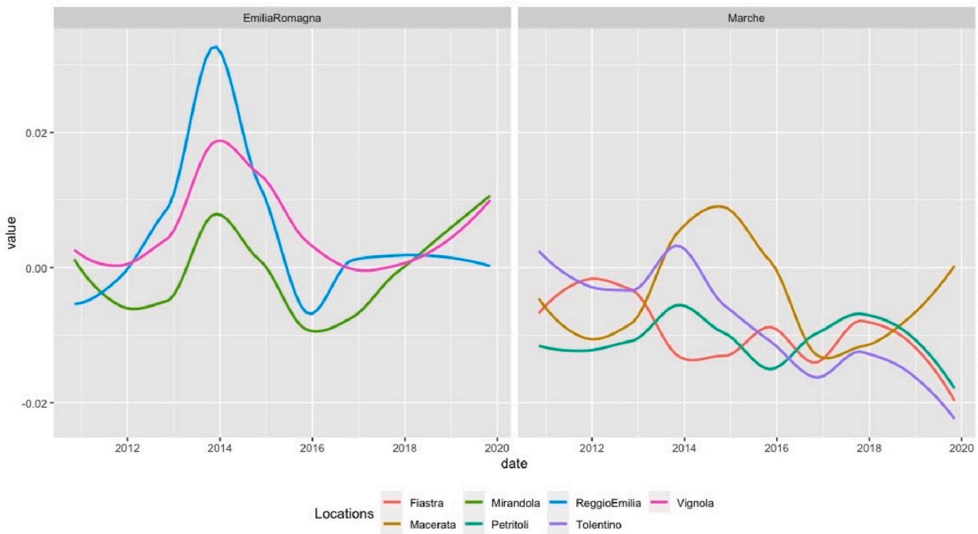

Fig. 4. Trend of population growth of cities in the sample, by Region.

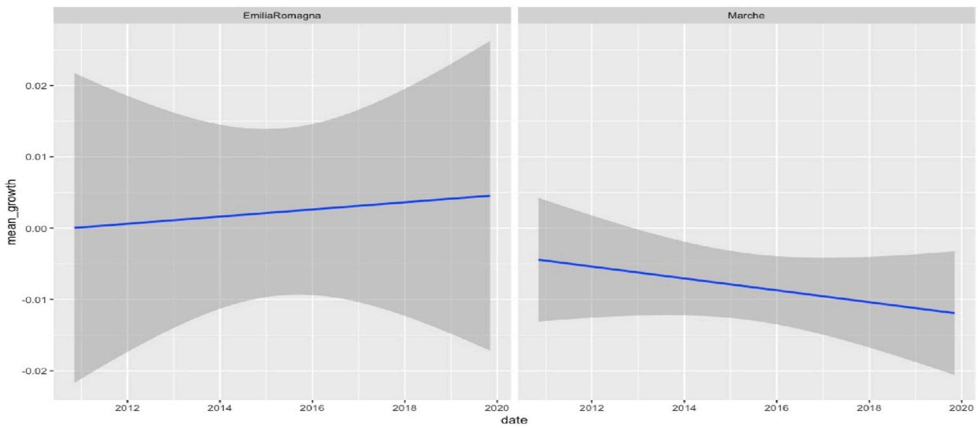

Fig. 5. Trend of population growth by Region.

in Fig. 5 we draw the regional trends. These results are consistent with national-level demographics data on the region[8]

Here we see that the two regions have observed a diametrically opposed trend in pop-ulation, growing in Emilia, and decreasing in Marche. The dynamics of the population is also consistent with the embeddedness indicator index of our sample, in which we observe higher levels for Emilia and lower levels for Marche.

A final remark regards the heterogeneity of observations in the sample, both at the level of the city and at the level of the region. There are differences in sample size, but we believe in the reliability of our results in the light of the representativeness of the target populations of the two regions. Emilia and Marche differ not only in terms of characteristics but also in terms of population size: in Table 8 we report the population of the cities selected at 2021 and an indicator -(N/POP)*1000 - that weights the number of participants per locality by the resident population. Although Fiastra (for example) has only 12 observations, the share of participants as a total of the population is the highest. In terms of the underlying population, the number of participants selected is comparable across cities and the heterogeneity of the sample selected is coherent with the heterogeneity of the populations of the two regions.

6. Discussion

Communities struck by disasters often face collective action dilemmas, wherein residents must decide whether to invest resources in aiding recovery or to benefit without contribut-ing, creating a free-rider problem [57]. Through lab-in-the-field experiments and survey inquiries, we explored how cooperation in social dilemmas and perceptions of fairness varied concerning the extent of damage, embeddedness, and merit-based prefer-ences. Our findings indicate that in two neighboring Italian regions affected by significant earthquakes in 2012 and 2016, individuals residing within the affected areas, particularly those reporting higher levels of damage, exhibited greater cooperation and a stronger incli-nation toward fairness. Surprisingly, embeddedness in a community was not correlated with high prosociality, nor was civic capital when analyzed alongside the damage variable.

Our findings diverge from previous research that suggests property damage predicts a widespread reduction in prosocial behaviors. For instance, Vardy and Atkinson [58] con-ducted four modified dictator-game experiments across two waves with the same in-dividuals on the small island of Vanuatu in the South Pacific Ocean, both before and after Cyclone Pam in 2015. Post-cyclone, participants demonstrated reduced inclination toward proso-cial behaviors concerning both in-group and out-group members. Additionally, there was an increased display of parochialism, i.e., a tendency to be more generous towards the in-group, when sharing between groups. In that context, experiencing greater property damage correlated with a general decline in prosocial allocations and a preference for participants' in-group. The discrepancy between their findings and ours may have different explanations. First, our data collection occurred a few years post-disaster, whereas Vardy and Atkinson [58] collected data almost immediately, i.e., after four months. Second, the amount of damage caused by Cyclone Pam in the area was much more extensive, with immediate repercussions on everyday life. Finally, community structures differ between Italy and the small Pacific Island of Vanuatu.

It is worth stressing that the literature on post-disaster cooperation is characterized by heterogeneity in every respect: context, disaster, participants' sample composition and size, experimental design, and many others. The presence and effectiveness of in-stitutions [59], kind of community structure [60], the cultural differences [61] and the economic impact [62] can also explain why such differences were found. Even if there are recent attempts at proposing general frameworks to interpret human behavior in crisis situations [63,64], there are still several open questions regarding human behavior in disasters. This points to the need for collecting more behavioral data in different populations affected by different disasters, in order to achieve a better understanding of how humans cope with and prepare to crises.

In general, evidence from disasters across the world shows huge variation in prosocial preferences after disasters [5], and show that neighborhoods and communities with more civic capital made efficient and effective post-disaster recoveries because of their ability to coordinate and cooperate [65,66]. In our study civic capital does not seem to be associated with the event, i.e., it does not correlate with the observed variation in prosociality. We speculate that the observed discrepancy of behavior in the laboratory could be predictive of future losses in terms of civic capital, if institutions fail to respond to people's trust in them, as far as reconstruction is concerned. Civic capital has been so far related to economic development [45], social distancing during the COVID-19 pandemic [67], corruption and crime [68], but not specifically to post-disaster resilience. In communities with higher civic capital, individuals trust their fellow community members and are able to display prosocial behavior that is not directly related to their self-interest. In these communities, citizens are able to provide public goods [69], but less is known about the relationship between civic capital and external shocks. Future work would be needed to study more systematically the effect of social capital on prosociality and its relationship with community resilience. Resilience does not only stem from individual preferences for helping others, but it is also the result of community norms and values that create a trusting and supportive environment.

There are some important limitations in our study that future work will address. First, we are aware that a within subjects before and after comparison would provide an ideal test bed for evaluating the effect of a disaster on a community. However, the unpredictabil-ity of disasters in general, and of earthquakes in our case, makes this design extremely difficult to implement in reality. Our experimental design does not allow us to make any causal claims about the direct effect of damage or embeddedness on prosociality, and the unobserved attributes of participants might play a role, but we believe that such an ex-ploratory study is still valuable to

[8] From Eurostat: The population density in the region is below the national average. In 2008, it was 161.5 inhabitants per square kilometer (418/sq mi), compared to the national figure of 198.8/km2 (515/sq mi). Between 1952 and 1967 the population of the region decreased by 1.7% as a result of a negative migration balance, well above the national average, with a rate varying between 4.9 and 10.0 per 1000 inhabitants. In the same period, the natural balance of the population was positive but lower than the national average and insufficient to counterbalance the net emigration. The population continued to decline until 1971, but in 1968 began growing again. In 2008, the Italian National Institute of Statistics (ISTAT) estimated that 115,299 foreign-born immigrants live in Marche, 7.4% of the total regional population.

better understand which factors might be more relevant in post-disaster prosociality. The lab-in-the-field experimental setup and the heterogeneous participant sample present higher variance compared to a standard behavioral experiment in the lab, usually conducted with a more homogeneous population of students. However, a lab-in-the field experiment with a close to representative sample is quite unique, and it gives a more externally valid picture of human behavior.

Finally, despite potential limits to the generalization of our findings to the overall popu-lation, our study on a selected sample of inhabitants in two different regions is nonetheless of great relevance. The lack of a significant effect of embeddedness, for instance, is inter-esting because it suggests that feeling close to other members of the same community does not increase prosocial behavior, at least in our sample. We believe that is the combination between the different results that makes this paper interesting for the DRR community, but also for a multi- and inter-disciplinary community of behavioral economists, sociologists and psychologists.

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CRediT authorship contribution statement

Francesca Pancotto: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Supervision, Validation, Writing – original draft, Writing – review & editing. **Francesca Giardini:** Conceptualization, Writing – original draft, Writing – review & editing. **Simone Righi:** Project administration, Software, Supervision, Validation, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ijdrr.2023.104165.

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