Life After The Storm: The Effect of L'Aquila Earthquake on Marriage Rates

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Abstract: Natural disasters represent a challenge for policy-makers both for the immediate aftermath and for the mid- and long-term consequences. Knowing the reaction of the struck communities is an invaluable help for planning and implementing informed policies. Embracing such a perspective, this paper aims to provide empirical evidence about the effect that natural disasters exert on the marriage rates reported by the struck communities. The analysis is focused on L'Aquila earthquake that occurred in 2009 and stroke a number of municipalities in the Abruzzo Region in Southern Italy. We exploit a natural experiment setting via a difference-in-differences design, using highly disaggregate data (municipality level) in order to assess whether the shock caused by the L'Aquila earthquake in 2009 resulted in a substantial variation of the marriage rate in the municipalities hit more severely by the natural disaster. We find that the municipalities that payed a higher toll show an increasing higher marriage rate with respect to those that did not experienced major damages.

Keywords: natural disasters, marriage rates, difference-in-differences
Jel codes: J12, J13 Q54

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1.Introduction

Natural disasters represent an enormous challenge for policy makers. The uncertainty associated with the occurrence of an earthquake undermines the possibility to plan *ex ante*, leaving the policy-maker with the only option of emergency interventions. Yet, this does not mean that societies should be left at the mercy of fate. Understanding the behavior of affected populations is paramount to build effective *ex post* policies. Indeed, the analysis of socio-economic outcomes of destructive events provides invaluable information for policy-makers.

This article provides a contribution in this direction by empirically analyzing the effect of earthquakes on marriage rates. In order to do so, this work exploits a natural experiment setting to perform a difference-in-difference analysis of the marriage rates in the municipalities most severely affected by L'Aquila earthquake of 2009.

The idea that natural disasters have profound consequences on marriages is not completely new in the academic literature. Indeed, researchers have recently started investigating the effects of disasters on life course transitions, such as marriage, having child(ren) and divorce (Cohan & Cole, 2002). However, both theoretical and empirical contributions provide conflicting results, leaving it unclear whether natural disasters enhance or reduce marriage rates after a natural disaster. Therefore, this article also adds to this literature by providing robust causal evidence of an effect of marriages in the municipalities where the earthquake dealt more damage.

Compared to most of European countries, Italy has one of the lowest rates of out of marriage birth (Cook & Furstenberg Jr., 2002). Indeed, roughly three out of four newborns have married parents and previous research highlights that in Italy marriage and childbirth almost coincide (Barbieri, Bozzon, Scherer, Grotti, & Lugo, 2015). Given this setting, the results of this work may be relevant for understanding the indirect demographic consequences of a destructive earthquake, which may be useful for long-term policies in the aftershock.

The paper proceeds as follows: the next section provides some background on the long-term effects of natural disasters; section three describes the L'Aquila earthquakes; section four provides the methodological framework and describes the data used in the empirical analysis; section five and six provide results and robustness check respectively, while the last section is devoted to conclusions and discussion.

2.Long-term effects of natural disasters

Immediate impacts of natural disasters on built heritage and on local economies are widely studied. Instead, natural disasters' aftermath consequences are usually out of the spotlight. Nevertheless, it has been widely recognized that catastrophic events might determine health problems (Adams & Adams, 1984; Freedy, Kilpatrick, & Resnick, 1993; Ironson et al., 1997; Neria, Nandi, & Galea, 2008; F. H. Norris, 1992; F. Norris & Kaniasty, 1996; Rubonis & Bickman, 1991; Shore, Tatum, & Vollmer, 1986; Torche, 2011) as well as a significant shifts in believes and decisions (Finlay, 2009).

In line with such a perspective, recent contributions highlight that the shock of a natural catastrophe may trigger decisions on life course transitions, as the sudden devastation challenges the idea that the world is a benevolent place (Janoff-Bulman, 1992). Coping with "their new reality of danger and randomness, people are motivated to revise old schemas and establish new ones" (Cohan & Cole, 2002, p. 21). The most important life course transitions undoubtedly concern the initiation of a new family and the birth of new children. Focusing on the latter, Finlay (2009) analyzes three large-scale earthquakes in India, Pakistan and Turkey, finding a positive fertility response in the communities hit by the disasters. A similar result has been found after the large scale loss of lives caused by the Indian Ocean tsunami in 2004

(Nobles, Frankenberg, & Thomas, 2015) and after the hurricane Hugo that hit South Carolina in 1989 (Cohan & Cole, 2002). While the theoretical framework and the results about fertility responses after natural disasters are quite straightforward, the same cannot be told for marriages.

Four theoretical frameworks have been formulated to explain the effect of natural disasters on marriage rates. First, following terror management theory (Solomon, Greenberg, & Pyszczynski, 1991) natural disasters enhance fear of death. Therefore, survived people may increase commitment to their partner as a way to cope with such a fear. For this reason, disasters might be associated to increasing marriage rates. Second, attachment theory (Bowlby, 1969) posits that adults exhibit proximity and support seeking responses similar to those of children. In response to acute stress, affected people may manifest attachment needs (Hazan & Shaver, 1994) and marriage might be an example of proximity seeking in response to a threat (Cohan & Cole, 2002). Therefore, marriage rates may increase following an acute stress such as a natural disaster. Third, stress research has highlighted that stress is divisive and environmental stressors may lead to poor relationship functioning (Story & Bradbury, 2004). Therefore, the stress determined by a natural disaster may be associated with a decline in marriages. Fourth, natural disasters affect economic circumstances. Since marriage rates are associated to employment opportunities and real wages (Oppenheimer, 1988; White & Rogers, 2000), the serious negative economic effects of natural disasters may be associated with declining marriage rates.

Previous evidence of the relation between marriages and natural disasters has brought contrasting results. The seminal work of Cohan and Cole (2002) found that marriage rates increased following the hurricane Hugo in South Carolina, suggesting that such a life course change is explained by attachment theory rather than stress and economic theories. A similar result has been shown for China during the decade 2000-2011, where earthquakes caused a reduction of marriage rates in the following year and an increase after two years (Xu & Feng, 2016). Hamamatsu et al. (2014) focused on the catastrophic 2011 earthquake in Japan, which resulted in the famous tsunami and the consequent accident at the Fukushima Nuclear Power Plant. Despite they find a short-term decreasing trend on marriage rates, they could not assess whether this was certainly due to the disaster. Ahmed (2018) studied the impact of the 2010 flood in Pakistan on the share of married people, finding a negative effect on the most impacted areas. Finally, Prati and Pierantoni (2014) replicate the study of Cohan and Cole on the Italian municipalities of Umbria and Marche regions, where they find a decline in marriage rates of municipalities hit by a tragic earthquake in 1997.

This paper aims to contribute to this literature by providing an empirical analysis of the consequences of the 2009 L'Aquila earthquake on marriage rates. Given that the literature reviewed provides both contrasting theories and contrasting evidences, we are agnostic on the hypothesized direction of the effects of the earthquake. However, media coverage has shown anecdotal evidence that the number of marriages has increased after 2009[1]. Therefore, this work tests whether such evidence is robust to a thorough empirical analysis.

3.L'Aquila earthquake

L'Aquila is a city in Southern Italy, close to the highest of the Apennine summits, both the capital city of the Abruzzo region and of the Province of L'Aquila. Earthquakes mark the history of the city, that was hit by destructive events in 1315, 1349, 1452, 1501, 1646, 1703, 1706 and 1958. On April 6th 2009 the city and the municipalities of Abruzzo were shocked by a major seismic event whose magnitude was rated 5.8 on the Richter magnitude scale (RMS) and 6.3 on the moment magnitude scale (MMS). As a

[1] See for example the following article published on the Italian newspaper "Avvenire" on January 2011 and available at https://www.avvenire.it/attualita/pagine/laquila-matrimoni-nascite_201101101046026830000 [last access on 15/9/2019]

result, 309 people died, 1,600 people were injured and the estimated damages amounted to 10 billion euros.

Differently from RMS and MMS, the Mercalli-Cancani-Sieberg scale (MCS) rates the intensity of earthquakes at a given location by analyzing the effects of seismic activity on people, land and buildings. MCS is a twelve-points scale, where the lowest degree indicates that the ground motions are not felt by the population but just measured by instruments, and the highest degree indicates catastrophic destruction. The MCS magnitude of L'Aquila earthquake varied from 3 to 9, depending on the location. In fact, the orographic features amplified or weakened the propagation of seismic waves, so that even neighboring communities experienced fairly different degrees of damage, as shown in Figure 1.

[FIGURE 1 ABOUT HERE]

The Italian Civil Protection identified as a "seismic crater" all the territories of the municipalities that experienced a magnitude of six and higher on the MCS. An earthquake with a MCS magnitude of six is considered "Strong", which means that the earthquake is felt by all the population, that it moves heavy furniture and causes some plaster to fall. In this area, 65,000 people were displaced in the immediate aftermath, even though less than a year after the earthquake the number dropped to 10,000. The mobilization of resources was impressive: the Italian government allocated an emergency budget and accepted the financial support from foreign countries and international organizations, resulting in 1.715 billion euros allocated in the first year after the earthquake, with an allocation of about 23,000 euros per capita for the displaced (Ventura, 2010). As a matter of comparison, the allocated emergency budget after the 1997 earthquake in Umbria and Marche amounted to just 262 million euros, with less than 5,000 euros per displaced person.

4.Data and methodology

Earthquakes are random events. Despite they are more likely to happen in seismic areas, the timing and the location of the epicenter cannot be forecasted. Further, the propagation of the seismic waves can be dramatically affected by the topographical features of the area where the earthquake strikes. For these reasons, it is not unusual to observe that neighboring communities experience fairly different degrees of damages (Belloc et al., 2016; Caruso & Miller, 2015; Finlay, 2009; Torche, 2011, 2018), which is also what happened in the case of L'Aquila earthquake. Therefore, this setting can be thought of as a natural experiment where the municipalities hit with a MCS magnitude equal or higher than six are the treated units, while the other municipalities of Abruzzo are the control units.

By using a difference-in-differences (DID) approach, we can assess whether in the post-earthquake period the marriage rate in the treated municipalities is higher or lower than it would have been in the absence of the earthquake, using the non-treated as counterfactuals (Angrist & Pischke, 2008). The key assumption is that the treatment (i.e. the earthquake) is not determined by the outcome (i.e. marriage rates). When this condition is met, a causal link can be established between the shock of the earthquake and marriage rates. Since the natural randomness of an earthquake, it is very likely uncorrelated with municipalities characteristics other than their topographical features (Torche, 2011). The second assumption is that marriage rates do not follow group-specific trends that could bias the estimation of treatment effects. In other words, this means assuming that the differences in marriage rates between control and treated units would have been constant had the earthquake not happened. This assumption, also known as parallel trends assumption, cannot be verified by means of a statistical test, but requires a visual inspection of the data to check whether the trend of the marriage rate before the treatment is similar between treated and control units. The third assumption is the absence of spillover effects, which means that the earthquake affects marriage rates only in treated municipalities. This is the most problematic assumption in our setting, therefore the robustness of our analysis to spillover effects is thoroughly discussed and tested in the following sections.

We define the treated and control group according to the MCS magnitude data provided by the Parametric Catalogue of Italian Earthquakes (CPTI15). Figure 2 shows a map of the treated and control municipalities: 45 of the 305 municipalities report an MCS magnitude equal or higher than six. It is again worth noting that the areas of several municipalities where the earthquake had destructive consequences have adjacent borders to areas of municipalities where the earthquake did not hit severely. This comforts the idea that control groups are good counterfactuals, as it is likely that close municipalities share the same cultural, social and economic characteristics that influence nuptiality.

[FIGURE 2 ABOUT HERE]

In order to assess the incidence of the earthquake on marriages, the yearly number of marriages and resident population data for all the 305 municipalities were extracted from the Demo-Istat database. According to this data, which we observe from 2006 to 2012, we calculated a nuptiality rate as the number of marriages for 1,000 inhabitants for each municipality. Despite this data is available from 2000, in the main analysis we choose to drop the observations from 2000 to 2005 for two reasons: one, because doing so we have a more balanced number of years before and after the earthquake. Two, because before 2005 some areas of Abruzzo experienced minor seismic events, which could result in unwanted disturbance in our analysis. Instead, unfortunately 2012 is a given boundary, as data availability stops in that year. However, with the available data we observe three years after the earthquakes, which we think is a sufficient time-span to verify if lifelong choices have been modified by the natural disaster. Further, a longer time span would have increased the risk of unwanted confounding factors influencing the outcome variable.

The trends of nuptiality for treated and control municipalities are plotted in Figure 3. At a first sight, the marriage rates before the 2009 earthquake follow very similar patterns, comforting the assumption of parallel trends. After the earthquake, the average marriage rate of the treated municipalities starts to increase, and it remains steadily larger than the average marriage rate of the control group until 2012.

[FIGURE 3 ABOUT HERE]

Following Angrist and Pischke (2008), to estimate the effects of the exogenous shock of the earthquake on marriage rate we can use a random effects panel regression to estimate the following equation:

$$Marriage\ rate_{it} = \beta_0 + \beta_1 Postearthquake_t + \beta_2 Treated_i + \beta_3 Postearthquake_t \cdot Treated_i + \varepsilon_{it}$$

where $Marriage\ rate_{it}$ is the marriage rate expressed as marriages per 1,000 inhabitants in the i^{th} municipality at time *t*, $Postearthquake_t$ is a dummy that has the value of 0 in the time period before the earthquake and 1 in the period following the earthquake, $Treated_i$ is a dummy that is equal to 1 for the treated municipalities (i.e. those where the MCS magnitude was at least six) and equal to 0 for the control municipalities, and ε_{it} is a random error term. With this specification, the coefficient β_0 is the average marriage rate of the control group before the earthquake, the sum of $\beta_0 + \beta_1$ is the average marriage rate of the control group after the earthquake, β_2 indicates the difference between the marriage rates of the treated and the control group before the earthquake, the sum of $\beta_0 + \beta_2$ is the average marriage rate for the treated group before the earthquake, $\beta_0 + \beta_1 + \beta_2 + \beta_3$ is the average marriage rate for the treated group after the earthquake, and β_3 is the DID estimation that indicates the difference between treated and control in the variation of marriage rates after the earthquake.

5.Results

The results of the regression estimation are reported in Table 1. For the sake of clarity, the coefficients have been summed up to indicate the averages in treated and control groups before and after the earthquake and the relative differences. Before the earthquake, the average marriage rate of treated municipalities is statistically not different from the average marriage rate of control municipalities. Both treatment and control groups show a little more than 4 marriages every 1,000 inhabitants. After the earthquake the treated municipalities have a higher marriage rate, while the control municipalities show a lower value. The key DID coefficient indicates that the change in marriage rates from before to after 2009 was greater in the treatment group than the change in the control group at the same time. In other words, after the earthquake in the municipalities where the earthquake was destructive (MCS magnitude equal or higher than six) there are on average 2.5 marriages more (per 1,000 inhabitants) than in the control municipalities. This result is statistically significant at the 1% level.

[TABLE 1 ABOUT HERE]

Our result is in line with those of Cohan and Cole (2002) and those of Xu and Feng (2016), which highlight that natural disasters may increase people commitment to their partner as a way to cope with fear and may also trigger proximity and support seeking as a response to stress. However, the result contradicts a previous study that analyzed the earthquake that hit the Italian regions of Umbria and Marche in 1997, which finds a negative impact of the shock from natural disaster on marriage rates (Prati & Pietrantoni, 2014). This is quite surprising, since one would expect a similar result given that the setting is so akin: Abruzzo and Marche are neighboring regions, the magnitudes of the two earthquakes are comparable and there is little more than 10 years between the two natural disasters.

Explaining this discrepancy is outside the objective of this study. However, two different explanation may be worth considering to explain the differing results: the first pertains to the methodology of the studies, the second is related to the response of the public sector. First, Prati and Pierantoni do not use a difference-in-difference approach and focus their analysis just on the year after the earthquake. It could be the case that the immediate hardships due to a natural disaster causes some weddings to be delayed or to be re-programmed. Second, the emergency budgets allocated in response to the respective earthquakes have remarkably different sizes. The funds allocated for each displaced person are almost five times higher for the L'Aquila earthquake than for the Umbria-Marche (Ventura, 2010). Thus, the great support provided by the government after L'Aquila earthquake may have incentivized the initiation of new families.

6.Robustness check

In order to test the robustness of our results, a number of potential sources of bias for our results have been taken into account. First, we extend the time span of analysis. Second, we tackle the issue of potential migration after the earthquake. Third, we tackle the risk of bias due to the potential spillover effects given by the presence of a large city among the treated units. All the estimations are consistent with the main results.

The choice of using data from 2006 is due to avoid the inclusion of minor seismic events (with a MCS magnitude lower than 5) that happened in the region in 2002 and 2004. However, in order to check the robustness of our results we replicated the analysis extending the time-span under analysis in order to include data from 2000. As Table 2 shows, the results do not change, confirming an increase of marriage rates in treated municipalities following the destructive earthquake of 2009.

[TABLE 2 ABOUT HERE]

Destruction caused by earthquakes may force people to change place of residence, especially in the treated municipalities where the damages were more intense. For this reason, one could argue that the earthquake causes a decrease in population, which in turn influences marriage rates. Of course, this would happen just in case the share of population with a higher propensity to get married is more likely to remain. In other words, one should assume that the consequence of the earthquake operates selectively on the part of the population that is less likely to get married in the next couple of years, making them more inclined to change residence. Unfortunately, the available data is not detailed enough to test such an assumption. However, we do have available the share of elderly population (more than 65 years), which is the part of population most unlikely to get married. Therefore, we replicate the main analysis including the share of elderly as a control variable in the difference in differences regression. As shown in Table 3, the results do not change, confirming a positive effect of the earthquake on the share of marriages. Indeed, the dynamics of population appear negligible, as it is shown in Table 4, where the average population together with the growth rate of population of treated and control municipalities are printed. In fact, the average population in treated municipalities was already decreasing even in some years before the earthquake. After the earthquake, the average population decreases by less than 1% in treated municipalities, while in 2012 is at the same level than 2009. This brings us to discard the hypothesis of a sizable effect due to changes of residence.

[TABLE 3 ABOUT HERE]

[TABLE 4 ABOUT HERE]

Another concern on the robustness of our analysis may depend on the specific features of L'Aquila, which is included in the treated group. In fact, the historical city center, where most of the administrative offices were located, suffered the worst consequences of the earthquake. Therefore, one could hypothesize that a number of marriages were not celebrated in L'Aquila due to material damages to the buildings where marriages are usually celebrated. As a matter of fact, it turns out that the marriage rate in L'Aquila shows a steep drop in 2009 that is followed by low values with respect to the years before the earthquake, as it is shown in Figure 4. This could mean that couples who wanted to get married in L'Aquila could not do so, and had to marry in another municipality. Difference-in-differences estimation can be biased and fail to establish a causal relation in presence of such spillover effects. Therefore, we perform another set of robustness check. On the one hand, we replicate the estimation just for the province of L'Aquila, which is the administrative level between regions and municipalities. On the other hand, we replicate the analysis excluding the municipality of L'Aquila and the neighboring municipalities (first and second tier)[2], where we expect that the marriage rate could have been influenced by a spillover from L'Aquila. As it shown in Table 5 and Table 6 respectively, the results hold for the L'Aquila province, and are of even higher magnitude when we exclude L'Aquila and the adjacent municipalities.

[FIGURE 4 ABOUT HERE]

[TABLE 5 ABOUT HERE]

[TABLE 6 ABOUT HERE]

7.Conclusions

This work studies the effect of a natural disaster on the choice of getting married. We exploit a natural experiment setting via a difference-in-differences design, using highly disaggregate data (municipality

[2] Municipalities in the first tier are those adjacent to the area of L'Aquila, while municipalities in the second tier are those adjacent to the area of first tier municipalities. The analysis has also been replicated excluding just L'Aquila municipality and excluding L'Aquila and first tier. The results, which are available upon request, are substantially alike to those presented here.

level) in order to assess whether the shock caused by the L'Aquila earthquake in 2009 resulted in a substantial variation of the marriage rate in the municipalities hit more severely by the natural disaster. We find that the municipalities that payed a higher toll in terms of destruction show a higher marriage rate with respect to those that did not experienced major damages, which is in line with the anecdotal evidence of L'Aquila's youth looking at the wedlock as the best way to guarantee themselves a thriving future.[3]

This result is coherent with a number of studies showing that the response to a shock imposed by a natural disaster triggers proximity and support seeking and motivates people to establish new schemas (Cohan & Cole, 2002). Indeed, by favoring intrinsic meanings such as interpersonal connections and family building, the acknowledgment of human frailty following a natural disaster may result in a renewed investment in family building (Nobles et al., 2015). We acknowledge that a similar study performed in Italy lead to antithetical results (Prati & Pietrantoni, 2014). We believe that this difference is mostly driven by a different methodological approach, but we also highlight a different response of the government, which was far more generous in the case of L'Aquila earthquake (Ventura, 2010). Indeed, this raises an interesting research question on the impact of governmental efforts in mediating individual choices in the aftermath of a natural disaster. An informed policy planning in the aftermath of a natural disaster may lead to different outcomes.

Our findings shed light on the long-term effects of natural disasters, which in our case study could well entail indirect demographical changes. In fact, Italy shows one of the lower rates of out of wedlock childbirth (Cook & Furstenberg Jr., 2002), which is even lower in the southern regions like Abruzzo. Further, in Italy marriage and childbirth almost coincide (Barbieri et al., 2015). For these reasons, it seems reasonable to hypothesize an increase of fertility rates in the municipalities where the marriage rates have increased. This insight may be also useful for policy planning. Providing nurseries and childcare for helping the newlyweds could represent a possible choice for policy-makers.

A longer run analysis of the demographic consequences of the L'Aquila earthquake would be a natural follow-up of this study. However, one should be concerned that in Italy births largely happens in hospitals, therefore newborns are registered in the municipality the hospital stands on. Therefore, the methodological design provided in the present study may not be suitable to the study of birth rates, and an ad hoc empirical framework should be designed.

[3] https://www.avvenire.it/attualita/pagine/laquila-matrimoni-nascite_20110110104602683000?fbclid=IwAR1OaECCV7t81OKgkUY5VPqdCZayGDgvcj4gmvcs88oR8ev9drvj4o5gAc4

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Figure 1: Map of the municipalities and magnitudes of L'Aquila earthquake in Mercalli-Cancani-Sieberg scale. Abruzzo region is highlighted in the upper right corner for reference.

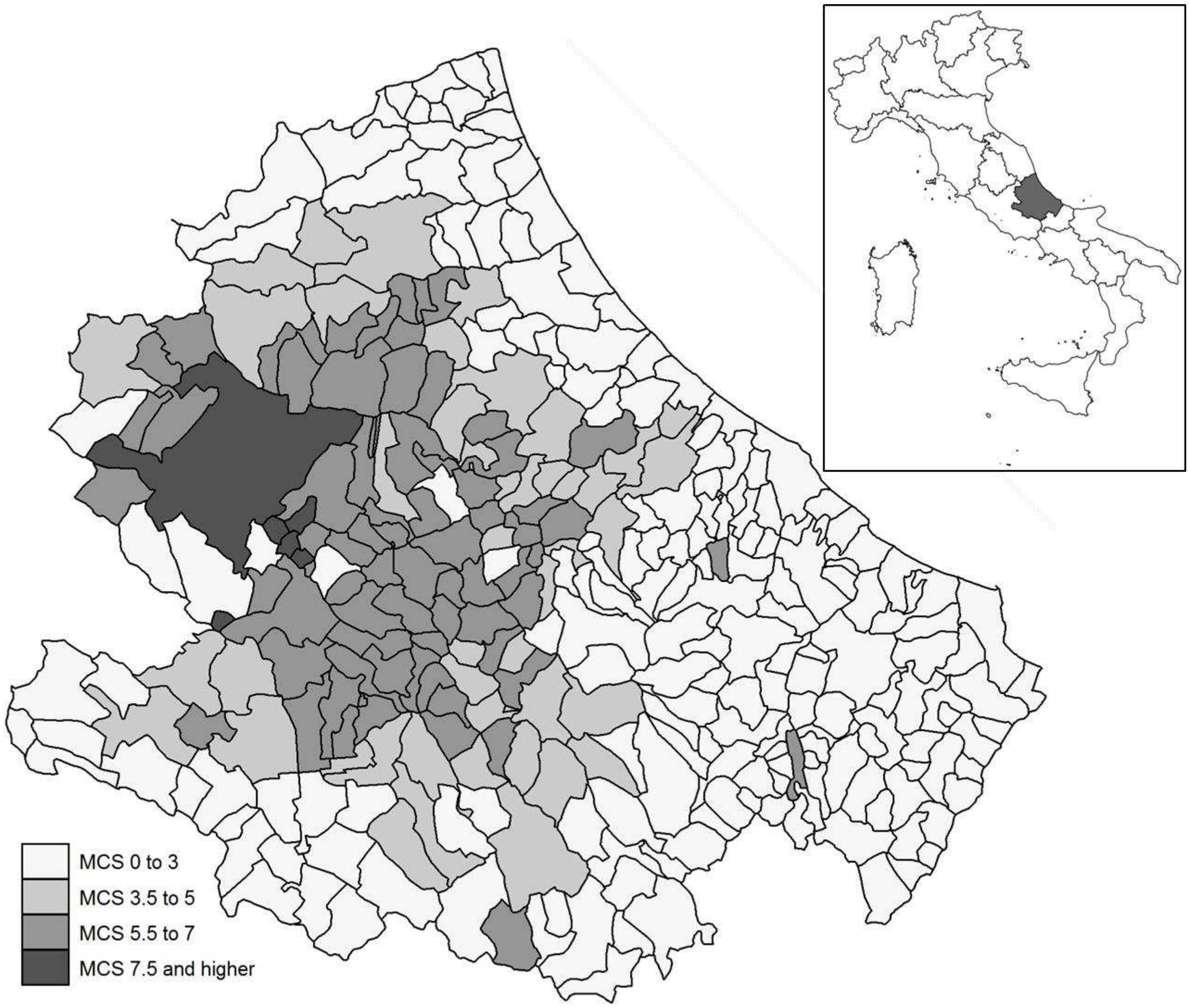

Figure 2: Map of the municipalities of Abruzzo Region. Municipalities where L'Aquila earthquake had a MCS magnitude of six and higher (treated units) are filled in grey. Non treated (control) municipalities are filled in white.

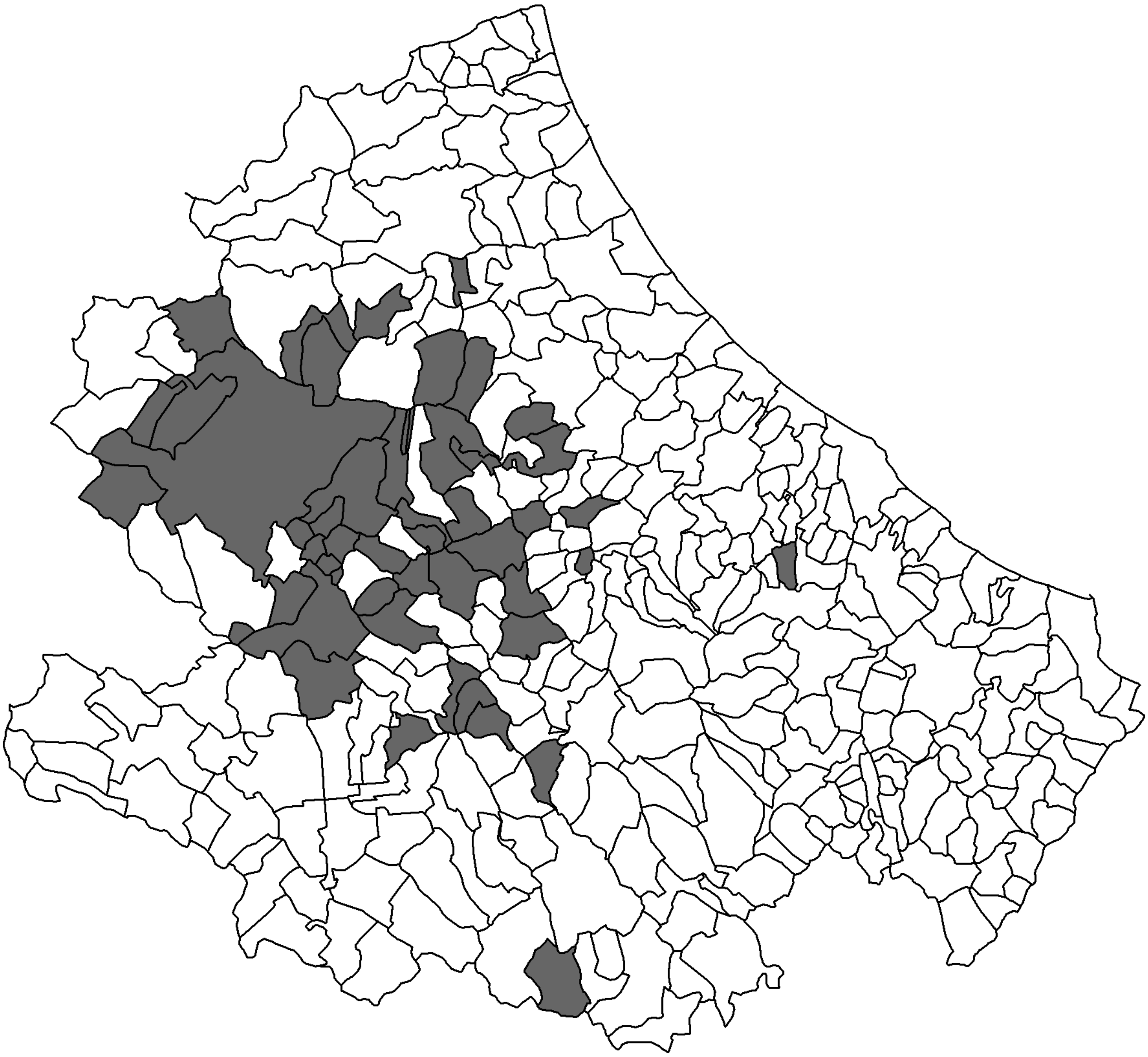

Figure 3: Marriage rates in Abruzzo for treated and control municipalities, 2006 to 2012. The added vertical line indicates the occurrence of L'Aquila earthquake (2009)

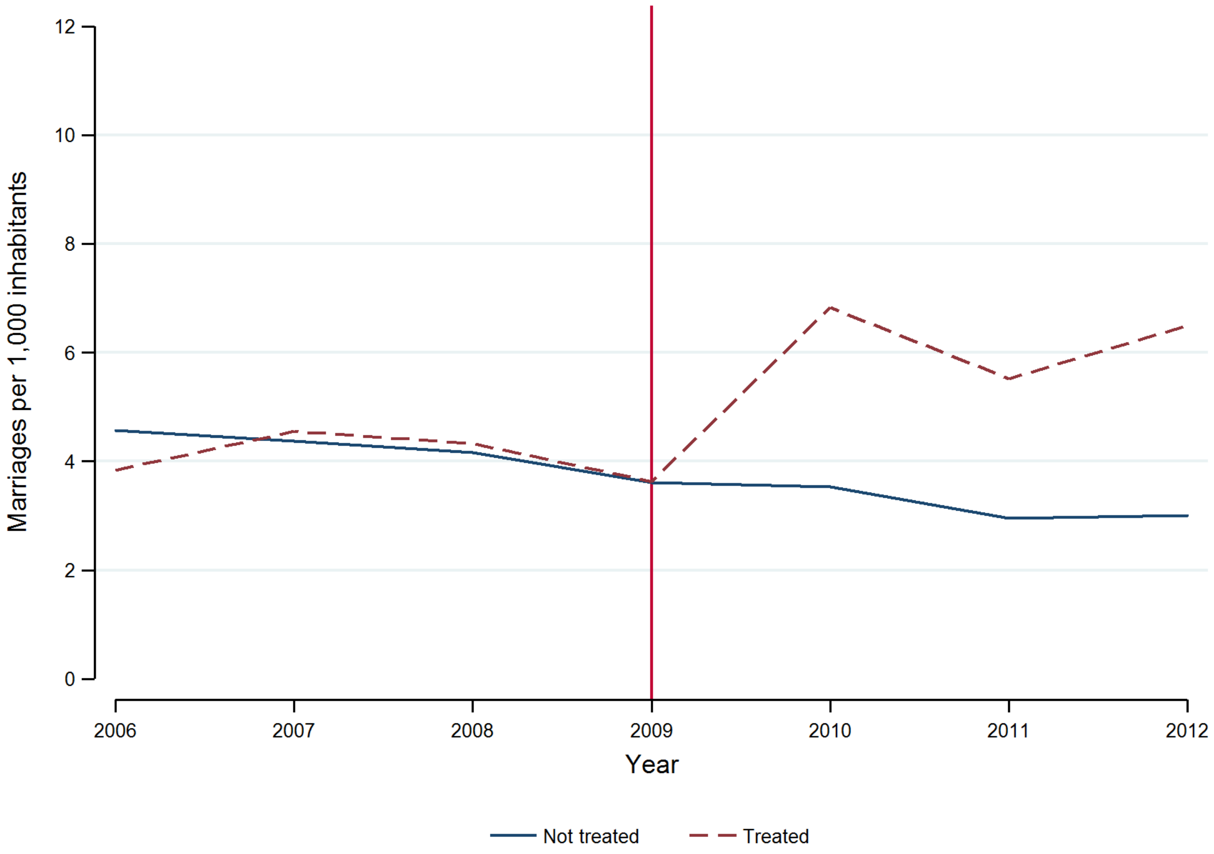

Figure 4: Trend of marriage rates for the city of L'Aquila

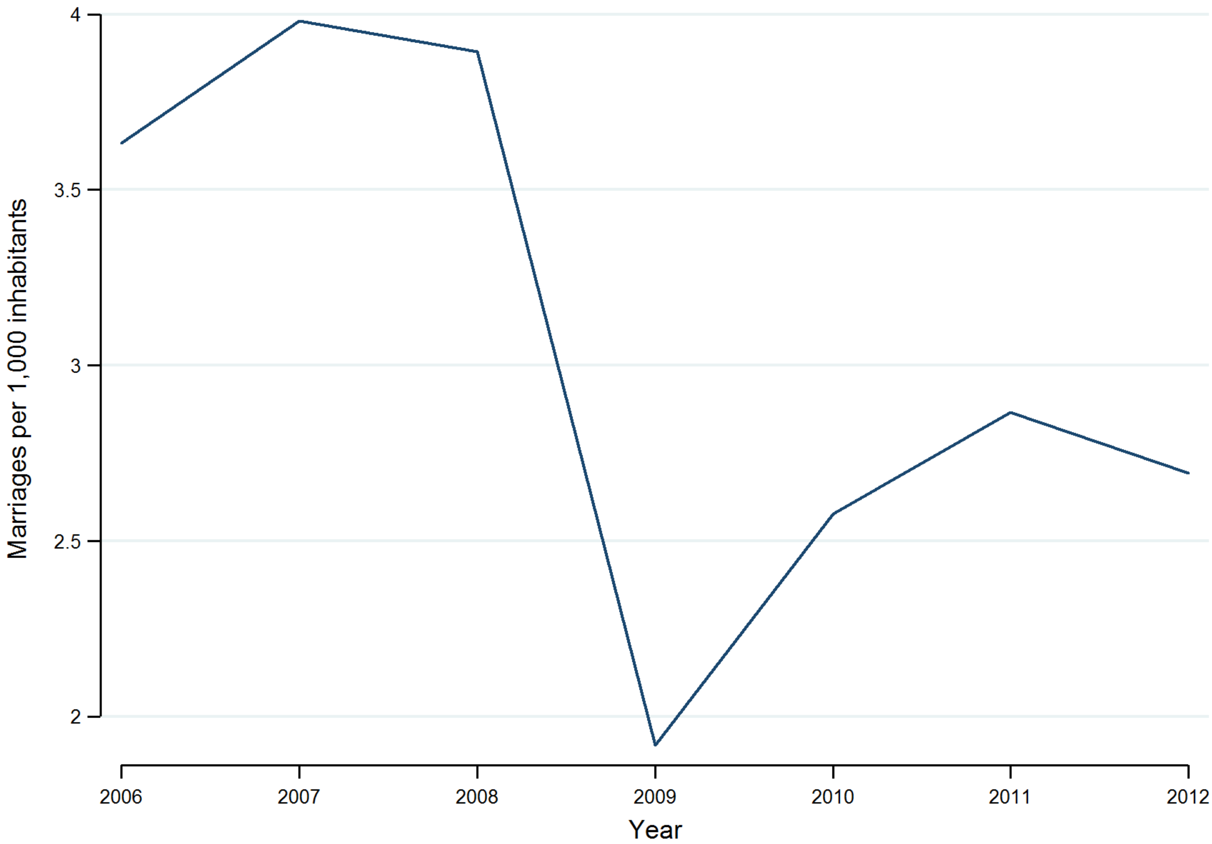

Table 1: Difference-in-differences estimation of L'Aquila 2009 earthquake effects on marriage rates in Abruzzo municipalities.

	Marriage rate	Std. Err.	z stat.	P>z
	Before			
Control	4.369***	0.394	11.08	0.000
Treated	4.238***	0.947	4.47	0.000
Diff (T-C)	-0.131	1.026	-0.13	0.898
	After			
Control	3.274***	0.381	8.60	0.000
Treated	5.619***	0.915	6.14	0.000
Diff (T-C)	2.344**	0.991	2.37	0.018
Diff-in-Diff	2.476***	0.708	3.50	0.000

	Before		*After*	
	Control	Treated	Control	Treated
Observations	780	135	1040	180
Municipalities	260	45	260	45

Notes: Coefficients and standard errors are estimated by a random effects panel regression on 2135 observation over 305 municipalities and 7 years. The earthquake happens at the 4th year. Treated group municipalities include those hit by a MCS magnitude equal or higher than six, control group includes all the other municipalities of Abruzzo. *** indicates statistical significance at 1%, ** indicates statistical significance at 5%.

Table 2: Robustness check on time-span selection of the difference-in-differences estimation of L'Aquila 2009 earthquake effects on marriage rates in Abruzzo municipalities

	Marriage rate	Std. Err.	z stat.	P>z
	Before			
Control	4.548***	0.359	12.66	0.000
Treated	4.468***	0.947	4.47	0.000
Diff (T-C)	-0.08	1.026	-0.13	0.898
	After			
Control	3.274***	0.379	8.64	0.000
Treated	5.619***	0.911	6.17	0.000
Diff (T-C)	2.344**	0.986	2.38	0.017
Diff-in-Diff	2.424***	0.505	4.80	0.000

	Before		*After*	
	Control	Treated	Control	Treated
Observations	2340	405	1040	180
Municipalities	260	45	260	45

Notes: Coefficients and standard errors are estimated by a random effects panel regression on 3965 observation over 305 municipalities and 13 years. The earthquake happens at the 10th year. Treated group municipalities include those hit by a MCS magnitude equal or higher than six, control group includes all the other municipalities of Abruzzo. *** indicates statistical significance at 1%, ** indicates statistical significance at 5%.

Table 3: Robustness check on elderly population dynamics of the difference-in-differences estimation of L'Aquila 2009 earthquake effects on marriage rates in Abruzzo municipalities

	Marriage rate	Std. Err.	z stat.	P>z
Before				
Control	4.369***	0.395	11.07	0.000
Treated	4.255***	0.952	4.47	0.000
Diff (T-C)	-0.114	1.031	-0.11	0.912
After				
Control	3.271***	0.381	8.57	0.000
Treated	5.628***	0.917	6.14	0.000
Diff (T-C)	2.357**	0.994	2.37	0.018
Diff-in-Diff	2.471***	0.708	3.49	0.000
Elderly	-0.886	4.107	-0.22	0.829

	Before		*After*	
	Control	Treated	Control	Treated
Observations	780	135	1040	180
Municipalities	260	45	260	45

Notes: Coefficients and standard errors are estimated by a random effects panel regression on 3965 observation over 305 municipalities and 7 years. The earthquake happens at the 4th year. Elderly is the share of population with 65 years or more. Treated group municipalities include those hit by a MCS magnitude equal or higher than six, control group includes all the other municipalities of Abruzzo. *** indicates statistical significance at 1%, ** indicates statistical significance at 5%.

Table 4: Average population and population growth rates for treated and control municipalities from 2000 to 2012.

	Control group		Treated group	
Year	Average Pop.	Pop. growth rate	Average Pop.	Pop. growth rate
2000	4395		2635	
2001	4397	0.05%	2637	0.05%
2002	4410	0.28%	2636	-0.02%
2003	4442	0.72%	2649	0.48%
2004	4464	0.51%	2651	0.09%
2005	4480	0.35%	2645	-0.23%
2006	4488	0.18%	2634	-0.41%
2007	4535	1.04%	2643	0.33%
2008	4565	0.67%	2646	0.13%
2009	4576	0.24%	2621	-0.97%
2010	4577	0.02%	2604	-0.66%
2011	4580	0.06%	2588	-0.59%
2012	4594	0.31%	2622	1.29%

Table 5: Difference-in-differences estimation of L'Aquila 2009 earthquake effects on marriage rates in the municipalities belonging to the province of L'Aquila.

	Marriage rate	Std. Err.	z stat.	P>z
Before				
Control	3.752***	1.025	3.66	0.000
Treated	5.119***	1.615	3.17	0.002
Diff (T-C)	1.367	1.913	0.71	0.475
After				
Control	3.284***	0.990	3.32	0.001
Treated	7.326***	1.561	4.69	0.000
Diff (T-C)	4.042**	1.848	2.19	0.029
Diff-in-Diff	2.675**	1.301	2.06	0.04

	Before		*After*	
	Control	Treated	Control	Treated
Observations	231	93	308	124
Municipalities	77	31	77	31

Notes: Coefficients and standard errors are estimated by a random effects panel regression on 756 observation over 108 municipalities and 7 years. The earthquake happens at the 4^{th} year. Treated group municipalities include those hit by a MCS magnitude equal or higher than six, control group includes all the other municipalities of the province of L'Aquila. *** indicates statistical significance at 1%, ** indicates statistical significance at 5%.

Table 6: Difference-in-differences estimation of L'Aquila 2009 earthquake effects on marriage rates in the Abruzzo municipalities, excluding L'Aquila and neighboring municipalities.

	Marriage rate	Std. Err.	z stat.	P>z
Before				
Control	4.221***	0.393	10.73	0.000
Treated	3.295**	1.327	2.48	0.013
Diff (T-C)	-0.926	1.384	-0.67	0.504
After				
Control	3.139***	0.378	8.3	0.000
Treated	8.215***	1.277	6.44	0.000
Diff (T-C)	5.076***	1.331	3.81	0.000
Diff-in-Diff	6.001***	0.997	6.02	0.000

	Before		*After*	
	Control	Treated	Control	Treated
Observations	717	63	956	84
Municipalities	239	21	239	21

Notes: Coefficients and standard errors are estimated by a random effects panel regression on 1820 observation over 260 municipalities and 7 years. The earthquake happens at the 4th year. Treated group municipalities include those hit by a MCS magnitude equal or higher than six, control group includes all the other municipalities of Abruzzo, except L'Aquila and neighboring municipalities. Neighboring municipalities are those whose area is adjacent to the area of L'Aquila municipality (tier 1) and those whose area is adjacent to the area of tier 1 municipalities (tier 2). *** indicates statistical significance at 1%, ** indicates statistical significance at 5%.