

# **Life after the storm: the effect of L'Aquila earthquake on marriage rates**

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**Abstract:** Natural disasters have been proven to exert a number of economic and health consequences on the struck communities (Cavallo and Noy, 2011; Noy, 2009; Neria et al., 2008). Such effects might also concern demographic phenomena. At first glance, this stems from the immediate tragic death toll that natural disasters might imply. Nevertheless, it might also originate from tangible and non-tangible aftermath consequences. 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.

**JEL classification:**

## Introduction

Natural disasters have profound consequences on the population, shaking human well-beings at individual, family and community level. Other than the immediate toll of deaths and destruction, natural disasters also have wide-ranging social impacts that often persist over time (Deloitte, 2016). 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).

A number of theoretical frameworks arising from social psychology and economics explain why such destructive events act as touchstones influencing lifelong decisions. On the one hand, natural disasters enhance fear of death, which may result in an increased commitment to partners as a way to cope with such a fear (Solomon, Greenberg, & Pyszczynski, 1991). Furthermore, adults exhibit proximity and support seeking in response to stress (Hazan & Shaver, 1994). On the other hand, research on stress have shown that environmental stressors may lead to poor relationship functioning (Story & Bradbury, 2004), while economic research highlights that the consequent worsening of economic conditions may delay the initiation of a new family (Oppenheimer, 1988; White & Rogers, 2000).

This work exploits a difference-in-differences approach on municipality-level data with the objective of assessing whether marriage rates have been affected by L'Aquila earthquake of 2009. Performing a similar analysis of the Umbria and Marche earthquake of 1997, Prati and Pierantoni (2014) found that marriages have declined after the shocking event. Nevertheless, anecdotal evidence points towards the opposite direction in Abruzzo, as media support the idea that "L'Aquila is looking forward" and its youth looks at the wedlock as the best way to guarantee themselves a thriving future.<sup>1</sup>

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 (ISTAT), while 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 are crucial in understanding the indirect demographic consequences of natural disasters.

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.

## Long-term effects of natural disasters

Catastrophic natural events are most of the times unpredictable. Despite some areas are more easily hit – e.g. earthquakes or volcanic eruption, the actual strength, the timing and the location of a disaster remain random. Indeed, natural disasters have two elements: risk and shock (Finlay, 2009). Even if individuals may accept being exposed to the risk of a natural disaster, the shock given by being actually hit may alter people's belief and decisions. Unlike immediate impacts of natural disasters, their aftermath consequences are usually out of the spotlight. However, a growing body of academic research has been identifying a number of long-term effects of natural disasters on individual choices, population dynamics and even institutions.

Belloc, Drago and Galbiati (2016) show that earthquakes that hit Italy between 1000 and 1300 CE have slowed down the process of institutional change in the cities where the religious leader also held political power. Governing bishops could exploit the shock to strengthen religiosity, thus increasing their power.

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<sup>1</sup> [https://www.avvenire.it/attualita/pagine/laquila-matrimoni-nascite\\_201101101046026830000?fbclid=IwAR1OaECCV7t81OKgkUY5VPqdCZayGDgvcj4gmvc88oR8ev9drvj4o5gAc4](https://www.avvenire.it/attualita/pagine/laquila-matrimoni-nascite_201101101046026830000?fbclid=IwAR1OaECCV7t81OKgkUY5VPqdCZayGDgvcj4gmvc88oR8ev9drvj4o5gAc4)

Shocks from natural disasters may also determine mental health consequences for the affected population (Adams & Adams, 1984; Freedy, Kilpatrick, & Resnick, 1993; Ironson et al., 1997; F. H. Norris, 1992; F. Norris & Kaniasty, 1996; Rubonis & Bickman, 1991; Shore, Tatum, & Vollmer, 1986), and represent an acute stressor for pregnant women, influencing birth outcomes (Torche, 2011), which in turn are related to children cognitive outcomes – in particular for socio-economically disadvantaged children (Torche, 2018). Caruso and Miller (2015) provide additional evidence on the negative effect of an earthquake on human capital accumulation and welfare, adding some evidence of negative repercussions also in the following generation.

It has been highlighted that natural disaster may often 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 and initiation of new families.

Four theoretical frameworks have been formulated to explain the effect of natural disasters on marriage rates. First, following terror management theory (Solomon et al., 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.

Here, we want to contribute to this literature by providing an empirical analysis on the consequences on marriage rates of the 2009 L'Aquila earthquake that shook the Abruzzo region. Given that the literature we reviewed provides both contrasting theories and contrasting evidences, we are agnostic on the hypothesized direction of our case-study. However, recent media coverage highlights anecdotal evidence that the number of marriage has increased after 2009. Therefore, this work tests whether such evidence is robust to a thorough empirical analysis.

## **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 6<sup>th</sup> 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 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.

L'Aquila earthquake had a MCS magnitude varying from 3 to 9, depending on the location. Indeed, the topographical features of the region magnified or diminished the propagation of seismic waves, so that even neighboring communities experienced fairly different degrees of damage, as can be seen 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”, and its definition is: “felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.”. In this area, 65,000 people were displaced in the immediate aftermath, but 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 pro capita for the displaced (Ventura, 2010). In comparison after the 1997 earthquake in Umbria and Marche the allocated emergency budget amounted to just 262 million euros, with less than 5,000 euros per displaced person.

## **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 land. 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). Therefore, being hit by a destructive earthquake is an event likely uncorrelated with population characteristics that influence marriage rates. In this setting, the municipalities where the earthquake hit with a MCS magnitude equal or higher than six can be

considered the treated units of a natural experiment, 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 marriage rates do not follow group-specific trends that could bias the estimation of treatment effects. 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).

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 had a 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 characteristics related to weddings.

[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. This data is available from 2000, however 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.

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 common 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  $\varepsilon_{it}$  is a random error term. With this specification, the coefficient  $\beta_0$  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,  $\beta_2$  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  $\beta_3$  is the DID estimation that indicates the difference between treated and control in the variation of marriage rates after the earthquake.

## 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, in the municipalities where the earthquake MCS magnitude was equal or higher than six, after the earthquake 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 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 & Pietrantonio, 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 magnitude of the earthquakes were comparable and there is little more than 10 years between the two natural disasters.

Explaining this discrepancy is not in the aims 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 Pierantonio do not use a difference-in-difference approach and focus their analysis on the year after the earthquake. It could be the case that the immediate hardships due to a natural disaster delay and prevent from programming a wedding – which however we do not find. However, we think that a focus on longer-term effects may be more appropriate when studying lifelong decisions. Second, the emergency budgets in response to the respective earthquakes are incomparable. 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.

## Robustness checks

The choice of using data from 2006 is due to 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 including 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. Then, we replicate the 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 are really 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. 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 consequences of the earthquake were most severe in the historical city center, where most of the administrative offices were located. Therefore, one could hypothesize that a number of marriages were not celebrated in L'Aquila due to material damages to the buildings where usually marriages are celebrated. Indeed, it turns out that the marriage rate in L'Aquila exhibit a steep drop in 2009 that is followed by low rates 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 checks. 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)<sup>2</sup>, 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, 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]

## Conclusions

This work studies the long-run effect of a natural disaster on the lifelong choice of getting married. 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

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<sup>2</sup> 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.

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.

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 & Pietrantonio, 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.

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 (ISTAT). 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. Indeed, 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, and are therefore 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.



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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.

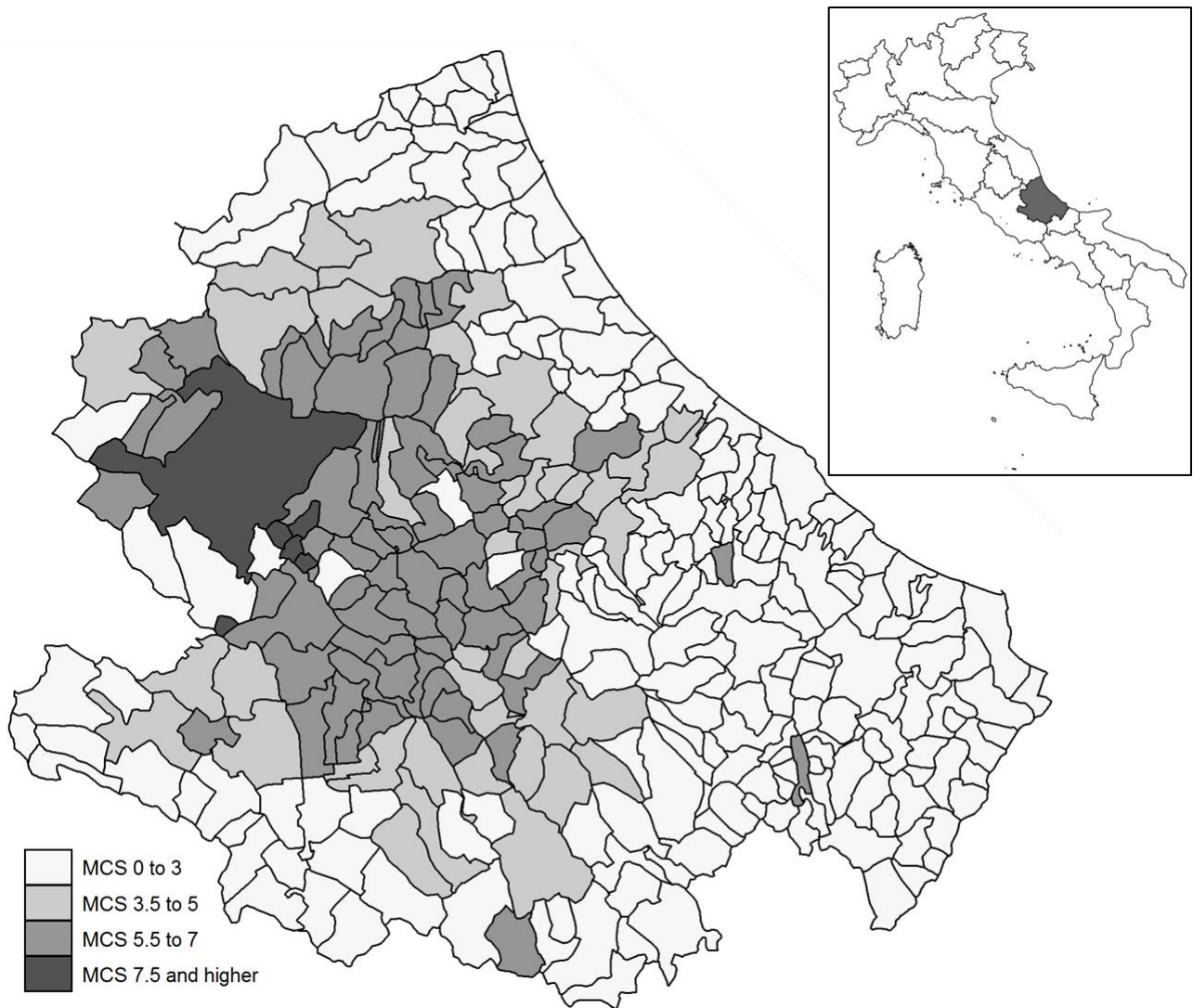


Figure 2: Map of the municipalities of Abruzzo Region. Municipalities where L'Aquila earthquake had a MCS magnitude of six and higher (treated units) are filled in grey. Non treated (control) municipalities are filled in white.

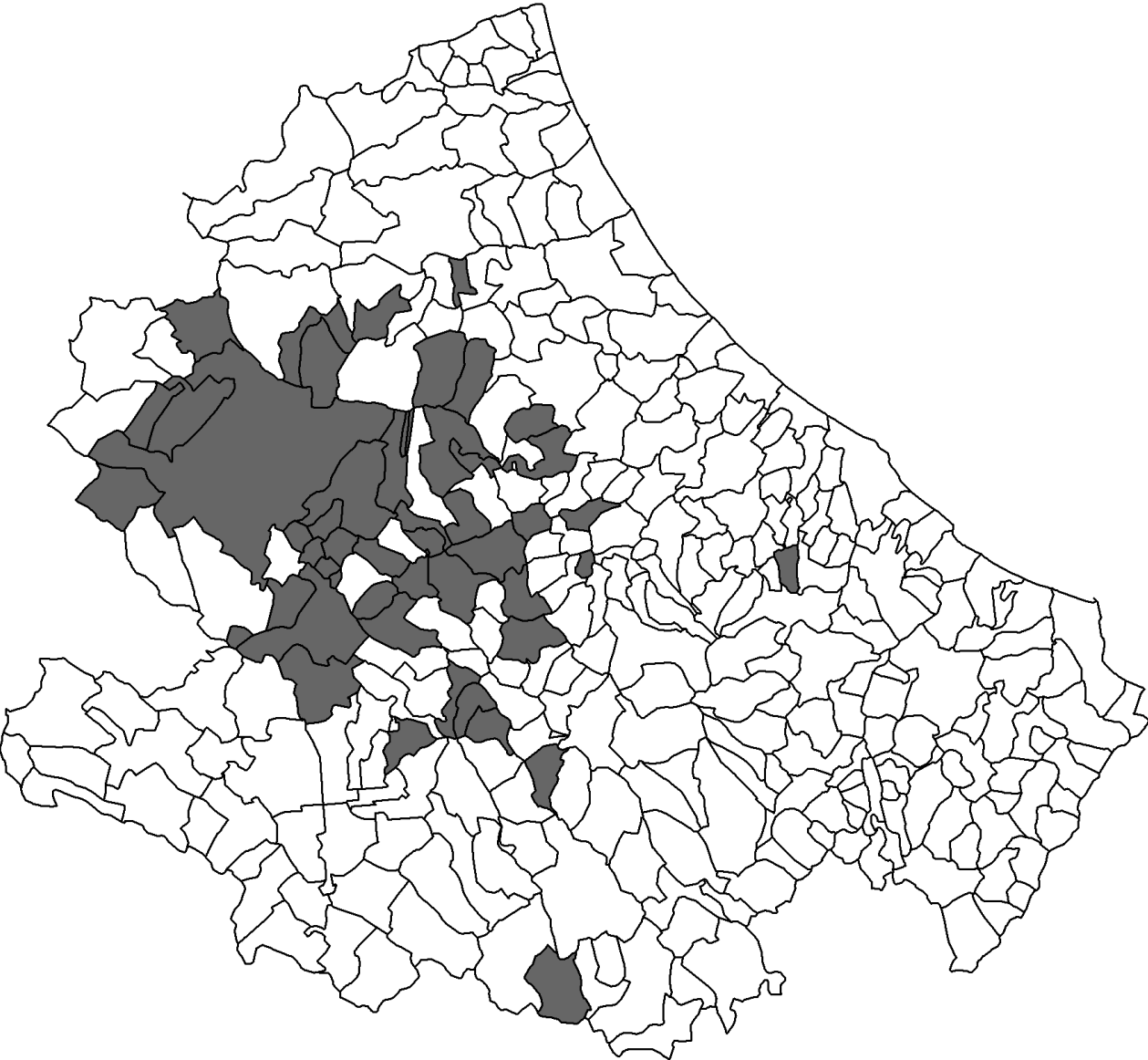


Figure 3: Marriage rates in Abruzzo for treated and control municipalities, 2006 to 2012. The added vertical line indicates the occurrence of L'Aquila earthquake (2009)

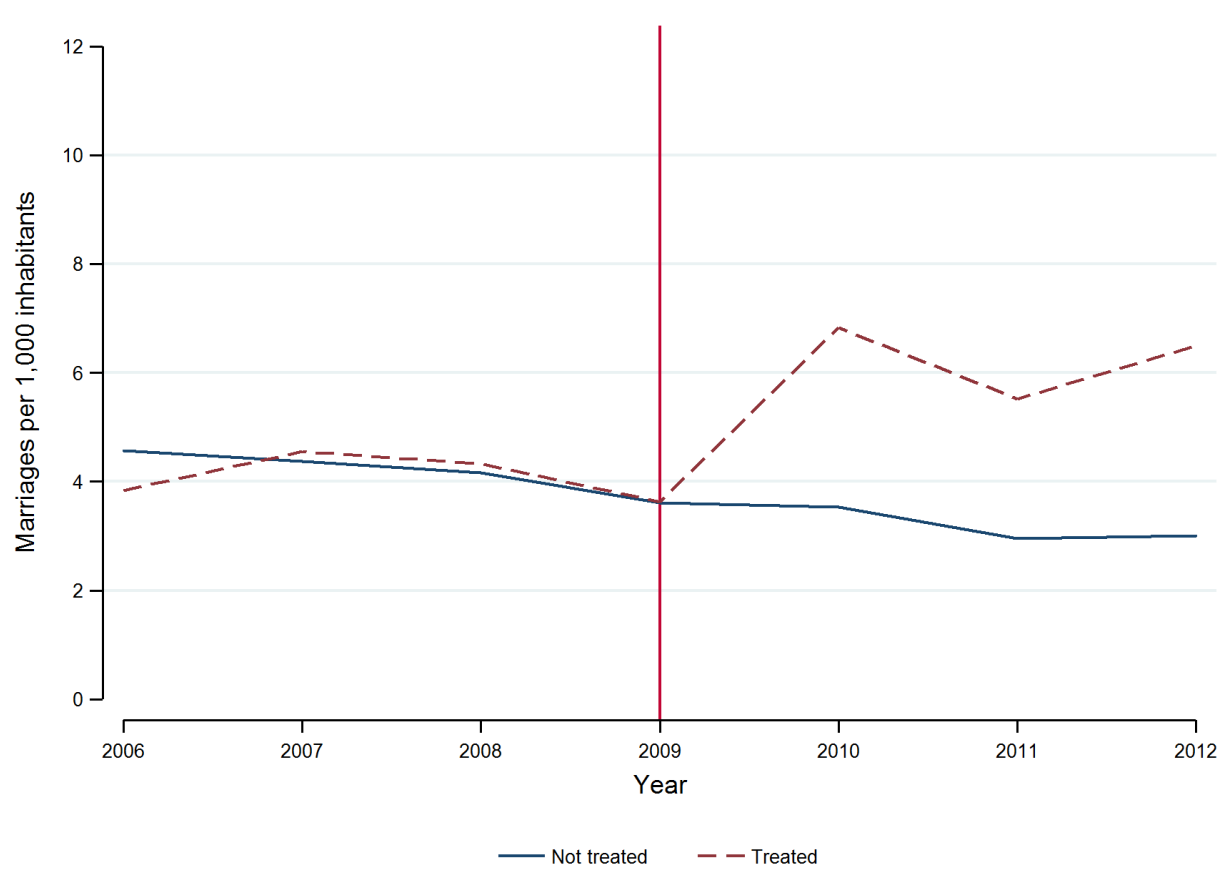


Figure 4: Trend of marriage rates for the city of L'Aquila

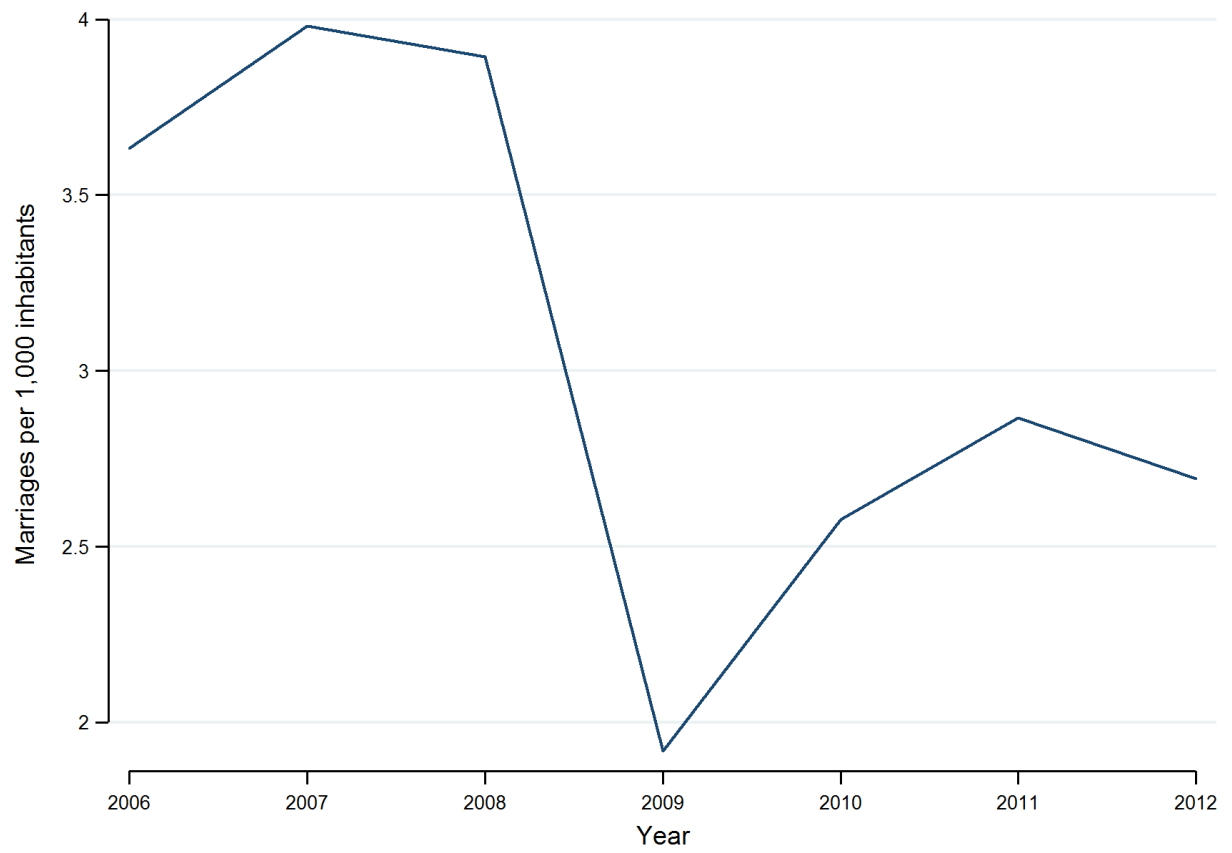


Table 1: Difference-in-differences estimation of L'Aquila 2009 earthquake effects on marriage rates in Abruzzo municipalities.

Marriage rate		Std. Err.	z stat.	P>z
<i>Before</i>				
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
<i>After</i>				
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

	<i>Before</i>		<i>After</i>	
	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 4<sup>th</sup> 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
<i>Before</i>				
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
<i>After</i>				
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
		<i>Before</i>		<i>After</i>
	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 10<sup>th</sup> 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
<i>Before</i>				
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
<i>After</i>				
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
		<i>Before</i>		<i>After</i>
	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 4<sup>th</sup> 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.

Year	Control group		Treated group	
	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 Abruzzo municipalities, excluding L'Aquila and neighboring municipalities.

	Marriage rate	Std. Err.	z stat.	P>z
<i>Before</i>				
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
<i>After</i>				
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
	<i>Before</i>		<i>After</i>	
	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<sup>th</sup> 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 municipalities belonging to the province of L'Aquila.

	Marriage rate	Std. Err.	z stat.	P>z
<i>Before</i>				
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
<i>After</i>				
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
		<i>Before</i>		<i>After</i>
	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 4<sup>th</sup> 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%.