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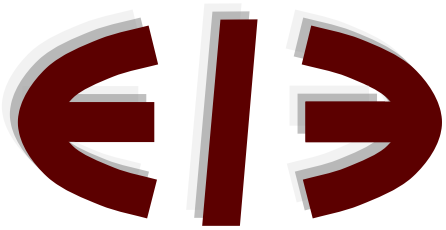

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Shocks and Selection: How Earthquakes Shape Local Political Representation *

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Abstract

This paper examines how natural disasters shape electoral preferences by analyzing the impact of earthquakes in Italy between 1990 and 2019. Using a staggered Difference-in-Differences design, we estimate that affected municipalities are more likely to elect female, more educated, and older city councilors. Similar shifts occur for mayors. These effects persist across election cycles and are robust to alternative specifications. We rule out competing explanations such as changes in turnout or candidate supply. The findings suggest that crises push voters to favor politicians perceived as more competent, experienced, and prosocial.

JEL Classification: D72, H84, J16, C23, O15

Keywords: Natural disasters; Electoral behavior; Local elections; Political selection; Gender and representation; Earthquakes; Difference-in-Differences; Voter preferences

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1 Introduction

The response of citizens to natural disasters largely depends on how much they trust institutions. Through electoral mechanisms, citizens can attempt to improve institutional performance by electing politicians they perceive as better suited to managing emergency situations. These perceptions are often shaped by how resources allocated to disaster-stricken areas are handled. Building on this idea, a growing body of research has explored how natural disasters — such as earthquakes, floods, and hurricanes — act as exogenous shocks that reshape the political landscape. Beyond their socioeconomic consequences (Cavallo and Noy, 2011), such events can alter the conditions of democratic competition, prompting voters to reassess the traits they value in political candidates (Bechtel and Hainmueller, 2011a, Fair et al., 2020, Healy and Malhotra, 2010). For instance, natural disasters may influence voters' evaluations of the incumbent, leading to either electoral rewards or punishments. However, especially at the local level — where officials are tasked with managing centrally allocated emergency funds — voters' preferences may shift not only with respect to incumbents, but also toward the broader political class. In the aftermath of a disaster, citizens may update their preferences based on traits they consider essential for managing emergencies. Do voters, for example, prefer gender-balanced political bodies, believing women exhibit more prosocial behavior? Or do gender stereotypes intensify, favoring male leadership in crisis contexts? Are competent politicians seen as better equipped to navigate post-disaster challenges, or does competence attributed to incumbents suffice? Finally, do citizens turn to younger, more dynamic figures, or do they favor the stability and experience associated with older politicians?

Motivated by these insights, we investigate how natural disasters shape electoral preferences by analyzing the impact of destructive earthquakes on the characteristics of locally elected politicians in Italy between 1990 and 2019. We take advantage of the occurrence of earthquakes in Italy, a fitting context given that Italy is one of the most seismically active countries in the Mediterranean.

Understanding how natural disasters shape electoral preferences is crucial for assessing the resilience and responsiveness of democratic institutions. While prior research has documented that voters respond to government performance in the aftermath of disasters — rewarding or punishing incumbents based on the perceived quality of disaster management (Besley and Burgess, 2002, Healy and Malhotra, 2009) — less is known about how such events affect the salience of individual politician characteristics, such as gender, competence, and age. By focusing on earthquakes in Italy, this study contributes to a growing body of literature on political behavior under crisis (Fair et al., 2020, Fukumoto and Kikuta, 2024), offering new insights into how voters update their preferences not only toward incumbents but toward broader traits they deem essential in emergency governance.

Leveraging the quasi-random nature of seismic shocks across time and space, we implement a staggered Difference-in-Differences (DiD) design to estimate how voters revise their preferences in the wake of crises. Our analysis focuses on three key attributes of local political elites — gender, education, and age — which serve as proxies for perceived prosociality, competence, and experience. The findings reveal that, following an earthquake of intensity ≥ 5 on the Mercalli scale, municipalities are significantly more likely to elect female (+ 13, 4%-12.9%), older (+ 1.14%-0.7%), and more educated (+ 1.09%-0.7%) city councilors. The effect is similarly robust for mayors: the likelihood of electing a female mayor increases by approximately from 4.4% to 3.7%, while the average education and age of mayors increase by 1.8% to 1.73% and by 2% to 1.5%, respectively. These effects are not short-lived: event-study estimates indicate that they persist across multiple electoral cycles and are not driven by pre-existing trends.

To reinforce the credibility of our identification strategy, we conduct a battery of robustness checks. We validate our findings using continuous DiD models based on earthquake intensity, which uncover a dose-response relationship between the magnitude of the disaster and the strength of electoral effects. We further address potential violations of the parallel trends assumption through the HonestDiD framework by Rambachan and Roth (2023) and confirm the results using both Lagged Dependent Variable (LDV) models (Angrist and Pischke, 2009) and the Sun and Abraham (2021) estimator, which accounts for treatment heterogeneity in staggered adoption settings. This robustness analyses confirm the DiD results except for the mayor's gender.

Our study shows that natural disasters can reshape electoral dynamics by altering voters' preferences for specific candidate attributes. In the aftermath of a major earthquake, Italian municipalities are more likely to elect older and more educated mayors, even when excluding repeated terms, suggesting a shift in prospective preferences rather than retrospective evaluations of performance. This voter-driven pattern, however, only partially extends to appointed officials: while aldermen tend to be slightly older after a disaster, no significant change is observed in their education or gender composition. These findings highlight the differentiated impact of disasters on electoral and executive selection, revealing that while democratic shocks can reconfigure who gets elected, their influence on who governs through appointments is more limited. Moreover, we rule out alternative explanations by showing that post-earthquake shifts in elected profiles are not attributable to changes in voter turnout, gender composition of the electorate, or candidate pool characteristics. Importantly, we find that these electoral shifts are not mediated by political alignment with national or regional governments, suggesting that voters prioritize intrinsic attributes — rather than partisan strategy — when responding to emergency governance needs.

Natural disasters are increasingly studied as critical events that shape political behavior. Our study contributes to this literature by examining how such shocks affect not

only retrospective evaluations of incumbents, but also voters' preferences for individual traits they consider important for crisis management. We discuss two strands of research to which our work is most closely related.

A first strand of research, rooted in *retrospective voting theory*, argues that voters assess politicians based on observed performance, especially in response to crises. Traits such as education and age are often interpreted as proxies for competence and experience (Arceneaux and Vander Wielen, 2023, Baltrunaite et al., 2014), and effective disaster management can increase trust in institutions and demand for qualified candidates (Fair et al., 2020). Empirical evidence across countries supports this view. In the U.S., voters reward visible post-disaster relief but neglect preparedness (Gasper and Reeves, 2011, Healy and Malhotra, 2009), sometimes even punishing incumbents for events beyond their control (Achen and Bartels, 2004, Heersink et al., 2020). Similar dynamics have been observed in Germany (Bechtel and Hainmueller, 2011b), Latin America (Acuña-Duarte and Salazar, 2021, Chen, 2013, Gallego, 2015, Neugart and Rode, 2021), and Italy (Cerqua et al., 2023, Gualtieri et al., 2025, Masiero and Santarossa, 2021), highlighting how disaster response can shape electoral outcomes depending on visibility, civic capital, and institutional capacity. Our study contributes to this literature by shifting the focus from whether voters reward competence to how natural disasters alter the traits they prioritize in political representatives — such as competence, gender, and age — during moments of crisis.

A second strand of literature, grounded in *political selection theory*, highlights that in emergency contexts voters prioritize governing capacity over ideological alignment (Clarke et al., 2004, Giuliano and Spilimbergo, 2025). Immediate and visible responses tend to be rewarded over long-term preventive measures, reinforcing a demand for competence, professionalism, and reassurance (Hartmann, 2022, Varieties of Democracy (V-Dem) Project, 2024). In these settings, personal characteristics such as education, age, and gender can become particularly salient in voters' evaluations. Empirical studies confirm that large-scale crises — whether economic, health-related, or environmental — can permanently alter voters' preferences and increase the value placed on technical skills. For instance, economic downturns have been linked to the election of more educated mayors in Spain (Bagues and Esteve-Volart, 2016) and Brazil (Brollo et al., 2013), and education is broadly associated with better governance and growth outcomes (Besley, 2005, Besley et al., 2011). In Chile, voters reward proven crisis managers after disasters (Acuña-Duarte and Salazar, 2021), and in Mexico, institutional incentives improve candidate quality (Dal Bó et al., 2013). In parallel, research in gender and disaster studies has shown that post-crisis environments often heighten demand for empathy, inclusion, and social cohesion — attributes frequently associated with female candidates (Bradshaw et al., 2022, Enarson, 2000). Experimental evidence suggests that, in the aftermath of disasters, women are evaluated more positively when electoral agendas prioritize welfare

and collective care (Carnes and Lupu, 2016, Teele et al., 2018). Our study adds to this literature by showing that natural disasters can act as catalysts for competence- and care-based political selection. We go beyond party alignment to explore how seismic shocks shift voter attention toward candidates' individual traits — such as education, age, and gender — highlighting how crisis contexts reshape both electoral demand and the personal attributes deemed desirable in local leadership.

Taken together, our findings suggest that natural disasters function as critical junctures in democratic life, prompting voters to recalibrate their expectations and demand more capable, credible, and inclusive leadership. From a policy perspective, this evidence underscores the need to consider how crisis events can influence not only public spending or institutional trust, but also the long-term composition and quality of political leadership at the local level. Recognizing and facilitating this shift — particularly through electoral rules or civic engagement efforts — may help enhance democratic resilience and administrative effectiveness in the face of future emergencies.

The rest of the paper is organized as follows. Section 2 outlines specific features of the Italian institutional framework and the possible voter's response to natural disasters. In Section 3 we describe the variables of the analysis. Section 4 illustrates the empirical strategy for the main analysis, and Section 5 presents evidence of the effect of the occurrence of a destructive earthquake on local politician's characteristics. Sections 6 and 7 show robustness to the estimation method and further evidences, respectively. Section 8 discusses the main results and analyses some alternative/additionally mechanisms. Section 9 concludes.

2 Italian Institutional Framework

Italy's sub-national government consists of regions (20), provinces (110), and municipalities (approximately 7,900), where this analysis focuses on. The political structure of a municipality consists of three distinct bodies: the Municipal Council (councilors), the Mayor, and the Municipal Executive (aldermen). Municipal Council is the main deliberative body of the municipality. Its functions include approving the municipal budget and financial plans, adopting urban planning regulations, overseeing the mayor and the executive, and passing local laws and policies. It represents the democratic will of the citizens at the local level. The Municipal Council is elected by citizens every five years[1] and its size is determined by the population of the municipality. The mayor, who is also directly elected by citizens, is subject to a two-term limit.[2] The mayor, who is also a

[1]The term was shortened to four years until 2000 (Law 25/3/1993, n. 81, art.2; DLgs 18/8/2000, n. 267, art.51).

[2]For municipalities with fewer than 3,000 inhabitants, the mayoral term limit was extended from two to three terms by Law 56/2014.

member of the Municipal Council, oversees the administration's governance, public order, civil defense, electoral and registry offices, and other duties delegated by a higher political body. Additionally, the mayor has the authority to issue decrees and ordinances. The Municipal Executive, selected by the mayor, collaborates with the mayor on municipal management. It is smaller than the Municipal Council, and its size is determined by the mayor, subject to a statutory maximum limit.[3]

Until 1993, the city council was elected using a proportional electoral system with closed party lists, and the mayor and executive were appointed from the elected councilors. However, Law 81/1993 reformed this system. Under the new system, the mayor is now directly elected by citizens using a plurality rule. Municipalities with fewer than 15,000 inhabitants hold a single voting round, while those with more than 15,000 inhabitants use a runoff system.

Although the mayor and the council are elected for a five-year term, their term may be terminated early under specific circumstances. These include permanent impediment, removal, expiration of the appointment, or death that prevents the mayor or the majority of the council from carrying out their duties. Additionally, early termination may occur in cases of violation of the Italian Constitution or laws, or failure to pass the budget. In such cases, early elections are held, meaning that the municipal elections in the data are staggered.

Since the analysis focuses on the outcome of the electoral process, we use panel data for the Italian municipalities in the *election year*, which refers to the year when the new administration is appointed.

In the time span of this analysis (1990-2019), two relevant institutional changes in municipal elections occurred, both dealing with the introduction of gender balance measures, that might be affected politician's characteristics. In 1993 Law no. 81/1993 introduced the gender quota at municipal elections. The reform prescribed, first, inter alia, the election of the mayor by universal suffrage; then, it established (art.5, subsequently modified by L 15/10/1993, no. 415, art. 2) that, for municipalities with more than 15,000 inhabitants, no more than 2/3 of the candidates on an electoral list could be of the same sex, whereas for municipalities with less than 15,000 inhabitants, the threshold was fixed at 3/4. In September 1995, the Constitutional Court (Sentence no. 422) declared the gender quota unconstitutional because prejudicial to art. 3 and art. 51 of the Italian Constitution that enshrine the fundamental principle of equal access to elective offices; hence, no preferential treatment could be performed on the basis of sex.[4] Therefore, the law was only enforced during municipal elections between March 25, 1993 and September 12, 1995. De Paola et al. (2010) find that that women's representation in politics grew

[3]The Italian law states that aldermen are nominated by the mayor among the elected council members (in municipalities with less than 15,000 inhabitants) or also outside (in municipalities with 15,000 or more inhabitants).

[4]All other provisions of law no. 81/1993 were unaffected by the Judgement of Constitutional Court.

considerably more in municipalities affected by Law 81 compared to those that were not affected. By exploiting the same gender reform, Baltrunaite et al. (2014) demonstrated that gender quota improved the quality of elected politicians (measured by their education) and that this effect is driven not only by the increased number of elected women, who tend to be more educated than men on average, but also by the reduced number of elected men with lower education.

The second change in municipal elections occurred in 2012, when Law 215 went in force. The law mandates that in municipalities with more than 5,000 residents, neither gender can make up more than two-thirds of the total candidates on party council lists. This means that at least one-third of the candidates must be women. Additionally, the law introduced a double-preference voting system based on gender, allowing voters to choose either one candidate from the list or one man and one woman (but not two men or two women). These provisions apply solely to the election of city councilors and do not extend to the mayor or executive committee members. Law 215/2012 does not apply to municipalities in the five special-statute regions — Friuli-Venezia Giulia, Sicily, Trentino-Alto Adige, Valle d'Aosta, and Sardinia — since these regions have their own legislative frameworks and use different laws to promote gender equality. Baltrunaite et al. (2019) provide evidence that Law 215/2012 was effective in promoting women presence in city council.

2.1 Possible voter's response to natural disasters

The political consequences of natural disasters are shaped not only by institutional responses but also by voters' evolving expectations and perceptions of political leadership. Disasters create high-stakes environments in which electoral preferences may shift, reflecting changing demands for specific leadership traits. In such contexts, voters may reassess the qualities they value in elected officials, including gender, education, and age, leading to potential reconfigurations in political support. The following sections explore how these individual characteristics of politicians influence voter preferences in the aftermath of an earthquake, drawing on existing literature and theoretical insights.

The preference of voters for female politicians after a natural disaster cannot be generalized, but it may depend on how voters perceive the qualities needed to address the crisis and how ready society is to overcome gender biases. Female politicians may be perceived as more empathetic and sensitive to the immediate needs of the population, such as managing shelters, caring for vulnerable people, and providing psychological support (Eagly et al., 2007). Some voters might prefer women in emergency situations due to the perception that they have a greater inclination toward care and emotional support, qualities that could seem particularly relevant after a natural disaster (Enarson, 2000). Some studies suggest that women, in general, tend to favor more collaborative and inclusive ap-

proaches in crisis management. In the context of post-earthquake reconstruction, policies of solidarity and cooperation may gain more support from voters, which could lead to an increase in support for female-led policies (Beaman et al., 2012). However, there are also gender stereotypes that could influence the perception of women's leadership abilities, especially in times of crisis (Eagly and Karau, 2002). Some voters may be less inclined to vote for women if they associate leadership with qualities traditionally perceived as more masculine, such as decisiveness, the ability to make quick and authoritative decisions (Capraro and Sippel, 2017, Schein, 2001).

After a natural disaster, voters tend to focus more on the perception of competence and the ability to solve urgent problems. Politicians with a solid academic background may be perceived as better prepared to make informed decisions and tackle the complexity of the situation (Arceneaux and Vander Wielen, 2023, Hansen and Tyner, 2019). However, in certain contexts, natural disasters may drive voters to prefer less-educated or more populist politicians. Hartmann (2022) finds that following extreme events, voters tend to reward immediate relief efforts rather than long-term preparedness, favoring candidates perceived as responsive and closely connected to local needs, but not necessarily technically skilled. Similarly, research on Hurricane Sandy in 2012 indicates that voter behavior was strongly influenced by partisan affiliation rather than candidate education or technical competence. In predominantly Democratic counties affected by the storm, Obama experienced increases in vote share, while in heavily Republican counties, his vote share declined — suggesting that partisan retrospection, rather than merit-based assessment, shaped electoral outcomes (Heersink et al., 2020).

The response of voters towards the age of politicians after an earthquake appears to be twofold. On the one hand, in the wake of a natural disaster, many voters may seek fresh, dynamic leaders who are perceived as capable of managing emergencies swiftly and efficiently. Younger politicians may be seen as more responsive, innovative, and attuned to contemporary technologies and solutions — qualities considered crucial for organizing relief efforts and planning post-disaster reconstruction. In this view, age may act as a proxy for energy, adaptability, and modern competence (McClean and Ono, 2024, Riggle and Johnson, 1996). Even without knowing their political background, voters may infer that older candidates have acquired broader experience through life, making them better equipped to handle complex, high-pressure situations such as the aftermath of an earthquake. In this sense, age may also function as a proxy for accumulated experience and resilience. As a result, voter preferences regarding the age of politicians after a disaster are ambiguous, and no clear-cut prediction can be made ex ante.

3 Data and variables

Main regressor. Since voters are unlikely to alter their political preferences without any visible impact of an earthquake, in our baseline analysis, we use destructive earthquakes to select municipalities in the treatment and control group from 1990 to 2019. Data on seismic events in Italy come from the INGV (Istituto Nazionale di Geofisica e Vulcanologia).[5]

To construct the dataset, we used the DBMI15 database provided by INGV, selecting all earthquakes that occurred between 1990 and 2019. The goal was to structure a panel dataset in which the statistical unit of reference was the municipality affected or not by a seismic event. However, a relevant methodological issue concerns the identification of the municipalities affected by an earthquake. The epicenter does not necessarily fall within a single municipality, but may be located in areas such as: 1) hamlets or subdivisions of municipalities, requiring reallocation of the event at the municipal level; 2) intermediate areas between multiple municipalities, where the earthquake affected several locations, requiring territorial aggregation to properly assign the event's effects. To address these complexities, we applied a territorial assignment procedure that allowed us to associate each seismic event with the municipalities actually involved, based on the macroseismic intensity data recorded in DBMI15. The territorial assignment of earthquakes was carried out using spatial geolocation techniques to ensure accurate matching between seismic events and the affected municipalities. Specifically, using the geographic coordinates (latitude and longitude) of the locations impacted by each earthquake, along with magnitude and intensity data, we assigned each event to the nearest municipality based on the updated territorial classification from ISTAT 2024. The result of this procedure is the construction of an original panel dataset that links each Italian municipality affected by an earthquake to the corresponding year of the event and its measured intensity. This structure allows us to track seismic exposure over time at the municipal level and to merge these data with socio-political and economic variables for empirical analysis. The dataset represents a valuable tool for studying the heterogeneous impacts of natural disasters across space and time.

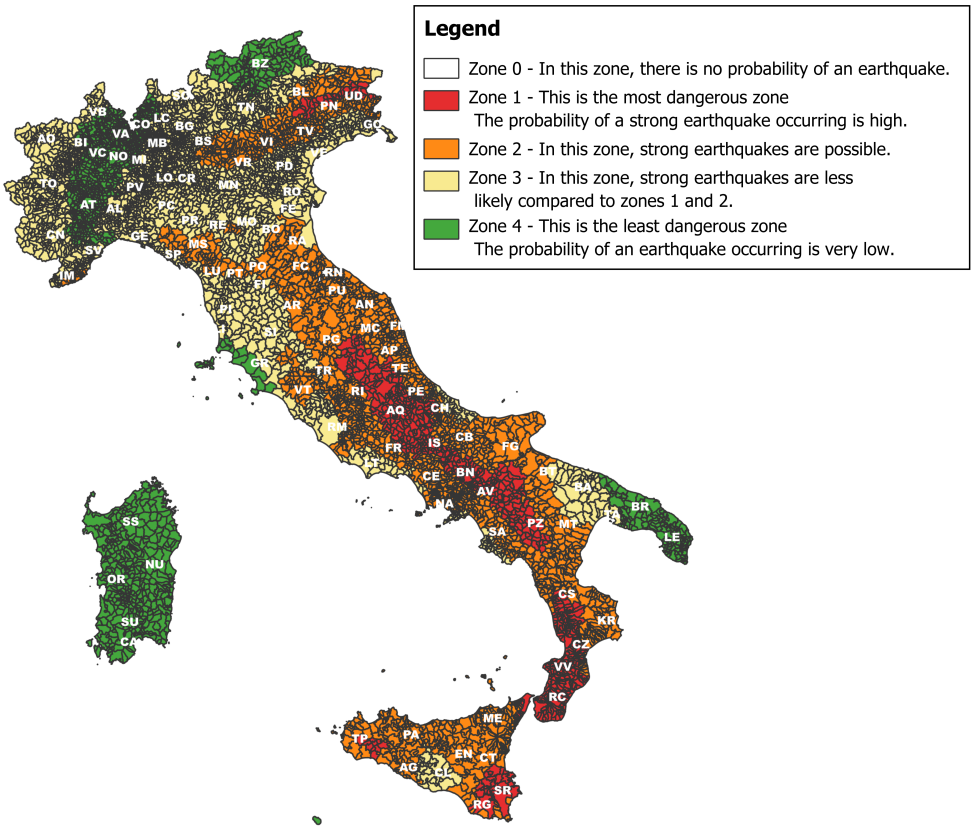
Although seismic event records in Italy are available from the beginning of the century, we restrict the time span of the analysis to the period starting in 1990. This choice is motivated by data availability: from 1990 onward, the Ministry of the Interior provides

[5]The Istituto Nazionale di Geofisica e Vulcanologia (INGV) is the Italian public agency responsible for monitoring seismic and volcanic activity across the national territory. It operates the National Seismic Network and collects, processes, and disseminates high-resolution data on seismic events, including magnitude, epicentral coordinates, focal depth, and macrosesmic parameters. Key datasets used in scientific research include the Catalogo Parametrico dei Terremoti Italiani (CPTI), which documents historical and recent earthquakes from the year 1000 onward, and the Database Macrosismico Italiano (DBMI), which provides intensity estimates based on observed impacts. INGV data are widely employed in studies of seismic risk assessment, institutional disaster response, and the socio-economic impacts of earthquakes.

more complete and systematically collected information on municipal elections, ensuring greater consistency and reliability for the political variables used in the analysis.

Following the economic literature (e.g., Belloc et al., 2016; Masiero and Santarossa, 2021; Cerqua et al., 2023), we define the treatment as the physical and human damages caused by earthquakes with intensity equal to or greater than 5 on the Mercalli scale.[6] Accordingly, the treatment group is made up of municipalities affected by an earthquake with intensity at least equal to 5. To avoid confounding effects, we insert in the control group those municipalities unaffected by earthquakes in the time-span 1990-2019.[7] Moreover, to compare municipalities that are as similar as possible in terms of treatment, we exclude from the sample all municipalities located in the green area on the map in Figure 1, that is, those municipalities belonging to areas with very low probability of an earthquake.

Figure 1: Geographical distribution of the earthquakes in Italy



Note. The colors in the map show the probability of an earthquake according to the legend. The two letters on the map correspond to the abbreviations of the provincial capitals. Period: 1990-2019. Our elaboration.

[6]The analysis of the effects of past earthquakes indicates that tremors with an intensity equal to or greater than level 5 on the Mercalli scale have generally caused structural damage.

[7]An analysis concerning the effect of earthquakes with an intensity lower than 5 on the Mercalli scale will be part of the robustness checks.

Dependent variables. The city council composition is provided by the Italian Ministry of the Interior. The Italian Ministry of Interior provides information on name, gender, education, occupation, date of birth, place of birth, political parties affiliation, etc, of councilors and mayor.

The first characteristic we are interested in is the gender composition of the city council. Accordingly, we use the percentage of female councilors elected at each electoral round from 1990 to 2019 (*Female councilors*). When dealing with leadership position, we consider a dummy for the gender of the mayor, 1 if she/he is female and 0 otherwise (*Mayor's gender*).

The second city councilor's characteristic is the education since it is considered as good proxy for the quality/ability of politicians (Besley and Reynal-Querol, 2011, Dal Bó et al., 2006, Fortunato and Panizza, 2015, Galasso and Nannicini, 2011, Glaeser et al., 2004, Kotakorpi and Poutvaara, 2011). We convert the qualitative data on the degrees held by councilors and mayors into years of education. Where data are not available, we exploit information about politicians' previous occupations to infer, where possible, the level of education required for such occupations. Therefore, we tab the measure of the city councilor's education as the follow: no education = 0 years; primary education = 5 years; lower secondary = 8 years; upper secondary = 13 years; university or higher = 18 years. We do the same for the mayoral education (*Councilor's edu* and *Mayor's edu*, respectively).

Finally, starting from the date of birth of councilors and mayor, we calculate their average age (*Councilor's age* and *Mayor's age*, respectively). Table A.1 in Appendix A shows the descriptive statistics.

Figure B.1 in Appendix B shows the dynamic, over years of elections in the treatment and control group of municipalities, of the three variables just described above for city councilors.

For female councilors in Graph B.1a their increase is clearly visible immediately after the two gender realignment laws, that is, after Law 81/1993 and Law 215/2012 in both the group of municipalities. Along the time-span 1990-2019, the trend of the percentage of female councilors is increasing and, on average, female councilors are higher in the control group than in the treatment group of municipalities. The same increasing trend is shown in both Graphs B.1b and B.1c; councilor's education seems higher in the treatment group than in the control group while councilor's age overlaps in both the groups of municipalities. For the last two measures of councilor's characteristics, the pattern over electoral years repeats when dealing with the mayor, as Graphs in Figure B.2 Appendix B show.

Control variables. In all the estimates we insert resident population that control for dimensional issues (*Pop*). In order to control for the two gender reform discussed above,

we control 1) for a dummy variable *Law81* that takes the value of 1 for municipalities voting under Law 81/1993 (i.e., those voting between March 25, 1993 and September 12, 1995) and 0 otherwise; 2) for a dummy variable *Law215* taking the value of 1 for municipalities voting under Law 215/2012 (i.e., those with resident population above 5,000 resident in the regions with ordinary statute) and 0 otherwise. For municipalities in regions with special statute the adoption dates of the dual gender preference voting system where: Sicily 9-10 June 2013, Sardinia 31 June - 1, 2015, Friuli-Venezia Giulia 25 May 2014, Trentino-Alto Adige / Südtirol 10 May 2015, and Valle d'Aosta September 20–21, 2020. Accordingly, we construct the dummy *Law215* for municipalities in regions with special statute.

As robustness, we add among regressors 1) the average education level of municipal resident population (*Municipal education*); 2) the rate of municipal unemployment (*Municipal unemployment*); 3) the municipal participation rate to the labor market (*Municipal participation*). These three variables are taken from the 1991-2001-2011 Census data. The descriptive statistics of the control variables are in Table A.2 in Appendix A.

4 Empirical strategy

In order to gauge how the occurrence of a destructive earthquake affects the preference of voters toward the gender, the quality/ability and the dynamism/competence of local politicians, we compare the percentage of female politicians, the average education and age of politicians at elections before and after the seismic shock between treated and untreated municipalities. In the first part of the analysis we concentrate on elected councilors that receive the votes from the electorate. We apply the Difference-in-differences (DiD) methodology by exploiting the staggered occurrence of destructive earthquakes over time (between 1990 and 2019) across Italian municipalities. As said above, we identify as the treatment group the municipalities interested by an earthquake of intensity greater or equal than 5 on the Mercalli scale and as control group the municipalities unaffected by earthquakes. Therefore, we drop from the sample the municipalities affected by earthquakes of intensity lower than 5. Accordingly, we define the treatment variable for the Average Treatment Effect (ATE) estimates, for municipalities in the treatment group, as a dummy taking the value of 1 starting from the first election after the earthquake onward and 0 before, while it is equal to 0 within the time-span for municipalities in the control group (thereafter *Earthquake*). This staggered DiD strategy makes it possible to calculate the average variation in politician's characteristics in elections before and after the occurrence of the seismic shock.

The equation estimating the ATE is the following:

$$Y_{it} = \beta_1 Earthquake_{it} + \alpha_i + \delta_{st} + X_{it} + \epsilon_{it} \tag{1}$$

where Y_{it} is the measure of politician's characteristics at election t in municipality i. α_i represents the set of municipality fixed effects that control for heterogeneity in the cross-section dimension and account for unobserved time-invariant factors that could engender omitted-variable bias. δ_{st} are the regional time trends controlling for unobserved time-specific events that affect all municipalities in the same region. X_{it} is the vector of control variables listed above, namely resident population, the two dummies for the gender quota laws, the variables controlling for the education, the unemployment and the labor force participation of municipalities. ϵ_{it} is the idiosyncratic error term.

In order to assess for the validity of the parallel trend assumption in DiD approach as well as for the comparison of the trajectories of politician's characteristics for treated and untreated municipalities in each electoral round after the occurrence of the earthquake, we estimate an event-study model (Mora and Reggio, 2019).

The fully-dynamic regression equation is:

$$Y_{it} = \sum_{t=-n}^{+n} \nu_t \cdot D_{it} + \alpha_i + \delta_{st} + X_{it} + \epsilon_{it} \tag{2}$$

where D_t is the set of event-time dummies, which take the value of 1 only for treated municipalities if the electoral year t is k periods before/after the occurrence of the earthquake. As usual in this kind of analysis, we use as the omitted category, D_{-1}, the electoral year before the first electoral round after the earthquake; the remaining ν_t coefficients measure the difference in the outcome variables in the period before and after the earthquake (t_0) in treated municipalities compared to untreated municipalities.

5 Results

5.1 ATE of earthquakes on councilor's characteristics

First, we are interested in examining the average impact of the occurrence of an earthquake on the characteristics of local political body, namely, the average variation in the gender composition of city council, in the councilor's level of education and age, between municipalities in the treatment and control group before and after the disaster. All outcome variables are expressed in logarithms to allow the interpretation of the treatment coefficients in terms of elasticities. We recall that municipalities in the treatment group experienced a *destructive* earthquake, namely an earthquake with intensity greater or equal than 5 on the Mercalli scale; municipalities in the control group experienced no earthquakes at all. Accordingly, assuming that the treatment is either on or off, we provide a binary treatment indicator, *Earthquake*, that assumes the value of 1 from the first election after the occurrence of the destructive earthquake onward and 0 otherwise. Moreover, in order to compare units as similar as possible, we drop from the sample all

the municipalities belonging to the green area in the map in Figure 1, that is, the area with the lowest probability of earthquakes. We consider, as unit of time, the electoral round where voters can express their preferences for local candidates and elect their representatives in city council. The time-span is 1990-2019. In all the empirical specifications we control for municipality FE, regional time trend and resident population; standard errors are clustered at municipal level.

The results of the DiD estimates as in eq. 1 are displayed in Table 1. At first glance, the coefficient of *Earthquake* is positive and highly significant everywhere meaning that the percentage of female councilors, the councilor's education and age increased as a consequence of the occurrence of a *destructive* earthquake. More in detail, Column 1 shows an increase of female councilors after a seismic event by 13.4% in the treatment group than in the control group. This coefficient slightly reduces when we control for municipal characteristics (as in Column 4). After an earthquake, the average councilors education and age increases of about 1% (as in Columns 2 and 3, respectively) in the treatment group compared to the untreated one and the coefficients slightly reduce when we add control variables (as in Columns 4 and 5).

To better contextualize the estimated effects, we compare them with the average values of the dependent variables reported in Table A.1. The DiD coefficient for the percentage of female councilors is approximately 0.13, which corresponds to a 13.9% increase. Given that the average percentage of female councilors is 20.4%, this implies an increase of about 2.8 percentage points — equivalent to roughly one-seventh of the mean level. For councilors' education, the estimated effect of 0.007 translates into a 0.7% increase relative to an average of 12.55 years, corresponding to an increase of approximately 0.09 years — less than 1% of the mean. Similarly, the effect on councilors' age implies a 0.68% increase over an average age of 42.63 years, amounting to roughly 0.29 years — again, a modest change relative to the baseline. These comparisons indicate that while the effects on education and age are quantitatively small, the shift in female representation is relatively more pronounced in proportional terms.

The coefficients associated with Law 81/1993 and Law 215/2012 provide important institutional context for interpreting changes in the composition of municipal councils. Law 81/1993 is consistently associated with a positive and statistically significant effect on the percentage of female councilors (Columns 1 and 4) and average education (Columns 2 and 5), while showing a negative effect on the average age of councilors (Columns 3 and 6). In contrast, Law 215/2012 exhibits a large and highly significant positive effect on the female percentage of council members (Columns 1 and 4), consistent with its intended goal of promoting gender balance in local representation. However, it is also associated with a statistically significant decrease in both education and age of elected officials (Columns 2, 3, 5, and 6). Together, these results highlight the importance of institutional reforms in shaping the profile of local political elites, and underline the need

to account for such legislative changes when estimating the impact of exogenous shocks such as natural disasters.

Table 1: ATE standard DiD - Councilor's characteristics

	(1)	(2)	(3)	(4)	(5)	(6)
Dep. Var.	Female councilors	Councillor's edu	Councillor's age	Female councilors	Councillor's edu	Councillor's age
Earthquake	0.134***	0.0114***	0.0109***	0.129***	0.00703**	0.00684***
	(0.0303)	(0.00334)	(0.00259)	(0.0298)	(0.00318)	(0.00254)
Pop	4.83e-06	1.08e-06**	1.26e-07	5.73e-06*	1.03e-06***	-1.20e-07
	(3.74e-06)	(4.32e-07)	(2.38e-07)	(3.27e-06)	(3.82e-07)	(2.45e-07)
Law81	0.709***	0.0183***	-0.0515***	0.708***	0.0215***	-0.0479***
	(0.0188)	(0.00199)	(0.00170)	(0.0191)	(0.00196)	(0.00170)
Law2012	0.621***	-0.0137***	-0.0328***	0.624***	-0.0101***	-0.0297***
	(0.0282)	(0.00361)	(0.00323)	(0.0284)	(0.00364)	(0.00324)
Municipal education				1.262***	0.302***	0.180***
				(0.337)	(0.0418)	(0.0305)
Municipal unemployment				0.466*	-0.0469*	-0.0629***
				(0.239)	(0.0270)	(0.0222)
Municipal participation				-0.433	0.0503	0.166***
				(0.272)	(0.0327)	(0.0289)
Observations	17,768	17,843	17,872	17,735	17,810	17,839
N. Municipalities	2,644	2,644	2,644	2,631	2,631	2,631
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
Regional time trends	Yes	Yes	Yes	Yes	Yes	Yes

Note. The dependent variables are: the percentage of female councilors, in natural log (Columns 1 and 4), the average years of education of councilors, in natural log (Columns 2 and 5), the average age of councilors, in natural log (Columns 3 and 6). *Earthquake* is a dummy taking the value of 1 for treated municipalities in all the years from the first voting after an earthquake with intensity greater or equal than 5 to 2019, and to 0 otherwise; for control group of municipalities *Earthquake* takes the value of 0 along the entire time-span. Coefficients of municipality FE and regional time trends are not reported. Standard errors adjusted for clustering at the municipal level are in brackets. Period: 1990-2019. Significant coefficients are indicated by * (10% level), ** (5% level) and *** (1% level).

The last three covariates in Table 1 - average education level of residents, local unemployment rate, and participation rate to the labor market - serve as controls for socio-economic conditions that may influence political selection. The results show that higher average education at the municipal level is positively associated with the election of more educated and older councilors (Columns 5 and 6), suggesting that more educated electorates may value experience and competence. Unemployment, by contrast, is negatively associated with both education and age of elected officials, potentially reflecting anti-incumbent or anti-establishment dynamics in economically distressed areas. Labor market participation appears only weakly correlated with the outcome variables, showing no consistent or significant pattern across specifications.

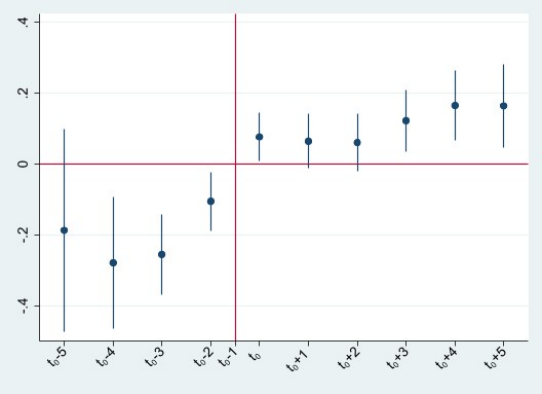
5.2 Dynamic specification

Figure 2 presents event-study estimates of the impact of earthquakes on the composition of municipal councils. The first panel (Graph 2a) shows a marked and persistent increase in the share of women among elected council members following the occurrence of a seismic event. The second and third panels (Graphs 2b and 2c) report similar dynamics for the average education and average age of council members, respectively. In all three cases, the treatment effects appear to materialize immediately after the event and remain stable or grow in magnitude across subsequent electoral cycles. Importantly, except for the percentage of female councilors, pre-treatment coefficients are generally close to zero and statistically indistinguishable from each other, lending support to the parallel

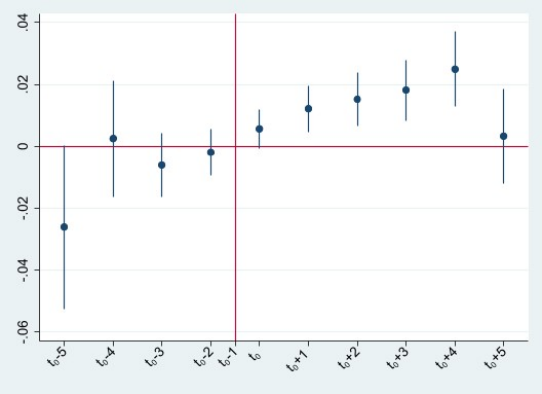
trends assumption at least for the average education and age of city councilors. The validity of the parallel trend assumption is also supported by the p-value of the F-test that all the pre-treatment coefficients are jointly equal to 0 that is equal to 0.25 and 0.84, respectively for Graphs 2b and 2c. Instead, for Graph 2a, it is equal to 0.00. This pattern strengthens the credibility of the causal interpretation, suggesting that the observed changes in political representation, at least in terms of higher education and age, are a direct response to the earthquake shock rather than the continuation of pre-existing trends. The persistence of the effects across multiple time periods further points to a durable shift in voter preferences or political selection mechanisms triggered by the disaster.

Figure 2: Event-study model

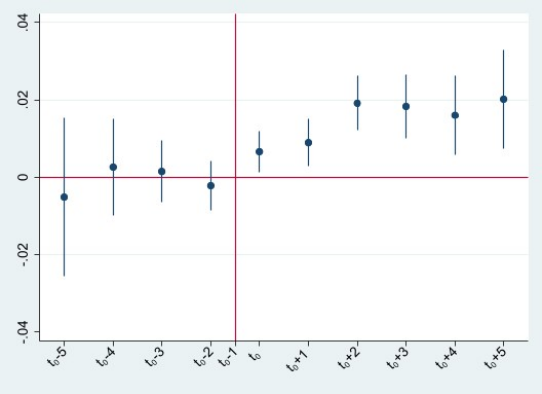
(a) Female councilors



(b) Councilor's education



(c) Councilor's age

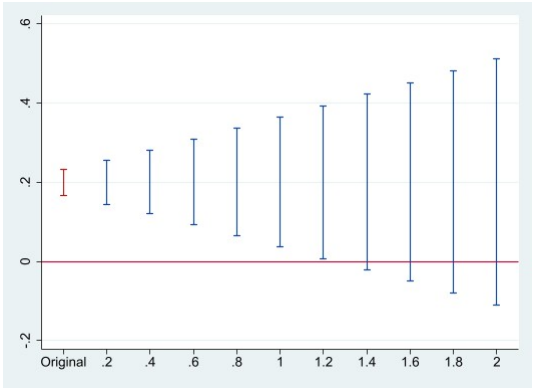


Note. The graph reports coefficients and confidence intervals estimated according to eq. 2. The dependent variables are: the percentage of female councilors, in natural log (Graph 2a), the average years of education of councilors, in natural log (Graph 2b), the average age of councilors, in natural log (Graph 2c). Standard errors are clustered at municipal level. Dots refer to point estimates, spikes to 95% confidence intervals. All regressions include municipality FE, regional time trends and additional controls: *Pop*, *Law81*, *Law215*. The p-value of the F-test that all the pre-treatment coefficients are jointly equal to 0 are 0.00, 0.25 and 0.84 for estimation in Graph 2a, Graph 2b and Graph 2c, respectively. Period: 1990-2019.

To assess the robustness of our estimated treatment effects under plausible violations of

the parallel trends assumption as in Graph 2a, we implement the Honest DiD methodology developed by Rambachan and Roth (2023). This approach relaxes the strict parallel trends assumption by allowing for a bounded degree of deviation in pre-treatment dynamics, controlled by the parameter M, which represents the maximum slope in the evolution of untreated potential outcomes. We apply the C-LF method and examine a range of values for M between 0 and 2. The results indicate that our original estimate remains within the confidence region even under moderate deviations from the parallel trends assumption. For instance, with M = 0.6, the identified set for the treatment effect is [0.093, 0.308], which still excludes zero and supports a positive effect. The lower bound of the interval becomes negative only for $M > 1.2$, suggesting that the main conclusions are robust unless one assumes implausibly large violations of parallel trends. This analysis reinforces the causal interpretation of our findings about the increase in female political representation in city council after an earthquake, as the estimated effect persists under reasonable relaxations of the identifying assumptions.

Figure 3: HonestDiD - Female councilors



Note. The Graph shows the result of the sensitivity analysis to violation of the parallel trend assumption for estimation of the percentage of female councilors by using the *honestDiD* Stata command by Bravo et al. (2024). Period: 1990-2019.

5.3 Continuous DiD

The standard DiD approach we just used assumes that the treatment effect is the same for every municipality in the treatment group, which might overlook important variations in how voters can be affected by the disaster. Moreover, the standard DiD accounts only for the variation in voters behavior to destructive earthquakes (being more plausible that voters can change their preferences toward politicians after a destructive disaster, as argued by the literature — Belloc et al. (2016)), neglecting the possibility of reactions according to the intensity of the earthquake. In order to catch for this aspect, we adopt a more suitable approach that is useful when the treatment varies in intensity over time or across different units, the continuous DiD. In this case, the treatment variable is the degree of the earthquake on the Mercalli scale. For municipality experiencing more than one

earthquake, the treatment variable assumes the value of the earthquake on the Mercalli scale from the first election after the first occurrence until the last election before the new earthquake and onward to the end of the dataset (hereafter *Earthquake Intensity*). The continuous approach can account for changes in outcomes as a function of the treatment intensity. Results of the ATE estimate are in Table 2.

Table 2: ATE Continuous DiD- Councilor's characteristics

	(1)	(2)	(3)	(4)	(5)	(6)
Dep. Var.	Female councilors	Councillor's edu	Councillor's age	Female councilors	Councillor's edu	Councillor's age
Earthquake Intensity	0.0358***	0.00245***	0.00108**	0.0354***	0.00192***	0.000568
	(0.00621)	(0.000687)	(0.000530)	(0.00613)	(0.000658)	(0.000518)
Pop	4.24e-06	1.03e-06**	6.92e-08	5.15e-06	1.00e-06***	-1.58e-07
	(3.79e-06)	(4.33e-07)	(2.36e-07)	(3.30e-06)	(3.83e-07)	(2.44e-07)
Law81	0.705***	0.0179***	-0.0521***	0.705***	0.0214***	-0.0481***
	(0.0187)	(0.00199)	(0.00170)	(0.0190)	(0.00196)	(0.00170)
Law2012	0.625***	-0.0135***	-0.0330***	0.629***	-0.00983***	-0.0297***
	(0.0283)	(0.00361)	(0.00324)	(0.0285)	(0.00364)	(0.00325)
Municipal education				1.298***	0.304***	0.184***
				(0.336)	(0.0417)	(0.0306)
Municipal unemployment				0.472**	-0.0466*	-0.0653***
				(0.239)	(0.0270)	(0.0222)
Municipal participation				-0.419	0.0510	0.168***
				(0.272)	(0.0327)	(0.0289)
Observations	17,768	17,843	17,872	17,735	17,810	17,839
N. Municipalities	2,644	2,644	2,644	2,631	2,631	2,631
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
Regional time trends	Yes	Yes	Yes	Yes	Yes	Yes

Note. The dependent variables are: the percentage of female councilors, in natural log (Columns 1 and 4), the average years of education of councilors, in natural log (Columns 2 and 5), the average age of councilors, in natural log (Columns 3 and 6). *Earthquake intensity* assumes the value of the earthquake on the Mercalli scale from the first election after the first occurrence until the last election before the new earthquake and onward to the end of the dataset; for control group of municipalities *Earthquake intensity* takes the value of 0 along the entire time-span. Coefficients of municipality FE and regional time trends are not reported. Standard errors adjusted for clustering at the municipal level are in brackets. Period: 1990-2019. Significant coefficients are indicated by * (10% level), ** (5% level) and *** (1% level).

We find consistent evidence that earthquakes are associated with a significant increase in the percentage of female councilors, as well as in the average education and age of elected officials. The point estimates in the continuous DiD model are smaller in magnitude than that in Table 1 but remain statistically significant, suggesting a dose-response relationship: more intense earthquakes yield stronger shifts in voter preferences. Importantly, the coefficients in the ATE model represent average differences across treated and control groups, while the continuous DiD specification allows for variation in the treatment intensity, providing a finer-grained interpretation of the earthquake's effect. The robustness of results across both specifications strengthens the credibility of our findings and supports the hypothesis that natural disasters induce systematic changes in the type of individuals elected to local office.

5.4 Mayor's characteristics

It is possible that the shift in voters' preferences after an earthquake regarding the gender, education, and age of politicians may not go in the same direction for leaders (the mayor) as it does for councilors. Therefore, we repeat the baseline analysis considering the gender, education, and age characteristics of the mayor.

For the gender of the mayor, we construct a dummy taking the value of 1 if the mayor is female and 0 otherwise (hereafter *Mayor's gender*), that expresses the probability of electing a female mayor. It makes sense to calculate the probability of electing a female

mayor only if there is at least one woman in the pool of mayoral candidates. Therefore, we exclude all election rounds where there are no women among the candidates for mayor.

As a proxy for the mayor's quality, we take the years of education of the mayor (hereafter *Mayor's edu*) and as a proxy for the dynamism/experience of the mayor, we take its age (hereafter *Mayor's age*), both in natural log.

The results in Table 3 reveal that the occurrence of an earthquake significantly influences the characteristics of elected mayors. Municipalities affected by a seismic event are more likely to elect female mayors (Columns 1 and 4), with the treatment coefficient ranging between 0.037 and 0.044. Earthquakes are also associated with a statistically significant increase in the years of education (Columns 2 and 5) and age (Columns 3 and 6) of elected mayors. These findings mirror the patterns observed for municipal councilors, suggesting that post-disaster electoral dynamics favor candidates perceived as more competent, experienced, or prosocial.

To contextualize the estimated effects on mayors' characteristics, we compare the results with the corresponding sample means reported in Table A.1. The DiD coefficient for mayor's gender (0.0437) implies a 4.5% relative increase, which corresponds to an absolute increase of only 0.4 percentage points over a baseline of 8.7%. For education, the estimated effect of 0.0173 translates into a 1.75% increase over a mean of 14.59 years, or approximately 0.26 additional years of schooling. Similarly, the effect on mayoral age (0.0154) implies a 1.55% increase, equivalent to roughly 0.75 additional years. These results suggest that, although the effects are modest in absolute terms, they reflect meaningful shifts relative to the baseline, particularly in terms of educational and age profiles of local executive leadership.

When comparing the effects of earthquakes on mayors versus councilors, the treatment appears consistently positive and significant across both groups, indicating a broad shift in voter preferences toward political recruitment in the aftermath of natural disasters. However, the magnitude of the treatment effect on the mayor's characteristics is somewhat smaller, especially for education and age, compared to the effects observed for council members. This may reflect greater constraints or party influence in candidate selection for mayoral races. Nevertheless, the consistent direction and significance of the estimates support the interpretation that earthquakes induce a meaningful change in the profile of local political leadership, affecting both executive and legislative branches of municipal government.

Table 3: ATE - Mayor's characteristics

	(1)	(2)	(3)	(4)	(5)	(6)
Dep. Var.	Mayor's gender	Mayor's edu	Mayor's age	Mayor's gender	Mayor's edu	Mayor's age
Earthquake	0.0437***	0.0181**	0.0201***	0.0371**	0.0173**	0.0154**
	(0.0158)	(0.00817)	(0.00643)	(0.0157)	(0.00829)	(0.00644)
Pop	-1.74e-06	1.96e-06	-1.08e-06	-1.84e-06	1.87e-06	-1.11e-06
	(1.68e-06)	(1.25e-06)	(9.06e-07)	(1.68e-06)	(1.23e-06)	(8.84e-07)
Municipal education				0.234	-0.0208	0.226***
				(0.200)	(0.0999)	(0.0798)
Municipal unemployment				-0.301**	-0.0433	-0.0882*
				(0.130)	(0.0555)	(0.0517)
Municipal participation				0.0850	0.0569	0.0583
				(0.183)	(0.0870)	(0.0670)
Observations	8,844	18,176	18,003	8,814	18,142	17,969
N. Municipalities	2,593	2,644	2,644	2,580	2,631	2,631
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
Regional time trend	Yes	Yes	Yes	Yes	Yes	Yes

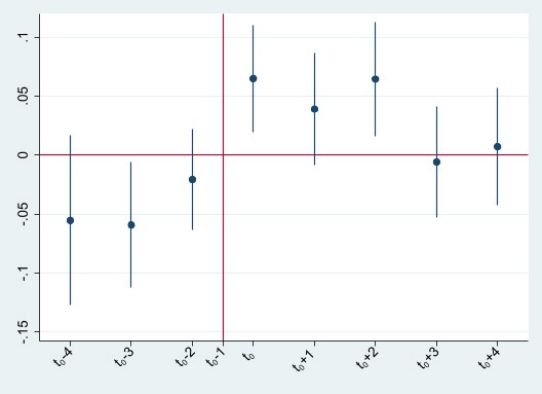
Note. The dependent variables are: a dummy for the gender of the mayor (Columns 1 and 4), the years of education of mayor, in natural log (Columns 2 and 5), the age of mayor, in natural log (Columns 3 and 6). *Earthquake* is a dummy taking the value of 1 for treated municipalities in all the years from the first voting after an earthquake with intensity greater or equal than 5 to 2019, and to 0 otherwise; for control group of municipalities *Earthquake* takes the value of 0 along the entire time-span. Coefficients of municipality FE and regional time trends are not reported. Standard errors adjusted for clustering at the municipal level are in brackets. Period: 1990-2019. Significant coefficients are indicated by * (10% level), ** (5% level) and *** (1% level).

Figure 4 presents event-study estimates of the effect of earthquakes on mayoral characteristics, including gender (Panel 4a), education (Panel 4b), and age (Panel 4c). Across all panels, the coefficients for pre-treatment periods are generally small and statistically indistinguishable from zero, suggesting that the parallel trends assumption is satisfied. For robustness, we perform the F-test that all the pre-treatment coefficients are jointly equal to 0. The p-value is equal to 0.14, 0.96 and 0.04, respectively. Therefore, while the validity of the parallel trends assumption is statistically supported for the mayor's gender and education, it is not for their average age.

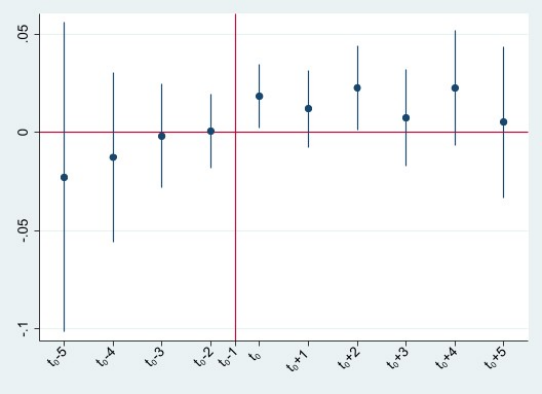
As we did previously, to assess the robustness of our findings to potential violations of the parallel trends assumption, as observed in Graph 4c, we implement the HonestDiD approach by Rambachan and Roth (2023), using the C-LF method. The results indicate that the original 95% confidence interval for the treatment effect lies between 0.014 and 0.038. As we allow for increasing deviations from parallel trends (indexed by the parameter M), the lower bound of the identified set gradually declines but remains positive up to M = 0.6, and only becomes negative for larger values of M. This suggests that the estimated effect remains robust under moderate violations of the identifying assumption, and that a substantially large and arguably implausible deviation from parallel trends would be required to overturn the positive effect. These results enhance the credibility of the causal interpretation.

Figure 4: Event-study model

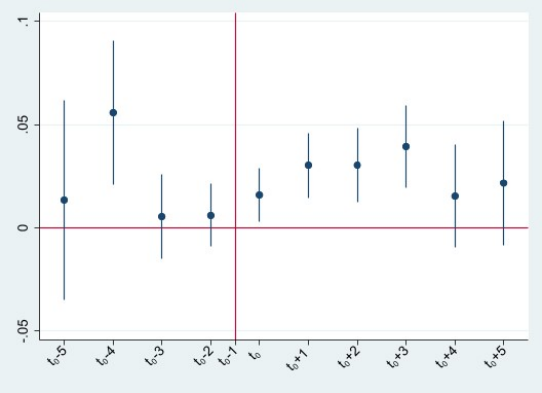
(a) Female mayor



(b) Mayor's education



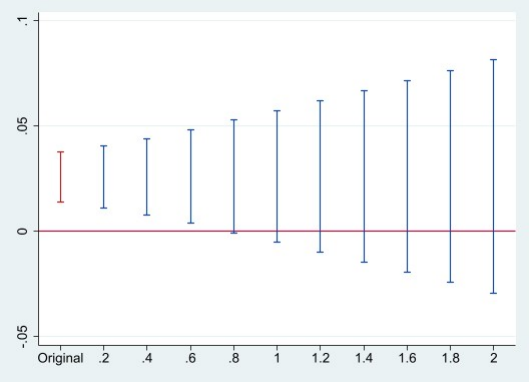
(c) Mayor's age



Note. The graph reports coefficients and confidence intervals estimated according to eq. 2. The dependent variables are: a dummy for the gender of the mayor, in natural log (Graph 4a), the average years of education of mayor, in natural log (Graph 4b), the average age of mayor, in natural log (Graph 4c). Standard errors are clustered at municipal level. Dots refer to point estimates, spikes to 95% confidence intervals. All regressions include municipality FE, regional time trends and *Pop* as additional control. The p-value of the F-test that all the pre-treatment coefficients are jointly equal to 0 are 0.14, 0.96 and 0.03 for estimation in Graph 4a, Graph 4b and Graph 4c, respectively. Period: 1990-2019.

The validation of the parallel trend assumption strengthens the causal interpretation of post-treatment effects. Following the earthquake, Panel 4a shows a marked and sustained increase in the probability of electing a female mayor, which remains positive and statistically significant at least for three electoral cycles. Panel 4b display more modest post-treatment effects: the average education of elected mayors increases slightly. Panel 4c display a more pronounced post-treatment effects for the mayor's age. Overall, the patterns suggest that seismic events trigger a shift in the profile of elected local executives, particularly along the gender and age dimension, while the effects on competence-related attributes (education) are present but more attenuated. The persistence of the effects across multiple terms points to a structural change in voter preferences in candidate selection mechanisms following a disaster.

Figure 5: HonestDiD - Mayor's age



Note. The Graph shows the result of the sensitivity analysis to violation of the parallel trend assumption for estimation of the mayor's age by using the *honestDiD* Stata command by Bravo et al. (2024). Period: 1990-2019.

5.5 Explanation of the post-treatment dynamic

Our event-study estimates indicate that the effect of earthquakes on the composition of local political elites is not transitory but persists across multiple electoral cycles. Following a seismic event, municipalities systematically elect more female, more educated, and older mayors and council members — not only in the immediate aftermath, but also in subsequent legislatures. One possible explanation for this persistence is that voters, initially motivated by the expectation of substantial post-disaster transfers from higher levels of government, select candidates perceived as better equipped to manage reconstruction funds — those with higher education, experience, and prosocial traits often associated with women. Over time, if these politicians meet or exceed expectations in managing public resources, voters may rationally update their beliefs and continue to reward these attributes in future elections. To assess the validity of this mechanism, we investigate the dynamics of post-disaster public procurement processes, focusing on the initiation and management of public works projects. Analyzing contracting procedures before and after the earthquake allows us to explore whether the persistence in voter preferences is linked to actual administrative performance in fund management, and not merely to symbolic signaling or initial strategic voting.

To this end, we regress the treatment variable (the occurrence of an earthquake) on the number of procurement contracts (CIGs) initiated by local administrations. The following data are taken from the ANAC (National Anti-Corruption Authority) database from 2007 to 2019.[8]

Table A.3, Appendix A, shows the results. In Column 1 we regress the treatment variable on the (log of) the total number of procedures initiated by the local government. Such procedures comprise those related to public works, services, and supplies. We use

[8]https://www.anticorruzione.it/banca-dati.

this comprehensive measure to capture the full scope of administrative response after an earthquake. While the largest increase is expected in public works - such as infrastructure repair and reconstruction - emergency situations typically also require a surge in service contracts (e.g., temporary housing, sanitation, technical assistance) and supply procurements (e.g., medical equipment, food, and other essential goods). The estimated coefficient measures an increase in the number of CIGs of 52% in municipalities affected by an earthquake compared to unaffected municipalities. In Column 2 we concentrate on the (log of) number of CIGs in public work. After a seismic disaster, we can observe an increase of this type of CIGs of about 35%.[9] Such a comprehensive rise in procurement activity across all categories of CIGs — and especially in public works — would offer stronger evidence that post-disaster local governance involves demanding and multifaceted administrative responsibilities. Crucially, it would suggest that voters reward these concrete efforts in managing reconstruction and emergency response by continuing, in subsequent elections, to favor candidates with traits perceived as effective for such tasks — namely, more educated, more experienced, and more frequently female political leaders.

6 Robustness of the DiD estimation method

6.1 Lagged Dependent Variable approach

In our baseline event-study specification, we examine the effect of earthquakes on the gender composition of municipal councils, using the occurrence of a seismic event with magnitude greater than 5 as the treatment. However, visual inspection of the pre-treatment dynamics and statistical tests indicate a violation of the parallel trends assumption for some outcomes, such as the share of women in local councils and the mayor's age. These results could be explained by the relevance of unobserved time-varying confounders correlated with the outcome and treatment that is at odds with parallel trends and DiD identification strategies. In this case, DiD estimates may be biased.

Since the early 1990s, Italian public opinion has increasingly focused on gender disparities in society, particularly in the political sphere. This growing attention has contributed to an upward trend in the representation of women in local councils (Baraldi et al., 2023). While we conducted a sensitivity analysis to assess the robustness of our causal claims against potential violations of the parallel trends assumption, we further address this issue by employing a lagged dependent variable model. This approach helps account for time-varying confounders by including the lagged outcome as a covariate. In

[9] To assess for the validity of such results, we estimate an event-study model for both the total number of CIGs and of CIGs in public works and we find the p-value of the F-test that all the pre-treatment coefficients are jointly equal to 0 are 0.16 and 0.24, respectively, supporting the validity of the parallel trend assumption for such estimates.

a lagged dependent variable (LDV) design, the identification of causal effects relies on the assumption of treatment unconfoundedness, conditional on past outcomes and observed time-varying covariates.(e.g., Angrist and Pischke, 2009; Arkhangelsky and Imbens, 2023; Roth et al., 2023; Xu, 2023). The occurrence of earthquakes can hardly be foreseen and the LDV model specification can purge estimates from the influence of time-varying confounders. Here, we estimate an LDV model of the static effect of the treatment and a specification that accounts for the dynamic future effects as in event-study specifications.

The LDV estimates reported in Table A.4 (Appendix A) broadly confirm the patterns identified in the standard DiD specifications (Tables 1 and 3), strengthening the interpretation that post-earthquake shifts in the composition of local political elites are not solely driven by pre-existing trends. In particular, the LDV results show that, after controlling for lagged values of the dependent variables, which helps account for potential violations of the parallel trends assumption detected in the event-study diagnostics, earthquakes are associated with a statistically significant increase in the percentage of female councilors (32.4%), the average education and age of councilors, as well as both the education and age of mayors.

Compared to the DiD results, the LDV estimates yield somewhat smaller effect sizes — consistent with the attenuation one might expect when accounting for past outcomes (e.g., Angrist and Pischke, 2009) — but the direction and statistical significance of the effects are largely consistent. For instance, in both approaches, earthquakes significantly increase the average years of education and the likelihood of female representation in municipal councils. The effect on mayoral characteristics is also confirmed: mayors in treated municipalities tend to be more educated and older, although the effect on the probability of electing a female mayor becomes statistically insignificant in the LDV framework. This attenuation may reflect greater persistence and inertia in mayoral turnover compared to council composition.

Figure B.3 in Appendix B shows the post-treatment dynamic of all the outcome variables that confirms the pattern displayed in Figures 2 and 4.

Overall, the LDV estimates provide robust support for the hypothesis that earthquakes act as a critical juncture, prompting a lasting change in voter preferences toward more competent, experienced, and gender-diverse political profiles, particularly at the council level. The consistency across estimation strategies increases our confidence that these observed shifts reflect genuine post-disaster political adaptation rather than mechanical statistical artifacts or baseline imbalances.

6.2 Heterogeneity of treatment effects

The resent literature (De Chaisemartin and d'Haultfoeuille, 2023) highlighted that, due to the staggered adoption of the treatment as in our case, where municipalities are affected

by earthquakes at different times, heterogeneous treatment effects emerge. These effects can lead to negative weights that could bias estimates. Indeed, since the causal impact of the treatment varies across different units and over time, the standard treatment effects derives from comparisons also between treated observations that, before the treatment, serve as controls. Therefore, the response to the treatment will not be uniform; for one unit or group, the treatment effect might be positive, while for another, it could be negative (De Chaisemartin and d'Haultfoeuille, 2020; Goodman-Bacon, 2021).

To tackle the issue of heterogeneous treatment effects, we apply the novel estimator introduced by Sun and Abraham (2021).[10] In this approach, the timing of policy adoption creates the heterogeneity. Units adopting the treatment within the same period experience similar dynamic effects, which differ from those observed in units from other cohorts. By aggregating the policy effect estimates for each cohort, we can obtain consistent average treatment effects.

Estimation results are in Table A.5 and in Figure B.4 respectively in Appendix A and B.

The results obtained using the Sun and Abraham (2021) estimator provide further validation of our DiD findings while addressing potential bias arising from treatment effect heterogeneity over time. Overall, the direction and statistical significance of the earthquake effects are largely consistent with those reported in the standard DiD estimates, though some effect sizes are slightly attenuated.

For councilors' characteristics, the Sun and Abraham (2021) estimates confirm that earthquakes are associated with an increase in the percentage of female councilors (Column 1), their average education (Column 2), and their average age (Column 3). These results mirror the DiD estimates in Table 1, reinforcing the interpretation that post-disaster environments foster the election of more educated, older, and more gender-diverse councils. Notably, the dynamic plots in Figure B.4 (panels B.4a–B.4c) indicate an upward trend in these outcomes that materializes gradually after the earthquake and stabilizes after two to three electoral cycles — supporting the view that these are persistent rather than short-lived effects. Moreover, the flat pre-treatment coefficients in the event-study plots suggest that the parallel trends assumption is more plausible for these outcomes.[11]

For mayoral characteristics, the Sun and Abraham (2021) estimator also yields results that align with the DiD estimates (Table 3), although with some differences. The effects on mayoral education (Column 5) and age (Column 6) are positive and statistically significant, consistent with the DiD findings. However, the effect on the probability of electing a female mayor remains negative and statistically insignificant, confirming the weak evidence found in the LDV specifications. These findings suggest that while the

[10] The Sun and Abraham (2021) estimator is implemented using the *eventstudyinteract* Stata command.

[11] In the footnote at Figure B.4 we report the p-value of the F-test that all the pre-treatment coefficients are jointly equal to.

composition of councils becomes more gender-diverse after an earthquake, changes in mayoral gender are less responsive — possibly due to incumbency dynamics or different voter expectations for executive roles.

The event-study plots (panels B.4d–B.4f in Figure B.4) also show that the effects on mayoral characteristics tend to materialize with a delay and exhibit more variability, consistent with the longer political cycles and less frequent turnover of mayors compared to councils. Nonetheless, the absence of strong pre-trends in these variables provides reassurance about the validity of the identification strategy.

In sum, the Sun and Abraham (2021) estimates provide a robust cross-check of our main findings, except for the gender of the mayor. They confirm that earthquakes act as a catalyst for compositional change in local political elites, particularly at the council level, and that these changes are sustained over time. Importantly, the improved credibility of the identification strategy strengthens the interpretation that voters respond not only to the symbolic appeal of certain candidate profiles but also to the perceived capacity of these individuals to manage complex post-disaster governance tasks.

7 Further evidences and robustness checks

7.1 Earthquakes with intensity lower than 5 on the Mercalli scale

In the main analysis, we provided statistical evidence that, following an earthquake with a intensity greater or equal than 5 on the Mercalli scale (i.e., an earthquake defined as destructive due to observable effects on humans, animals, buildings, and objects), voter preferences shift towards politicians with different characteristics in terms of gender, education, and age. But is this shift in preferences caused by the actual occurrence of damage generated by the earthquake, or can it also be observed if voters only perceive the risk of a destructive earthquake? To check for this, we perform the DiD analysis on councilor's and mayor's characteristics (except for the mayoral gender) using, as treated units, all the municipalities experiencing an earthquake of intensity lower than 5 in the Mercally scale, that is, a *weak* earthquake *Earthquake (*< 5*)*. The control group remains tha same as in the baseline analysis. Results ate in Table A.6, Appendix A.

No significant effects (at the conventional level of 5%) appear in the case of low-intensity earthquakes. Compared to the baseline DiD estimates in Tables 1 and 3, which show strong and robust increases in the education and age of both councilors and mayors as well as in the percentage of female councilors following destructive earthquakes, the insignificant effects observed here suggest that actual damage, rather than mere perceived risk, is what drives substantive changes in the composition of local political elites. Therefore, deeper transformations in terms of gender, competence and experience seem

to require the more demanding governance challenges posed by destructive events.

7.2 Municipalities at high hydro-geological risk

Italy is a country at high hydro-geological risk, namely, it is highly vulnerable to natural events related to land degradation, such as landslides, floods, mudslides, and inundations. Given the high probability of such events, which, like earthquakes, in their most devastating forms, require significant resources for reconstruction and the ability of politicians to manage these resources, they may have influenced voter preferences regarding the characteristics of local politicians. Therefore, in municipalities with high seismic and hydro-geological risk, the shift in voter preferences could be due to the occurrence of both events, earthquakes and landslides and/or floods. Alternatively, the occurrence of hydro-geological events could have influenced voter preferences in municipalities that have not experienced earthquakes, altering our control group. Furthermore, municipalities affected by an earthquake (the treated group) may have previously been affected by hydro-geological events that influenced voter preferences. These situations would alter our quasi-experimental design. To account for this, we collected data at the municipal level on the percentage of the municipal territory affected by hydro-geological disasters and excluded from the sample municipalities where this percentage exceeds 35% (this implies dropping 936 observations). To ensure the validity of our quasi-experimental design, we excluded from the sample municipalities where more than 35% of the territory is classified as being at hydro-geological risk. This threshold was chosen as an ad hoc yet conservative criterion to minimize the potential influence of overlapping vulnerabilities on voter behavior. Municipalities with extensive exposure to floods or landslides may develop distinct political dynamics or expectations, even in the absence of recent events, thus potentially confounding the identification of earthquake effects. The 35% cutoff reflects a practical judgment based on disaster planning practices, where areas with more than one-third of their surface exposed are often considered structurally vulnerable. At the same time, this choice allows us to preserve a sufficiently large and balanced sample for empirical analysis, maintaining internal validity without sacrificing statistical power. Results are in Table A.7, Appendix A.

The key patterns observed in the baseline DiD analysis remain largely intact. The estimated effect of earthquakes on councilor characteristics continues to be positive and statistically significant for education and age (Columns 2 and 3), while the coefficient for the percentage of female councilors (Column 1) is still positive, though now statistically insignificant at conventional levels. For mayoral characteristics, both education and age (Columns 4 and 5) remain significantly associated with the earthquake shock, with magnitudes comparable to those in the full-sample estimates of Table 3.

These results suggest that our main findings are not driven by the confounding influ-

ence of hydro-geological events. While we observe a slight reduction in statistical precision — possibly due to the exclusion of 936 observations — the direction and size of the effects are consistent with the baseline results. This strengthens the causal interpretation of our DiD design and confirms that destructive earthquakes, rather than general exposure to natural disasters, are the primary drivers of the observed compositional changes in local political elites.

8 Discussion of results

Our main analysis shows that in the aftermath of a disruptive earthquake, voters become more likely to elect council members who are female, older, and more educated. This shift in voter's preferences applies also for the education and age of the mayor. These patterns suggest a shift in electoral preferences toward candidates perceived as more competent, experienced, or prosocial in the face of local emergencies.

In contrast to existing studies that emphasize retrospective voting based on disaster management performance (Besley and Burgess, 2002, Cerqua et al., 2023, Gualtieri et al., 2025, Healy and Malhotra, 2009, Masiero and Santarossa, 2021), our analysis explores whether natural disasters also reshape voters' prior beliefs about the desirable characteristics of political leaders. To disentangle these mechanisms, we exclude from the sample mayoral elections where the winning candidate previously held the office. This restriction allows us to focus on electoral outcomes that cannot be explained by voters' evaluations of past performance. Instead, we interpret any observed shifts in the attributes of elected mayors — such as gender, education, or age — as evidence that disasters influence the type of political profiles that voters deem more suitable or trustworthy in the aftermath of a crisis. This approach highlights how natural disasters can trigger prospective preferences about leadership qualities, beyond mere reward or punishment of incumbents. Results are in Table 4.

The positive and statistically significant coefficients for both mayor's education and age indicate that the main effects documented in our baseline results persist even when retrospective evaluations of past performance are excluded. This suggests that the observed shift toward older and more educated mayors in the aftermath of an earthquake is not primarily driven by a reward mechanism for incumbents who successfully managed the crisis. Rather, the findings point to a broader shift in voters' prospective preferences for candidates who signal experience and competence — attributes that are likely perceived as particularly valuable in post-disaster governance contexts. By focusing on first-time mayors, we provide additional evidence that natural disasters can reshape the criteria that voters use when selecting local leaders, independently of any retrospective assessment.

Table 4: ATE - Multiple mayoral terms

	(1)	(2)
Dep. Var.	Mayor's edu	Mayor's age
Earthquake	0.0184**	0.0150**
	(0.00874)	(0.00710)
	(0.0830)	(0.0730)
Observations	13,347	13,180
N. Municipalities	2,631	2,631
Municipality FE	Yes	Yes
Regional time trend	Yes	Yes
Controls	Yes	Yes

Note. The dependent variables are: the years of education of mayor, in natural log (Column 2), the age of mayor, in natural log (Column 3). *Earthquake* is a dummy taking the value of 1 for treated municipalities in all the years from the first voting after an earthquake with intensity greater or equal than 5 to 2019, and to 0 otherwise; for control group of municipalities *Earthquake* takes the value of 0 along the entire time-span. Coefficients of municipality FE and regional time trends are not reported. We control for *Law81*, *Law215*, *Pop*, *Municipal education*, *Municipal unemployment*, *Municipal participation*. Standard errors adjusted for clustering at the municipal level are in brackets. Period: 1990-2019. Significant coefficients are indicated by * (10% level), ** (5% level) and *** (1% level).

In addition to studying the characteristics of elected officials, it is analytically relevant to examine whether post-disaster shifts in voter preferences are also reflected in the composition of the municipal executive. In Italian municipalities, aldermen (local cabinet members) are appointed by the mayor and play a key role in the governance and implementation of public policies, especially in sectors such as urban planning, public works, social welfare, and emergency response. As such, the composition of the municipal cabinet represents a crucial dimension of local political decision-making and administrative capacity.

Building on this institutional framework, we investigate whether the observed post-earthquake increase in the election of female, more educated, and older mayors and council members is mirrored in the profile of appointed aldermen. If voters reward these attributes in response to a crisis, mayors — seeking legitimacy or responding to political signals — may strategically appoint executive team members with similar characteristics. In other words, the mayor's cabinet could serve as an additional channel through which voter preferences influence local governance. Examining this downstream effect allows us to assess whether political shocks like natural disasters trigger broader transformations not only in who gets elected, but also in who governs. Table 5 reports the average treatment effects of experiencing an earthquake on the composition of the municipal executive, measured in terms of the percentage of female aldermen (Column 1), their average education (Column 2), and average age (Column 3), all expressed in natural logarithms.

Table 5: ATE - Alderman's characteristics

	(1)	(2)	(3)
Dep. Var.	Female aldermen	Alderman's edu	Alderman's age
Earthquake	-0.0380	0.00614	0.00972**
	(0.0504)	(0.00567)	(0.00446)
Observations	17,788	17,556	17,751
No. Municipalities	2,631	2,631	2,631
Municipality FE	Yes	Yes	Yes
Regional time trends	Yes	Yes	Yes
Controls	Yes	Yes	Yes

Note. The dependent variables are: the percentage of female aldermen, in natural log (Column 1), the average years of education of aldermen, in natural log (Column 2), the average age of aldermen, in natural log (Column 3). *Earthquake* is a dummy taking the value of 1 for treated municipalities in all the years from the first voting after an earthquake with intensity greater or equal than 5 to 2019, and to 0 otherwise; for control group of municipalities *Earthquake* takes the value of 0 along the entire time-span. Coefficients of municipality FE and regional time trends are not reported. We control for *Law81*, *Law215*, *Pop*, *Municipal education*, *Municipal unemployment*, *Municipal participation*. Standard errors adjusted for clustering at the municipal level are in brackets. Period: 1990-2019. Significant coefficients are indicated by * (10% level), ** (5% level) and *** (1% level).

The estimates suggest that, unlike for elected officials, the appointment of female or more educated aldermen does not significantly respond to earthquake exposure. The coefficients in Columns (1) and (2) are small in magnitude and statistically insignificant, indicating no systematic change in the gender or educational composition of the local cabinet after a disaster.

However, Column (3) reveals a positive and statistically significant effect on alderman's average age: municipalities hit by a major earthquake tend to appoint slightly older individuals to executive roles in the aftermath. This result aligns with the patterns found for elected officials, reinforcing the idea that post-disaster governance may rely more heavily on individuals perceived as more experienced. Still, the absence of significant shifts in gender and education contrasts with the more robust voter-driven changes observed in the city council and mayoral offices.

Overall, these findings suggest that while natural disasters may reshape electoral outcomes — leading to the selection of more female, older, and educated officials — such shifts only partially translate into the composition of the appointed municipal executive. The observed divergence points to the limits of voter influence over non-elected positions, and highlights the selective nature of responsiveness in local political appointments.

8.1 Possible alternative/complementary mechanisms

The main analysis has shown that, in the aftermath of a destructive earthquake, voters tend to favor local political elites with different attributes — namely, greater female representation, higher education levels, and older age profiles. However, an important question remains: are these changes solely driven by a shift in voter preferences, or could they also reflect compositional changes in the electorate or in the pool of candidates?

To investigate these alternative (an, likely, complementary) mechanisms, we first examine whether earthquakes have any effect on voter turnout, measured as the ratio of voters to eligible voters (*Turnout*). Column (1) of Table 6 reports the average treatment effect using standard DiD estimates. The coefficient is small and statistically insignificant, suggesting that earthquakes do not significantly alter overall electoral participation.

A related concern is that the observed increase in female councilors might be explained by greater female participation in elections — either through higher female turnout or a higher share of female voters in the electorate (*Female turnout* and *Female voters*, respectively). Columns (2) and (3) address these hypotheses by estimating the effect of earthquakes on female turnout and on the share of female voters, respectively. Again, we find no statistically significant differences between treated and control municipalities. This suggests that the post-earthquake gender shift in councils is unlikely to be driven by changes in the gender composition of the voting population.

Next, we explore the possibility that the observed effects are driven by changes in the characteristics of the candidates, rather than voters' preferences per se. While detailed information on councilor candidates' education and age is not available, for mayoral candidates the Ministry of the Interior provides this detail. We leverage the fact that under Italian municipal electoral law, losing mayoral candidates may enter the city council if they obtain a sufficiently high number of votes. By merging election archives with the database of elected local officials, we recover demographic information (gender, education, age) for a subset of mayoral candidates who later served as councilors.

Columns (4)–(6) in Table 6 report the DiD estimates using the share of female mayoral candidates (*Female candidates*), the average years of education (in natural log — *Candidate's education*), and the average age (in natural log — *Candidate's age*) of mayoral candidates as outcome variables. None of these coefficients is statistically significant, indicating that the composition of the candidate pool does not change systematically after an earthquake. Thus, the observed post-disaster shifts in elected officials' profiles are unlikely to be mechanically driven by candidate supply.

A further alternative explanation for our findings is rooted not in voter preferences for prosocial behavior, competence, or experience per se, but in strategic political alignment following a disaster, as the previously mentioned literature stated (Hartmann, 2022, Heersink et al., 2020). In the aftermath of an earthquake, local voters may prioritize securing national reconstruction funds, perceiving alignment with the national government as a key channel for accessing resources. As a result, they may be more likely to support local candidates affiliated with the ruling national coalition. If, for reasons unrelated to the earthquake, these nationally aligned parties happen to field more female, more educated, or older candidates during the post-disaster elections, our estimated effects could reflect compositional shifts in candidate pools rather than changes in voter preferences. This alignment-based mechanism — voting to maximize access to intergovernmental transfers

— could therefore generate similar patterns in observed outcomes, despite being driven by instrumental rather than intrinsic motivations. This alternative mechanism is partly ruled out by the previous analysis on the candidates.

Table 6: ATE - Additional mechanisms

	(1)	(2)	(3)	(4)	(5)	(6)
Dep. Var.	Turnout	Female turnout	Female voters	Female candidates	Candidate's edu	Candidate's age
Earthquake	-0.349	0.0506	0.00122	-0.00649	0.00302	0.00476
	(0.272)	(0.346)	(0.00265)	(0.00754)	(0.00767)	(0.00628)
Observations	13,372	10,814	10,814	13,372	12,905	13,029
R-squared	0.501	0.396	0.061	0.030	0.016	0.088
N. Municipalities	2,631	2,594	2,594	2,631	2,629	2,630
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
Regional time trend	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes

Note. The table reports estimations according to the DiD procedure. The dependent variables are: the percentage of female councilors, in natural log (Column 1), the average years of education of councilors, in natural log (Column 2), the average age of councilors, in natural log (Column 3), a dummy for the gender of the mayor (Column 4), the average years of education of mayor, in natural log (Column 5), the average age of mayor, in natural log (Column 6). *Earthquake* is a dummy taking the value of 1 for treated municipalities in all the years from the first voting after an earthquake with intensity greater or equal than 5 to 2019, and to 0 otherwise; for control group of municipalities *Earthquake* takes the value of 0 along the entire time-span. Coefficients of municipality FE and regional time trends are not reported. We control for *Pop*, *Municipal education*, *Municipal unemployment*, *Municipal participation*. In Columns 1-3 we also control for *Law81* and *Law215*. Standard errors adjusted for clustering at the municipal level are in brackets. Period: 1990-2019. Significant coefficients are indicated by * (10% level), ** (5% level) and *** (1% level).

However, we further test its plausibility by examining whether the observed changes in the attributes of local politicians could be driven by political alignment with the national or regional government, rather than by changes in voters' underlying preferences. First, it is important to note that this alignment-based explanation can only be empirically tested for mayors. While in principle it would be informative to assess the political alignment of municipal councils, in practice this is infeasible. Even when political information on councilors is available, it is not possible to reliably reconstruct majority-opposition dynamics within councils, nor to systematically determine which parties are in control of the executive coalition. Second, to carry out the analysis, we developed a macro-categorization of the political orientation of municipalities based on a textual classification of the mayor's party affiliation into center, center-left and center-right. This approach does not allow us to categorize civic lists without clear political orientation, which constitute the majority of political affiliations in smaller municipalities, as their names typically do not reveal a clear ideological leaning. Consequently, the analysis is limited to a subset of municipalities for which party labels could be reliably interpreted. Third, we applied the same categorization method to determine the political orientation of the national and regional governments over time. This enables us to test whether voters tend to elect mayors who are politically aligned with higher levels of government in the aftermath of an earthquake. Fourth, we created a binary variable that captures political alignment: it takes the value of 1 if the mayor shares the same political orientation as the national (or regional) government in a given year, and 0 otherwise. This variable is interacted with the treatment variable and, then, included in the DiD regression alongside the main treatment variable (*Earthquake*National political alignment* and *Earthquake*Regional political alignment*,

respectively). If the alignment mechanism were driving the results, we would expect the treatment dummy (i.e., the occurrence of an earthquake) to lose statistical significance once the interaction is included, and for the interaction term to display a significant and positive effect. However, the opposite occurs. As shown in Table 7, the treatment effect remains positive and statistically significant for both the average education and age of the mayor, while the interaction term — indicating political alignment with the central or regional government — is either insignificant or, in some cases, even negative and marginally significant (e.g., Column 4).

Table 7: ATE - Mayor's political orientation

	(1)	(2)	(3)	(4)
Dep. Var.	Mayor's edu	Mayor's age	Mayor's edu	Mayor's age
Earthquake	0.0171**	0.0194***	0.0193**	0.0227***
	(0.00847)	(0.00664)	(0.00830)	(0.00662)
Earthquake*National political alignment	0.00653	0.00432		
	(0.00826)	(0.00723)		
Earthquake*Regional political alignment			-0.00835	-0.0184*
			(0.0114)	(0.00989)
Observations	18,176	18,003	18,176	18,003
N. Municipalities	2,644	2,644	2,644	2,644
Municipality FE	Yes	Yes	Yes	Yes
Regional time trend	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes

Note. The table reports estimations according to the DiD procedure. The dependent variables are: the percentage of female councilors, in natural log (Column 1), the average years of education of councilors, in natural log (Column 2), the average age of councilors, in natural log (Column 3), a dummy for the gender of the mayor (Column 4), the average years of education of mayor, in natural log (Column 5), the average age of mayor, in natural log (Column 6). *Earthquake* is a dummy taking the value of 1 for treated municipalities in all the years from the first voting after an earthquake with intensity greater or equal than 5 to 2019, and to 0 otherwise; for control group of municipalities *Earthquake* takes the value of 0 along the entire time-span. Coefficients of municipality FE and regional time trends are not reported. We control for *Pop*, *Municipal education*, *Municipal unemployment*, *Municipal participation*. In Columns 1-3 we also control for *Law81* and *Law215*. Standard errors adjusted for clustering at the municipal level are in brackets. Period: 1990-2019. Significant coefficients are indicated by * (10% level), ** (5% level) and *** (1% level).

These results suggest that political alignment does not explain the observed post-earthquake shifts in mayoral characteristics, at least not systematically. This strengthens the interpretation that voters are primarily responding to intrinsic qualities of the candidates — such as competence, experience, and prosocial traits — rather than engaging in strategic voting aimed at maximizing access to external resources through partisan channels.

Taken together, these results provide compelling evidence that the transformations observed in local political representation following an earthquake are indeed attributable to changes in voter preferences, not to mechanical shifts in electoral participation or candidate characteristics or strategic voting. Voters appear to respond to the demands of post-disaster governance by favoring candidates with traits — such as education, experience, and prosocial signals (e.g., gender diversity) — that they perceive as better suited to managing recovery and reconstruction. This reinforces our main interpretation that natural disasters serve as a critical juncture for political selection, with lasting implications for the composition of local governing elites.

9 Conclusions

This paper contributes to the growing literature on the political consequences of natural disasters by providing causal evidence that destructive earthquakes can shape voter preferences and alter the composition of local political elites. Drawing on a rich dataset of municipal elections in Italy between 1990 and 2019 and exploiting the quasi-random timing and location of seismic events, we show that voters in earthquake-affected municipalities are significantly more likely to elect politicians who are female, more educated, and older — attributes commonly associated with prosocial behavior, competence, and experience. These effects are not only statistically robust across a variety of model specifications — including continuous DiD, event-study, lagged dependent variable models, and the Sun and Abraham (2021) estimator — but also persistent across electoral cycles.

By ruling out alternative mechanisms such as shifts in candidate supply, turnout, or political alignment with higher-tier governments, our findings support the interpretation that natural disasters act as critical junctures, prompting voters to update their preferences in favor of leadership profiles perceived as better suited to manage crisis and recovery (Fair et al., 2020, Fukumoto and Kikuta, 2024, Healy and Malhotra, 2009). These results add a new dimension to the literature on democratic accountability under duress (Arceneaux and Vander Wielen, 2023, Besley and Burgess, 2002), moving beyond incumbency effects to show how crises affect the salience of individual candidate characteristics. Moreover, our analysis of post-disaster procurement activity suggests that this recalibration of voter preferences may be sustained by observable improvements in administrative performance, thus reinforcing a virtuous cycle of political selection.

From a policy perspective, these findings highlight the importance of institutional frameworks that facilitate the emergence and electoral viability of competent and inclusive candidates, particularly in the wake of crises. Electoral rules that lower barriers to entry for underrepresented groups, civic engagement efforts that foster voter deliberation, and transparency in post-disaster fund allocation can help channel the political aftermath of disasters into opportunities for improving local governance capacity and democratic resilience.

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Appendix

A *Tables*

Table A.1: Descriptive statistics of dependent variables

	Obs	Mean	Std.Dev.	Min	Max
Female councilors	18194	20.383	13.715	0	80
Mayor's gender	18468	0.087	0.282	0	1
Councillor's edu	18267	12.554	1.837	5	18
Mayor's edu	18604	14.592	3.572	3	18
Councillor's age	18298	42.633	4.646	22.581	66.74
Mayor's age	18429	48.482	10.215	20.359	94.288

Note. Descriptive statistics of dependent variables. Time-span: 1990-2019.

Table A.2: Descriptive statistics of control variables

	Obs	Mean	Std.Dev.	Min	Max
Pop	18176	6824.872	29993.834	11	1070685
Municipal education	18142	0.865	0.077	0.507	1
Municipal unemployment	18142	0.139	0.112	0	0.616
Municipal participation	18142	0.447	0.072	0.161	0.771

Note. Descriptive statistics of control variables. Time-span: 1990-2019.

Table A.3: ATE - N. CIGs

	(1)	(2)
Dep. Var.	N. CIGs	N. CIGs in Public works
Earthquake	0.520***	0.355***
	(0.126)	(0.111)
Observations	17,247	17,247
N. Municipalities	1,328	1,328
Municipality FE	Yes	Yes
Regional time trend	Yes	Yes
Controls	Yes	Yes

Note. The dependent variables are: the log of the number of CIGs managed by local government in Column 1, and the log of the number of CIGs in public work managed by local government in Column 2. *Earthquake* is a dummy taking the value of 1 for treated municipalities in all the years from the first voting after an earthquake with intensity greater or equal than 5 to 2019, and to 0 otherwise; for control group of municipalities *Earthquake* takes the value of 0 along the entire time-span. Coefficients of municipality FE and regional time trends are not reported. We control for the resident population. Standard errors adjusted for clustering at the municipal level are in brackets. Period: 2007-2019. Significant coefficients are indicated by * (10% level), ** (5% level) and *** (1% level).

Table A.4: ATE - LDV estimates

	(1)	(2)	(3)	(4)	(5)	(6)
Dep. Var.	Female councilors	Concilor's edu	Concilor's age	Female mayor	Mayor's edu	Mayor's age
Earthquake	0.0324**	0.00746***	0.00394**	-0.0126	0.0174***	0.00882**
	(0.0167)	(0.00181)	(0.00164)	(0.0148)	(0.00435)	(0.00361)
Female councilors (t-1)	0.231***					
	(0.00897)					
Councillor's edu (t-1)		0.593***				
		(0.00842)				
Councillor's age (t-1)			0.409***			
			(0.00897)			
Mayor's gender (t-1)				0.392***		
				(0.0183)		
Mayor's edu (t-1)					0.412***	
					(0.00965)	
Mayor's age (t-1)						0.363***
						(0.00856)
Observations	14,780	14,938	14,974	3,523	15,510	15,200
Regional time trend	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes

Note. The table reports estimations according to the LDV procedure. The dependent variables are: the percentage of female councilors, in natural log (Column 1), the average years of education of councilors, in natural log (Column 2), the average age of councilors, in natural log (Column 3), a dummy for the gender of the mayor (Column 4), the average years of education of mayor, in natural log (Column 5), the average age of mayor, in natural log (Column 6). *Earthquake* is a dummy taking the value of 1 for treated municipalities in all the years from the first voting after an earthquake with intensity greater or equal than 5 to 2019, and to 0 otherwise; for control group of municipalities *Earthquake* takes the value of 0 along the entire time-span. Coefficients of municipality FE and regional time trends are not reported. We control for *Pop*, *Municipal education*, *Municipal unemployment*, *Municipal participation*. In Columns 1-3 we also control for *Law81* and *Law215*. Standard errors adjusted for clustering at the municipal level are in brackets. Period: 1990-2019. Significant coefficients are indicated by * (10% level), ** (5% level) and *** (1% level).

Table A.5: ATE - Sun and Abraham (2021)'s estimates

	(1)	(2)	(3)	(4)	(5)	(6)
Dep. Var.	Female councilors	Concilor's edu	Concilor's age	Female mayor	Mayor's edu	Mayor's age
Earthquake	0.0917**	0.0104**	0.0146***	-0.0160	0.0192*	0.0241***
	(0.0391)	(0.0043)	(0.0033)	(0.0226)	(0.0114)	(0.0085)
Observations	17,752	17,827	17,856	8,615	18,161	17,989
N. Municipalities	2,641	2,641	2,641	2,377	2,642	2,642
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
Regional time trend	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes

Note. The table reports estimations according to the Sun and Abraham (2021)'s procedure. The dependent variables are: the percentage of female councilors, in natural log (Column 1), the average years of education of councilors, in natural log (Column 2), the average age of councilors, in natural log (Column 3), a dummy for the gender of the mayor (Column 4), the average years of education of mayor, in natural log (Column 5), the average age of mayor, in natural log (Column 6). *Earthquake* is a dummy taking the value of 1 for treated municipalities in all the years from the first voting after an earthquake with intensity greater or equal than 5 to 2019, and to 0 otherwise; for control group of municipalities *Earthquake* takes the value of 0 along the entire time-span. Coefficients of municipality FE and regional time trends are not reported. We control for *Pop*, *Municipal education*, *Municipal unemployment*, *Municipal participation*. In Columns 1-3 we also control for *Law81* and *Law215*. Standard errors adjusted for clustering at the municipal level are in brackets. Period: 1990-2019. Significant coefficients are indicated by * (10% level), ** (5% level) and *** (1% level).

Table A.6: ATE - Councilor's and Mayor's characteristics with earthquakes lower than 5 on the Mercalli scale

	(1)	(2)	(3)	(4)	(5)
Dep. Var.	Female councilors	Councillor's edu	Councillor's age	Mayor's edu	Mayor's age
Earthquake (< 5)	0.0547*	0.00218	0.00140	0.0202*	-0.000239
	(0.0315)	(0.00371)	(0.00298)	(0.0104)	(0.00754)
Observations	15,025	15,087	15,109	15,321	15,198
N. Municipalities	2,225	2,225	2,225	2,225	2,225
Municipality FE	Yes	Yes	Yes	Yes	Yes
Regional time trend	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes

Note. The dependent variables are: a dummy for the gender of the mayor (Columns 1 and 4), the years of education of mayor, in natural log (Columns 2 and 5), the age of mayor, in natural log (Columns 3 and 6). *Earthquake* is a dummy taking the value of 1 for treated municipalities in all the years from the first voting after an earthquake with intensity lower than 5 on the Mercalli scale to 2019, and to 0 otherwise; for control group of municipalities *Earthquake* takes the value of 0 along the entire time-span. Coefficients of municipality FE and regional time trends are not reported. We control for *Pop*, *Municipal education*, *Municipal unemployment*, *Municipal participation*. In Columns 1-3 we also control for *Law81* and *Law215*. Standard errors adjusted for clustering at the municipal level are in brackets. Period: 1990-2019. Significant coefficients are indicated by * (10% level), ** (5% level) and *** (1% level).

Table A.7: DiD - Councilor's and Mayor's characteristics dropping municipality with high hydro-geological risk

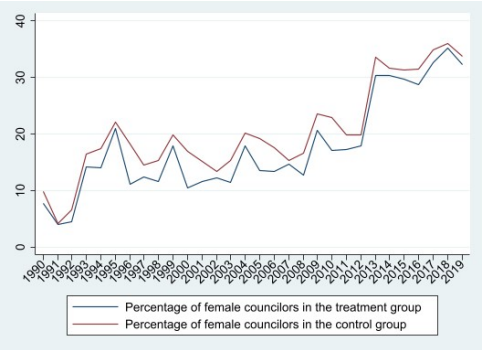
	(1)	(2)	(3)	(4)	(5)
Dep. Var.	Female councilors	Councillor's edu	Councillor's age	Mayor's edu	Mayor's age
Earthquake	0.0379	0.00895***	0.0181***	0.0168**	0.0164**
	(0.0309)	(0.00336)	(0.00266)	(0.00832)	(0.00647)
Observations	17,835	17,909	17,937	17,882	17,709
N. Municipalities	2,722	2,722	2,722	2,593	2,593
Municipality FE	Yes	Yes	Yes	Yes	Yes
Regional time trend	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes

Note. The dependent variables are: a dummy for the gender of the mayor (Columns 1 and 4), the years of education of mayor, in natural log (Columns 2 and 5), the age of mayor, in natural log (Columns 3 and 6). *Earthquake* is a dummy taking the value of 1 for treated municipalities in all the years from the first voting after an earthquake with intensity greater or equal than 5 to 2019, and to 0 otherwise; for control group of municipalities *Earthquake* takes the value of 0 along the entire time-span. Coefficients of municipality FE and regional time trends are not reported. We control for *Pop*, *Municipal education*, *Municipal unemployment*, *Municipal participation*. In Columns 1-3 we also control for *Law81* and *Law215*. Standard errors adjusted for clustering at the municipal level are in brackets. Period: 1990-2019. Significant coefficients are indicated by * (10% level), ** (5% level) and *** (1% level).

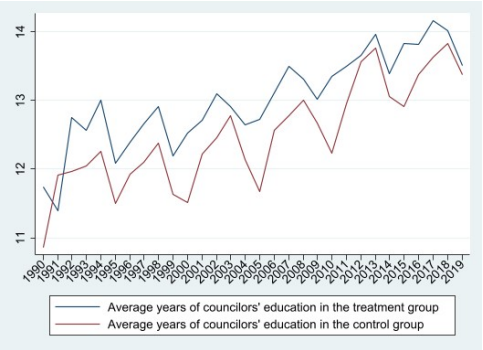
B *Figures*

Figure B.1: Female councilors, councilor's education and age over year of elections

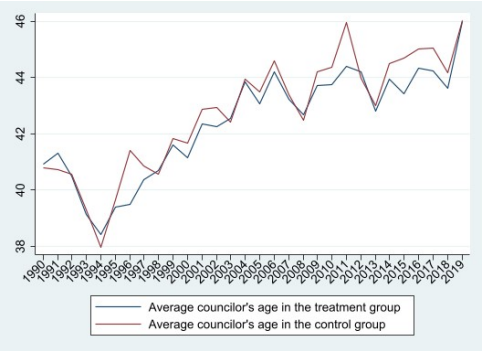
(a) Female councilors



(b) Councilor's education



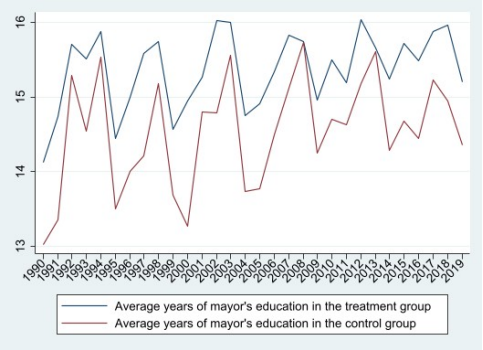
(c) Councilor's age



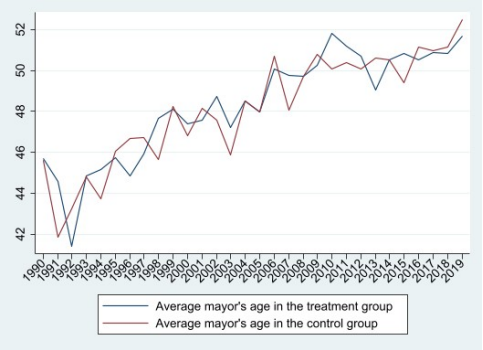
Note. The Graphs show the mean, over the electoral years, of the percentage of female councilors (Graph B.1a), of the average years of education (Graph B.1b) and average age (Graph B.1c) of councilors. Period: 1990-2019.

Figure B.2: Mayor's education and age over year of elections

(a) Mayor's education



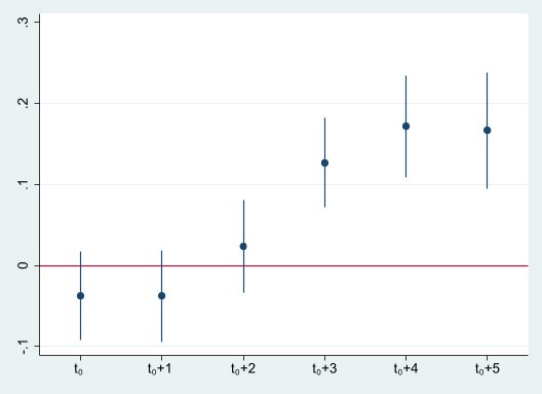
(b) Mayor's age



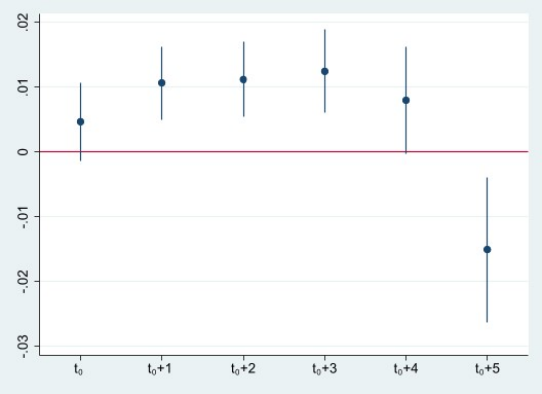
Note. The Graphs show the mean, over the electoral years, of the mayor's education (Graph B.2a) and age (Graph B.2b). Period: 1990-2019.

Figure B.3: Event-study model — LDV approach

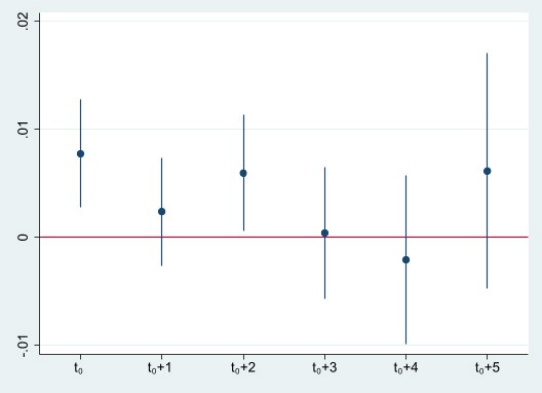
(a) Female councilors



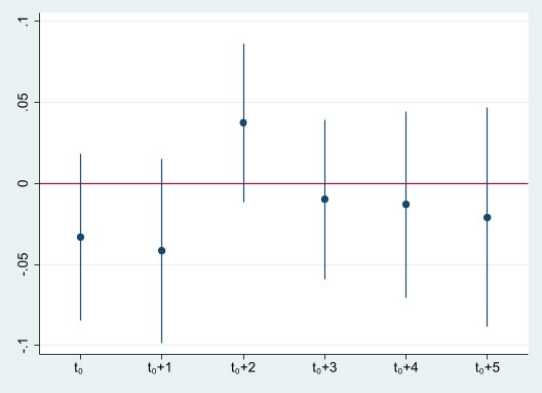
(b) Councilor's education



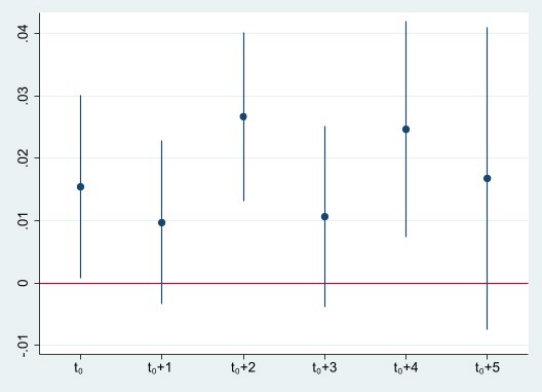
(c) Councilor's age



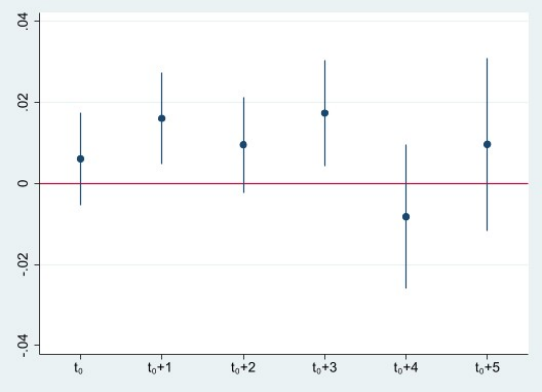
(d) Mayor's gender



(e) Mayor's education



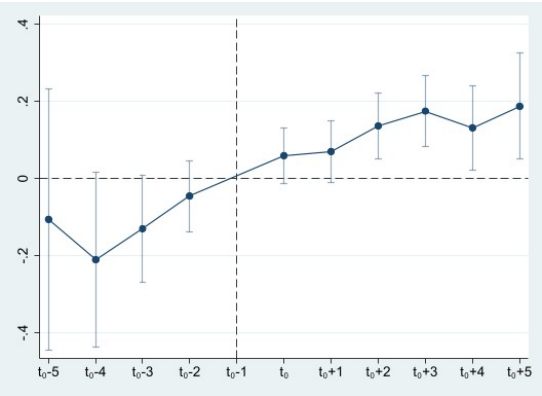
(f) Mayor's age



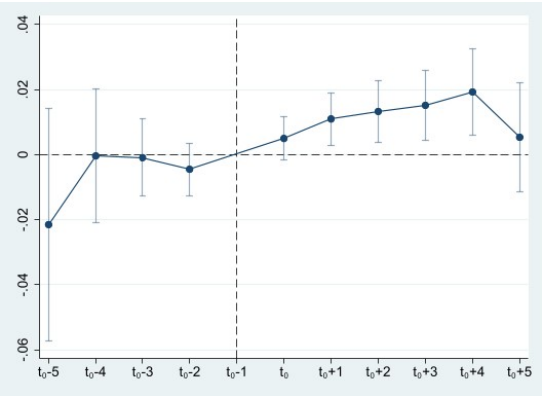
Note. The graph reports coefficients and confidence intervals estimated according to eq. 2. The dependent variables are: the percentage of female councilors, in natural log (Graph B.3a), the average years of education of councilors, in natural log (Graph B.3b), the average age of councilors, in natural log (Graph B.3c), a dummy for the gender of the mayor (Graph B.3d), the average years of education of mayor, in natural log (Graph B.3e), the average age of mayor, in natural log (Graph B.3f). Standard errors are clustered at municipal level. Dots refer to point estimates, spikes to 95% confidence intervals. All regressions include regional time trends. We control for *Pop*, *Municipal education*, *Municipal unemployment*, *Municipal participation*. In Graphs B.3a, B.3b and B.3c we also control for *Law81* and *Law215*. Standard errors adjusted for clustering at the municipal level are in brackets. Period: 1990-2019.

Figure B.4: Event-study Sun and Abraham (2021)'s estimator on councilor's and mayor's characteristics

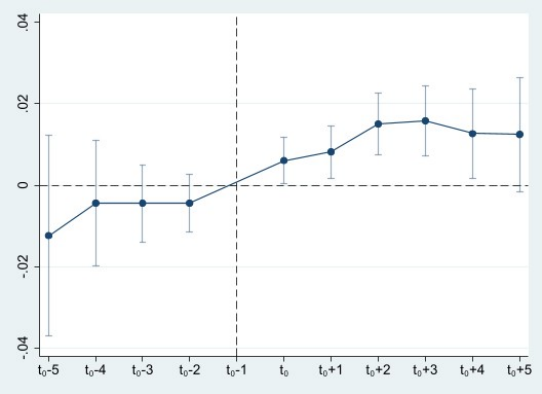
(a) Female councilors



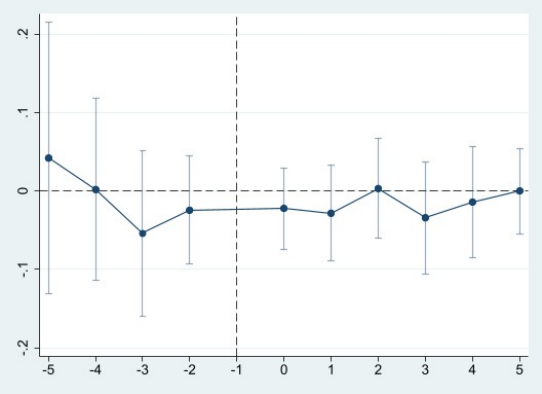
(b) Councilor's education



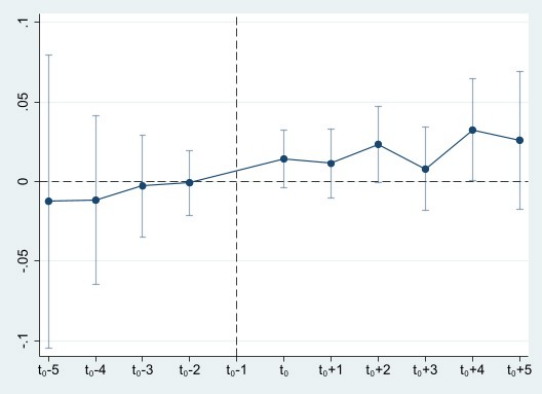
(c) Councilor's education



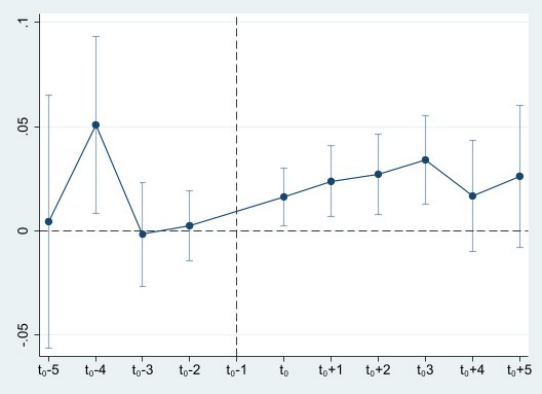
(d) Female mayor



(e) Mayor's education



(f) Mayor's age



Note. The graph reports coefficients and confidence intervals estimated according to the Sun and Abraham (2021)'s procedure. The dependent variables are: the percentage of female councilors, in natural log (Graph B.4a), the average years of education of councilors, in natural log (Graph B.4b), the average age of councilors, in natural log (Graph B.4c), a dummy for the gender of the mayor (Graph B.4d), the average years of education of mayor, in natural log (Graph B.4e), the average age of mayor, in natural log (Graph B.4f). Standard errors are clustered at municipal level. Dots refer to point estimates, spikes to 95% confidence intervals. All regressions include municipality FE, regional time trends and *Pop* as additional control. In Graphs B.4a, B.4b and B.4c we also control for *Law81* and *Law215*. The p-value of the F-test that all the pre-treatment coefficients are jointly equal to 0.29, 0.55, 0.66, 0.99, 0.99 and 0.13 for estimation in Graphs B.4a-B.4f, respectively. Period: 1990-2019.