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Female Political Leaders and Public Funding Attraction: Evidence from Italian Municipalities

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Abstract

We study the role of mayoral gender in attracting public funding in Italian municipalities. We exploit a novel administrative dataset containing detailed information on all projects aimed at the digitalisation of local public administrations and funded under Italy's National Recovery and Resilience Plan between 2022 and 2024. Exogenous variation in the timing of municipal elections and switches from male to female mayors provides quasi-experimental identification within a staggered difference-in-differences framework. We find that female mayors attract significantly larger amounts of national public funding for the digitalisation of municipal administrative services. This effect is particularly strong when female leadership is combined with high levels of human, or supported by a high quality local bureaucrats, and a policy environment characterised by substantial funding opportunities. By contrast, the share of women in municipal councils and executives does not play a significant role. We also find that our main results are driven by small and territorially fragile municipalities.

JEL classification

D72, H72, H76, J16, R58

Keywords

public funding, female political leadership, local governments, difference-in-differences, event-study, causal inference

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1 Introduction

The presence of women in political office has been linked to significant improvements across a broad range of economic and social outcomes (Hessami and da Fonseca, 2020). A growing body of empirical research indicates that female political representation is associated with stronger economic growth (Jayasuriya and Burke, 2013; Mirziyoyeva and Salahodjaev, 2023; Baskaran et al., 2024), reduced income inequality (Nelson and Goel, 2023; Hortas-Rico and Rios, 2025), enhanced environmental protection and sustainability (Salahodjaev and Jarilkapova, 2020; Kostakis et al., 2024), expanded childcare provision (Besley and Case, 2003; Svaleryd, 2009), higher educational attainment (Clots-Figueras, 2012), improved student performance (Priyanka, 2022), and better healthcare services (Clayton and Zetterberg, 2018; Bhalotra and Clots-Figueras, 2014). These patterns are commonly interpreted as reflecting systematic differences in policy priorities and preferences between female and male politicians (Taylor-Robinson and Heath, 2003; Poggione, 2004; Khan, 2017; Yao and You, 2018; Catalano Weeks, 2022), with women typically emphasising social investment, equity, and inclusive governance (Kittilson, 2008; Atchison and Down, 2009; Araujo and Tejedo-Romero, 2018; Kim, 2022).

Although the literature on the economic effects of women's political representation is extensive, their role in fundraising remains underexplored and has been examined primarily in the context of electoral campaigns (Burrell, 1985; Barber et al., 2016; Brollo and Troiano, 2016; Feo et al., 2023; Janusz, 2025). In our study, we address this gap by examining whether local political institutions with greater female representation attract more central government funding for the digitization of local public administrations than those led by men. To the best of our knowledge, this is the first study to address this issue in depth. To this end, we exploited a novel administrative data set that contains detailed information on all projects financed under the Italian National Recovery and Resilience Plan (NRRP) between 2022 and 2024, aimed at digitizing local public administrations. Italy represents an ideal case study for examining the effects of political gender on the ability to secure NRRP funding from the central government, as it received one of the largest allocations of Next Generation EU funds (Kengyel, 2025) through the implementation of the NRRP. The plan also offers a unique empirical setting to investigate this issue as it channels resources to public administrations across multiple domains[1] including dig-

[1] See https://www.italynextgeneration.eu/recoveryfund-en (last accessed on January 9, 2026) for further information on the Next Generation EU fund.

italization of public services, environmental sustainability, infrastructure for sustainable mobility, educational facilities and services, social inclusion, territorial cohesion, and the strengthening of local health service networks.

Examining political gender differences in attracting NRRP funds for digital innovation is particularly relevant, as female politicians tend to show greater commitment to technology initiatives that foster local economic development (Dahlum et al., 2022; Mirziyoyeva and Salahodjaev, 2023), suggesting that they may outperform their male counterparts in both the number of approved projects and the total funding secured. To shed light on this issue, we exploit exogenous variation in the timing of municipal elections and switches from male to female mayors to estimate the impact of female mayors on the quarterly probability of having a project funded and on the total amount of quarterly funding, using a staggered difference-in-differences (DiD) estimator proposed by Callaway and Sant'Anna (2021) that is robust to treatment-effect heterogeneity across groups and over time. We operate in a staggered framework because transitions from male to female mayors occur at different points in time, corresponding to different municipal election dates.

The main findings indicate that a transition from a male- to a female-led mayoral administration significantly increases per capita quarterly public funding for municipal digitalisation obtained through NRRP calls. The estimated effect is substantial, amounting to approximately a 70% increase relative to the pre-treatment average among treated municipalities. This result is robust to the use of alternative DiD estimators and to different definitions of the control group. By contrast, when examining the impact of the gender composition of municipal councils and executive bodies, we find no effect on the ability to attract NRRP funding for municipal digitalisation. This pattern is consistent with empirical evidence suggesting that leadership positions enable women to play a key role in leveraging managerial and administrative capabilities (Eagly and Carli, 2003; La Rocca et al., 2024; Roy, 2024).

Analysing the mechanisms underlying our main result, we find that this effect is primarily concentrated in 2022, when central government NRRP funding opportunities were at their peak, and is driven by female mayors with higher levels of human capital. In other words, female leadership proves more effective than male leadership in securing public funding for digitalisation when it is combined with sufficient human capital or adequate bureaucratic capacity, and a policy environment characterised by abundant funding opportunities. Additional factors also help explain the positive impact of female political leadership on public fundraising. In particular, we find that small and territorially fragile

municipalities governed by female mayors are more successful in securing public funding. This suggests that in small and fragile areas, characterised by a limited range of public services and lower territorial attractiveness, female mayors can make a meaningful difference in municipal technological modernisation, potentially contributing to a reduction in territorial disparities through NRRP funding. Finally, we find no statistically significant differences in the effect of female mayors on attracting NRRP funding for digitalisation between southern and northern municipalities.

Overall, our empirical analysis reveals distinct attitudes of male and female political leaders in attracting public resources, given the financial opportunities available to them. Contrary to the prevailing view that women are more risk-averse and less competitive than men (Borghans et al., 2009; Croson and Gneezy, 2009; Niederle and Vesterlund, 2011), our results show that female political leaders with higher human capital are not only more willing to invest and compete but also more proactive in leveraging the generous funding provided by exceptional national policy interventions, such as the NRRP. These findings underscore the importance of considering policymakers' characteristics, alongside gender, when analyzing differences in risk aversion and competitiveness in decision-making.

The remainder of the paper is structured as follows. Section 2 reviews the related literature and delineates our contribution to the literature. Section 3 outlines the institutional setting. Section 4 describes the data, sample construction, identification strategy, and estimation methodology. Section 5 presents the main results, including mechanisms, heterogeneity analyses and robustness checks. Section 6 concludes.

2 Literature review and contribution

2.1 Gender differences in political leadership and policy decisions

Over the past several decades, women's participation in formal political institutions has increased substantially across OECD countries. Focusing on national parliaments, in 2025 women held, on average, 34% of seats in the lower or single houses, compared to 26% in 2012. While this represents a significant improvement, progress has been highly uneven across countries. Female parliamentary representation is particularly high in some OECD countries, such as Mexico and Costa Rica (around 50%), and in Scandinavian countries, where women hold approximately 45% of seats. In many European Union member states, by contrast, women continue to occupy close to one third of parliamentary seats (e.g., 36%

in France and Germany, 33% in Italy, and 31% in Poland; OECD, 2025).

In parallel with this increase in female political representation, a growing body of economic research has examined whether and how women differ from men as policy-makers and political leaders, and the implications of these differences for policy choices, governance, and public sector performance. A large empirical literature documents gender differences in policy-making arising from systematic variation in policy preferences between women and men (Yao and You, 2018; Catalano Weeks, 2022). This evidence is broadly consistent with the citizen-candidate model (Osborne and Slivinski, 1996), in which voters select candidates partly on the basis of policy preferences and governing capacity (Besley and Coate, 1997). Within this framework, several studies show that female politicians tend to place greater weight on redistributive and social policies. For example, Alesina and La Ferrara (2005) finds that female politicians favor more redistributive policies, while Chattopadhyay and Duflo (2004) show that reserving village council seats for women in India altered the composition of local good provision. Related evidence indicates that female political leadership can affect inheritance rights (Brulé, 2020), land reforms and social spending (Clots-Figueras, 2011), and municipal expenditure patterns (Andreoli et al., 2022).

A closely related strand of the literature highlights women's stronger support for policies promoting gender equality and social protection. Greater female representation in parliament has been linked to expansions in maternity and childcare benefits (Kittilson, 2008; Atchison and Down, 2009), reductions in maternal mortality following quota reforms (Bhalotra et al., 2023), lower income inequality (Nelson and Goel, 2023), and reduced legal discrimination against women in access to economic opportunities (Kim, 2022). Other studies document gender differences in environmental preferences and outcomes: female politicians are more likely to introduce environmentally oriented legislation (Ramstetter and Habersack, 2020), adopt green fiscal measures (Kandemir et al., 2024), and contribute to improved environmental performance, including lower CO_2 emissions, reduced deforestation, and higher renewable energy consumption (Kostakis et al., 2024; Salahodjaev and Jarilkapova, 2020; Salamon, 2023). More generally, women in political office tend to allocate relatively less spending to the military and research and development, and more to health, education, family assistance, and government consumption (Besley and Case, 2003; Svaleryd, 2009; Clayton and Zetterberg, 2018; Chen, 2021; Nginyu, 2025).

At the same time, other contributions emphasize that increased female political repre-

sentation does not always translate into substantively different policy outcomes. In some contexts, women's presence in political office may primarily reflect symbolic representation rather than distinct policy priorities (Norris and Lovenduski, 1989). Empirical studies have found limited or no effects of female leadership on a range of policy outcomes, including local government size and spending composition (Ferreira and Gyourko, 2014), policy decisions at the subnational level (Ban and Rao, 2008), and broader indicators of women's well-being following large increases in female legislative representation (Grier et al., 2025). These findings are often interpreted through the lens of the median voter model (Downs, 1957), which predicts that elected officials, regardless of personal characteristics such as gender, adopt policies aligned with the preferences of the median voter (Paxton et al., 2007; Hessami and da Fonseca, 2020).

2.2 Gender differences in executive leadership and administrative performance

Evidence on gender differences in executive political leadership suggests that female mayors may differ from their male counterparts not only in policy decisions, but also in organizational practices, administrative effectiveness, and the ability to foster environments conducive to innovation and investment. A growing literature documents that women's political participation is associated with improved economic performance (Baskaran et al., 2024), higher levels of well-being (York and Bell, 2014; Ermini et al., 2023), higher quality of elected politicians (Júlio and Tavares, 2017), as evidenced by higher levels of educational attainment (Baltrunaite et al., 2014; Aldrich and Daniel, 2024), and stronger support for investments in key drivers of long-run growth, including innovative technologies and human capital accumulation (Mirziyoyeva and Salahodjaev, 2023). From a political economy perspective, Dahlum et al. (2022) show that greater female representation in legislatures promotes technological change and economic growth, highlighting the role of inclusive decision-making processes in enhancing idea generation, selection, and diffusion. Related evidence indicates that women's political participation is positively associated with green innovation (Wang et al., 2025), financial inclusion (Ghosh, 2022), and access to economic opportunities (Kim, 2022), all of which may strengthen the institutional and administrative foundations necessary for effective policy implementation.[2]

[2] Although this evidence largely concerns legislative participation and macroeconomic outcomes, similar mechanisms have been documented in organizational and management settings. For example, Dezsö and

More direct evidence on executive political leadership suggests that gender differences may also emerge in the management of local governments and in bureaucratic outcomes. Using data on mayoral elections in the US, Ferreira and Gyourko (2014) find no systematic gender differences in the size of local government or the composition of municipal spending, but document differences in incumbency advantages and electoral performance, highlighting the relevance of executive capacity rather than policy preferences alone. Focusing explicitly on bureaucratic organization, Alberti et al. (2022) show that, in Chile, municipalities led by female mayors employ smaller and more gender-balanced bureaucracies. Related evidence indicates that female local leadership is associated with stronger fiscal discipline and improved financial health of municipalities (Guillamón et al., 2024). Braga and Scervini (2017) show that, in Italian municipalities, greater female political representation is associated with higher administrative efficiency, proxied by a more streamlined municipal executive structure. Similarly, Ríos et al. (2023) find that large Spanish municipalities with a higher presence of women in politics exhibit greater efficiency in public service provision, particularly when female representation in municipal councils is sufficiently high.

Taken together, these findings suggest that gender differences in executive leadership may manifest through enhanced administrative efficiency, different organizational choices, and improved management of public sector resources. These dimensions of performance may be especially relevant in contexts where municipalities face high regulatory complexity and stringent procedural requirements, and where the success of securing funding for technological innovation and administrative modernisation, such as under the NRRP, depends on digital, technical, and administrative capacity to design projects aligned with program objectives. This motivates the main hypotheses empirically tested in our study, which we elaborate in the next subsection.

Although the literature on the role of women as policymakers in shaping policy decisions and outcomes is extensive, their role in the acquisition of intergovernmental public funding remains comparatively underexplored and has been examined primarily in the context of electoral fundraising (Burrell, 1985; Barber et al., 2016; Brollo and Troiano, 2016; Feo et al., 2023; Janusz, 2025). Our study addresses this gap by investigating whether female mayors are more effective than their male counterparts in attracting fund-

Ross (2012) show that female representation in top management teams enhances firm performance when innovation is central to the firm's strategy. Consistent results are reported by Wang and Mahn (2025), who find a positive association between women's economic empowerment and innovative activity across countries.

ing from the central government aimed at digitizing local public administrations. To the best of our knowledge, this is the first study to provide systematic evidence on gender differences in access to competitive, project-based public funding at the municipal level.

In the context of the NRRP for digital innovation, policymakers' preferences for innovation, together with technical expertise and administrative capacity, are likely to be particularly important for securing public funding. Existing evidence suggests that these characteristics may be more prevalent among female politicians (Braga and Scervini, 2017; Ríos et al., 2023; De Benedetto et al., 2025), who have been associated with stronger support for technological change and innovation-oriented policies (Dahlum et al., 2022; Mirziyoyeva and Salahodjaev, 2023), potentially enabling them to attract greater NRRP funding for digital innovation. At the same time, a broad body of research documents that women tend to be more risk-averse and less competitive than men (Borghans et al., 2009; Croson and Gneezy, 2009; Niederle and Vesterlund, 2011), leading them to favor investments characterized by lower financial risk (Fehr-Duda et al., 2006; Halko et al., 2012; Fisher and Yao, 2017).[3] As a result, female politicians may be less responsive to NRRP funding opportunities, even when these target policy areas, such as digital innovation, that are typically associated with their preferences. This theoretical ambiguity motivates the empirical analysis conducted in this study.

Investigating whether female mayors are more or less responsive to NRRP funding opportunities is a relevant research question because it addresses a gap in the literature on gendered political behavior in executive roles and has direct implications for the equitable and efficient allocation of high-stakes public investment programs. In addition, we provide new evidence on the mechanisms underlying gendered responsiveness, considering the mediating role of the municipal council's and executive committee's gender composition, the size of funding opportunities, and the mayor's human capital. Identifying whether differences in funding responsiveness stem primarily from the mayor's personal characteristics, from the institutional environment of local government, or from the scale of available resources is crucial for policy design, because it allows interventions to be targeted appropriately – toward capacity building for individual officeholders, institutional reforms, or adjustments in program structure – thereby supporting both effective and equitable allocation of public funds.

[3]Consistent evidence from local public finance shows that female officeholders exhibit more financially sustainable behavior than male politicians (Suzuki and Avellaneda, 2018; Balaguer-Coll and Ivanova-Toneva, 2021).

3 Institutional setting

Municipalities constitute the lowest tier of local government in Italy. On January 1, 2026, there were 7,896 municipalities,[4] approximately 70% of which had a population below 5,000 inhabitants. Of these municipalities, 83% are located in Ordinary Statute Regions (OSRs), which operate under a common national legislative framework, while the remaining 17% are located in Special Statute Regions[5], which enjoy greater fiscal and legislative autonomy compared to municipalities in OSRs.

The institutional architecture of Italian municipalities comprises three bodies: the mayor (*Sindaco*), the executive committee (*Giunta comunale*), and the municipal council (*Consiglio comunale*). The mayor is responsible for municipal administration and has the authority to appoint and dismiss members of the executive committee (Law 81/1993; Legislative Decree 267/2000), who assist the mayor in implementing the electoral program and the policy directions set by the municipal council. The mayor is directly elected by voters (Law 81/1993) and serves a maximum of two consecutive five-year terms (Law 81/1993; Legislative Decree 267/2000). This term limit does not apply to municipalities with fewer than 5,000 inhabitants (Law 38/2024), and in municipalities with a population of up to 15,000 inhabitants it has been extended to three consecutive terms (Law 38/2024).[6] The mayor is elected using a single-round plurality system in municipalities with up to 15,000 residents, while a two-round system is used in municipalities with more than 15,000 residents. Under the two-round system, a candidate who secures more than 50% of valid votes in the first round is elected mayor; if no candidate reaches this threshold, a runoff election is held between the two candidates with the highest number of votes, and the candidate receiving the most votes in the second round is elected.

The municipal council is responsible for setting policy guidelines, approving strategic plans, and overseeing the administration of the municipality. Council members are elected concurrently with the mayor. In municipalities with up to 15,000 inhabitants, a majority bonus guarantees that two-thirds of the council seats are allocated to the list supporting the elected mayor, with the remaining seats distributed proportionally among the other lists.

[4]The list of Italian municipalities can be found at the following permanent Istat link: https://www.istat.it/storage/codici-unita-amministrative/Elenco-comuni-italiani.xlsx.

[5]The Special Statute Regions are Aosta Valley, Friuli Venezia Giulia, Sardinia, Sicily, and Trentino-Alto Adige.

[6]In 2014, the population threshold for three consecutive terms was set at 3,000 inhabitants (Law 56/2014) and was subsequently raised to 5,000 inhabitants in 2022 (Law 35/2022).

In municipalities with more than 15,000 inhabitants, the list or group of lists associated with a mayor elected in the first round is granted 60% of the council seats if it obtains at least 50% of valid votes. If the mayor is elected in the second round, the majority bonus ensuring 60% of council seats is granted only if no other list or group of connected lists exceeded 50% of valid votes in the first round (Law 81/1993; Legislative Decree 267/2000).

To promote gender-balanced representation in Italian municipal politics, the national legislature has implemented several initiatives aimed at reducing gender disparities at the local level of government. The first intervention dates back to Law 81/1993, which introduced gender quotas in municipal elections by establishing that neither gender could represent more than two-thirds of candidates on a party list. However, this provision was declared unconstitutional by the Constitutional Court in 1995 (Judgment No. 422/1995). After nearly two decades, a second legislative intervention sought to strengthen gender equality in municipal institutions. Law 215/2012 established that electoral procedures for municipal councillors, as well as the appointment of members of executive bodies, must comply with the principle of equal access for women and men to elected office. In particular, mayors are required to ensure the presence of both genders within the municipal executive committee. Gender balance in municipal councils is primarily promoted through the regulation of candidate lists, which must include candidates of both sexes. In municipalities with populations between 5,000 and 15,000 inhabitants, neither gender may represent more than two-thirds of the candidates on a given party list supporting a mayoral candidate. Moreover, Law 215/2012 introduced a double-gender preference system in these municipalities, allowing voters to cast up to two preferences for council candidates, provided that the two preferences are assigned to candidates of different sexes from the same list; otherwise, the second preference is invalid. A further strengthening of gender equality in municipal executive bodies was introduced by Law 56/2014, which established that in municipalities with more than 3,000 inhabitants, neither gender may represent less than 40% of the members of the municipal executive committee. Taken together, these legislative reforms have substantially reduced the risk of gender overrepresentation in Italian municipal politics and have contributed to making local political institutions more inclusive and representative.

Municipalities are responsible for the provision of local public goods and services within their territory, including civil registry and electoral services, street lighting, public transport, waste collection, preschool education, and the maintenance of municipal roads,

among others. They also play a key role in implementing the NRRP at the local level, particularly through the digitization of public service delivery to citizens and businesses. This includes the introduction of advanced digital infrastructures to enable data migration to qualified cloud services, the acceleration of digital payment systems (e.g., pagoPA),[7] the development of direct digital communication channels between citizens and municipalities (e.g., IO app),[8] and the promotion of digital identity systems to facilitate access to municipal services. Approximately €2 billion has been allocated to Italian municipalities through the NRRP-financed "Digital PA 2026" program to support the digital transformation of local public services. These transfers are particularly important for small municipalities, which constitute the majority of Italian municipalities, given their limited fiscal capacity, the increasing demand for local public goods and services, and large fixed costs due to initial investments in infrastructure, technology, and organization (Terlizzi, 2021).

Municipal administrations participated in NRRP competitive tenders by submitting project proposals under Mission 1, Component 1 (M1C1), entitled *digitalisation, innovation, and security in the public administration*. The design and implementation of projects involving digital and innovative technologies require municipal political and administrative actors to possess advanced and specialized technical skills, as well as the administrative capacity to comply with complex regulatory requirements. They also demand a commitment to a culture of technological innovation that supports organizational change, competitiveness, and territorial resilience. In this context, the gender of local political leadership may have influenced both the likelihood of project approval and the amount of funding received, as existing studies suggest that female political leaders are more likely to foster policies aimed at promoting technological change and innovation (Dahlum et al., 2022; Mirziyoyeva and Salahodjaev, 2023).

4 Method

4.1 Data and sample

Data on digital NRRP funding come from the Department of Digital Transformation of the Italian Government (Presidency of the Council of Ministers)[9] and contain information on

[7] See https://www.pagopa.gov.it.

[8] See https://ioapp.it/.

[9] They are freely available for download at https://padigitale2026.gov.it/open-data#0 (last accessed on November 26, 2025).

approved projects submitted by Italian municipalities from April 2022, when the digital NRRP program for local authorities began, until February 2025.[10] For each approved project, we know the municipality that obtained the funding, the application date, the type of call, and the funding amount. Using this information, we build a balanced panel of all Italian municipalities on a quarterly basis, starting from April 2022 and continuing until December 2024. In each month, for each municipality, we construct variables indicating whether the municipality obtained any digital NRRP funding and the total amount of funding that the municipality was able to attract.

Data on local administrators are gathered by the Department for Internal and Territorial Affairs of the Italian Ministry of the Interior.[11] For each municipality, we know the mayor, municipal councillors, and members of the municipal executive committee, along with personal information such as gender, date of birth, education, occupation, political party or coalition, and the dates marking the beginning and end of the mandate. Next, similarly to what we do with the data on digital NRRP funding, we construct a quarterly panel of Italian municipalities spanning from 2022 until 2024 containing, for each observation, the gender of the mayor, the share of women in the municipal council and in the municipal executive committee, a dummy indicator for the mayor's tertiary education, the exact day on which the mayor was appointed, the age of the mayor, and indicators for the mayor's political alignment (left, right, or other).[12]

Finally, from Istat we obtained a set of municipal characteristics that we use as covariates to make the treatment and control groups more comparable by controlling and balancing for potential systematic differences. In more detail, we collect both time-varying and time-invariant variables. Among the time-varying covariates, we use population, the fraction of women, and taxable income per capita in the previous year. In order to capture

[10]The Italian Presidency of the Council of Ministers makes available on its webpage https://www.italiadomani.gov.it/content/sogei-ng/it/it/catalogo-open-data/Progetti_del_PNRR.html (last accessed on January 9, 2026) information on approved NRRP projects across all missions, not only those related to digitalisation. However, we are unable to use this more comprehensive dataset because it does not report the submission date of project applications. Without this information, it is not possible to assign project submissions to the correct electoral cycle.

[11]They are freely available for download at https://dait.interno.gov.it/elezioni/open-data?f%5B0%5D=node%253Afield_argomento%3A180&f%5B1%5D=node%253Afield_argomento%3A180 (last accessed on November 26, 2025).

[12]For variables that vary monthly, we compute quarterly averages. For the gender of the mayor, if a change in office occurred in the last month of the quarter and involved a change in gender, we assign the change to the subsequent quarter. If the change in gender occurred in the first or second month of a given quarter, we assign to that quarter the gender of the new mayor.

potential spillover effects across bordering municipalities, we also control for a dummy variable equal to one if one of the neighbouring municipalities is led by a female mayor. Among the time-invariant covariates, we use 2021 values of population density, inactivity rate, unemployment rate, employment rate, and the Municipal Fragility Index (MFI). The latter is a composite indicator developed by Istat to measure how "fragile" Italian municipalities are, in the sense of their exposure to natural or anthropic risks and to socio-economic or demographic vulnerabilities.[13]

After matching these three main data sources – digital NRRP funding, local administrators, and Istat municipal characteristics – we obtain a balanced panel of 7,333 municipalities observed from April 2022 to December 2024.[14] After removing municipalities that already had a female mayor in the first observed quarter (April–June 2022), we are left with a balanced panel of 6,236 municipalities observed for 11 quarters and headed by a male mayor in the first quarter, for a total of 68,596 observations. Among these 6,236 municipalities, 5,886 never experienced a change from a male to a female mayor in the observed time window, whereas 350 did.

The gender change occurred at different times, resulting in a staggered treatment design. Table 1 reports the number of treated observations and the timing of the change in the mayor's gender from male to female. It shows that two thirds of the treated municipalities experienced a change in the mayor's gender by the last quarter of our observation window, and almost 20% did so in the second quarter. This implies that, when studying dynamic effects, we will be much more precise in estimating the contemporaneous effect and the effect in the subsequent quarter than in estimating effects further out in time. Figure 1 visualizes the geographical location of the treated municipalities by treatment timing. It shows that mayor's gender change occurred across all the country, although with a larger intensity in the North.

Table 2 reports descriptive statistics for the covariates used to balance treated and untreated municipalities and thus ensure comparability between the two groups. Municipalities experiencing a change in the gender of the mayor are richer in terms of taxable

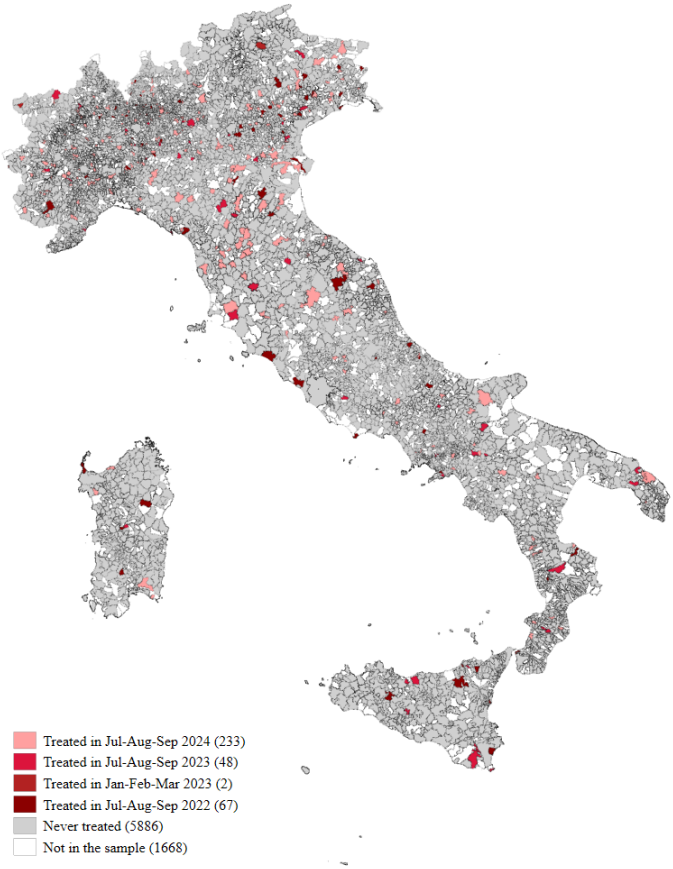
[13]The MFI aggregates twelve elementary indicators capturing dimensions such as environmental risk, land consumption, access to essential services, demographic dependency, educational levels, employment rates, and the density and productivity of the local economic fabric, among others. The resulting composite index assigns each municipality a score and groups them into deciles: municipalities in the highest deciles are classified as the most fragile. See https://www.istat.it/en/press-release/municipal-fragility-index-ifc/ for more details.

[14]We also remove 5 municipalities that held elections twice between 2022 and 2024 due to being placed under special administration by a government-appointed commissioner.

Table 1: Staggered treatment design from April 2022 to December 2024

	Quarter	# of municipalities	# of observations
Always male mayor (never treated)		5,886	64,746
From male to female mayor (treated)			
All	–	350	3,850
Jul-Aug-Sep 2022	2	67	737
Jan-Feb-Mar 2023	4	2	22
Jul-Aug-Sep 2023	6	48	528
Jul-Aug-Sep 2024	10	233	2,563
Total		6,236	68,596

Figure 1: Map of Italian municipalities by treatment status and timing



Notes: The treatment is the change in the gender of the mayor from male to female.

income per capita, more populated, display a slightly higher share of women, and are less likely to be governed by centre-right parties or coalitions. They are also more densely populated, exhibit lower inactivity and unemployment rates, and have a lower value of the municipal fragility index. Their mayors tend to be younger and are more likely to hold a tertiary degree.

Table 2: Summary statistics of the outcomes and covariates by treatment status

	Never treated and not-treated-yet		Treated		Difference	Significance test of the difference
	Mean (1)	Std. Dev. (2)	Mean (3)	Std. Dev. (4)	(3)−(1) (5)	p-value[(a)] (6)
a) Outcomes						
At least one funded project (per quarter)	0.387	0.487	0.417	0.493	0.030	0.004
Total funding (€ per quarter per capita)	14.380	65.941	5.508	23.204	-8.871	0.000
b) Covariates						
Mayor's age	51.681	11.273	50.012	9.489	-1.669	0.009
Mayor's tertiary education	0.429	0.495	0.546	0.498	0.116	0.001
Taxable income per capita (€)	19,270.26	4,019.78	20,765.53	4,157.57	1,495.27	0.000
Fraction of women	0.502	0.017	0.504	0.013	0.002	0.010
Centre-right	0.034	0.180	0.044	0.206	0.011	0.468
Centre-left	0.029	0.168	0.064	0.245	0.035	0.035
Other party/coalition	0.937	0.243	0.892	0.311	-0.045	0.033
Ln(population)	7.790	1.356	8.274	1.331	0.483	0.000
Female mayor in a neighbouring municipality	0.552	0.497	0.565	0.496	0.013	0.690
Population density per Km^2	284.902	601.723	368.329	538.735	83.427	0.023
Inactivity rate (%)	51.106	6.476	49.421	5.976	-1.685	0.000
Unemployment rate (%)	8.806	3.902	8.124	3.662	-0.681	0.012
Employment rate (%)	44.761	7.293	46.607	6.682	1.846	0.000
Tertiary education attainment rate (%)	22.083	5.864	22.583	5.899	0.500	0.203
Municipal fragility index	5.160	2.870	4.540	2.915	-0.620	0.003
Observations	67,156		1,440		68,596	

Notes: The treatment is the change in the gender of the mayor from male to female.
[(a)] The significance test is robust to heteroskedasticity and within-municipality correlation.

4.2 Difference-in-differences identification strategy

The main interest of our study is to understand the causal impact of having a female mayor on the municipality's ability to have its projects approved and funded. The treatment, the change in the gender of the mayor from male to female, is denoted by $D_{i,t}$, a dummy indicator equal to one if municipality i is treated at time t and equal to zero for all municipalities in our sample in the first quarter. Then, for $t = 2, \ldots, 11$, once a municipality becomes treated – i.e., when a male mayor is replaced by a female mayor as a result of the elections – the treatment indicator switches to one and remains equal to one until the

end of our observation window. As a matter of fact, the mandate lasts 5 years and our time window is not long enough to observe any reversal of treatment status. Hence, the treatment is irreversible and binary.

Using the same notation as Callaway and Sant'Anna (2021), let us define G_i as the time period when municipality i is first treated. In our application, in which time is measured on a quarterly basis, $G_i \in \{2, 4, 6, 10, \infty\}$, with $G_i = \infty$ for those municipalities that never experienced a change in the mayor's gender from male to female. We define $G_{i,g}$ as a binary variable equal to 1 if municipality i is first treated in period g, and C_i as an indicator variable equal to one if municipality i is never treated.

We estimate the effect of having a female mayor in obtaining digital NRRP funding using a staggered Difference-in-Differences (DiD) design. Recent contributions have highlighted important limitations of the conventional two-way fixed effects (TWFE) estimator when treatment effects vary across groups or over time (e.g. de Chaisemartin and D'Haultfœuille, 2020; Callaway and Sant'Anna, 2021; Goodman-Bacon, 2021; Sun and Abraham, 2021; Borusyak et al., 2024). A key difficulty in staggered DiD settings is that standard TWFE and event-study estimators may assign negative weights to certain municipality-period comparisons, especially when treatment effects differ across municipalities or over time. Such weighting can lead to aggregated estimates that invert the sign of the true treatment effect, even when the underlying municipal-level impacts are uniformly positive or negative.

To address these concerns, we rely on the identification strategy proposed by Callaway and Sant'Anna (2021). This approach accommodates heterogeneous treatment effects and satisfies the no-sign-reversal property. The basic estimand of interest is the average treatment effect on the treated (ATT), defined for each group of municipalities first treated in period g and measured in quarter t

$$ATT(g,t) = E\big[Y_t(g) - Y_t(0)|G_g = 1\big], \tag{1}$$

where $Y_t(g)$ is the outcome at quarter t for municipalities treated in quarter g, and $Y_t(0)$ is the counterfactual outcome at quarter t for those municipalities had they not been treated.

Callaway and Sant'Anna (2021) show that, under no treatment anticipation, conditional parallel trends based on not-yet-treated groups, and an overlap assumption for a generalized propensity score,[15] the group-time average treatment effect $ATT(g,t)$ in

[15] See Assumptions 3, 5, and 6 in Callaway and Sant'Anna (2021) for their formal statements.

Equation (1) can be identified, under independent and identically distributed units of observation, through the following doubly robust (DR) estimand:

$$ATT_{dr}(g,t) = E\left[\left(\frac{G_g}{E\big[G_g\big]} - \frac{\frac{p_{g,t}(X)(1-D_t)(1-G_g)}{1-p_{g,t}(X)}}{E\Big[\frac{p_{g,t}(X)(1-D_t)(1-G_g)}{1-p_{g,t}(X)}\Big]}\right)\Big(Y_t - Y_{g-1} - m_{g,t}(X)\Big)\right], \quad (2)$$

where $p_{g,t}(X)$ is the generalized propensity score, i.e. the probability of being first treated at quarter g, conditional on pre-treatment covariates X and on belonging either to the group of municipalities treated in quarter g or to the set of not-yet-treated municipalities by time t. The term $m_{g,t}(X) = E[Y_t - Y_{g-1}|X, D_t = 0, G_g = 0]$ is the population Outcome Regression (OR) for the not-yet-treated municipalities by time t.

The outer expectation in Equation (2) can be decomposed to isolate the contribution of treated and not-yet-treated units:

$$\underbrace{E\left[\frac{G_g}{E\big[G_g\big]}\big(Y_t - Y_{g-1} - m_{g,t}(X)\big)\right]}_{\text{treated part}} - \underbrace{E\left[\frac{\frac{p_{g,t}(X)(1-D_t)(1-G_g)}{1-p_{g,t}(X)}}{E\Big[\frac{p_{g,t}(X)(1-D_t)(1-G_g)}{1-p_{g,t}(X)}\Big]}\big(Y_t - Y_{g-1} - m_{g,t}(X)\big)\right]}_{\text{not-yet-treated part}}. \quad (3)$$

Expression (3) shows that the first term corresponds to the average differenced outcome at quarter t among municipalities first treated in quarter g, while the second term is the normalized inverse-odds-weighted average differenced outcome among the comparison units, i.e. the municipalities not in group g ($G_g = 0$) and not yet treated by quarter t ($D_t = 0$). The function $m_{g,t}(X)$ represents the OR component and requires modelling the conditional expectation in the outcome change from $g-1$ to t. The term involving the generalized propensity score $p_{g,t}(X)$ constitutes the Inverse Probability Weighting (IPW) component and requires modelling the conditional probability of being first treated in quarter g.

Subsequently, we aggregate the group-time average treatment effects in Equation (2) to highlight heterogeneity in the treatment effect across different lengths of treatment exposure, $q = t-g$. Following Callaway and Sant'Anna (2021), this is done by computing a weighted average of the effects for groups with identified treatment exposure length equal to q quarters, where the weights are given by group size among those with that exposure length.

4.3 Estimation

Following Callaway and Sant'Anna (2021), the group-time average treatment effect in Equation (3) is estimated using a three-step procedure.[16]

In the first step, for each group g and time period t, the generalized propensity scores $p_{g,t}(X)$ are estimated using a logit model and the covariates reported in panel b of Table 2, with values fixed at the first quarter, as some of them may be potentially affected by the treatment.[17] We denote by $\widehat{p}_{g,t}(X;\widehat{\pi}_{g,t})$ the predicted propensity scores, which depend on the logit-estimated parameters $\widehat{\pi}_{g,t}$.

In the second step, for each (g,t) pair, $m_{g,t}(X)$ – the population OR for the not-yet-treated municipalities at time t – is estimated by linear regression, and the fitted values $\widehat{m}_{g,t}(X;\widehat{\beta}_{g,t})$ are computed.

In the third step, the predicted propensity scores and the fitted values of the OR are plugged into the sample analogue of the group-time average treatment effects in Equation (2), yielding:

$$\begin{aligned}\widehat{ATT}_{dr}(g,t) &= \sum_{i=1}^{N_g}\frac{1}{\sum_{j=1}^{N_g}G_{j,g}}\left[Y_{i,t}-Y_{i,g-1}-\widehat{m}_{g,t}(X_i;\widehat{\beta}_{g,t})\right] \\ &- \sum_{i=1}^{N_t^{ny}}\frac{\frac{\widehat{p}_{g,t}(X_i)}{1-\widehat{p}_{g,t}(X_i)}}{\sum_{j=1}^{N_t^{ny}}\left[\frac{\widehat{p}_{g,t}(X_j)}{1-\widehat{p}_{g,t}(X_j)}\right]}\left[Y_{i,t}-Y_{i,g-1}-\widehat{m}_{g,t}(X_i;\widehat{\beta}_{g,t})\right], \qquad (4)\end{aligned}$$

where N_g is the number of municipalities treated in quarter g and N_t^{ny} is the number of municipalities not yet treated in quarter t.

To obtain event-study-type estimates q quarters after treatment, we compute the weighted average of $\widehat{ATT}_{dr}(g,g+q)$ for groups with treatment exposure length equal to q, where the weights are given by group size among those with exposure length q.

This estimator in Equation (4) of the group-time average treatment effect, being based on both the OR approach and IPW, is DR (Callaway and Sant'Anna, 2021): it is con-

[16] We use the Stata command `csdid`.

[17] In order to account for potential non-linearities in the effect of population, we include the natural logarithm of population and indicators for population levels between 3,000 and 4,999, between 5,000 and 14,999, and 15,000 or above. These categories reflect administrative classifications used in national laws and regulations (see Section 3), which often rely on population thresholds when defining municipal functions, the composition of councils, or other institutional obligations. For example, whether a municipality's population is below or above 3,000 or 5,000 determines the number of councillors or the gender composition of the executive committee.

sistent if either, but not necessarily both, the propensity score model or the OR model is correctly specified (Sant'Anna and Zhao, 2020). An important advantage of this estimator over other approaches, such as those proposed by Athey and Imbens (2022), Sun and Abraham (2021), or de Chaisemartin and D'Haultfœuille (2020), lies in its robustness to model misspecification and in its reliance on weaker assumptions. Athey and Imbens (2022) assume that the treatment adoption date is fully randomized and do not consider the role played by covariates. The event-study approach in Sun and Abraham (2021) is based on regression-based estimators under an unconditional version of the parallel trends assumption. de Chaisemartin and D'Haultfœuille (2020) focuses on the immediate effect, and the role played by covariates is investigated only through an OR approach. The DR estimator proposed by Callaway and Sant'Anna (2021) instead exploits a weaker version of the parallel trends assumption, conditional on covariates, and remains consistent even if one of the two models (propensity score or OR) is misspecified. Moreover, by combining weighting and regression, it may achieve efficiency gains relative to methods that rely solely on one approach (Tan, 2007).

Finally, in interpreting the findings of the event-study aggregation, it should be considered that the evolution of the treatment effect over exposure time may be driven by compositional changes in the municipalities identifying the different parameters. In our framework, as already highlighted in Table 1, few municipalities are treated at an early point in the observed time window, and most of the male-to-female switches took place in the penultimate quarter. This implies that while all treated municipalities contribute to identifying the contemporaneous effect and the effect after one quarter, only about 20% of the treated municipalities experienced the mayor's gender change in the second quarter and therefore contribute to identifying the longer-term effect. Nonetheless, this pattern reflects the institutional determination of treatment timing by the local election calendar, which occurs every five years and is therefore exogenous with respect to both the treatment itself (the switch from a male to a female mayor) and the outcome variable, namely obtaining digital NRRP funding, conditional on covariates.

5 Results

5.1 Main findings

Table 3 reports event-study estimates of the effect of switching from a male to a female mayor on the quarterly probability of having at least one project approved for funding (columns 1 and 2) and on the total amount of quarterly funding (columns 3 and 4). Panel a) presents the post-treatment effects, including the average post-treatment effect. Panel b) reports the pre-treatment effects, along with a test of the joint significance of the group–time pre-treatment ATT estimates. This test is crucial for assessing the credibility of the conditional parallel trends assumption underlying causal identification. The resulting p-values do not allow rejection of the null hypothesis, thereby supporting the validity of the parallel trends assumption. This conclusion is further supported by the visualization of the pre-treatment estimates in Figure 2.

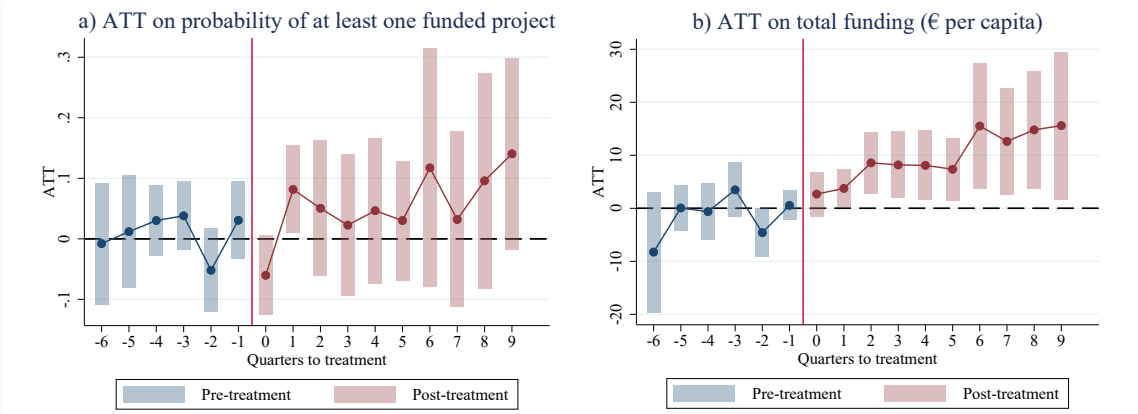
Table 3: Impact of female mayors on municipal digital NRRP project approval and funding

Dependent variable:	At least one funded project			Total funding (€ per capita)		
	Coeff. (1)		Std.Err. (2)	Coeff. (3)		Std.Err. (4)
a) Post-treatment impact						
Impact at $q = 0$	-0.060	*	0.034	2.691		2.158
Impact at $q = 1$	0.082	**	0.037	3.757	**	1.802
Impact at $q = 2$	0.050		0.057	8.581	***	2.968
Impact at $q = 3$	0.023		0.059	8.193	**	3.179
Impact at $q = 4$	0.046		0.061	8.110	**	3.320
Impact at $q = 5$	0.030		0.050	7.373	**	3.029
Impact at $q = 6$	0.117		0.101	15.528	**	6.047
Impact at $q = 7$	0.032		0.074	12.638	**	5.106
Impact at $q = 8$	0.096		0.091	14.808	***	5.632
Impact at $q = 9$	0.140	*	0.081	15.606	**	7.097
Post-treatment average	0.056		0.043	9.729	***	3.729
b) Pre-treatment impact						
Placebo at $q = -6$	-0.008		0.051	-8.252		5.775
Placebo at $q = -5$	0.012		0.047	0.074		2.170
Placebo at $q = -4$	0.030		0.030	-0.620		2.700
Placebo at $q = -3$	0.038		0.029	3.491		2.601
Placebo at $q = -2$	-0.052		0.035	-4.582	**	2.335
Placebo at $q = -1$	0.031		0.033	0.559		1.431
Pre-trend test, H_0: all pre-treatment $\widehat{ATT}_{dr}(g,t)$=0, p-value	0.620			0.324		
Average of the dependent variable for the treated (before treatment)	0.373			13.944		
Number of observations	68,596			68,596		
Number of treated obser. (municipalities)	3,850 (350)			3,850 (350)		
Number of control obser. (municipalities)	67,156 (5,886)			67,156 (5,886)		

Notes: * Significant at 10%, ** significant at 5% and *** significant at 1%. Standard errors robust to heteroskedasticity and within-municipality correlation.

The switch from a male to a female mayor has positive and sizeable effects on both the quarterly probability of having at least one project approved for funding and the total amount of quarterly funding. However, only the latter effect is statistically significant. The average post-treatment effect on the quarterly probability of having at least one project approved for funding is 5.6 percentage points, which is large relative to the pre-treatment mean for the treated group (37.3%), corresponding to an increase of approximately 15%. Nevertheless, except for the quarter immediately following treatment, this effect is not statistically different from zero.

Figure 2: Impact of female mayors on municipal digital NRRP project approval and funding



Notes: These graphs display the event-study estimates from Table 3. The shaded areas denote 95% confidence intervals that are robust to heteroskedasticity and within-municipality correlation.

By contrast, the impact on the total amount of quarterly funding is highly significant. The average post-treatment effect amounts to €9.73 per capita, with a p-value below 0.01. This corresponds to a 70% increase relative to the pre-treatment mean for the treated group (€13.94). The dynamic pattern of the effect is not constant over time. It is close to zero in the initial periods, rises to about €8 between two and five quarters after treatment, and then increases to approximately €15 by the end of the observation window, exceeding a 100% increase relative to the pre-treatment mean.

A cautionary note is warranted when interpreting this increasing dynamic. The composition of the treated population contributing to the estimates varies with exposure length. As shown in Subsection 5.2.2, this compositional change fully accounts for the observed pattern: the positive effect is driven entirely by municipalities treated earlier, while no effect is detected among municipalities treated in 2023 or 2024. In Subsection 5.2.2, we

provide an explanation for this evidence.

5.2 Mechanisms

5.2.1 The role of gender composition in the municipal council and executive committee

In order to uncover the positive effect of female mayors on municipalities' ability to attract central government funding, we examine the role played by the gender composition of the municipal council and the executive committee. The gender of the mayor may indeed be correlated with the composition of the executive committee, which is appointed and dismissed by the mayor, as well as with the composition of the council, which may reflect stronger party-level commitments to gender representation.[18]

We replicate the DiD analysis using as treatment variables the fraction of women in the council and in the executive committee. These treatments are non-binary and non-absorbing, and they may increase or decrease multiple times over time, as the composition of both bodies can change within the same legislature. The Callaway and Sant'Anna's (2021) estimator cannot accommodate this empirical setup. We therefore use the estimator proposed by de Chaisemartin and d'Haultfœuille (2024), which nests the Callaway and Sant'Anna's (2021) estimator as a special case. The de Chaisemartin and d'Haultfœuille's (2024) estimator is applicable to a broad class of designs, provided that some groups retain their period-one treatment level for several periods. More specifically, we implement their design 3 normalized DiD estimator.[19] In our sample, the average fraction of women in municipal councils (executive committees) is 29% (40%), with standard deviation equal to 13% (26%).

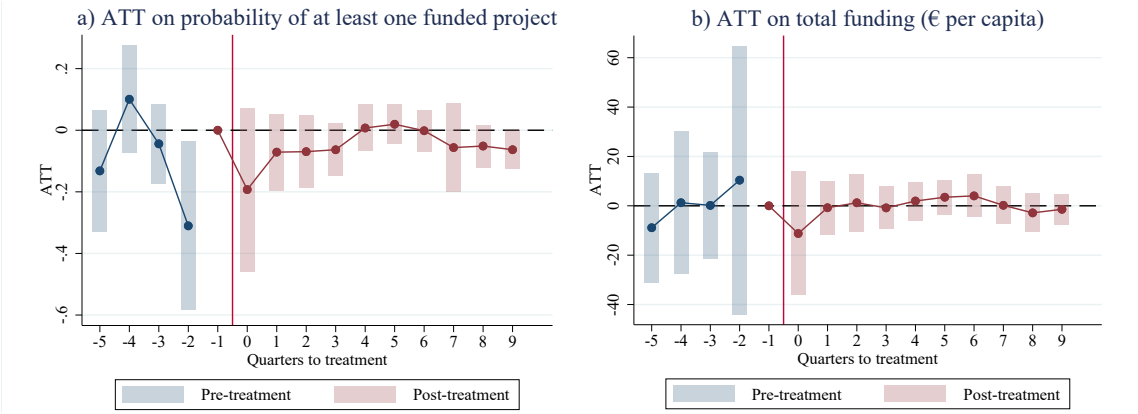
Figures 3 and 4 show the normalized estimated effects, which should be interpreted bearing in mind that treatment intensity ranges from 0 to 1. The estimates should therefore be divided by ten to obtain the effect of a 10-percentage point increase in the female share. These figures indicate that neither the share of women in the municipal council nor that in the executive committee affects the ability to obtain digital NPRR funding. Hence, the

[18] The mayor may be elected president of the municipal council, although in municipalities with fewer than 15,000 inhabitants, the mayor automatically serves as president unless the municipal statute provides otherwise (Legislative Decree 267/2000, Art. 39).

[19] We use the Stata command `did_multiplegt_dyn`. To reduce the computational burden, we discretize the continuous fraction by partitioning the $[0, 1]$ support into 25 equally spaced intervals and assigning to each observation the lower bound of the corresponding interval.

results of the main analysis are entirely driven by the role and function of female mayors, rather than indirectly by the gender composition of other institutional bodies.

Figure 3: Impact of share of women in the municipal council



Notes: The joint tests of the null hypothesis that the post-treatment (pre-treatment placebo) coefficients are zero yield the following p-values for panels (a) and (b): 0.054 (0.055) and 0.376 (0.859), respectively. The shaded areas denote 95% confidence intervals that are robust to heteroskedasticity and within-municipality correlation.

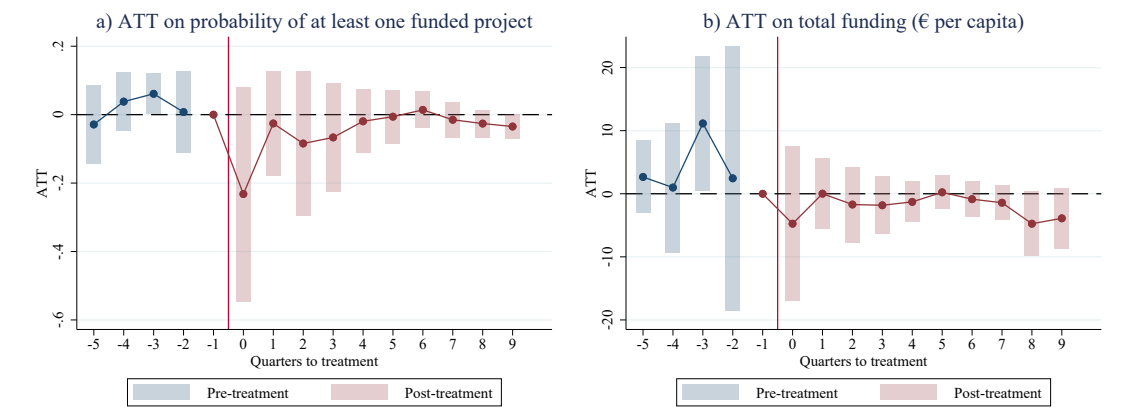
5.2.2 High-stakes funding and the role of mayoral education and local bureaucratic capacity

The distribution of digital NRRP funding has not been homogeneous over time. In particular, funding was heavily front-loaded in 2022, when total allocations to digital NRRP projects amounted to nearly €1.5 billion. In 2023 and 2024, this figure declined sharply to approximately €200 million.

Figure 5 combines information on total digital NRRP funding with the timing of treatment. The first municipal elections, and thus the first transitions from male to female mayors, occurred between July and September 2022, when approximately €500 million in funding was allocated. By the second treatment period (January-March 2023), this amount had fallen to about €130 million, and by the third period (July-September 2023) it had reached a minimum of €12 million.

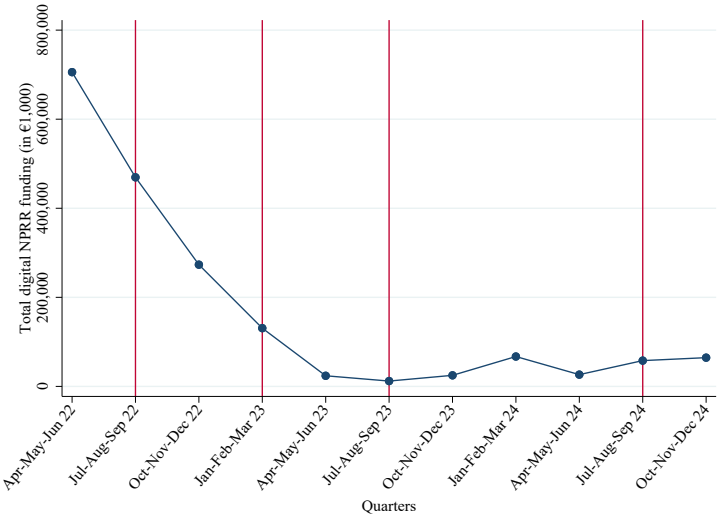
Given this heavily front-loaded allocation of resources, with funding in 2022 nearly eight times higher than in subsequent years, one may hypothesize that the effect of a switch to a female mayor in 2022, coinciding with a high-stakes funding environment, was larger. In such a context, application quality, administrative effort, and strategic pri-

Figure 4: Impact of share of women in the municipal executive committee



Notes: The joint tests of the null hypothesis that the post-treatment (pre-treatment placebo) coefficients are zero yield the following p-values for panels (a) and (b): 0.035 (0.267) and 0.184 (0.262), respectively. The shaded areas denote 95% confidence intervals that are robust to heteroskedasticity and within-municipality correlation.

Figure 5: Overall funding in digital NRRP projects



Notes: The vertical red lines indicate the timing of treatment across groups.

oritization likely yielded higher returns. After 2022, when funding availability became substantially more limited, even superior administrative performance under the female leadership may have translated into negligible additional resources, rendering the treatment effect statistically and economically insignificant.

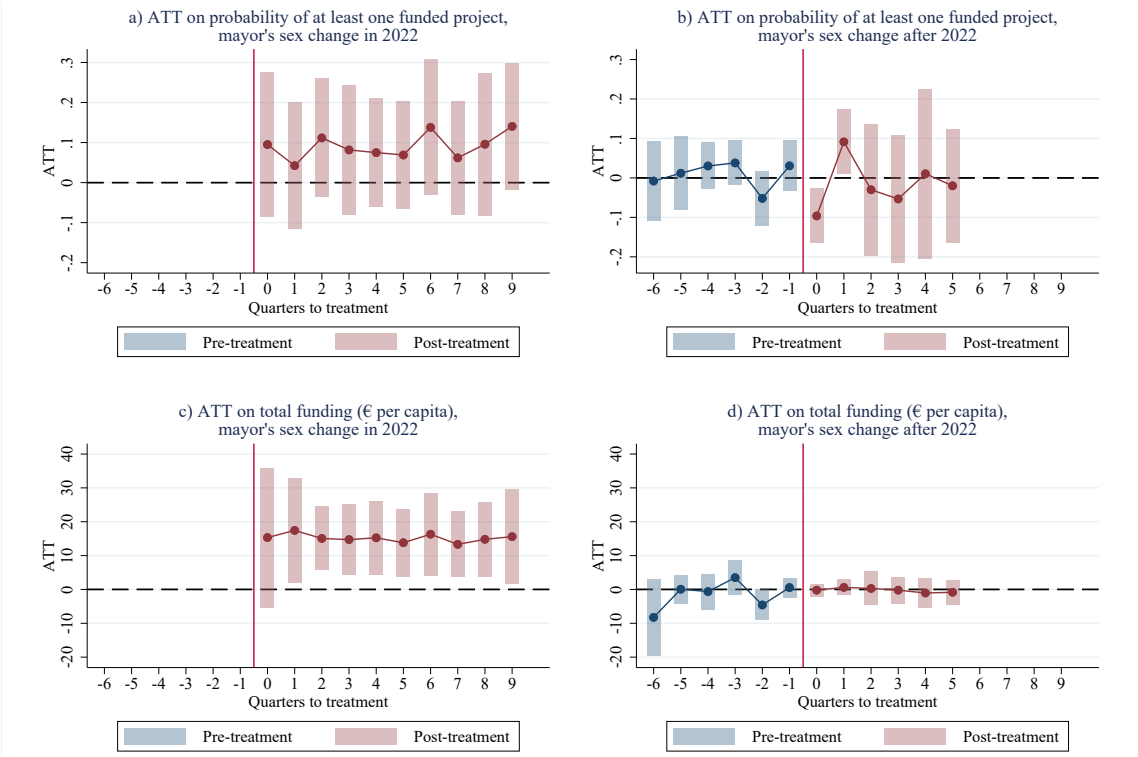
To test this hypothesis and assess whether the dynamic treatment effect varies with treatment timing, we split treated municipalities into those treated in 2022 and those treated in later years, and re-estimate the effect of having a female mayor. Figure 6 presents the results. Panels a) and c) on the left report estimates for municipalities treated in 2022, while panels b) and d) on the right show the corresponding results for those treated later. The figures indicate that the positive effect of female leadership on total funding observed in the full sample of treated municipalities is driven entirely by municipalities that held elections in 2022. For municipalities treated in 2023 or 2024, the switch to a female mayor yields no statistically or economically significant effects. These findings are consistent with the front-loaded policy environment depicted in Figure 5: female leadership appears to matter when administrative effort and strategic action are rewarded by large funding opportunities. Once funding becomes more constrained, leadership differences lose relevance because the policy margin effectively disappears.

To further probe the mechanisms underlying the timing-specific effects documented above, we replicate the analysis by treatment timing separately for municipalities led by tertiary-educated and non-tertiary-educated, and by splitting municipalities according to the quality of the local bureaucracy. These extensions are motivated by the hypothesis that, given the administrative complexity involved in applying for NRRP projects, the effectiveness of political leadership in securing funding may depend not only on gender but also on individual human capital and the capacity of the local bureaucracy.

In a high-stakes funding environment, such as that prevailing in 2022, mayors with higher educational attainment, or those supported by a highly capable local bureaucracy, may be better equipped to navigate application procedures, coordinate municipal administrations, and strategically prioritise projects. By contrast, when funding availability is more limited, even high levels of administrative competence can yield little marginal return. Consequently, splitting the analysis by educational attainment or by the capacity of the local bureaucracy allows us to assess whether the observed concentration of effects in 2022 reflects gender per se, or rather gender interacting with leadership capacity or the quality of the supporting administrative apparatus.

Turning to mayoral tertiary education, Figure 7 reports the results when the dependent

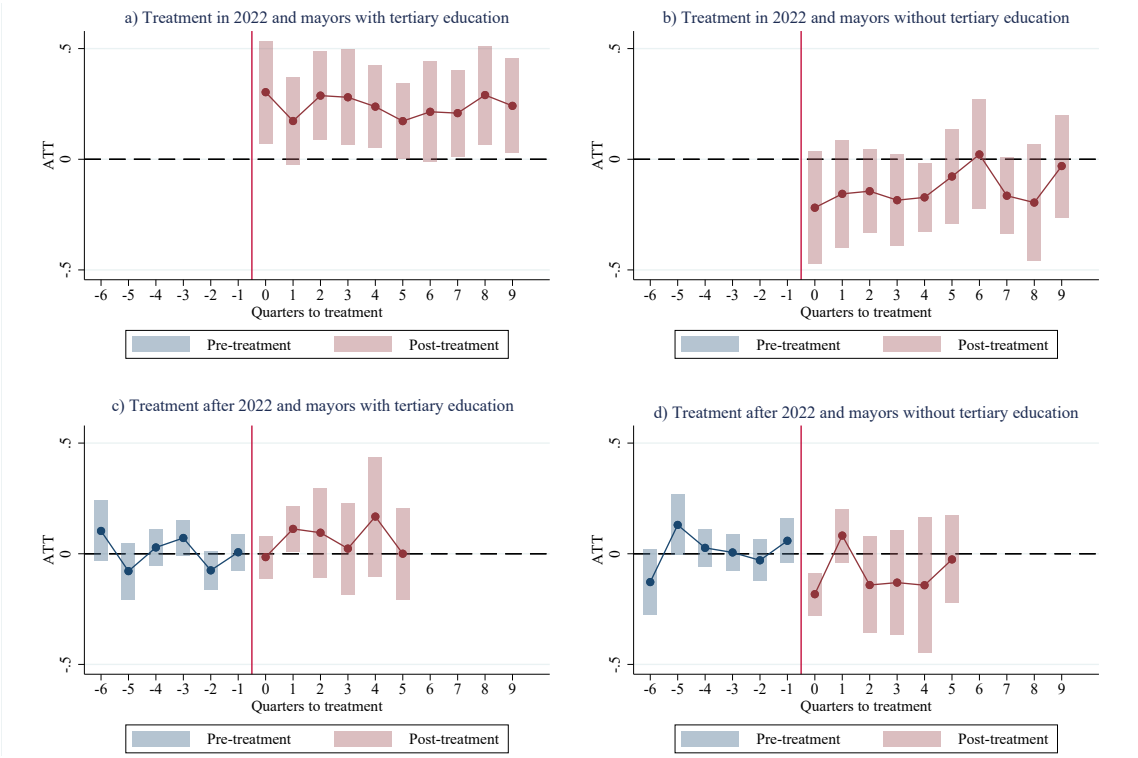
Figure 6: Impact of female mayors on municipal digital NRRP project approval and funding by treatment timing (2022 vs 2023-2024)



Notes: The shaded areas denote 95% confidence intervals that are robust to heteroskedasticity and within-municipality correlation. The post-treatment averages are (p-values in parenthesis): 0.091 (0.141) in graph a; -0.016 (0.738) in graph b; 15.168 (0.009) in graph c; -0.227 (0.873) in graph d. For municipalities treated after 2022, we can also estimate the effects six and seven quarters after treatment. However, the corresponding confidence intervals are very wide; for this reason, these estimates are not shown in graphs b and d. The number of treated (control) municipalities are: 67 (5,886) in graphs a and c; 283 (5,886) in graphs b and d.

variable is an indicator for receiving at least one funded project, whereas Figure 8 presents the results for total funding received. Figure 7 shows that, for municipalities treated in 2022, female leadership combined with tertiary education leads to a statistically significant increase in the probability of obtaining funding, with an average post-treatment effect of 24 percentage points (p-value $= 0.004$). In contrast, when the female mayor does not hold a tertiary degree, the effect is negative, amounting on average to -13 percentage points (p-value $= 0.083$). When treatment occurs after 2022, no clear differences emerge by the mayor's education level, and post-treatment average effects are not statistically different from zero.

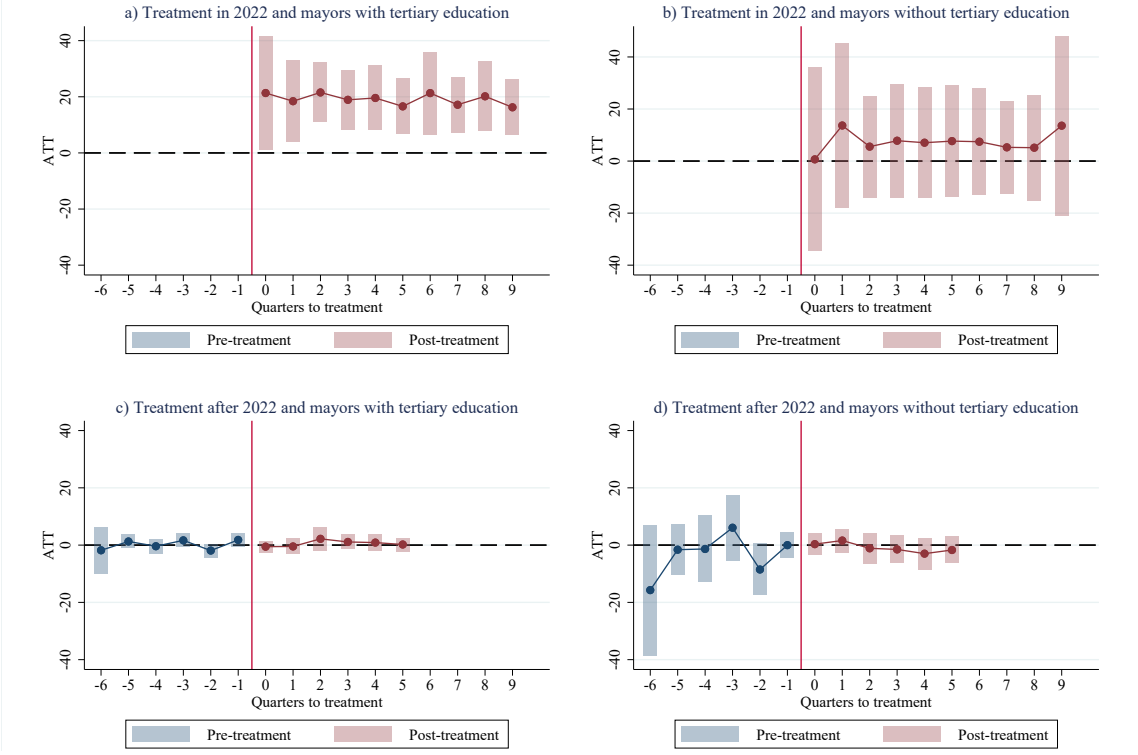
Figure 7: Impact of female mayors on quarterly probability of at least one funded project by mayor's tertiary education and treatment timing



Notes: The shaded areas denote 95% confidence intervals that are robust to heteroskedasticity and within-municipality correlation. The post-treatment averages are (p-values in parenthesis): 0.241 (0.004) in graph a; -0.132 (0.083) in graph b; 0.064 (0.254) in graph c; -0.090 (0.199) in graph d. The number of treated (control) municipalities are: 41 (2,454) in graph a; 26 (3,276) in graph b; 150 (2,626) in graph c; 133 (3,473) in graph d.

Consistent with these results, Figure 8 shows that mayoral education does not affect total obtained funding when treatment occurs after 2022. However, when the transition

Figure 8: Impact of female mayors on quarterly total funding (€ per inhabitant) by mayor's tertiary education and treatment timing



Notes: The shaded areas denote 95% confidence intervals that are robust to heteroskedasticity and within-municipality correlation. The post-treatment averages are (*p*-values in parenthesis): 19.129 (0.001) in graph a; 7.389 (0.535) in graph b; 0.569 (0.397) in graph c; -0.888 (0.624) in graph d. The number of treated (control) municipalities are: 41 (2,454) in graph a; 26 (3,276) in graph b; 150 (2,626) in graph c; 133 (3,473) in graph d.

to female leadership takes place in 2022, a strong and positive effect on total funding emerges if the female mayor has a tertiary education, with an average post-treatment increase of €19 per capita (p-value=0.001). By contrast, the estimated effect is substantially smaller (€7 per capita) and statistically insignificant (p-value=0.535) for female mayors without tertiary education.

To assess whether gender differences in mayors' ability to attract central government funding are mediated by the quality and competence of the local bureaucracy, we rely on Pillar I of the Municipal Administrative Quality Index (MAQI) for Italian municipalities, developed by Cerqua et al. (2025).[20] Pillar I captures bureaucratic quality and administrative capacity.[21] This measure allows us to test whether political leadership and administrative capacity act as complements in the allocation of high-stakes public investments. In line with the findings for mayoral education, we find that when the transition to female leadership occurs in 2022, there is a strong and positive effect on total funding in municipalities supported by high-quality bureaucracies, with an average post-treatment increase of €31 per capita (p-value=0.003). By contrast, the estimated effect is essentially nil for female mayors not supported by a high-quality local bureaucracy (see Figures 9 and 10).

Taken together, the heterogeneity analyses by mayoral education and bureaucratic quality indicate that gender differences in funding acquisition arise when female leadership is coupled with sufficient individual human capital or adequate bureaucratic capacity, and when municipalities operate in a policy environment characterised by large funding opportunities.

5.2.3 High-stakes funding and further heterogeneity dimensions

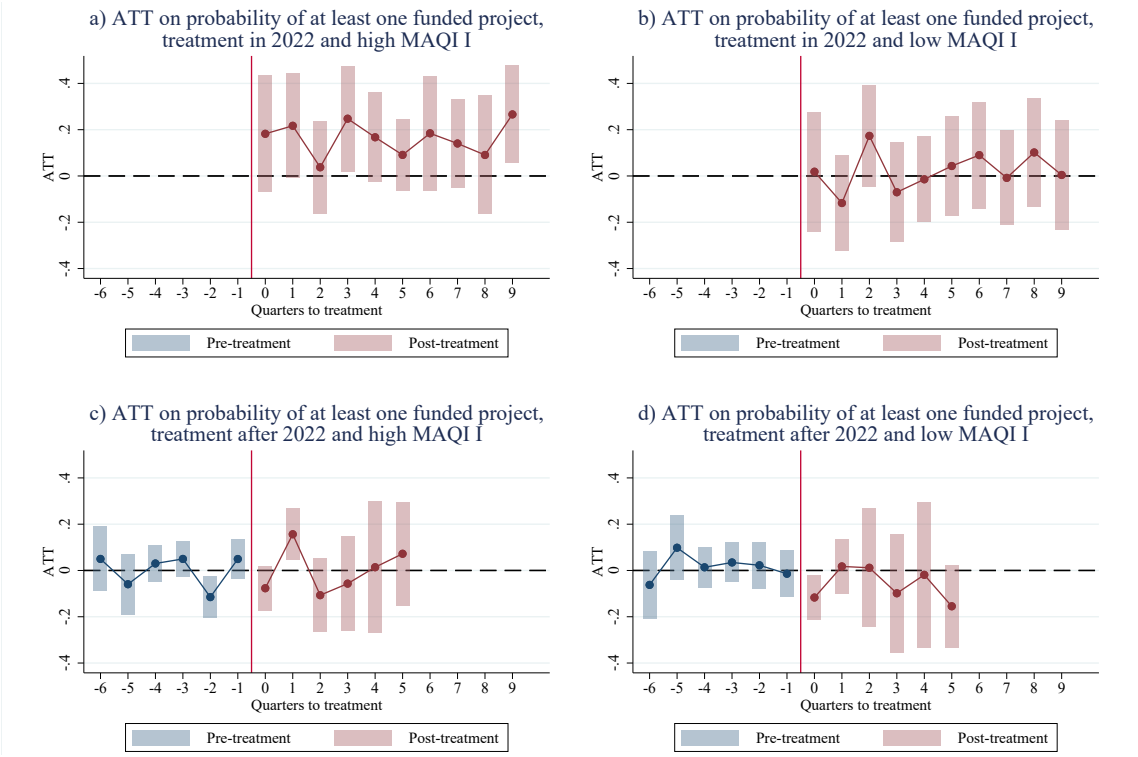
We further investigate additional dimensions of heterogeneity, namely geographic macroareas, population, and municipal fragility index (hereafter, MFI).[22]

[20] The MAQI and its decomposition into three pillars are available at https://sites.google.com/view/maqi/home (last accessed on January 30, 2026).

[21] Specifically, Pillar I is a composite index based on four indicators: the average years of education of public employees, the number of bureaucrats per 1,000 inhabitants, the average number of absences among municipal employees, and the turnover rate of public employees. We use the 2021 value. Since the MAQI is not available for all municipalities in our sample due to boundary changes during the period in which it was constructed by Cerqua et al. (2025), the sample used in the empirical analysis with MAQI is approximately 2% smaller than that used in the rest of the study. Specifically, we lose 7 treated municipalities and 135 control municipalities.

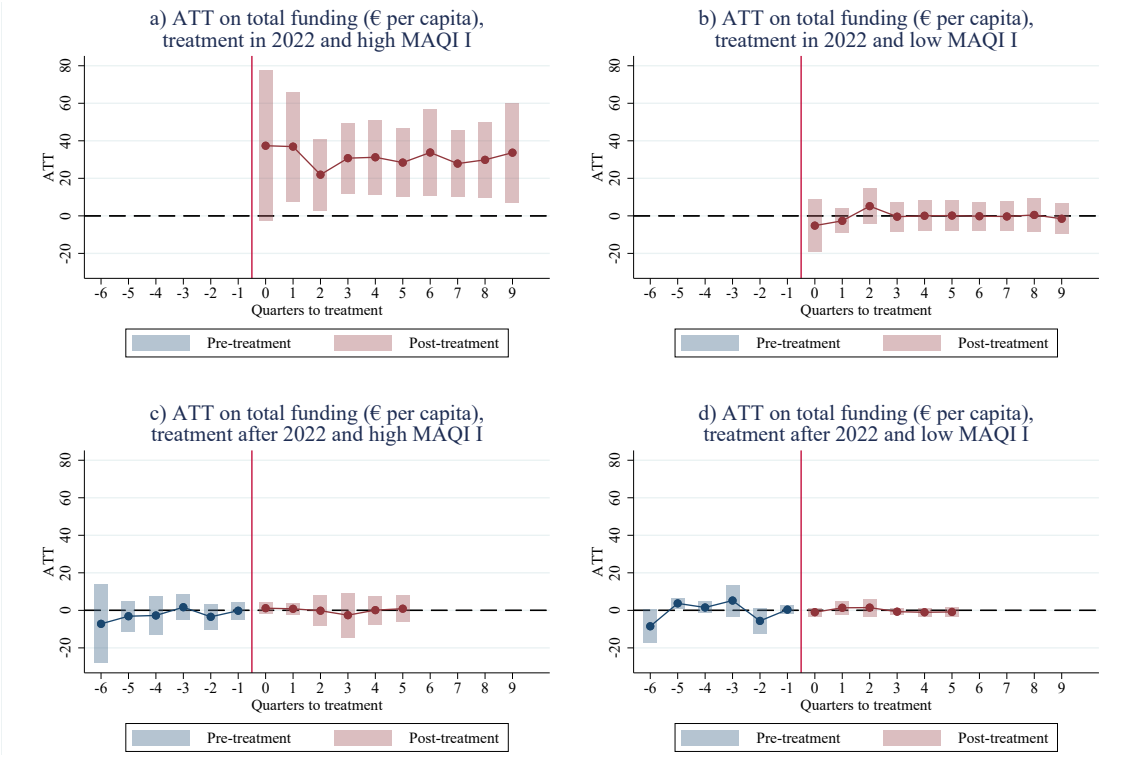
[22] Table A.1 in the appendix reports the correlation for the treated municipalities between these three heterogeneity dimensions, mayoral tertiary eduction and Pillar I of MAQI. The correlations are weak, sug-

Figure 9: Impact of female mayors on quarterly probability of at least one funded project by Pillar I of MAQI and treatment timing



Notes: We split the treated municipalities into high and low MAQI I according to the treated median value: municipalities with MAQI I values strictly above the median are classified as high MAQI I. The shaded areas denote 95% confidence intervals that are robust to heteroskedasticity and within-municipality correlation. The post-treatment averages are (p-values in parenthesis): 0.162 (0.054) in graph a; 0.022 (0.800) in graph b; 0.0004 (0.994) in graph c; -0.060 (0.410) in graph d. The number of treated (control) municipalities are: 33 (2,920) in graph a; 34 (2,831) in graph b; 138 (2,920) in graph c; 138 (2,831) in graph d.

Figure 10: Impact of female mayors on quarterly total funding (€ per inhabitant) by Pillar I of MAQI and treatment timing



Notes: We split the treated municipalities into high and low MAQI I according to the treated median value: municipalities with MAQI I values strictly above the median are classified as high MAQI I. The shaded areas denote 95% confidence intervals that are robust to heteroskedasticity and within-municipality correlation. The post-treatment averages are (p-values in parenthesis): 31.184 (0.003) in graph a; -0.440 (0.916) in graph b; 0.042 (0.988) in graph c; -0.107 (0.902) in graph d. The number of treated (control) municipalities are: 33 (2,920) in graph a; 34 (2,831) in graph b; 138 (2,920) in graph c; 138 (2,831) in graph d.

We first examine whether the results differ across geographic macro-areas, splitting the sample into the North and the Centre-South. The North differs from the Centre-South in terms of administrative capacity, labor market structure, and reliance on intergovernmental transfers. Municipalities in the Centre-South tend to rely more heavily on external funding, making mayoral effort in securing such funding more important. Moreover, gender norms also differ across areas (Carrer and De Masi, 2024), and the novelty effect of female leadership may be more salient where women are historically underrepresented. Figures A.1 and A.2 in the appendix show that, from a statistical perspective, the effect does not differ across macro-areas, although the point estimates suggest that the effect is slightly smaller in the North.

Second, we investigate whether the effect depends on municipal population. This dimension may capture differences in administrative capacity, as smaller municipalities typically have fewer specialized staff. In municipalities with a small population, the mayor may exercise greater direct control over funding applications; consequently, mayoral characteristics may play a larger role in shaping outcomes. Moreover, in small municipalities, the proximity between voters and politicians is higher, generating stronger incentives and higher returns for mayors to channel resources toward projects. In line with these hypotheses, Figures A.3 and A.4 in the appendix show that the effect for municipalities treated in 2022 is driven by small municipalities.[23] The post-treatment average effect on the probability of obtaining at least one funded project is 22.4 percentage points in low-population municipalities, compared with 2.9 percentage points in high-population municipalities. The post-treatment average effect on total funding is €43.40 in low-population municipalities, compared with -€1.03 in high-population municipalities.

Lastly, we study effect heterogeneity along the MFI, which captures socioeconomic disadvantage, demographic stress, and anthropic pressures. In fragile municipalities, additional funding may yield larger welfare and political payoffs, thereby increasing incentives to actively pursue external resources. These municipalities may also face tighter budget constraints, making external funding more salient and potentially more contested. Moreover, female mayors in high-fragility contexts may be more positively selected in terms of competence, motivation, or civic engagement, having overcome higher barriers to political entry. Based on this, local governments with fragile territories are expected to

gesting that the five dimensions are not redundant and should capture different aspects of municipalities' characteristics.

[23] We split municipalities into high- and low-population groups according to the median value: municipalities with population strictly above 3,735 inhabitants are classified as high population.

exhibit superior performance in attracting public funding for innovation-related technologies when the political representation of women is higher, relative to their male-dominated counterparts. Consistent with this hypothesis, we find that the effect of a female mayor is larger in municipalities with an MFI above the median. The post-treatment average effect on total funding is €26.58 in municipalities with MFI above the median, compared with €8.08 in municipalities below the median (see Figures A.5 and A.6 in the appendix).

5.3 Robustness checks

Treated municipalities are those that held elections between 2022 and 2024 and experienced a switch from a male to a female mayor. Our control group consists of not-yet-treated municipalities as well as never-treated municipalities. Among the never-treated municipalities, we include both municipalities that did not hold elections during the observed period and municipalities that held elections but either re-elected the incumbent male mayor or elected a new male mayor. One may wonder whether municipalities that did not hold elections or that re-elected the incumbent mayor systematically differ from treated units. For example, if the incumbent mayor is re-elected, the municipality may benefit from greater accumulated leadership knowledge and larger administrative experience and institutional knowledge, which could be correlated with the probability of obtaining project funding. Ignoring this heterogeneity could bias our estimates if the untreated controls are not comparable to treated units.

To assess whether our findings are biased by compositional differences in the control group, we re-estimate the model by: (i) limiting the control group to municipalities that held elections between 2022 and 2024, and (ii) further restricting the control group to municipalities that held elections in this period and did not re-elect the incumbent mayor. The results, presented in Table 4, are very similar to the benchmark estimates. We therefore conclude that potential compositional differences in the control group do not bias our findings.

We further assess the robustness of our findings using alternative estimators. Table 5 reports the post-treatment effects obtained with: the TWFE estimator (panel a), which is not robust to treatment heterogeneity across groups and over time; the de Chaisemartin and d'Haultfœuille's (2024) estimator (panel b), which handles covariates differently using an OR approach; and the Callaway and Sant'Anna's (2021) estimator, using either the OR approach (panel c) or the IPW approach (panel d). In all cases, the main findings

Table 4: Impact of female mayors selecting only municipalities that held elections between April 2022 and December 2024

Dependent variable:	Controls that held elections				Controls that held elections and did not confirm the incumbent mayor			
	At least one funded project		Total funding (€ per capita)		At least one funded project		Total funding (€ per capita)	
	Coeff. (1)	Std.Err. (2)	Coeff. (3)	Std.Err. (4)	Coeff. (5)	Std.Err. (6)	Coeff. (7)	Std.Err. (8)
a) Post-treatment impact								
Impact at $q = 0$	-0.053*	0.034	2.746	2.364	-0.047	0.034	3.198	2.299
Impact at $q = 1$	0.086**	0.037	3.023	1.963	0.078**	0.038	2.861	1.889
Impact at $q = 2$	0.066	0.055	9.551***	3.188	0.058	0.057	8.344***	3.157
Impact at $q = 3$	0.016	0.059	9.043***	3.416	0.004	0.061	7.414**	3.424
Impact at $q = 4$	0.047	0.060	9.160**	3.542	0.032	0.062	8.251**	3.470
Impact at $q = 5$	0.029	0.050	8.044**	3.247	0.020	0.052	6.569**	3.177
Impact at $q = 6$	0.150	0.096	18.467***	6.781	0.111	0.104	14.155**	6.344
Impact at $q = 7$	0.027	0.074	15.487***	5.544	0.021	0.076	11.717**	5.034
Impact at $q = 8$	0.100	0.091	16.645***	6.240	0.099	0.091	14.943**	5.888
Impact at $q = 9$	0.159**	0.081	17.017**	7.515	0.146	0.083	15.264**	7.309
Post-treatment average	0.063	0.044	10.918***	4.058	0.052*	0.045	9.271**	3.854
b) Pre-treatment impact								
Placebo at $q = -6$	0.015	0.052	-8.209	5.804	0.031	0.053	-8.559	5.890
Placebo at $q = -5$	-0.007	0.048	-0.119	2.189	-0.021	0.050	0.397	2.353
Placebo at $q = -4$	0.035	0.031	-0.560	2.726	0.036	0.032	-0.483	2.718
Placebo at $q = -3$	0.037	0.029	3.215	2.618	0.040	0.030	3.244	2.641
Placebo at $q = -2$	-0.032	0.035	-5.217**	2.508	-0.038	0.037	-4.426*	2.421
Placebo at $q = -1$	0.010	0.033	-0.925	1.859	0.010	0.034	0.357	1.448
Pre-trend test, H_0: all pre-treatment $\widehat{ATT}_{dr}(g,t)$=0, p-value	0.556		0.121		0.462		0.549	
Number of observations	47,223		47,223		24,761		24,761	
Number of treated obser. (municipalities)	3,850 (350)		3,850 (350)		3,850 (350)		3,850 (350)	
Number of control obser. (municipalities)	43,373 (3,943)		43,373 (3,943)		20,911 (1,901)		20,911 (1,901)	

Notes: * Significant at 10%, ** significant at 5% and *** significant at 1%. Standard errors robust to heteroskedasticity and within-municipality correlation.

are confirmed, both qualitatively and quantitatively: female leadership has no significant effect on the probability of obtaining project funding, but it does significantly and largely increase total funding.

Table 5: Further estimators

Dependent variable:	At least one funded project		Total funding (€ per capita)		At least one funded project		Total funding (€ per capita)	
	Coeff.	Std.Err.	Coeff.	Std.Err.	Coeff.	Std.Err.	Coeff.	Std.Err.
	a) TWFE estimates[(a)]				*b) de Chaisemartin and d'Haultfœuille's (2024) estimates*[(a)]			
Impact at $q = 0$	-0.065**	0.033	1.806	2.204	-0.066**	0.033	2.351	2.202
Impact at $q = 1$	0.078**	0.035	4.893***	1.591	0.078**	0.036	5.300***	1.553
Impact at $q = 2$	0.019	0.049	10.502***	2.353	0.036	0.056	14.593***	2.075
Impact at $q = 3$	-0.02	0.048	11.723***	2.190	-0.005	0.060	15.829***	2.126
Impact at $q = 4$	-0.006	0.047	11.224***	2.285	0.009	0.060	15.404***	2.194
Impact at $q = 5$	-0.016	0.044	10.380***	2.208	-0.002	0.051	14.393***	2.108
Impact at $q = 6$	0.033	0.064	14.381***	3.368	0.06	0.087	27.629***	4.266
Impact at $q = 7$	-0.034	0.056	11.947***	2.655	-0.007	0.074	25.237***	3.335
Impact at $q = 8$	0.019	0.068	12.407***	2.656	0.055	0.094	26.782***	3.936
Impact at $q = 9$	0.061	0.068	13.663***	2.823	0.100	0.083	27.964***	5.267
	c) Callaway and Sant'Anna's (2021) estimates with OR only				*d) Callaway and Sant'Anna's (2021) estimates* with IPW only			
Impact at $q = 0$	-0.062*	0.033	2.505	2.101	-0.060*	0.034	2.700	2.170
Impact at $q = 1$	0.076**	0.035	3.217*	1.700	0.082**	0.038	3.724**	1.777
Impact at $q = 2$	0.047	0.054	7.942***	2.862	0.052	0.058	8.494***	2.851
Impact at $q = 3$	0.015	0.059	7.338**	3.197	0.024	0.060	8.061**	3.109
Impact at $q = 4$	0.037	0.059	7.514**	3.284	0.048	0.061	8.114**	3.293
Impact at $q = 5$	0.021	0.050	6.630**	3.006	0.032	0.050	7.325**	2.976
Impact at $q = 6$	0.117	0.085	13.950**	5.901	0.121	0.102	15.444**	6.000
Impact at $q = 7$	0.031	0.072	10.997**	4.817	0.031	0.076	12.404**	4.953
Impact at $q = 8$	0.092	0.090	13.165**	5.610	0.096	0.091	14.783***	5.621
Impact at $q = 9$	0.137*	0.081	14.032**	6.962	0.141*	0.081	15.576**	7.072

Notes: * Significant at 10%, ** significant at 5% and *** significant at 1%. Standard errors robust to heteroskedasticity and within-municipality correlation.

[(a)] In the TWFE and de Chaisemartin and d'Haultfœuille's (2024) estimators, we include the following time-varying covariates: the mayor's age and a tertiary-education dummy, taxable income per capita, the fraction of women, political party or coalition dummies, a dummy indicating the presence of a female mayor in a neighbouring municipality, the natural logarithm of population, and indicators for population levels between 3,000 and 4,999, between 5,000 and 14,999, and 15,000 or above. In Callaway and Sant'Anna's (2021) approach, these covariates are fixed at the values they take in the first quarter of the observed time window.

6 Conclusions

Our study contributes to shedding light on an important yet largely overlooked dimension of research on the effects of gender in politics, namely the ability of female politicians to attract public funding opportunities aimed at digitizing local public administrations. While much of the existing literature emphasises the impact of gender differences in political representation on various economic outcomes, relatively little attention has been

paid to how women, particularly in political leadership positions, strategically engage with public funding systems. Our empirical analysis shows that the switch from a male to a female mayor has positive and sizeable effects on both the quarterly probability of having at least one project approved for funding and the total amount of quarterly funding. However, only the latter effect is statistically significant. The average post-treatment effect on total funding amounts to €9.73 per capita, corresponding to a 70% increase relative to the pre-treatment mean for the treated group.

Examining heterogeneity by treatment timing, mayoral human capital and the capacity of local bureaucracy, we find that the estimated effect is driven by municipalities treated in 2022, when funding opportunities aimed at digitizing local public administrations were by far most abundant, and led by female mayors with tertiary education or supported by high quality bureaucrats. We interpret this evidence as indicating that female mayors are able to attract significantly larger amounts of central public funding for digitalization when female leadership is combined with sufficient human capital, or adequate bureaucratic capacity, and a policy environment characterized by ample funding opportunities. By contrast, when funding becomes more constrained, leadership differences lose relevance, as the effective policy margin disappears.

Our findings suggest that female political leadership can enhance the ability of local governments to attract specific public funding, but only under specific conditions, namely sufficient human capital or enough bureaucratic capacity, and abundant funding opportunities. This implies that the effectiveness of political leadership is shaped not only by leaders' individual characteristics, but also by institutional and budgetary constraints. From a policy perspective, these results indicate that facilitating women's access to political leadership positions may yield efficiency gains in fund absorption for digitalization, in addition to promoting gender equality, especially during periods of substantial public funding. Moreover, the importance of mayoral tertiary education and of the capacity of the local bureaucracy highlights the potential role of capacity-building initiatives aimed at enabling local political leaders to better exploit opportunities from central public funding. At the same time, the absence of leadership effects in more constrained funding environments suggests that financial constraints may dominate individual leadership characteristics and the quality of the local bureaucracy. This underscores the importance of aligning decentralization reforms and the generosity of funding mechanisms with local administrative capacity.

Finally, when investigating additional dimensions of heterogeneity, we find that the

effects of female mayors are more pronounced in small and fragile municipalities. These municipalities are typically the most exposed to persistent disadvantages and face higher per capita fixed costs related to initial investments in infrastructure, technology, and organizational capacity, which may constitute significant barriers to the digitalization of local public services. In this context, female political leadership appears to be particularly effective in securing external funding. Overall, these findings suggest that increasing gender diversity in local leadership may help reduce disparities in access to public funding across municipalities, particularly between high- and low-capacity areas.

A limitation of our study is that we cannot extend the analysis to NRRP intervention areas beyond digitalisation, due to the lack of comparably detailed municipal-level data on the timing of project submissions. Examining gender effects in local government political leadership across other NRRP missions would have helped disentangle performance-based effects from differences in policy preferences between female and male incumbent politicians, as emphasized in the literature (Chattopadhyay and Duflo, 2004; Brulé, 2020; Clots-Figueras, 2011). In particular, such an analysis could clarify whether female mayors are generally more effective in securing public funding or are instead more likely to prioritize specific policy domains, such as digitalisation. We leave this question for future research, should more detailed data on the timing of project submissions and approvals become available.

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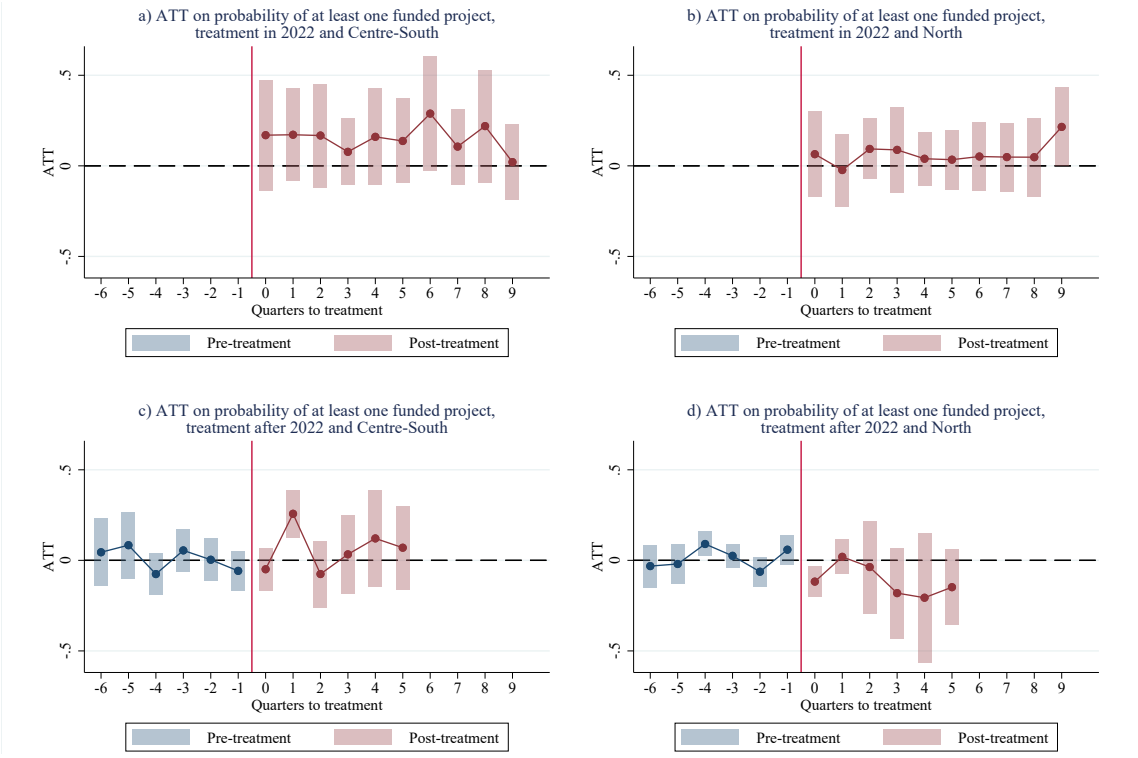
Appendix: Further heterogeneity results

Table A.1: Correlation between heterogeneity dimensions for treated municipalities

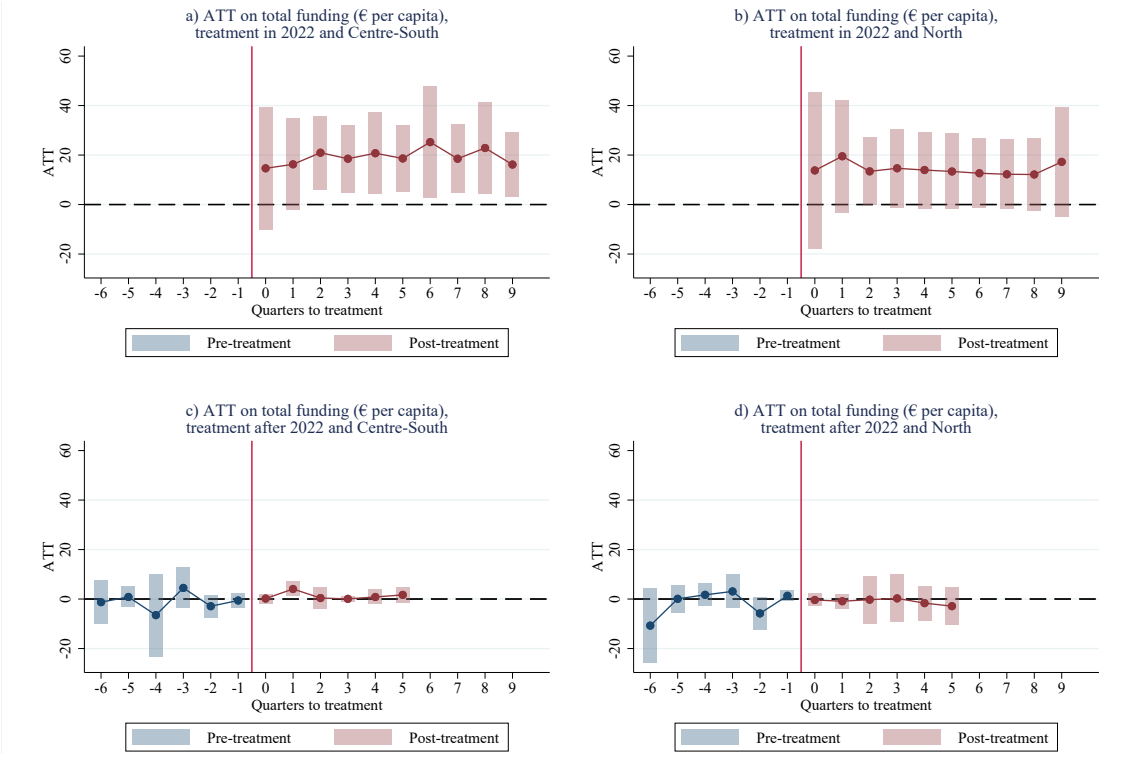
	Mayor's tertiary education	High MAQI I	High population	High MFI	Centre-South
Mayor's tertiary education	1.000	–	–	–	–
High MAQI I	-0.096	1.000	–	–	–
High population	0.086	-0.059	1.000	–	–
High MFI	-0.009	0.055	-0.338	1.000	–
Centre-South	0.097	0.071	0.097	0.300	1.000

Figure A.1: Impact of female mayors on quarterly probability of at least one funded project by geographical area and treatment timing



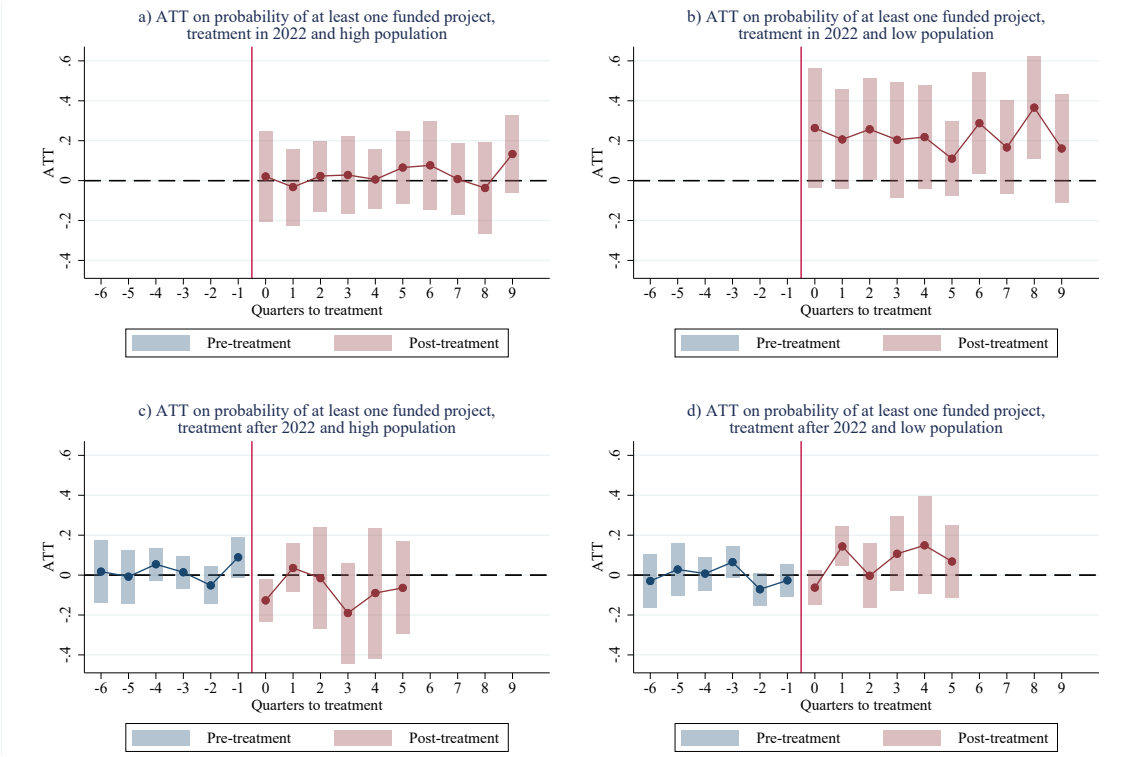
Notes: The shaded areas denote 95% confidence intervals that are robust to heteroskedasticity and within-municipality correlation. The post-treatment averages are (p-values in parenthesis): 0.152 (0.131) in graph a; 0.066 (0.407) in graph b; 0.059 (0.323) in graph c; -0.112 (0.158) in graph d. The number of treated (control) municipalities are: 25 (2,725) in graph a; 42 (3,161) in graph b; 83 (2,725) in graph c; 200 (3,161) in graph d.

Figure A.2: Impact of female mayors on quarterly total funding (€ per inhabitant) by geographical area and treatment timing



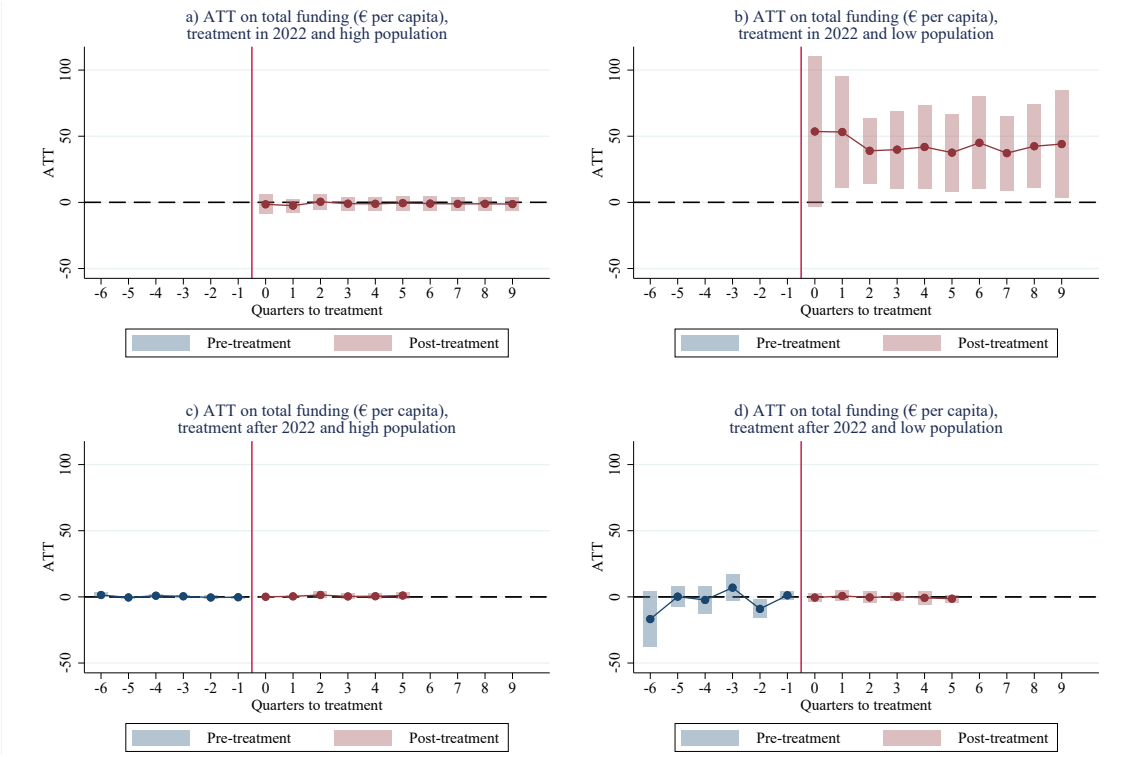
Notes: The shaded areas denote 95% confidence intervals that are robust to heteroskedasticity and within-municipality correlation. The post-treatment averages are (p-values in parenthesis): 19.257 (0.011) in graph a; 14.299 (0.098) in graph b; 1.215 (0.086) in graph c; -0.956 (0.728) in graph d. The number of treated (control) municipalities are: 25 (2,725) in graph a; 42 (3,161) in graph b; 83 (2,725) in graph c; 200 (3,161) in graph d.

Figure A.3: Impact of female mayors on quarterly probability of at least one funded project by municipal population and treatment timing



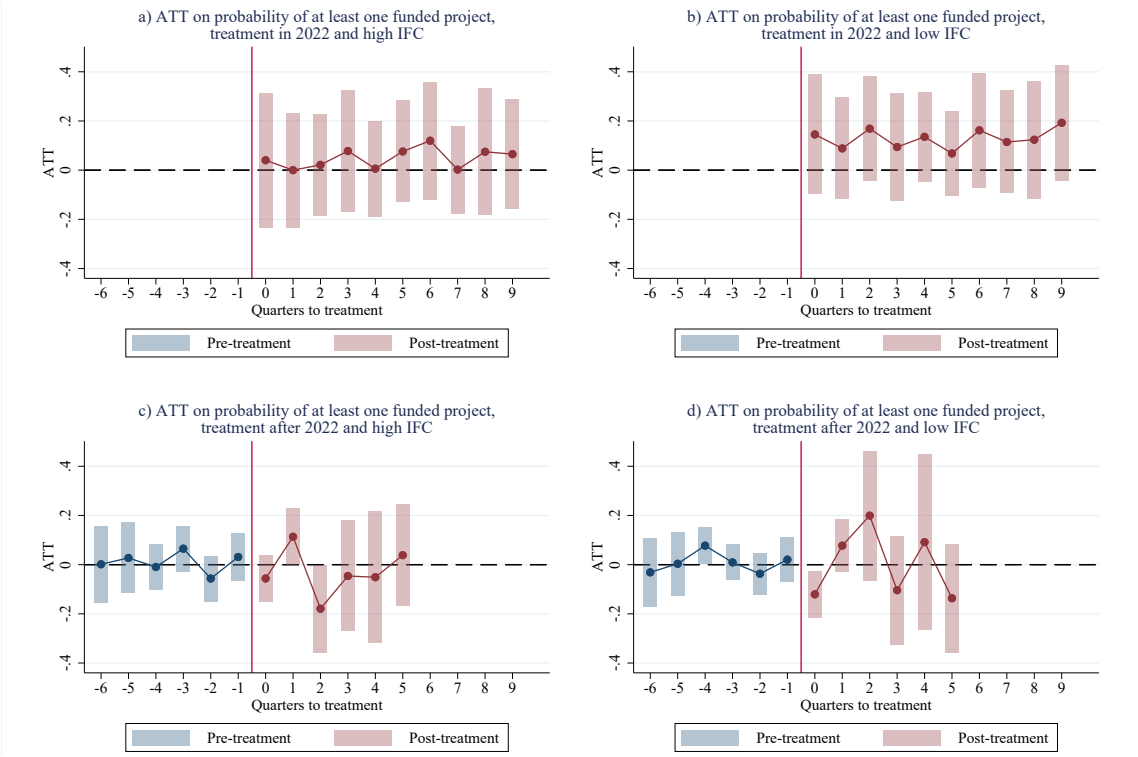
Notes: We split the treated municipalities into high- and low-population groups according to the median value: municipalities with population strictly above 3,735 inhabitants are classified as high population. The shaded areas denote 95% confidence intervals that are robust to heteroskedasticity and within-municipality correlation. The post-treatment averages are (p-values in parenthesis): 0.029 (0.701) in graph a; 0.224 (0.030) in graph b; -0.075 (0.354) in graph c; 0.067 (0.138) in graph d. The number of treated (control) municipalities are: 42 (2,176) in graph a; 25 (3,710) in graph b; 136 (2,189) in graph c; 154 (3,750) in graph d.

Figure A.4: Impact of female mayors on quarterly total funding (€ per inhabitant) by municipal population and treatment timing



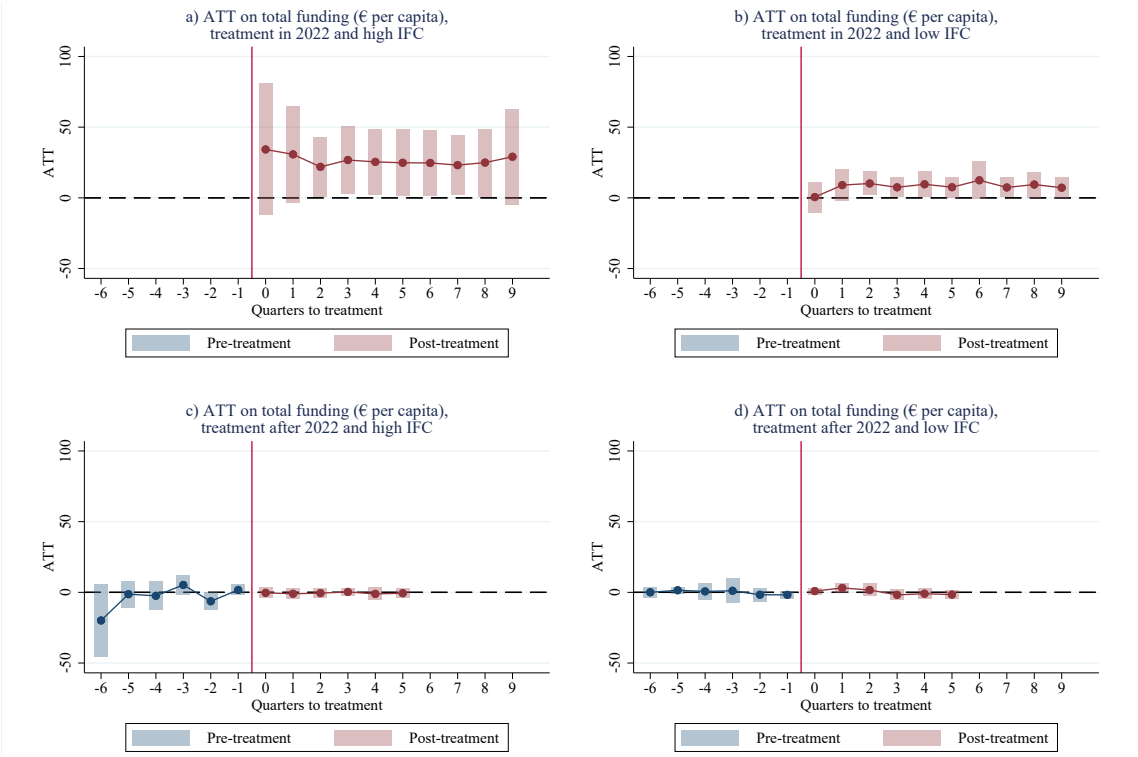
Notes: We split the treated municipalities into high- and low-population groups according to the median value: municipalities with population strictly above 3,735 inhabitants are classified as high population. The shaded areas denote 95% confidence intervals that are robust to heteroskedasticity and within-municipality correlation. The post-treatment averages are (p-values in parenthesis): -1.026 (0.703) in graph a; 43.397 (0.009) in graph b; 0.642 (0.388) in graph c; -0.355 (0.760) in graph d. The number of treated (control) municipalities are: 42 (2,176) in graph a; 25 (3,710) in graph b; 136 (2,189) in graph c; 154 (3,750) in graph d.

Figure A.5: Impact of female mayors on quarterly probability of at least one funded project by Municipal Fragility Index and treatment timing



Notes: We split the treated municipalities into high and low MFI according to the median value: municipalities with MFI values strictly above the median are classified as high MFI. The shaded areas denote 95% confidence intervals that are robust to heteroskedasticity and within-municipality correlation. The post-treatment averages are (p-values in parenthesis): 0.048 (0.568) in graph a; 0.129 (0.135) in graph b; -0.030 (0.640) in graph c; 0.001 (0.987) in graph d. The number of treated (control) municipalities are: 30 (3,295) in graph a; 37 (2,591) in graph b; 134 (3,295) in graph c; 149 (2,591) in graph d.

Figure A.6: Impact of female mayors on quarterly total funding (€ per inhabitant) by Municipal Fragility Index and treatment timing



Notes: We split the treated municipalities into high and low MFI according to the median value: municipalities with MFI values strictly above the median are classified as high MFI. The shaded areas denote 95% confidence intervals that are robust to heteroskedasticity and within-municipality correlation. The post-treatment averages are (p-values in parenthesis): 26.584 (0.044) in graph a; 8.078 (0.046) in graph b; -0.540 (0.602) in graph c; 0.226 (0.851) in graph d. The number of treated (control) municipalities are: 30 (3,295) in graph a; 37 (2,591) in graph b; 134 (3,295) in graph c; 149 (2,591) in graph d.