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Published Version:
Women's representation in politics: The effect of electoral systems / Gonzalez-Eiras M.; Sanz C.. - In: JOURNAL OF PUBLIC ECONOMICS. - ISSN 0047-2727. - ELETTRONICO. - 198:(2021), pp. 104399.1-104399.17. [10.1016/j.jpubeco.2021.104399]

Availability:
This version is available at: https://hdl.handle.net/11585/875653 since: 2022-03-01

Published:
DOI: http://doi.org/10.1016/j.jpubeco.2021.104399

Women's Representation in Politics: The Effect of Electoral Systems*

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February 24, 2021

Abstract

We study how electoral systems affect the presence of women in politics in the context of Spanish municipal elections, in which national law mandates that municipalities follow one of two electoral systems: a closed-list system in which voters pick one party-list, or an open-list system, in which voters pick individual candidates. Using a regression discontinuity design, we find that the closed-list system increases the share of women among candidates, councilors, and mayors, by 4.1, 4.8, and 7.1 percentage points, respectively. We develop a model that allows us to test for three possible mechanisms: gender differences in the supply of candidates between the electoral systems, voter bias, and party bias. Model estimation indicates that a combination of supply differences and party bias best explains the results.

Keywords: voting, electoral systems, gender bias, regression discontinuity.
JEL Codes: D72, J16, J71.

*Declarations of interest: none. We thank the editor Maria Petrova, three anonymous referees, Manuel Arellano, Guillermo Caruana, Sebastián Fanelli, Clodomiro Ferreira, Thomas Fujiwara, Nezih Guner, Monica Martinez-Bravo, Enrique Moral-Benito, Roberto Ramos, Johanna Rickne, Rocío Titiunik, Ernesto Villanueva, and seminar participants at the Bank of Spain, CEMFI, CUNEF, European Political Institutions Conference, ESEM, IBEO workshop, Universidad Carlos III, and Universidad de Montevideo for helpful comments. We thank Andrés Gago and Carlos Victoria for sharing the data on the gender of mayors, Manuel Bagues for sharing the codes to match first names with gender, and Alfonso Gordaliza for invaluable information on Spanish municipal politics.

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1 Introduction

Women are underrepresented in politics. For example, they hold only 25% of legislative seats in national assemblies.[1] This situation has attracted much attention in the media and in the academic literature. Perhaps the most important reason behind this interest is that having women in public office may have an impact on policy.[2] In addition, women in public office may serve as role models, improving women's self-confidence and affecting attitudes towards them both within politics and in society at large (Beaman, Chattopadhyay, Duflo, Pande, and Topalova (2009), Beaman, Duflo, Pande, and Topalova (2012)).

How to increase the presence of women in politics is therefore a pressing question. In recent decades, several countries have introduced gender quotas that require parties to field a minimum of female candidates. There is consensus that quotas are successful in increasing female participation in politics, but they have some drawbacks.[3] Besides the introduction of quotas, it has been suggested that an alternative policy to increase female representation in politics is the reform of the electoral system.In this paper we empirically show that electoral systems may have a sizable impact on women's representation, and provide a theoretical model with several possible mechanisms: voter bias, party bias, and differences in supply.

Our analysis is based on Spanish municipal elections. We exploit the fact that, depending on their population, municipalities follow one of two different electoral systems. Municipalities with more than 250 inhabitants must use a closed list (CL), proportional representation system to elect a city council. Municipalities with 250 or fewer inhabitants must use an open list (OL) system, in which voters can vote for up to four individual candidates from the same or different parties.[4] In the first meeting after the election, the council selects a mayor among the councilors. In the CL system, only the councilors at the top of their party-lists can be selected, while in the OL system any councilor can be selected. Therefore, these two systems differ in two dimensions: the rule to elect the councilors (in CL, voters pick party-lists; in OL, individual candidates) and the rule to select the mayor (in CL, voters know ex-ante which candidate can be mayor for all competing parties; in OL, the mayor is selected after the vote). Municipalities

[1]World Bank data as of 2020. See $https://data.worldbank.org/indicator/SG.GEN.PARL.ZS$.

[2]For example, there is evidence that female leaders cater more to women's needs. In India, Chattopadhyay and Duflo (2004) show that female leaders spend more in infrastructure that is directly relevant to the needs of women, and Bhalotra and Clots-Figueras (2014) find that women's representation improves public provision of antenatal and childhood health services, reducing neonatal mortality.

[3]See the discussion in Pande and Ford (2011). First, quotas can reduce women's incentives to invest, if they believe that their advancement is made easier by quotas. Second, quotas can be perceived as unfair and worsen attitudes towards women—women selected through quotas may be stereotyped as less qualified. Third, they can even fail to lift the barriers that prevent women from playing an influential role in politics. Bagues and Campa (2017) find that quotas in larger Spanish municipalities increased the share of female candidates and councilors, but failed to increase the share of women among party leaders or mayors—but see O'Brien and Rickne (2016), who find that quotas can have an acceleration effect on women's representation in leadership positions.

[4]More specifically, this is a *limited voting* system. Throughout the paper, we stick to the more general term *open list*, as this system is commonly referred to in Spain.

at both sides of the population threshold are not affected by gender quotas.[5]

This context is well suited to obtain credible estimates of causal effects. First, the electoral system is determined by population size, as mandated by national law. Hence, we can implement a regression discontinuity (RD) design to compare women's representation in the two electoral systems. Second, the treatment is clearly defined, as all the municipalities in one or the other electoral system must follow the same rules. This is in opposition to cross-country studies, where it is inevitable to pool different systems into the same category. Finally, there are many observations close to the threshold. There are around 2,400 municipalities in a window of 150 inhabitants, and data are available for five election-years (2003, 2007, 2011, 2015, and 2019).

The results show that, relative to the OL system, the CL system increases the share of female candidates by 4.1 percentage points (p.p.), a relative increase of 15.7%. Similarly, the CL system increases the share of female councilors by 4.8 p.p. (22.5%) and the share of female mayors by 7.1 p.p. (45.1%).

To study what drives these effects, we develop a theoretical model that allows to structurally estimate the relative weight of three possible mechanisms that have been highlighted in previous work: supply differences, voter bias, and party bias. In our model, there are three types of agents—voters, parties, and candidates. There is a general election to elect the councilors, and preferences are aggregated through probabilistic voting. Parties are office-motivated and have to choose the candidates for the general election from a limited supply of potential candidates, who differ in gender and competence. We allow the *supply* of potential female candidates to differ between the two systems. We also allow for the possibility of *voter bias*, i.e., voters having a preference against women that may make them prefer lower-competence men to more competent women, and *party bias*, i.e., parties having a preference against women that makes them prefer to increase the probability that a man is in office at the expense of reducing the probability of winning the election. After the general election, elected councilors select among themselves a mayor. Matching Spanish electoral rules, in CL the mayor will be the top-listed candidate of the majority party, while in OL the majority party can appoint any of its councilors as mayor. In this case, the party will trade-off its own possible party bias with a social norm prescribing that the councilor that obtained the most votes in the general election should be the mayor.

We show, analytically and with numerical simulations, the implications that voter bias, party bias, and supply differences have on the difference in the share of female candidates, councilors, and mayors between the two electoral systems. Given that we find that no mechanism in isolation can explain the entirety of our empirical evidence, we estimate the model to see what combination of the three best fits the data. We adopt a simulated method of moments (SMM) approach targeting the observed differences in the share of female candidates, coun-

[5] The 2007 Equality Law introduced gender quotas for Spanish elections, but only for municipalities of more than 3,000 inhabitants, which are far from the threshold and not used in our analysis.

cilors, and mayors between the two electoral systems. We find that the empirical results are best explained by sizable supply effects and party bias, while voter bias is slightly negative and not significant. In addition, we show that the results are driven, to some extent, by the mayor-selection rule: in a counter-factual simulation in which we impose that the most voted councilor is always appointed mayor in the OL system, the difference in the share of female mayors between the two systems is considerably reduced. Intuitively, the existing mayor-selection rule in the OL system, which allows parties to select the mayor ex-post among its councilors, gives biased parties a better chance to appoint a male mayor.

Finally, we evaluate other possible mechanisms that are not present in our model. First, in addition to the difference in the ballot structure (closed vs. open lists), there is a difference in council size (seven councilors in the CL system vs. five in the OL system). Hence, from the perspective of studying the effects of the ballot structure specifically, the difference in council size could be thought of as an issue of compound treatments, which is common in population-threshold RD designs (Eggers, Freier, Grembi, and Nannicini (2018)). We provide two tests to study whether the difference in council size could explain the results: (i) we focus on the share of women in the top-five positions of the CL party-lists, and show that the effect is similar to the baseline, against the hypothesis that the share of women in CL is higher because they fill in the bottom positions of the lists; (ii) we exploit another threshold (1,000 inhabitants), at which there is a change in council size but not in ballot structure. We perform a similar RD analysis and find no significant effects, further suggesting that council size does not drive the results. We also study if our findings may be driven by different party structures in the two electoral systems and provide evidence against this.

Our paper contributes to five strands of the literature. First, it adds to the empirical literature on the effects of electoral systems on women's representation in politics. Previous work has found that CL systems increase women's representation relative to OL systems (e.g., Thames and Williams (2010) and Valdini (2012)).[6] We contribute by providing evidence from a setting that allows us to obtain a clean identification. Estimating the effects of electoral systems is challenging due to endogeneity issues.[7] For this reason, exploiting discontinuities at population thresholds is becoming a popular way to obtain credible estimates of causal effects. Our paper provides one of the first RD designs to estimate the effect of electoral systems on women's representation. The closest work is Baltrunaite, Casarico, Profeta, and Savio (2019), who use a RD design to estimate the effects of double preference voting conditioned on gender coupled

[6]Thames and Williams (2010) uses OLS cross-country regressions and Valdini (2012) exploits the reform of the electoral system in Japan in 1994 to compare women's representation before and after the reform. In contrast, Schmidt (2009), using OLS cross-country regressions, does not find significant effects.

[7]Roberts, Seawright, and Cyr (2013) argue that most previous literature on the effects of electoral systems on women's representation suffers from serious methodological problems. They try to circumvent the issue using within-country changes in electoral systems and matching methods, and find that the effect of electoral systems may not be as large as previously thought. Similarly, Fortin-Rittberger and Rittberger (2014) argue that the empirical connection between electoral systems and descriptive representation might in fact be an endogenous rather than a causal relationship.

with gender quotas. In their setting the effect of the electoral system cannot be disentangled from the effect of the quotas, as both change at the same time and at the same population threshold. In contrast, our RD isolates the effect of the electoral system, as all the municipalities in our study lay well below the threshold for gender quotas.

Second, our paper contributes to the theoretical literature that discusses how women's representation is affected by the electoral system. Previous work has argued that, relative to OL systems, CL systems are better (worse) for women if voters are relatively more (less) biased against women than parties (Jones (1998)).[8] It has also been argued that women's willingness to run for office ("supply") differs by electoral system, with fewer women running in systems with more "adversarial" or aggressive campaigns (Salmond (2006)).[9] For example, Jones (1998) argue that majoritarian elections tend to produce more adversarial district-level campaigning than proportional-representation elections. Regarding the ballot structure, OL systems induce competition among individual candidates, even within a party, and there is evidence that they lead to more campaign effort than CL systems (Hangartner, Ruiz, and Tukiainen (2019)). Hence, women may be relatively more reluctant to run for office in OL systems. Our contribution is to develop a theoretical model that formalizes these points and allows to obtain predictions for different values of voter bias, party bias, and supply differences. Specifically, our model captures the common argument that, in the presence of party bias and a weaker voter bias, OL systems are better for women. But the model also brings nuance to this prediction: (i) if there are supply differences, with women being less likely to run in OL systems, then women's representation may end up being lower in OL than in CL systems even in the presence of party bias; and (ii) an OL system that gives (biased) parties the ability to select the executive after the election allows parties not to appoint female mayors, and thus the share of female mayors may end up being lower in OL than in CL systems. Although we lay out the specifics to match the Spanish context, the model is flexible and can be applied to other settings.[10]

Third, our paper contributes to the literature that studies the reasons behind women's overall underrepresentation in politics. The literature has discussed three main arguments: (i) that women's underrepresentation is supply-driven, (ii) that it follows from voter bias against women, and (iii) that it follows from party bias against women. The model estimation indicates that, in our context, party bias plays an important role in women's underrepresentation, with voter bias being negligible—if anything, negative. This is consistent with Esteve-Volart and Bagues (2012) and Casas-Arce and Saiz (2015), which provide reduced-form evidence that

[8]In particular, if there is voter bias against women, a CL system may protect women better by the more party-centered nature of voting within that system, while an OL system requires voters to choose or order preferences among individual candidates, therefore leaving women candidates more vulnerable (Engstrom (1987)). If there is *party* bias against women, then the opposite should be true (Larserud and Taphorn (2007), Jones (1998)).

[9]This is related to abundant evidence showing that women shy away from competition, relative to men (e.g., Gneezy, Niederle, and Rustichini (2003), Niederle and Vesterlund (2007)), and that women are more election-averse than men (Kanthak and Woon (2015)).

[10]As examples, it can be adapted to compare women's representation in majoritarian and proportional representation systems, or to study the impact of double-preference voting conditioned on gender—see Baltrunaite, Casarico, Profeta, and Savio (2019).

there is no voter bias against women in Spain.[11] Our model only allows us to estimate the *difference* in supply between the systems, not the levels. Thus, we are silent on the weight of (i) relative to (ii) and (iii).

Fourth, our paper contributes to the growing literature on the effects of electoral systems, which have been shown to have many policy implications (Persson and Tabellini (2005)). More specifically, our work adds to the literature discussing the costs and benefits of closed versus open lists. Persson, Tabellini, and Trebbi (2003) provide cross-country evidence that open lists reduce corruption, suggesting that CL systems weaken individual incentives for good behavior by creating free-rider problems and more indirect chains of delegation (Chang and Golden (2007) find that this effect depends on district magnitude). Hangartner, Ruiz, and Tukiainen (2019) use a RD design in Colombia and find that candidates in an OL system are more experienced, more engaged in their constituencies and campaigns, and less likely to have committed election fraud in the past than in a CL system. Blumenau, Eggers, Hangartner, and Hix (2017) provide experimental evidence from the UK suggesting that OL system would increase support for mainstream parties at the expense of less-established parties. Sanz (2017) provides fixed-effect RD evidence from Spain on how OL systems affect voter turnout. Our paper brings an important element to this picture by showing that opting for closed or open list systems also has implications regarding women's representation.

Finally, our paper is related to the growing literature on social norms—informal understandings that govern individual behavior in society—and, more specifically, on how norms can affect women's work participation.[12] Our paper builds on Fujiwara and Sanz (2020), which provide evidence consistent with a norm that "the most voted *party* should form the government in a parliamentary system". We show that a similar rank effect exists in bargaining *among councilors of the same party*, that is, that "the most voted *councilor* should become mayor". Importantly, we show, theoretically and empirically, that such a norm can have important implications for women's representation.

The rest of this paper is organized as follows. Section 2 provides some background on the institutional setting. Section 3 presents the data, the empirical strategy, and the results on the effect of the electoral system on women's representation. Section 4 lays out the theoretical model, derives its implications analytically and with numerical simulations, and performs a SMM estimation of model parameters. Section 5 discusses other possible mechanisms. Section 6 concludes. The appendix contains proofs and some additional results.

[11] By contrast, Fréchette, Maniquet, and Morelli (2008) and Le Barbanchon and Sauvagnat (2019), in France, and De Paola, Scoppa, and Lombardo (2010), in Italy, suggest that the lack of female legislators may reflect voter bias.

[12] Bursztyn, González, and Yanagizawa-Drott (2020) provide evidence from Saudi Arabia that men underestimate other men's support for women working outside the home. They also show that correcting these beliefs increases men's willingness to help their wives search for jobs and, subsequently, the number of jobs applications by these women. Also see, for example, Bursztyn, Fujiwara, and Pallais (2017) and Fernandez and Fogli (2009).

2 Background: Spanish Municipal Elections

Spain is a highly decentralized country. It is divided into 17 regions, 50 provinces, and more than 8,000 municipalities. Each municipality is run by a municipal government that has substantial autonomy: they can set their own taxes (the most important being a property tax) and spend a considerable amount of money (municipalities close to the threshold spend more than 600 euros per capita per year on average—see Sanz (2019)).[13] It is important to note that, even though the 2007 Equality Law mandates gender quotas, this is of no direct consequence for our study as only municipalities of more than 3,000 inhabitants are subject to the law.[14]

Municipal elections are held simultaneously in all municipalities every four years. The electoral system depends on the population size of the municipality in the year before municipal elections: municipalities with a population of more than 250 inhabitants must use a CL proportional representation, and those with 250 or fewer (but at least 100) inhabitants must use an OL system.[15] This institutional framework was established by national law in 1978, before the first municipal elections after Franco's regime, and has not changed since then.[16]

Municipalities in the CL system elect a city council in a single-district election. All municipalities in this system that are used for identification elect a seven-member council (larger municipalities have larger councils, but, again, this is irrelevant for our purposes). Each party presents a list of candidates and voters pick one of the party-lists. Typically, it is the provincial management of political parties that is responsible of making the lists.[17] To convert votes into seats the D'Hondt rule is used.[18] Councilors are drawn from each list in the order in which the candidates are listed. For example, if a party obtains four seats according to the votes obtained by the party-list, then the four candidates at the top of the list become councilors. In the first meeting after the election, the council selects a mayor among the councilors. In CL, only councilors that were at the first spot of their party-lists can be appointed mayor. This means that parties choose their candidate for mayor before the general election. The selection of mayor among the top-listed candidates of each party is done by majority rule, i.e., the councilor that

[13] Municipal governments spend 13% of the overall spending of the country. Typical services that are provided by small municipalities include public lighting, waste collection, cemeteries, street cleaning, road pavement, touristic information to visitors, and local festivities.

[14] The threshold was 5,000 in 2007. The effect of this law is studied by Bagues and Campa (2017), Bagues and Campa (2019), and Casas-Arce and Saiz (2015).

[15] Municipalities with fewer than 100 inhabitants use a completely different *government* system, namely, a direct democracy system—see Sanz (2019).

[16] The OL system for smaller municipalities was introduced after a proposal by the right-wing Alianza Popular, and was only opposed by the Communist Party. The argument to introduce the OL system only in small municipalities was that it is more likely that people know the candidates in those municipalities than in larger places.

[17] According to conversations we had with Spanish political scientists and mayors of small municipalities, provincial managers have delegates at the municipal level, who talk to potential candidates and hence provide the provincial managers with first-hand input to help create the lists.

[18] There is an electoral threshold at 5%, i.e., parties need to get at least 5% of the votes to enter the D'Hondt distribution of seats. However, this threshold very rarely plays a role in the municipalities of interest here, due to the low number of seats.

obtains a majority of the votes is selected as mayor. If no councilor obtains a majority of votes, the "status-quo rule" is that the top-listed candidate of the party that obtained the most votes in the general election is appointed mayor.

Municipalities in the OL system elect a city council of five members. Candidates are listed on party-lists created by political parties, as in the CL system. However, voters do not pick one of the party-lists, but rather check up to four candidates belonging to one or more party-lists. The five most voted individual candidates in this general election are elected members of the council. As in the CL system, there is a "mayor selection" in the first council meeting after the general election, in which the council selects a mayor among its members by majority rule. If no councilor obtains a majority of votes, the status-quo rule is that the councilor that obtained the most votes in the general election is appointed mayor. Importantly, unlike in CL, all of the councilors can be elected as mayors, not only those at the top spot of the party-lists.

The roles of the council and the mayor are identical under the two systems. Although the council is responsible for approving the budget, controlling the governing bodies, and for the roll-call vote of confidence on the mayor, mayors are the "*the center of gravity of political life in the municipality*" and by law hold the most important executive functions and exercise leadership in municipal politics (Vallés and Brugué 2001). Mayors are very rarely removed by the council, further indicating their strength (in our sample, 96.5% of mayors stayed the whole term). They have a central role in running the government by chairing council meetings and appointing and dismissing cabinet members and staff, and have substantial control over determination and allocation of expenditures, since they prepare municipal budgets and approve construction processes. Indeed, Spanish municipal governments exemplify a case of strong executive power and have been described as municipal presidentialism (Magre-Ferran and Bertrana-Horta 2005).

3 Empirical Evidence

In this section, we empirically estimate the effect of the electoral system on the share of female candidates, councilors, and mayors. Section 3.1 lays out the data used in the regressions, section 3.2 presents the empirical strategy, and section 3.3 shows the results.

3.1 Data

Data for municipal elections are from the Ministry of the Interior and are publicly available. Information on the gender of candidates, councilors, and mayors can be obtained for five election-years: 2003, 2007, 2011, 2015, and 2019. For municipalities in the OL system and for those in the CL system in 2003, we imputed the gender from the first name. Names in Spain are strongly gender-oriented, so ambiguous cases are extremely rare (this approach has been used by previous work, e.g., Casas-Arce and Saiz (2015) and Esteve-Volart and Bagues (2012)).

Additionally, we use data from national Congress elections (also from the Ministry of Interior) and some demographic variables (from the National Institute of Statistics) to assess covariate balance around the threshold. These data are also publicly available.

We focus on municipalities within a window of 150 inhabitants around the cutoff, that is, from 100 to 400 inhabitants.[19] The final data set contains observations for 11,617 municipal elections.[20]

Table 1 shows the share of female candidates, councilors, and mayors, by year and electoral system. On average, 26.2% of candidates, 23.2% of councilors, and 16.3% of mayors are female. Three things are worth noting. First, women are more present among candidates than among councilors and mayors. Second, women's representation has increased significantly over the sample period. Third, women are more represented in the CL than in the OL system. This *prima facie* evidence might suggest that the CL system increases women's representation, but should not be interpreted causally at this stage, as it is a mere comparison of means.

3.2 Empirical Strategy

We implement a RD design to estimate the effect of the electoral system on the share of female candidates, councilors, and mayors:

$$Outcome_{mt} \quad = \quad \alpha + \chi CL_{mt} + f(Pop_{mt} - 250) + u_{mt}, \tag{1}$$

where $Outcome_{mt}$ is the outcome of interest (e.g., the share of female candidates), CL_{mt} is a treatment dummy that takes the value of 1 if municipality m used the CL system in election-year t, Pop_{mt} is the assignment variable (population the year before the elections), $f(Pop_{mt} - 250)$ denotes a first- (or, in some specifications, second-) degree polynomial on population size and its interaction with the treatment dummy CL_{mt}, and u_{mt} is an error term. The parameter of interest is χ.

The identification assumption is that municipalities at both sides of the threshold do not differ in characteristics, other than the electoral system, that may affect women's representation in politics. We assess the validity of the empirical approach with two tests that are standard in

[19]We take 100 as the lower limit because municipalities below 100 inhabitants use not only a different electoral system but also a different government system: they elect a mayor in a first-past-the-post and have no city council, whose role is played out by town meetings in a direct democracy system. We take 400 inhabitants as the upper limit so that there is the same number of inhabitants at both sides of the threshold. One alternative would be to take 1,000 inhabitants as the upper limit, as municipalities up to 1,000 inhabitants use the same electoral system (municipalities with more than 1,000 inhabitants have larger council sizes). Another alternative would be to take an upper limit such that the number of observations is the same at both sides of the threshold. We find that this point is reached at 615 inhabitants. Results under these alternative initial windows are very similar and are provided in the appendix. Also note that 100-400 is our initial sample but, given that we used local regressions, only a fraction of those municipalities will effectively enter the estimation.

[20]This is 96.6% of all the potential observations. The remaining are cases with missing or erroneous data in the original files, or in which we cannot identify the gender of one or more of the candidates or councilors.

RD designs.

First, we show that there is no manipulation around the threshold. If having a population size just above or just below the threshold is as good as random, then the density of populations should be continuous near the threshold. We cannot reject the null of no manipulation, as shown in figure 1.[21]

Second, we show that covariates are balanced around the threshold. We study whether municipalities at both sides of the threshold are similar in a number of socioeconomic and political characteristics: average age of the population, share of foreigners and EU foreigners, a measure of the ideology (the difference in votes shares in the last national Congress election before election-year t between the two main parties, the right-wing Popular Party (PP) and the left-wing Socialist Party (PSOE)), voter turnout at the last national Congress election, unemployment rate, female and male unemployment and hiring rates, and percent of women in the population.[22] We also study whether the observations at both sides of the threshold are equally likely to come from any given year. As mentioned, women's representation has been increasing over our sample period. If our CL observations are from more recent years than those from OL, that could spuriously drive our results. Hence, if the empirical strategy is valid, we should find that the electoral system is not correlated with any of these variables. The results, displayed in table 2 and figure 2, show that all of the coefficients are close to zero and not statistically significant at any conventional level.

3.3 Results

Table 3 presents the main estimates of the impact of the electoral system on the share of female candidates, councilors, and mayors. Columns (1) and (2) provide the estimated effect with the bandwidth proposed by Calonico, Cattaneo, and Titiunik (2014), a uniform kernel, and linear and quadratic polynomials, respectively. Columns (3) and (4) use the entire sample with linear and quadratic specifications. Column (5) reports the results with the bias correction and robust inference procedure by Calonico, Cattaneo, and Titiunik (2014). Column (6) considers a triangular kernel. Column (7) uses the local randomization strategy introduced by Cattaneo, Frandsen, and Titiunik (2015).[23] Results for a wide range of bandwidths are shown in figure A1. Robustness checks to other initial samples and to outcomes in logs are presented in table

[21] Cattaneo, Jansson, and Ma (2020)' test yields a p-value of .11. Frandsen (2017)' test, which is well suited for discrete running variables, yields a p-value of .81 in the specification that detects manipulation in the most stringent situation ($k = 0$).

[22] Note that the election variables (ideology, turnout) refer to Congress elections, in which there is no change in the electoral system at the threshold. Differences in turnout and party vote shares at municipal elections are discussed as possible mechanisms in Section 5.

[23] To calculate the window, we use the covariates listed in table 2. We start from the possible smallest window (size 1) and study 10 5-inhabitant increments. The resulting window is 26 inhabitants. Note that, under local randomization, one derives the exact distribution of the statistic in the randomization of the treatment. This distribution is exact and need not be symmetric, and hence standard errors are not defined. For this reason, we report the p-values in this column.

A1.

Panel A of table 3 shows the effect of the electoral system on candidates. According to the local linear regression with the optimal bandwidth (column (1)), the CL system increases the share of female candidates by 4.1 p.p. Given the dependent variable mean in OL (25.8), this represents a relative increase of 15.7%. This effect is significant at conventional levels. A graphical representation of the results can be seen in panel A of figure 3. Panel B of table 3 and panel B of figure 3 show that the CL system increases the share of female councilors by 4.8 p.p. (22.5%). This effect is also statistically significant. Finally, panel C of table 3 and panel C of figure 3 show that the CL system increases the share of female mayors by 7.1 p.p. (45.1%). These estimates are slightly noisier than those for candidates and councilors but also significant at conventional levels.

In sum, the evidence indicates that the CL system increases the share of female candidates, councilors, and mayors. As in any RD design, these estimates are identified for units close to the threshold. Next, we lay out and structurally estimate a theoretical model, which will allow us to test for the relevance of various possible mechanisms, and to obtain predictions for the effects in other contexts—for example, larger Spanish municipalities, or under a different selection rule for mayors in OL.

4 Theoretical Model

4.1 Setup

General description. We consider a static setting with three types of agents: voters, candidates, and political parties. There are two parties, A and B, that differ in their ideology and compete in an election. Voters vote in a general election to elect the councilors. Each party presents a list of two candidates, and three councilors are elected. We consider two electoral systems: CL and OL. Under CL, voters choose the entire list of candidates from one party. Under OL, voters cast two preference votes which are not restricted to be for the same party. Parties have to choose the two candidates in their lists from a limited supply of potential candidates who differ in competence and gender.[24]

We allow the possibility of gender differences in the supply of candidates across electoral systems. In particular, we allow for women to be less willing to run for office under OL than under CL.[25] In CL, parties have two male and two female draws for candidates, while in OL, parties have two male draws but two female draws with probability $p \in [0, 1]$ and only one

[24]Hence, we assume that the number of councilors to be elected is the same in the two systems. At the end of this subsection we discuss this and other assumptions and alternatives in detail.

[25]In OL, candidates have to directly compete to secure votes, even within the same party, as voters vote for individual candidates and not for parties. This might result in a more aggressive campaign than in CL, which may discourage women more than men (Salmond (2006)). Also, note that the OL system might introduce an ex-post bargaining in the appointment of the mayor, which women may dislike more than men.

female draw with probability $1 - p$.[26] Hence, p captures the difference in the supply of female potential candidates between CL and OL.

After this general election, the three elected councilors select a mayor among themselves. Note that, given that there are three elected councilors and only two parties, one party will always have the majority in the council. This matches the reality of elections in our context.[27] Only councilors at the top of the party-lists can be appointed mayors in CL. Hence, the mayor will always be the councilor at the top of the list of the party that has the majority in the council, i.e., the party that obtained the most votes in the general election. In OL, by contrast, any councilor can be appointed mayor. Hence, the mayor will be either of the two councilors of the majority party.

Voters' preferences. There is a continuum of voters that care about the competence and gender of candidates and the ideology of parties.[28] Candidates' competence is i.i.d. and is perfectly observed by parties, but only imperfectly observed by voters. Preferences are aggregated through a standard probabilistic voting model as in Lindbeck and Weibull (1987). An explicit microfoundation is provided in appendix A. To illustrate the results, we consider the comparison of two candidates, one from each party, $A1$ and $B1$ (henceforth jn refers to the n ranked candidate of party j). We assume that the expected indirect utilities that voter i receives from these candidates are given by[29]

$$E[v^i(A1)] = s^{A1} + \xi^{A1,i} - \mu \mathbb{1}_{g(A1)=f} + \sigma^i + \delta, \tag{2}$$

$$E[v^i(B1)] = s^{B1} + \xi^{B1,i} - \mu \mathbb{1}_{g(B1)=f}, \tag{3}$$

where s^x is the competence of candidate x, $g(x)$ is its gender, f for female and m for male, and $\mathbb{1}_{g(x)=f}$ is an indicator for whether candidate x is female or not. The parameter μ measures the average gender bias in the electorate.[30] $\xi^{Xj,i}$ captures the uncertainty in voter i's observation of candidate Xj's competence, and σ^i reflects the importance for voter i of ideology from voting for party A. It is assumed that σ^i is uniformly distributed with mean zero.[31] Voters' preferences are also affected by a common relative popularity shock, δ, which is assumed to be uniformly

[26] That is, the supply of women is allowed to be different in CL and OL. The estimation of the model will establish whether there are supply differences ($p < 1$) or not ($p = 1$).

[27] In our sample, one party has a majority in 97.5% (92.2%) of the OL (CL) councils.

[28] Under citizen-candidate models, such as Osborne and Slivinski (1996) and Besley and Coate (1997), voters care about candidate competence as this will result in the implementation of better policies. One interpretation is that the probability that a candidate solves a problem that benefits voters is increasing in her competence.

[29] Since competence is imperfectly observed, voters can only evaluate the expected utility they would derive under the alternative candidates.

[30] For simplicity, we assume that every voter has the same bias. We could instead have different biases for male and female voters, or a distribution of biases. As long as the bias, or its distribution, is orthogonal to the distribution of ideology, results are not affected. A negative value of μ corresponds to a preference for female candidates.

[31] Since we have only one group of voters, this distribution, which renders the probability of winning a voter's support a continuous function of the candidate's characteristics, becomes irrelevant. Thus, we do not need to specify its dispersion.

distributed, $\delta \sim U[-\frac{1}{\psi}, \frac{1}{\psi}]$, with $\psi > 0$.

With these assumptions, and considering a vote restricted to take place only between $A1$ and $B1$, the probability that the candidate from party A wins is given by (see appendix A for derivation):

$$P^A = \frac{1}{2} + \psi \left(s^{A1} - s^{B1} - \mu(\mathbb{1}_{g(A1)=f} - \mathbb{1}_{g(B1)=f}) \right). \tag{4}$$

In CL, as only top-listed candidates can be appointed mayors, we assume that voters only care about the gender and competence of top-listed candidates. Under this assumption, equation (4) gives the probability that party A wins the election in CL.

In OL, we assume that voters first rank candidates in each party such that the candidate ranked first for voter i is the one with perceived highest value for competence net of gender bias and taking into account party bias.[32] Then a pairwise comparison of the highest ranked candidates for both parties, $A1$ and $B1$, is made, and the first vote is cast for the candidate that gives the voter the higher utility according to (2) and (3). To cast the second vote, the voter now compares the second ranked candidate of the party that got her first vote with the highest ranked candidate of the other party, i.e., a comparison of either $A2$ and $B1$, or $B2$ and $A1$. Again the vote is cast to the candidate that gives the voter the higher utility according to (2) and (3). The three most voted candidates are elected and the party that gets both of its candidates elected chooses the mayor among them. Importantly, since voters only imperfectly observe candidate competence, and thus do not know ex ante which candidate will be chosen as mayor, they will express a gender bias when casting *both* votes in OL. This stands in contrast to CL, where only the gender of the top-listed candidate matters, as only this candidate can eventually be appointed mayor. To be more precise, we assume that the expected indirect utility that voter i receives from candidates Xn and Yq is given by

$$\begin{aligned} E[v^i(Xn, Yq)] &= P^i[\text{mayor}(X) = Xn] \left[s^{Xn} + \xi^{Xn,i} - \mu \mathbb{1}_{g(Xn)=f} + \left(\sigma^i + \delta\right) \mathbb{1}_{Xn \in A}) \right] \\ &\quad + P^i[\text{mayor}(Y) = Yq] \left[s^{Yq} + \xi^{Yq,i} - \mu \mathbb{1}_{g(Yq)=f} + \left(\sigma^i + \delta\right) \mathbb{1}_{Yq \in A} \right], \end{aligned}$$

where $\text{mayor}(X)$ is a function that selects party X's choice of mayor, should it win the election, and $P^i[\text{mayor}(X) = Xn]$ is the probability that voter i attaches to candidate Xn being selected mayor in this event. Voters choose the pair that gives them the highest expected utility. For tractability, we assume that the standard deviation of $\xi^{Xn,i}$ is sufficiently large relative to the standard deviation of s^{Xn}. Under this assumption, voters are uncertain of which candidate of the winning party would be later selected as mayor and thus place a weight of 1/2 on the pair of candidates considered.[33] Thus, the expected indirect utility that voter i receives from candidates

[32] As will be explained later, party bias might influence the winning party's mayor selection, such that the mayor is not the most voted councilor. This is known in advance by voters who rank the candidates accordingly.

[33] Otherwise, voters would have to take into account the probability that each candidate is selected mayor. This would complicate the analysis with little value added as voters would still express a bias towards all female candidates as long as they perceive that female candidates can be selected mayor with positive probability.

Xn and Yq is given by

$$E[v^i(Xn,Yq)] = \frac{1}{2}\left[s^{Xn} + \xi^{Xn,i} - \mu \mathbb{1}_{g(Xn)=f} + \left(\sigma^i + \delta\right)\mathbb{1}_{Xn\in A}\right] + \frac{1}{2}\left[s^{Yq} + \xi^{Yq,i} - \mu \mathbb{1}_{g(Yq)=f} + \left(\sigma^i + \delta\right)\mathbb{1}_{Yq\in A}\right]. \quad (5)$$

We resort to numerical simulations to assess the validity of the assumption on voters' expectation (see appendix A). We show that, as the standard deviation of the error in voters' observation of competence increases, the probability that the candidate with the highest observed competence is the most competent one decreases from values close to 1 to values slightly above .5. For example, when the standard deviation of the error in voters' observation of competence is five times larger than the standard deviation of competence, the probability that the candidate with the highest observed competence is actually the most competent of its party is approximately 56%. Note that equation (5) would also follow under the assumption that, when casting their votes, voters are not forward looking regarding the mayor selection process.

In OL the probability that party A wins the election is given by (see appendix A for derivation):

$$P^A = \frac{1}{2} + \psi\frac{1}{2}\left(s^{A1} + s^{A2} - s^{B1} - s^{B2} - \mu(\mathbb{1}_{g(A1)=f} + \mathbb{1}_{g(A2)=f} - \mathbb{1}_{g(B1)=f} - \mathbb{1}_{g(B2)=f})\right). \quad (6)$$

Parties' preferences. We assume that parties are office motivated and might also have a bias against women. In particular, regardless of electoral system, party j maximizes

$$U^j = P^j - \nu\psi\mathbb{1}_{g(\text{mayor}(j))=f}, \quad (7)$$

where $\nu\psi$ is the cost, relative to the rents from office, of having a female candidate for mayor.[34] In CL, the candidate for mayor is the top-listed candidate. In OL, the candidate for mayor is the one that parties expect to appoint should they win the election, according to the procedure that we describe next.

We need to determine which of the two elected councilors of the winning party will be appointed mayor in OL. If parties are biased ($\nu > 0$) and the two councilors are of different gender, then parties will have a preference for appointing the man. At the same time, parties might also want to respect, to some extent, the votes obtained by its two councilors. That is, even if parties have a preference for men, they might want to appoint the female councilor if she obtained sufficiently more votes than the male councilor in the general election. One argument for this rank effect is given by Fujiwara and Sanz (2020), who provide evidence that is consistent with a norm that the most voted party appoints the executive (prime minister or mayor) in parliamentary systems.[35] In Appendix C, we show evidence that a similar norm

[34] A negative value of ν denotes a preference for having a female candidate for mayor. We proceed as if $\nu > 0$, given that the model estimation in section 4.3 provides evidence that this is the case.

[35] Another possible argument for a rank effect in our context is that, as explained in Section 2, there is a status-

exists in our context of OL elections. We introduce this in our model by assuming that, if the most voted candidate is female, the second most voted candidate is male, and there is party bias ($\nu > 0$), then the party will select the man as mayor if and only if

$$\beta(v_{f_1} - v_{m_1}) < \nu,$$

where v_{g_1} are the votes that candidate g_1 got in the election, and $\beta > 0$ measures the relative importance of the norm that the most voted candidate be selected as mayor. Given that voting outcomes are random at the time of selecting candidates, and knowing that voters internalize the mayor selection mechanism (and the role of party bias in it), parties anticipate that they will select the male candidate if and only if

$$\beta(f_1 - m_1 - \mu) < \nu, \tag{8}$$

where f_1 is the competence of the (female) most voted candidate and m_1 is the competence of the (male) second most voted candidate, and the expected differences in votes obtained is proportional to $f_1 - m_1 - \mu$.[36] In other words, if the most voted candidate is female and the second is male, the party will appoint one or the other as mayor depending on the relative strength of party bias and the norm. In the case that the most voted candidate is male and the second is female, we assume that the party will always appoint the male, as both forces work in the same direction. Note that, to keep the symmetry with the CL system, we assume that parties directly appoint the mayor in OL too.[37] A similar characterization follows under the assumption that OL mayor selection is determined by Nash bargaining between the two councilors of the majority party, with gender and norm strength determining their relative bargaining power.

Finally, recall that voters in CL only care about the gender and competence of the top-listed candidate, as only he or she can become mayor. Hence, we need to determine how parties will fill in the second places in their CL lists. We assume that, after determining their top-listed candidate, parties will choose the most competent candidate among the remaining three draws.[38]

Stages of the game. First, nature draws the number of draws of female candidates (in OL)

quo rule that states that, if no councilor obtains a majority of votes in the council, the councilor that obtained the most voted in the general election. This might give the most voted councilor an advantage. Also note that we are not imposing that there exists such rank effect—we are just introducing this possibility through a parameter, β, to be estimated.

[36]For convenience we assume a one-to-one relation between competence and vote share. Note that by the law of large numbers this must hold in the limit of a large number of voters.

[37]Note that condition (8) does not impose an asymmetry across systems: In CL, when two candidates of different gender are chosen, the man will be the top-listed (and thus the mayor should the party win the election) if $(f_1 - m_1 - \mu) < \nu$; see (11) below. Thus, the only difference is that, since the selection is made ex post in OL, the strength of the norm, as captured by β in (8), must be taken into consideration.

[38]We assume that parties follow this convention in order to reward competent candidates and preserve them for future elections. All the results of the model are very similar if we assume that parties fill in the second place of their lists randomly instead of with the most competent remaining candidate—see Section 4.3.

and the competence of all candidates. Second, parties simultaneously choose candidates and (in CL) their order in the list, based on expectations of voters' behavior. Third, voters imperfectly observe the competence of candidates and vote for either a list (in CL) or two candidates (in OL). Fourth, given the result of the election, the winning party chooses the mayor. It is worth noting that, when voters vote in OL, they are aware of the ex post mayor selection process and their votes might be influenced by this.

Discussion of assumptions. Before deriving the model's results, we discuss some of its assumptions: (i) the number of councilors to be elected is the same in the two systems; (ii) the supply of candidates is exogenous; (iii) voters in CL care only about the gender and quality of the top-listed candidate; and (iv) the number of candidates in OL party-lists is fixed.

(i) In Spanish municipal elections, seven councilors are elected in CL and five in OL, while in the model we assume that the number of councilors is the same in both systems. The model could be expanded to include a difference in the number of councilors (at the cost of making it less tractable). However, in Section 5 we discuss why the difference in council size is unlikely to drive the effects, so we abstract from this aspect.

(ii) We assume that (female) potential candidates have, on average, the same competence in the two systems, independent of p. In other words, women "discouraged" by the OL system are no more or less competent than the rest.[39] In Section 4.3, moreover, we show that the estimation results do not change much when we lift this assumption. Also note that p captures *exogenous* factors that may make women more willing to run in one system than in the other (e.g., different aggressiveness of the campaign). For simplicity, we abstract from possible *endogenous* responses of the supply of women. For example, if the combination of voter and party biases makes women less likely to be elected in a given system, this could in turn reduce the supply of women in that system. Endogenizing the decision of whether to run or not would complicate the model, requiring the estimation of more parameters, with little value added to our purpose. This is because we care mostly about women facing potentially different entry costs in the two electoral systems, not on the source of this difference, or on the level of entry costs.

(iii) We assume that voters in CL care only about the top-listed candidate. There are several reasons for this. First, as explained in Section 2, it is well known that mayors exert most of the power in Spanish local politics, and only top-listed candidates can become mayors in this system. Second, a growing amount of evidence suggests that voter fatigue and inattention are relevant aspects of voter behavior (Augenblick and Nicholson 2015). Hence, even in a system in which other candidates in the list could exert substantive power, voters might still care more about the characteristics of the top-listed candidate, using the characteristics of the top-listed candidate as an indicator of the quality of the whole list.[40] Third, it would be trivial to add

[39] Note that this does not imply that competence of male and female councilors and mayors is the same. In the presence of party bias, female elected politicians will be more competent than their male counterparts. We find evidence of this and discuss it in section 4.4.

[40] Furthermore, Buisseret, Folke, Prato, and Rickne (2019), using Swedish data, find strong evidence that more

a parameter to capture voters' preference for gender diversity in equation (4). However, this would come at the cost of an additional parameter to estimate, and another moment to target. Hence, we consider instead an alternative selection mechanism that is gender neutral—that the rest of the list is filled randomly.[41] We show results are robust to this alternative specification of the model.

(iv) We assume that, in OL (as in CL) parties run with two candidates to the election. In practice, however, parties in OL could be strategic about the number of candidates. As explained in Section 2, in this system voters can vote for up to four candidates, but five candidates are elected. Hence, parties can pursue two main strategies. One is to present four candidates, so that voters do not split the votes among candidates of the party. The other is to present five candidates. The latter strategy only makes sense if parties are confident that they are going to obtain a majority and, therefore, the mayor. In other words, there is a trade-off between the probability of obtaining the mayor and having the possibility of obtaining all five seats in the council. We do not allow parties the option of presenting three candidates, instead of two. Note that, in the model, parties only care about winning the election, so it would not be rational for them to take any risk by fielding a third candidate. Furthermore, we only consider competitive elections, where the cost of fielding more candidates is higher.[42]

4.2 Analytical Results and Numerical Simulations

Candidates' competence is assumed to be distributed according to $H(\cdot)$. We only impose minor restrictions on this distribution function, namely, that it has a compact support and no mass points. Furthermore, these properties should be inherited by the distributions of the maximum and minimum of two independent draws. Denote by m_1 and $m_2 < m_1$ (respectively f_1 and $f_2 < f_1$) the two competence draws for male (female) candidates from this distribution for a given party. We denote by H_1 (H_2) the probability distribution for the maximum (minimum) of two independent draws.[43]

We start by evaluating the predictions of the model regarding the electoral impact of having female (as opposed to male) candidates. For CL, we study the impact of having a woman, as opposed to a man, as the candidate for mayor, i.e., as the top-listed candidate. Equation (4) gives the probability that a party wins an election, conditional on the competence and gender of the competing candidates. Therefore, if party A is contemplating replacing m_1 with f_1 as its

competent candidates are placed in the top ranks of PR lists, consistent with parties caring about the quality of potential legislators more than voters caring about the competence of marginal candidates.

[41] Note that this alternative assumption would be a force towards gender balance, as the second candidate would be of a different gender than the first with probability 2/3, regardless of voter or party biases.

[42] Consistent with this, in the data we observe that parties present five candidates in 24% of cases. In competitive elections, defined as those in which the difference in votes obtained by the top two parties is below the median, this figure goes down to 16%.

[43] If there is only one draw for female candidates, then $f_2 = 0$ and $H_1 = H_2 = H$.

candidate for mayor, this has an effect on its vote share that is proportional to:

$$P^A|f_1 - P^A|m_1 = \psi\left(f_1 - m_1 - \mu\right). \tag{9}$$

The effect of replacing a male with a female candidate on the electoral prospects in OL is derived similarly using (6). We find that if party A is contemplating replacing, say, m_1 with f_2 as a candidate, this has an effect on its vote share proportional to:

$$P^A|f_1, f_2 - P^A|f_1, m_1 = \frac{\psi}{2}\left(f_2 - m_1 - \mu\right). \tag{10}$$

We summarize this result in the following lemma.

Lemma 1. *If there is voter bias against women ($\mu > 0$), then having a female candidate for mayor in CL (female candidates in OL) reduces the party's vote share, conditional on candidates' competence.*

The probability that the party chooses a female candidate for mayor under CL is given by

$$\begin{aligned} P(f_1 > m_1 + \mu + \nu) &= \int_0^\infty \int_{m_1+\mu+\nu}^\infty dH_1(f_1) dH_1(m_1) \\ &= \int_0^\infty \left(1 - H_1(m_1 + \mu + \nu)\right) dH_1(m_1) \\ &= 1 - \int_0^\infty H_1(m_1 + \mu + \nu) dH_1(m_1). \end{aligned} \tag{11}$$

Since $H_1(\cdot)$ is an increasing function, the probability of choosing a female candidate is decreasing with voter and party bias against women.

Denote by F the number of female candidates, and by $P^{CL}(F = j)$ and $P^{OL}(F = j)$ the probabilities that the party chooses j female candidates in CL and OL, respectively. Then, the difference in the expected number of female candidates between CL and OL is given by

$$\mathrm{E}[F]^{CL} - E[F]^{OL} = P^{CL}(F = 1) + 2P^{CL}(F = 2) - \left[P^{OL}(F = 1) + 2P^{OL}(F = 2)\right].$$

We now evaluate the partial effects of voter bias, party bias, and supply effects, i.e., the effect of each mechanism on the CL/OL differences when the others are not present.

Voter bias.

Proposition 1.

- *If there is voter bias against women ($\mu > 0$) and no party bias ($\nu = 0$) nor supply differences ($p = 1$), then the expected share of female candidates is higher under CL, $\mathrm{E}[F]^{CL} > E[F]^{OL}$.*
- *If there is voter bias against women ($\mu > 0$), no party bias ($\nu = 0$) nor supply differences ($p = 1$), then the expected share of female mayors is higher under OL.*

Proof. See appendix B. □

Note that this proposition does not contain any predictions regarding the effect of the electoral system on the share of female *councilors*. This has to be done numerically, as we need to combine the results of lemma 1 and the effect of voter bias on female candidates, as a party's electoral performance determines whether it gets one or two councilors, and performance depends on candidates' competence and gender. We posit $\psi = 1$ and assume that candidates' competence is proportional to income and drawn from a lognormal distribution, as empirical studies have documented that the income distribution in most countries follows such distribution. Medrano-Adán, Salas-Fumás, and Sánchez-Asín (2018) estimate a lognormal distribution for general skills in Spain with dispersion around the mean of 0.39. We consider biases between zero and 0.15.

Graph (a) of figure 4 shows the results of these simulations for the case of voter bias. We see that the share of female candidates and councilors is higher in CL (and increasing in the size of the voter bias) while the share of female mayors is slightly higher in OL.

The intuition behind the result for candidates is that, in OL, parties avoid choosing female candidates *for the two spots* of the list, as they will attract fewer votes than male candidates. In CL, by contrast, voters only care about the gender of the top-listed candidate (as only he or she can become mayor), and hence parties avoid choosing a female candidate *only for the first spot* of the list. Hence, the share of female candidates will be higher in CL.

Regarding councilors, in OL the female share is approximately the same as the share of female candidates, given that, as mentioned, all candidates are equally likely to be female and the party selected them taking into account voter bias in voting behavior. In CL, by contrast, the share of female councilors is lower than the share of female candidates, reducing the difference with OL. The reason is that, for the losing party, only the top-listed candidate is elected councilor, and the top-listed candidate in CL is more likely to be male. Graph (a) of figure 4 shows that the share of female councilors is still higher in CL than in OL, but the difference is smaller than for candidates.

For mayors, appendix B proves that, when only voter bias is present, the probability that a female candidate is top-listed in CL is the *same* as the probability that a female candidate is ex-post selected as mayor in OL. Thus, the only way for the electoral system to have an effect on the share of female mayors is by affecting the probability that a party running with a female candidate for mayor wins the election. Equations (9) and (10) show that having a female candidate for mayor has a larger negative effect on the probability of winning in CL than in OL. Thus, there is a lower probability of having a female mayor in CL.

Note that these implications are not consistent with the data. In particular, they predict that the share of female mayors is *lower* in CL, while in the data we observe a sizable, positive effect. Hence, voter bias cannot explain our empirical findings.

Party bias. Regarding party bias, we need to consider the effect of two parameters, ν and

β. Given our normalization of $\psi = 1$, the former reflects how much probability of winning an election are parties willing to trade-off for having a male candidate for mayor. The latter, which relates to the strength of the norm that the most voted councilors should be appointed mayor, is specific to the mayor appointment in OL, and captures which of the two councilors will the majority party appoint as mayor when they are of different gender. Recall that, if $\beta \to \infty$, then parties will always appoint the most voted councilor as the mayor, irrespective of their gender, and if $\beta \to 0$, then they will always appoint the man (if $\nu > 0$), irrespective of their votes.

Proposition 2.
- *If there is party bias* ($\nu > 0$)*, no voter bias* ($\mu = 0$) *nor supply differences* ($p = 1$)*, and* $\nu << E[f_1] - E[f_2]$ *or* $\nu >> E[f_1] - E[f_2]$*, then the expected share of female candidates is higher under CL* , $\mathrm{E}[F]^{CL} > E[F]^{OL}$.
- *If there is party bias* ($\nu > 0$)*, no voter bias* ($\mu = 0$) *nor supply differences* ($p = 1$)*, then the difference in the expected share of female mayors between CL and OL is decreasing in* β*. For* $\beta \to 0$ *the expected share of female mayors is higher under CL, while the reverse happens when* $\beta > \bar{\beta}$*, with* $0 < \bar{\beta} < 2$.

Proof. See appendix B. □

As we did for voter bias, we perform numerical simulations to confirm these predictions, and to evaluate the effect of party bias on female councilors, for which we do not have analytical results. We consider two cases: a strong norm ($\beta = 2$) and a weak norm ($\beta = .5$). The results are shown in graphs (b) and (c) of figure 4.

The simulations confirm that CL increases the share of female candidates, irrespective of β.[44] The intuition behind this result is similar to the one for voter bias: parties are less likely to put a woman at the top spot of the list in CL—given party bias, parties want to avoid that a woman becomes mayor if the party wins the election—but at both spots for OL.

Regarding councilors, note that, for both parties in OL, the most competent candidate will always receive more votes regardless of gender (as voters are not biased). Thus, the share of female councilors will be the *same* as the share of female candidates in OL. In contrast, in CL the losing party's councilor is more likely to be male, implying the share of female councilors is lower than the share of female candidates. If this effect dominates the positive effect that party bias has on female candidates in CL, then the share of female councilors is higher in OL. This is what we see in graphs (b) and (c) of figure 4 (the same result holds for the other distributions of competence considered in section 4.3). In other words, voters, who are not biased, are more powerful to offset the bias of parties in OL.

Finally, regarding mayors, the predictions of proposition 2 depend on the strength of the norm. If it is strong, parties do not have any ex-post power in the selection of mayor to amend the decision of voters, so the result of councilors translates into a similar effect on mayors,

[44] Note that we are considering values of $\nu \in [0, 0.15]$, i.e., the condition $\nu << E[f_1] - E[f_2] \approx 0.63$ (which comes from a lognormal distribution with a dispersion of 0.39) is satisfied.

i.e., there will be more female mayors in OL, and this difference is increasing in party bias. However, as the norm becomes weaker, parties become more and more likely to appoint men as mayors, as they become less and less constrained by the norm. When the norm is sufficiently weak, there will be more female mayors in CL, with this difference also increasing with party bias.

Note that, regardless of the strength of the norm, CL reduces the share of female councilors in the presence of party bias. However, this is at odds with our empirical finding that there is a higher share of female councilors in CL. Hence, party bias cannot explain our empirical findings.

Supply effects.

Proposition 3. *If there are supply differences* ($p < 1$)*, no voter bias* ($\mu = 0$) *nor party bias* ($\nu = 0$)*, then the difference in the share of female candidates, councilors, and mayors in CL relative to OL is* $1/2 - (2 + p)/6$*, and is thus decreasing in* p*.*

Proof. See appendix B. □

Proposition 3 tells us that, as supply differences increase (p is reduced), we should observe proportional reductions in female shares of candidates, councilors, and mayors in OL relative to CL. This is represented on graph (d) of figure 4.[45] This case is the one that most closely resembles the data, as it predicts a higher share of female candidates, councilors, and mayors in CL than in OL. However, it cannot explain why we observe a larger effect for mayors.

Discussion. The results presented so far suggest that none of the three possible mechanisms can, on its own, fully explain all the empirical findings. In the next subsection, we allow for the three channels to operate simultaneously and estimate the model to gauge their relative importance.

4.3 Model Estimation

Candidate choice and election outcomes depend on observed gender, and *unobserved* competence. Thus, to estimate voter bias, party bias, and supply effects (μ, ν, β, and p) from the data we need to simulate the model. We adopt a SMM approach in which the target moments are the differences in the average share of female candidates, councilors, and mayors between CL and OL, and the difference in likelihood of being appointed mayor between most voted male and female councilors—see Appendix C for an explanation on how this moment is derived and

[45]Note that the figure shows the percent difference between the two systems,

$$\frac{1/2 - (2 + p)/6}{1/2} = \frac{1 - p}{3}.$$

Hence, it matches the prediction of proposition 3. For example, if $p = .5$, then the predicted percent difference between CL and OL is 1/6, or 16.7%.

estimated in the data and in the model.[46] We take all the municipalities within the bandwidth of Cattaneo, Frandsen, and Titiunik's (2015) local randomization strategy. With this approach, it is not necessary to control for population, and hence it is best suited to estimate the model. Our estimation sample has 1,825 observations (916 in CL).

We generate the simulated moments by simulating competence draws and voting outcomes at each municipality M times.[47] By the law of large numbers, the standard deviations of simulated outcomes at the municipal level tend to zero as M increases. Thus, we calibrate M to match the standard deviations of the share of female candidates, councilors, and mayors observed in the data.[48] Table A2 reports results for $M = 1, 2, 3$, from which we infer that the choice of $M = 2$ provides the best fit in this respect.

We estimate the four parameters, μ, ν, β, and p that minimize the difference between the simulated moments and their data counterparts.[49] As we did for the simulations presented in Section 4.2, we take competence from a lognormal distribution with dispersion around the mean of 0.39 following Medrano-Adán, Salas-Fumás, and Sánchez-Asín (2018). Standard errors of parameters are computed by estimating the model 5,000 times.

Our results reveal the presence of party bias, a moderate norm for appointing the most voted female councilor as mayor in OL, sizable supply differences, and a small negative voter bias. Column (1) of table 4 presents the means and standard errors of the estimated parameters for the baseline specification. Estimated voter bias is -0.013 but it is not statistically significant. To put this number into perspective, note that the average competence of a candidate is normalized to be one. For our lognormal distribution, the average maximum of two independent draws is roughly 1.317. Thus, voter bias of -0.013 corresponds to a 1.0% preference for female candidates relative to the average competence of the highest-ranked male candidate. Estimated party bias is 0.073 and statistically significant. This implies that biased political parties are willing to trade off a reduction of 7.3% in their chance of winning an election to secure the mayoral position for a male candidate. Parameter β measuring the strength of the norm is

[46]For a textbook treatment of SMM, and model estimation using the simplex method, see DeJong and Dave (2011).

[47]To identify model parameters, the first moment is provided by the gender differences in the OL norm. The strength of the norm, β, is tightly linked to it. The other three moments are the differences across electoral systems of the share of female candidates, councilors, and mayors. From proposition 3 we expect that the model estimation will produce supply differences ($p < 1$). But, given that we observe larger effects for mayors than for candidates and councilors, there must be another mechanism at play. It is the strength of the norm that helps pin down the relative contribution of these mechanisms (voter and party bias).

[48]More precisely, since female shares have different averages across electoral systems, we target the average of the standard deviations for CL and OL for each outcome. Note that we do not use variances or standard deviations as additional moments for the estimation. The moments on means are calculated over *differences* across electoral systems. To calculate second moments we would need to pair municipalities in the dataset and, as this would require random sampling, the corresponding moments would be random as well. Thus, the estimation would be more complex, with little value added.

[49]For a given exogenous draw of shocks, we use the Nelder Mead simplex algorithm to find the parameters that provide the best fit to the observed data moments. This is a robust algorithm best suited to deal with potential non-linearities in the moments (e.g., the asymmetry in the norm if ν changes signs). This comes at the cost of small numerical errors, of about 0.5%, in matching the moments, even though the model is just-identified.

0.403. Finally, the estimate of p is 0.630, which implies that women are approximately 18.5% less likely to engage in local politics in OL than in CL.

The remaining columns of table 4 present some robustness checks. In column (2), we increase the dispersion around the mean of the lognormal distribution by 10% (reducing it by 10% also yields similar results). In column (3), we reduce our data sample to include the 1,597 observations within the bandwidth of Calonico, Cattaneo, and Titiunik (2014). In columns (4) and (5), we consider respectively a Gamma and a Pareto distribution for competence.[50] In column (6), we change the assumption that, in CL, parties fill the second spot of the list with the most competent candidate (among the remaining choices), and consider instead that they fill it in randomly. Finally, in column (7) we change the assumption that differences in supply p do not affect the average competence of (female) candidates between the two systems. Here we consider instead that the parameter p also truncates the distribution of candidate competence. For example, if $p = 0.8$, then parties always have two draws for female candidates, but with probability 20%, for the second draw in OL parties can only choose a woman from the bottom 80% of competence distribution. The estimated parameters are quite stable across specifications. All of them suggest that supply differences and party bias explain most of the differences in female representation between the CL and OL systems. Thus, the results are robust to changes in the data sample, the underlying distribution of candidate competence, and some model assumptions.

In figure A2 we represent the relative importance of the three channels. As can be seen, differential supply is the most important, accounting for approximately between 85%, 74%, and 56% of the observed difference in female representation for candidates, councilors, and mayors respectively. The second most important mechanism is party bias, which accounts for roughly 22% and 43% of the observed differences for councilors and mayors respectively, and is negligible for candidates. Importantly, while for mayors the effect of party bias reinforces the higher female participation in CL from differential supply, for councilors the effect of party bias goes in the opposite direction. Finally, voter bias has a negligible effect on mayors, while for candidates and councilors its effect goes in the opposite direction than differential supply, potentially explaining roughly 9% and 4% of the observed difference, respectively.

[50]The gamma distribution is given by

$$f(x) = \frac{\lambda}{b^a \Gamma(a)} x^{a-1} e^{-x/b}.$$

Pindado, Pindado, and Cubas (2017) estimate $a = 1.188$ and $b = 2.856$ using wages in Spain for the period 1999 to 2014. The Pareto distribution is given by

$$1 - F(s) = \left(\frac{k}{s}\right)^{\iota}.$$

Bartels and Metzing (2019) estimate $\iota = 1.8491$ using income data in Spain from 2001 to 2012.

4.4 Discussion

In addition to disentangle the role of three possible mechanisms, the model allows us to assess other important aspects: (i) the relevance of differences in supply and in the mayor appointment system, (ii) the external validity of our results, and (iii) the predicted competence of mayors.

(i) The estimation results indicate that supply effects and party bias are important, and that voter bias is negligible and, if anything, negative. This last point requires some discussion: as mentioned in the introduction, the literature has suggested that, if parties are biased, then OL systems should be better for women, while we find the opposite.

Our model does capture the common argument that, in the presence of party bias (and weaker or no voter bias), OL systems are better for women. However, the model also brings nuance to this prediction, as there might be other forces at play. First, if there are supply differences, with women being less likely to run in OL, then women's representation may end up being lower in OL than in CL even in the presence of party bias. Second, an OL system that gives (biased) parties the ability to select the mayor after the election allows parties not to appoint female mayors, and thus the share of female mayors may end up being lower in OL than in CL. This will depend on the intensity of the norm. If the norm is strong, then parties have their hands tied and cannot discriminate in appointing the mayor. In this case, assuming no differences in supply, the OL system will result in a higher share of female mayors. By contrast, if the norm is weak, parties have more leeway and OL will result in a lower share of female mayors. We quantify the importance of the mayor selection rule in our context in the next point.

(ii) While RD designs are well known for providing a credible *internal* estimation of causal effects, they can be less conclusive with respect to the *external* validity of the findings, i.e., what the effects would be in other contexts. In this regard, our theoretical model is useful, as it allows us to obtain predictions for other settings. Here we consider what the results would like under an alternative OL mayor selection rule and on the context of larger Spanish municipalities.

First, to quantify the role of differences in the mayor selection rule in our context, we perform a simulation exercise, such that the most voted councilor of the majority party always becomes mayor in OL. This can be done by imposing $\beta \to \infty$ and keeping other parameters as estimated.[51] We find that this would increase the difference in the share of female candidates and councilors between CL and OL by about 2.4% and 12.8%, respectively, relative to the baseline estimation, but would *reduce* the difference in the share of female mayors by 65.2% (i.e., the difference would decrease from 7.1 to 2.5 p.p.). Hence, we would still observe a higher share of female candidates, councilors, and mayors in the CL system, but the magnitudes would be different, especially for the case of mayors. This highlights the importance of taking both aspects of the electoral system—the rules to elect councilors and mayors—when evaluating its

[51]Note that these estimates should be taken as a lower bound. If part of the reason why women are less willing to run in OL is the mayor selection rule itself, changing it may increase the supply in OL, and therefore reduce the gap relative to CL.

implications.

Second, we conjecture on the effects of the electoral system in larger Spanish municipalities, which differ in some aspects from the ones used in this paper. Perhaps most importantly, small municipalities are, on average, older and more conservative. Average age in our sample is 52 years (see column (1) of Table 2), while it is 48.2 in the whole country; and, the vote share of the PP (relative to the PSOE) is 7 p.p. higher in our sample compared with the whole country.

With these aspects in mind, we conjecture the following. First, given that we find no voter bias in our sample, we expect no voter bias in larger municipalities, which have a slightly younger, less conservative population. Second, given that candidate selection is done at the provincial level (see section 2), we expect party bias to not depend on municipal population size. In fact, Casas-Arce and Saiz (2015), studying municipal elections in larger municipalities, and Esteve-Volart and Bagues (2012), studying Senate elections in the whole country, also find evidence of party bias and no evidence of voter bias. Third, it is reasonable to expect supply differences to be smaller in younger and less conservative municipalities.[52] From the previous simulations (see panel C of figure 4), this would result in smaller effects of CL. In particular, if supply differences disappeared completely, the OL system would lead to *more* female councilors than the CL system. However, the CL system would still lead to more female mayors and (slightly) more female candidates.

(iii) Our model yields some predictions regarding competence. In particular, we compute the average competence of selected mayors by gender in the baseline estimation and find that in CL (OL) female mayors are on average 3.5% (8.8%) more competent than their male counterparts. This is because, if parties are biased, women competing against men only win when they are significantly more competent. Although we cannot directly test this model prediction, some correlations suggest that it may hold: in our sample, we observe that 9.7% of mayors hold a university degree, but this figure is 16.7% for *female* mayors.[53] Furthermore, this prediction is consistent with evidence from other contexts. For example, Anzia and Berry (2011) find that, in the United States House of Representatives, congresswomen secure 9% more spending from federal programs, and sponsor and cosponsor more bills, than congressmen. They argue that this finding is the expected outcome if parties are biased against women, or if women self-select into politics based on perceptions that there is sex discrimination in the electoral process. Our model provides a mathematical formalization of this argument.[54]

[52]As discussed earlier, supply differences may be driven by women being less willing to run for office in systems with more aggressive campaigns. This should play a smaller role in larger municipalities with a younger, less conservative, population.

[53]These figures refer to the period 2003-2015 as data are not available for 2019.

[54]Note that, while in Anzia and Berry (2011) candidates self-select, in our model parties are biased when selecting candidates. As noted above, we could endogenize participation, at the cost of higher model complexity and the need of more moments to estimate the extra parameters.

5 Other Possible Mechanisms

In this section, we discuss three alternative explanations to our findings.

Council size. It has been argued that larger council sizes increase women's representation (Matland and Brown 1992). A possible reason is that they facilitate "ticket balancing", i.e., putting men at the top of the list and balancing the list with women at the bottom. In our context, seven councilors are elected in CL, and five in OL, so it should be easier to do ticket balancing in the former system. Importantly, however, while this might explain the effect on candidates or councilors, it cannot account for the effect on mayors. Furthermore, we conduct two additional tests to assess the possible relevance of this mechanism.

First, we focus on the five top-listed candidates. That is, we define our outcome variable as the share of female candidates among parties' five top candidates in the lists—hence, for OL observations, this variable is the same as in the baseline, while it may take other values for CL observations. If the main results are driven by women filling in the bottom positions of the lists in the CL system, we should see no effect on this alternative outcome variable. The results from this test are reported on table 5. They reveal that the effect on this variable is statistically significant and similar in magnitude to the baseline.

Second, we conduct a placebo test at another threshold. Municipalities with fewer than 1,000 inhabitants (and more than 250) elect seven councilors, while those with 1,000 or more inhabitants elect nine councilors—hence, they both use the CL system but with different council sizes. We perform an analysis at this threshold using the same empirical strategy as for the 250-inhabitant threshold. The results from this test, displayed in table A4 and figure A3, reveals no effect of the council size on the share of candidates, councilors, or mayors. Figure A4 shows that there is no manipulation of the running variable around this threshold, and table A3 shows that covariates are balanced.

Party structures. The two electoral systems might lead to different party structures, and this in turn have an impact on women's representation. For example, if one electoral system favors left-wing parties, and left-wing parties include more women in their lists, this system could end up with a higher share of female candidates.

To shed light on this mechanism, we conduct two tests. First, we study whether the electoral system affects which party the mayor belongs to. We estimate equation (1) with the party of the mayor as the dependent variable. Panels A and B of table A5 and figure A5 show that the electoral system does not affect which party is in office: the point estimates of CL are very close to zero and are not statistically significant. Second, we test whether the share of female candidates, councilors, and mayors is different in the two systems, *for a given party*. The results (table A6 and figure A6) reveal no heterogeneity in the effect for candidates and councilors: the two main parties, the PP and the PSOE, both include a higher share of female candidates and have a higher share of women among their councilors in CL. For mayors, the point estimate is considerably larger for the PP, but we cannot reject the null that they are equal for both parties (p-value = 0.27).

Voter turnout. There are ways in which the share of female candidates could arguably affect turnout. For example, if men are better at mobilizing voters and there is a higher share of male candidates in the OL system, this provides a possible mechanism for why turnout is higher under OL. For the present paper, however, we are interested in the opposite question, i.e., whether differences in women's representation can be explained by differences in voter turnout across electoral systems. Arguments in this direction are not that natural. One possible such mechanism is that the OL system leads to more voter turnout and this in turn hurts some parties that are more prone to include women in their lists or appoint female mayors.[55]

We test for this possible mechanism by estimating equation (1) with voter turnout at local elections as the outcome. Panels C of table A5 and figure A5 show the results. We find no significant differences across electoral systems in our sample, against the hypothesis that differences in turnout drive our findings.[56]

6 Conclusion

Using a RD design in the context of Spanish municipal elections, we have shown that a CL system increases the share of female candidates, councilors, and mayors by 4.1, 4.8, and 7.1 p.p., respectively, relative to an OL system. To disentangle three potential explanations suggested by previous literature, we have developed a model of candidate choice and mayor selection. Our estimation of the model indicates that supply differences between the two systems and party bias explain most of the effects, while voter bias is negligible.

Our paper has two policy-relevant implications. First, the electoral system may have substantial impact on women's representation in both directly- and indirectly-elected offices, i.e., councilors and mayors, respectively. Much of the work on women's representation is about elected offices, but the evidence on selected executive posts is scarce and mixed. This is unfortunately as indirectly-elected offices hold, in many cases, most of the power. For example, Bagues and Campa (2017) show that the introduction of quotas in Spain was successful in increasing women's representation in directly elected offices, but failed to lift the barriers to indirectly-elected, leadership positions. Our results show that, in the same country, which electoral system is used significantly affects not only the share of female councilors but also the share of female mayors.

And second, our model indicates that, to increase women's representation, it is important to consider not only the system to elect the councilors but also the mayor appointment rule. In our context, two ways to increase women's representation would be to (i) expand the use of the

[55]The tests provided in the previous paragraph, however, show that there is no difference in the share of PP and PSOE mayors at the threshold, so this is unlikely to explain the results.

[56]Sanz (2017) shows there was a difference in turnout in another time period (1979-2011), with the OL system leading to more voter turnout. The point estimates for our sample suggest a similar relation, but are not statistically significant.

CL system, and (ii) change the OL mayor selection rule, so that the mayor is always the most voted candidate of the majority party.

While the RD design identifies the effects for units that are close to the threshold, i.e., small municipalities, our model allows us to obtain predictions for other contexts as a function of voter and party biases and supply differences. For example, we have argued that in larger Spanish municipalities, where supply differences are likely to be reduced, the CL system would have smaller effects, but would still result in a higher share of female mayors. Furthermore, while we have matched the specifics of the model to the Spanish context, the model can be adapted to study the effect of other electoral systems on female representation. For example, consider the election of several, equally powerful, representatives. Under a first-past-the-post electoral system, there would be one election per district and voters would only care about the candidates in their districts. Under a multi-member, proportional-representation system, when deciding which party to vote for, voters would have to form expectations on the probability that each candidate of a given list is elected councilor. When selecting candidates, parties would take this different behavior, as well as voter and party biases and the supply of female candidates into account. This is an interesting avenue for future research.

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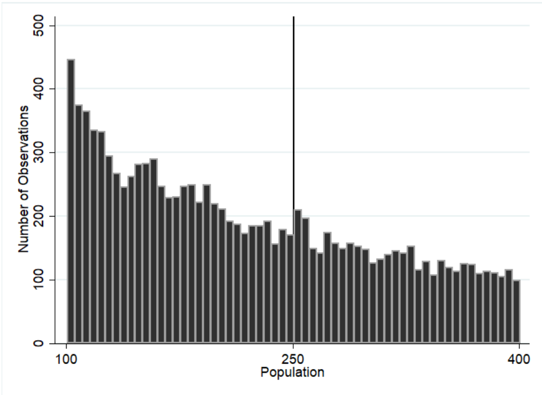
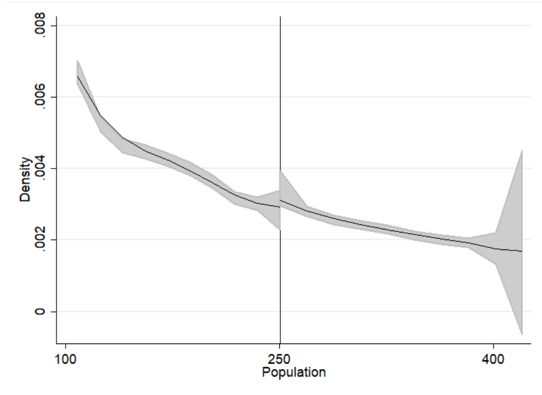
Figures

Figure 1: Test of Manipulation of the Running Variable



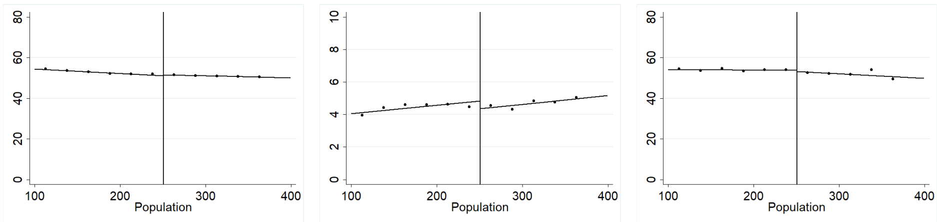
(a) Histogram



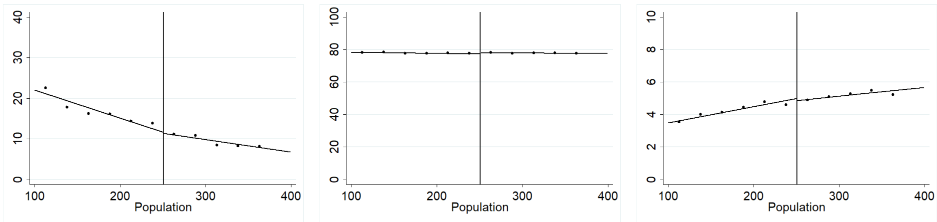
(b) Test of manipulation

Figure (a) shows the histogram of population sizes. The unit of observation is a municipality-election. Bins are 25-inhabitant wide. Figure (b) shows the manipulation test by Cattaneo, Jansson, and Ma (2020): p-value = 0.11.

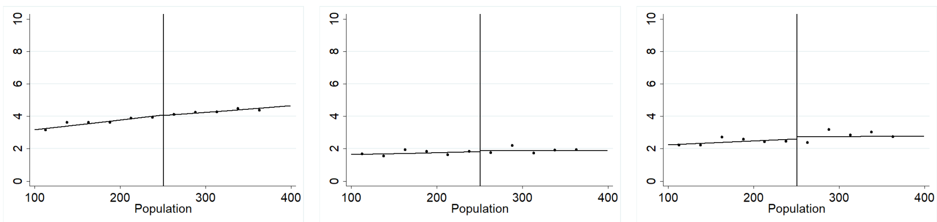
Figure 2: Covariate Smoothness around the Threshold



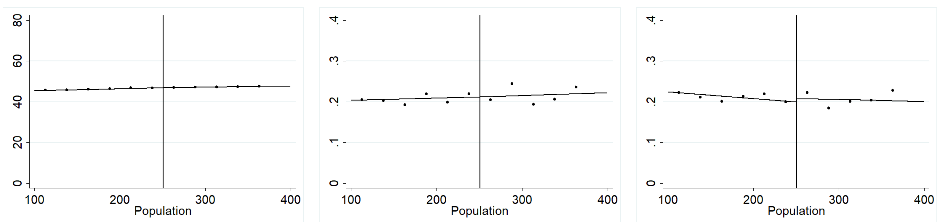
(a) Average age (years) (b) Foreigners (%) (c) EU foreigners (%)



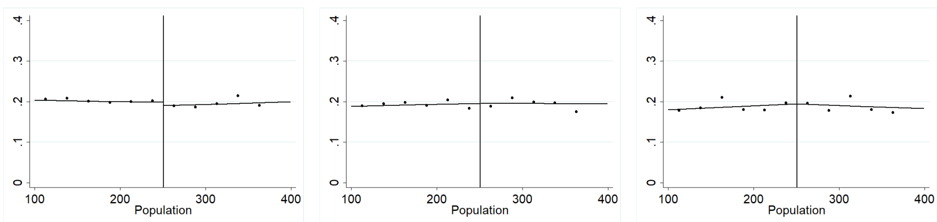
(d) Ideology (%) (e) Turnout (%) (f) Female Unem. (%)



(g) Male Unem. (%) (h) Female Hiring (%) (i) Male Hiring (%)



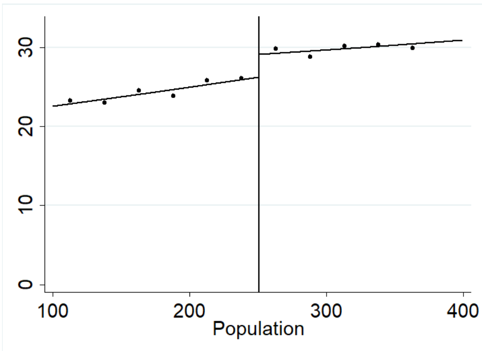
(j) Female Population (%) (k) $\mathbb{1}_{year=2003}$ (l) $\mathbb{1}_{year=2007}$



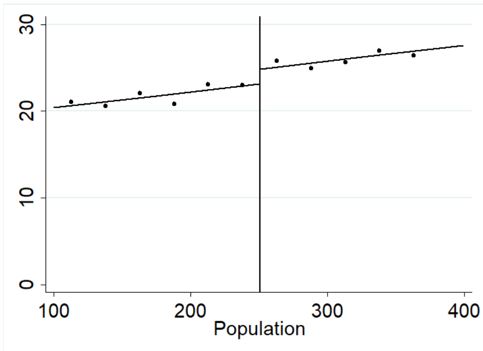
(m) $\mathbb{1}_{year=2011}$ (n) $\mathbb{1}_{year=2015}$ (o) $\mathbb{1}_{year=2019}$

The unit of observation is a municipality-election. Circles represent the local averages of the variables. Averages are calculated within 25 inhabitant-wide bins of population (x-axis). Continuous lines are a linear fit over the original (unbinned) data.

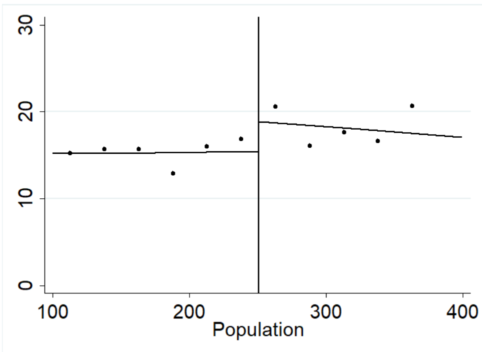
Figure 3: Effect of the Electoral System on the Percent of Female Candidates, Councilors, and Mayors



(a) Percent of female candidates



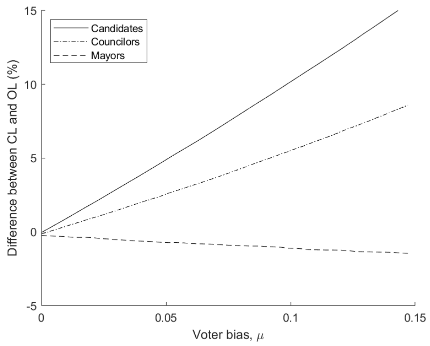
(b) Percent of female councilors



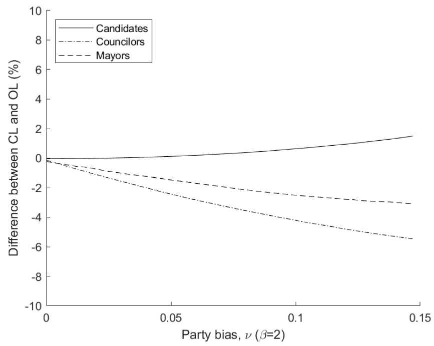
(c) Percent of female mayors

The unit of observation is a municipality-election. Circles represent the local averages of the variables. Averages are calculated within 25 inhabitant-wide bins of population (x-axis). Continuous lines are a linear fit over the original (unbinned) data.

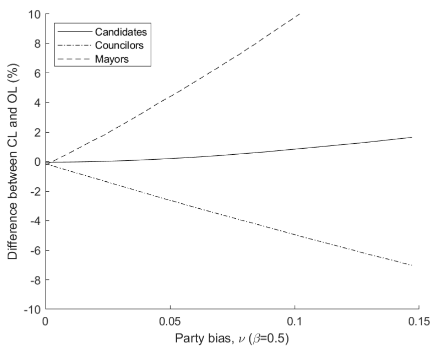
Figure 4: Model Simulations



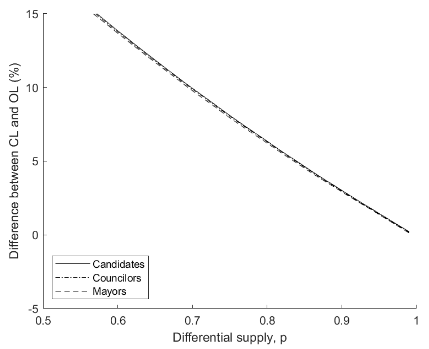
(a) Voter bias



(b) Party bias, strong norm



(c) Party bias, weak norm



(d) Supply differences

The lines show the expected difference in the share of female candidates, councilors, or mayors, between the CL and the OL systems. Results are based on 1,000,000 simulations of the theoretical model using a Pareto distribution for the competence of candidates. Figure (a) shows the case of voter bias and no party bias nor supply differences. Figures (b) and (c) show the case of party bias and no voter bias nor supply differences for two values of the OL-norm parameter: $\beta = 2$ (strong norm) and $\beta = .5$ (weak norm), respectively. Figure (d) shows the case of supply differences and no voter or party bias.

Tables

Table 1: Average Shares of Female Candidates, Councilors, and Mayors

Year	System	Sh Fem Candidates	Sh Fem Councilors	Sh Fem Mayors
2003	CL	23.9	19.7	14.5
	OL	19.1	15.9	11.8
2007	CL	28.3	23.9	16.6
	OL	23.1	20.1	14.3
2011	CL	30.1	26.1	17.3
	OL	24.6	21.7	15.8
2015	CL	31.9	29.3	19.8
	OL	25.4	23.4	17.1
2019	CL	36.6	32.7	22.5
	OL	29.1	27.4	17.9

The unit of observation is a municipality-election. N=11,617.

Table 2: Covariate Smoothness around the Threshold

Variable	(1) Mean	(2) Bandwidth	(3) Results
Average Age (years)	52.30	47	0.0313
		[N = 3306]	(0.513)
Foreigners (%)	4.50	54	0.0580
		[N = 3806]	(0.113)
EU Foreigners (%)	53.14	49	-2.319
		[N = 3015]	(1.559)
Ideology (%)	14.67	32	-3.264
		[N = 2282]	(2.012)
Nat. Turnout (%)	77.90	34	0.457
		[N = 2414]	(0.646)
Female Unemployment (%)	4.52	34	0.203
		[N = 1892]	(0.169)
Male Unemployment (%)	3.82	33	0.0772
		[N = 1790]	(0.304)
Female Hiring (%)	1.78	29	-0.0806
		[N = 1592]	(0.147)
Male Hiring (%)	2.53	46	-0.254
		[N = 2491]	(0.274)
Female Population (%)	46.54	35	0.324
		[N = 2414]	(0.257)
$\mathbb{1}_{year=2003}$	0.21	25	-0.0403
		[N = 1827]	(0.0300)
$\mathbb{1}_{year=2007}$	0.21	37	0.0366
		[N = 2620]	(0.0246)
$\mathbb{1}_{year=2011}$	0.20	39	-0.0178
		[N = 2758]	(0.0157)
$\mathbb{1}_{year=2015}$	0.19	43	-0.00227
		[N = 2962]	(0.0118)
$\mathbb{1}_{year=2019}$	0.19	27	0.0596
		[N = 1886]	(0.0418)

Column (1) shows the mean of the variables within the bandwidth. Column (2) shows the Calonico, Cattaneo, and Titiunik (2014) bandwidth values and number of observations for a placebo test that estimates the effect of CL on the corresponding variable. Column (3) shows the results for the placebo tests: each column is a separate local linear regression with a uniform kernel. Standard errors, clustered by municipality and election period, are in parentheses.

Table 3: Effect on the Percent of Female Candidates, Councilors, and Mayors

Panel A: Percent of Female Candidates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
CL	4.056***	5.532***	2.787***	3.140***	4.699***	4.652***	3.426***
	(1.192)	(2.064)	(0.456)	(0.677)	(1.593)	(1.519)	p-v = 0.000
Constant	25.78						
Observations	1674	3461	11617	11617	1674	2490	1827
Bw Size	23	49	150	150	23	36	26
Bw Method	CCT	CCT	All	All	CCT	CCT	Local
Polynomial	1	2	1	2	1	1	randomization
Kernel	Uniform	Uniform	Uniform	Uniform	Uniform	Triangular	
S.e.	Clustered	Clustered	Clustered	Clustered	CCT Rob.	Clustered	

Panel B: Percent of Female Councilors

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
CL	4.801***	5.917***	1.691*	2.241**	5.477***	4.660***	2.395***
	(1.145)	(1.682)	(0.919)	(0.956)	(1.877)	(1.771)	p-v = 0.008
Constant	21.34						
Observations	1886	3882	11617	11617	1886	2620	1827
Bw Size	26	56	150	150	26	37	26
Bw Method	CCT	CCT	All	All	CCT	CCT	Local
Polynomial	1	2	1	2	1	1	randomization
Kernel	Uniform	Uniform	Uniform	Uniform	Uniform	Triangular	
S.e.	Clustered	Clustered	Clustered	Clustered	CCT Rob.	Clustered	

Panel C: Percent of Female Mayors

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
CL	7.096***	7.795***	3.389***	3.621*	7.684**	6.747**	3.541**
	(2.385)	(2.761)	(1.263)	(1.865)	(3.168)	(3.146)	p-v = 0.048
Constant	15.72						
Observations	2958	4333	11603	11603	2958	3584	1825
Bw Size	43	61	150	150	43	51	26
Bw Method	CCT	CCT	All	All	CCT	CCT	Local
Polynomial	1	2	1	2	1	1	randomization
Kernel	Uniform	Uniform	Uniform	Uniform	Uniform	Triangular	
S.e.	Clustered	Clustered	Clustered	Clustered	CCT Rob.	Clustered	

Results from estimating $Outcome_{mt} = \alpha + \beta CL_{mt} + f(Pop_{mt} - 250) + u_{mt}$. Each column reports a separate local polynomial regression estimate with the specified bandwidth, polynomial order, and standard errors. Separate polynomials are fitted on each side of the threshold. The last column shows the results from Cattaneo, Frandsen, and Titiunik (2015)'s procedure. Clustered standard errors are clustered by municipality and election period. CCT Rob. standard errors refers to bias-corrected estimates, robust standard errors, as proposed by Calonico, Cattaneo, and Titiunik (2014).

Table 4: Model Estimation

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
μ	-0.013	-0.009	0.006	-0.025	-0.003	0.019	0.060
	(0.031)	(0.035)	(0.038)	(0.036)	(0.013)	(0.041)	(0.022)
ν	0.073	0.064	0.064	0.112	0.038	0.091	0.077
	(0.032)	(0.028)	(0.027)	(0.032)	(0.011)	(0.028)	(0.023)
β	0.403	0.348	0.378	0.409	0.294	0. 505	0. 524
	(0.182)	(0.160)	(0.179)	(0.128)	(0.095)	(0.167)	(0.163)
p	0.630	0.633	0.576	0.625	0.655	0.618	0.515
	(0.089)	(0.080)	(0.092)	(0.069)	(0.078)	(0.083)	(0.067)
Lognormal parameter	0.39	0.43	0.39			0.39	0.39
Sample bandwidth	26	26	23	26	26	26	26
Distribution	Lognormal	Lognormal	Lognormal	Gamma	Pareto	Lognormal	Lognormal
Random 2nd CL candidate						Y	
Supply affects competence							Y

Results from estimating μ, ν, β, and p from the model with 5,000 simulations, $M = 2$, standard errors in parenthesis. See text for details.

Table 5: Effect on the Percent of Female Candidates among Top-5 Candidates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
CL	4.291***	4.758**	2.246***	2.906***	4.874***	4.358***	3.085***
	(1.121)	(1.968)	(0.620)	(0.718)	(1.599)	(1.494)	p-v = 0.001
Constant	25.25						
Observations	1816	3278	11357	11357	1816	2662	1759
Bw Size	26	49	150	150	26	39	26
Bw Method	CCT	CCT	All	All	CCT	CCT	Local
Polynomial	1	2	1	2	1	1	randomization
Kernel	Uniform	Uniform	Uniform	Uniform	Uniform	Triangular	
S.e.	Clustered	Clustered	Clustered	Clustered	CCT Rob.	Clustered	

Results from estimating $Outcome_{mt} = \alpha + \beta CL_{mt} + f(Pop_{mt} - 250) + u_{mt}$, where only the outcome is the share of females among candidates in the top five positions of the lists. Each column reports a separate local polynomial regression estimate with the specified bandwidth, polynomial order, and standard errors. Separate polynomials are fitted on each side of the threshold. The last column shows the results from Cattaneo, Frandsen, and Titiunik (2015)'s procedure. Clustered standard errors are clustered by municipality and election period. CCT Rob. standard errors refers to bias-corrected estimates, robust standard errors, as proposed by Calonico, Cattaneo, and Titiunik (2014).

Online Appendices

A Probabilistic Voting

The microfoundations for the political part of the model laid out in section 3 are due to Lindbeck and Weibull (1987) and Persson and Tabellini (2002). For simplicity, there is only one group of voters in each municipality.[I] Since the candidates (and the voters) lack commitment, the election is driven by candidates' competence, voters' gender bias, and ideology: Voters prefer more competent candidates, as these would be more likely to implement good policies. At the same time, voters might have a bias against female candidates, thus preferring a less competent male candidate. Which candidates a voter support depends not only on the candidates' competence (which is imperfectly observed by voters) and gender, but also on the relative "ideological" attachment of the voter to the candidate's party. Finally, in the OL system we assume that voters know how parties might select the mayor among the elected councilors and take this into account when deciding their votes.

We first consider the choice among the two competing top-listed candidates in the CL system (recall voters only care about top-listed candidates as only these can become mayor). Voters' expected indirect utilities from these candidates are given by (2) and (3) in the main text, reproduced here:

$$\begin{aligned} E[v^i(A1)] &= s^{A1} + \xi^{A1,i} - \mu \mathbb{1}_{g(A1)=f} + \sigma^i + \delta, \\ E[v^i(B1)] &= s^{B1} + \xi^{B1,i} - \mu \mathbb{1}_{g(B1)=f}, \end{aligned}$$

where s^i is the competence of candidate i, $g(i)$ is its gender, f for female, m for male, $\xi^{Xj,i}$ and $\xi^{Yk,i}$ capture the imperfect observability of candidate competence, μ measures voter gender bias, $\mathbb{1}_{g(X1)=f}$ is an indicator for whether candidate from party X is female, and the voter-specific ideological bias, denoted by σ^i, is drawn from a symmetric uniform distribution.[II] There is an aggregate shock to ideological attachment which is realized after the parties have chosen candidates. It is denoted by δ and is drawn from a symmetric, uniform distribution, $\delta \sim U[-1/(2\psi), 1/(2\psi)]$. The sum of the two ideological components represents the total bias of voter i in favor of candidates from party A in the current election.

With this structure, the probability that party A wins the election is given by the probability that party A gets more votes, i.e., that, given candidates' competence and potential voter bias, the aggregate ideological shock is sufficiently in favor of that party. This requires that $\delta >$

[I] The model can be extended to include two groups, say, male and female voters.

[II] With only one group of voters, there is no need to specify the distribution of voter specific ideology. With more than one group, the distributions must be specified, and the relative dispersion of ideologies determines the relative weights parties attach to groups when selecting candidates. Note that notation $s^{Xj} + \xi^{Xj,i}$ represents, in reduced form, a signal extraction problem of the expected competence of candidate Xj given voter's i imperfect observation of it.

$s^{A1} - s^{B1} - \mu(\mathbb{1}_{g(A1)=f} - \mathbb{1}_{g(B1)=f})$. Given the assumption that δ is uniformly distributed, this implies (4) in the main text.

We now consider the choice of two councilors among four competing candidates in a given OL municipality. Denote the candidates by $A1$, $A2$, $B1$, and $B2$, where it is understood that candidate $X1$ has higher competence net of voter and party bias than candidate $X2$.[III] Voter i supports candidates $A1$ and $A2$ if the voter's indirect utility from this pair of candidates exceeds the indirect utility from the other three possible combinations, by more than some threshold values. These threshold values have a voter-specific component, reflecting both the ideological attachment and imperfect observation of competence mentioned before, and an aggregate component.[IV]

Let $E[v^i(\pi)]$ denote the indirect expected utility function of voter i when pair of candidates $\pi \in \{(A1, A2), (A1, B1), (B1, A1), (B1, B2)\}$ is elected.[V] Thus, the expected utility from pair Xn, Yq is given by

$$\begin{aligned} E[v^i(Xn, Yq)] \;\; = \;\; & P^i[\text{mayor}(X) = Xn] \left[s^{Xn} + \xi^{Xn,i} - \mu \mathbb{1}_{g(Xn)=f} + \left(\sigma^i + \delta\right) \mathbb{1}_{Xn \in A})\right] \\ & + P^i[\text{mayor}(Y) = Yq] \left[s^{Yq} + \xi^{Yq,i} - \mu \mathbb{1}_{g(Yq)=f} + \left(\sigma^i + \delta\right) \mathbb{1}_{Yq \in A}\right], \end{aligned}$$

where $P^i[\text{mayor}(X) = Xn]$ is the probability that voter i attaches to candidate Xn being selected mayor if party X wins the election. For simplicity, we assume that candidate competence is so imperfectly observed that voters attach equal probability of being the mayor to all four competing candidates.[VI] To assess the validity of this approximation we use numerical simulation under the assumption that $\xi^{Xn,i}$ is normally distributed with standard deviation $Q\sigma$, where σ is the standard deviation of competence (see section 4.3 for distributions used for competence in model estimation).[VII] We find that, for each party, the probability that the candidate with highest observed competence is actually the most competent one is approximately 63% when $Q = 2$, 56% when $Q = 5$, and 53% when $Q = 10$. Thus, assuming that voters attach equal probability of being the mayor to all four competing candidates is a reasonable

[III] Although voters only directly care about candidates' competence and gender, they are aware that parties might select the second most voted male councilor over the most voted female councilor and take this into consideration when ranking candidates. For example, suppose the voter's ranking not taking into account party bias is $A1$, $B1$, $A2$, $B2$. If the voter expects party B to choose $B2$ as mayor in case of winning the election, then the voter ranking taking this into account is $A1$, $A2$, $B1$, $B2$.

[IV] For simplicity, we assume that voter i observes aggregate competence of each party perfectly, i.e., $\xi^{X1,i} = -\xi^{X2,i}$.

[V] Note that $A2, B2$ and $B2, A2$ are dominated, respectively, by $A1, B1$ and $B1, A1$ for all voters, and thus can be disregarded.

[VI] Thus, we abstract from situations in which the observed competence of candidates is so diverse that voters infer, correctly, that their probabilities of being selected are not homogenous.

[VII] For simplicity, we compare two candidates of the same gender, as we are interested in the effect of observational uncertainty on voters' expectations. We simulate 500,000 pairs of competence draws and their observational errors. We estimate the frequency with which the ranking of pairs of competence draws plus errors coincides with the ranking of the respective pairs of draws, i.e., the probability that the candidate with the highest observed competence is the most competent one (and would be selected mayor should the party win). We do this for values of Q between 0.1 and 10 finding that this probability goes from close to 1 to slightly above 1/2.

approximation of voters' expectations when uncertainty in voters' observation of competence is high.

For the cases of interest in the OL system, voters with strong attachment to party B will vote $B1, B2$. As ideology is dampened, voters vote $B1, A1$, and for weak ideological attachment to party A the vote switches to $A1, B1$, with voters with strong ties to party A voting $A1, A2$. Since the party that gets two councilors wins the election, the election will be decided by the mass of votes $A1, A2$ relative to $B1, B2$. These are determined by the choice of voters that are indifferent on one hand between $A1, A2$ and $A1, B1$, and those that are indifferent between $B1, B2$ and $B1, A1$. These decisions are determined by the comparisons of marginal voters. For simplicity we consider the "average" marginal voters (those for which $\xi^{Ak,i} = \xi^{Bk,i} = 0$) identified by their specific components, σ^{AB} and σ^{BA} respectively,

$$\begin{aligned}
E[v^{AB}(A1A2)] &= E[v^{AB}(A1B1)] \\
\rightarrow \frac{1}{2}\left[s^{A1} - \mu \mathbb{1}_{g(A1)=f} + s^{A2} - \mu \mathbb{1}_{g(A2)=f}\right] &= \frac{1}{2}\left[s^{A1} - \mu \mathbb{1}_{g(A1)=f} + s^{B1} - \mu \mathbb{1}_{g(B1)=f} - \delta - \sigma^{AB}\right], \\
E[v^{BA}(B1B2)] &= E[v^{BA}(B1A1)] \\
\rightarrow \frac{1}{2}\left[s^{B1} - \mu \mathbb{1}_{g(B1)=f} + s^{B2} - \mu \mathbb{1}_{g(B2)=f}\right] &= \frac{1}{2}\left[s^{A1} - \mu \mathbb{1}_{g(A1)=f} + s^{B1} - \mu \mathbb{1}_{g(B1)=f} + \delta + \sigma^{BA}\right].
\end{aligned}$$

In the OL system, the probability that party A wins, P^A, is given by the probability that $\sigma^{AB} + \sigma^{BA} < 0$, i.e., the probability that there are more voters above σ^{AB} than voters below σ^{BA}. From the expressions above, P^A is given by the probability that $2\delta > s^{A1} + s^{A2} - s^{B1} - s^{B2} - \mu(\mathbb{1}_{g(A1)=f} + \mathbb{1}_{g(A2)=f} - \mathbb{1}_{g(B1)=f} - \mathbb{1}_{g(B2)=f})$. Given the assumption that δ is uniformly distributed, this implies (6) in the main text.

B Proofs of Propositions 1, 2, and 3

General results

Denoting by F the number of female candidates, the probabilities that the party chooses none, $P^{CL}(F = 0)$, or two, $P^{CL}(F = 2)$, female candidates are given by[VIII]

$$P^{CL}(F = 0) = P(f_1 < m_1 + \mu + \nu \wedge f_1 < m_2) = P(f_1 < m_2), \quad \text{(B.1)}$$
$$P^{CL}(F = 2) = P(f_1 > m_1 + \mu + \nu \wedge f_2 > m_1) = P(m_1 < \min[f_2, f_1 - \mu - \nu]), \quad \text{(B.2)}$$

and the probability of one female candidate is $P^{CL}(F = 1) = 1 - P^{CL}(F = 0) - P^{CL}(F = 2)$. Equations (B.1) and (B.2) show that, in CL, parties may have a bias against having a female candidate for mayor, and also internalize voter bias when comparing f_1 and m_1, but there is no bias for the second placed candidate.

[VIII]The expressions below involve integrals of dH_1 and dH_2 (or dH if the party has only one draw for female candidates) as in the derivation of $P(f_1 > m_1 + \mu + \nu)$ in the main text; see (11).

In the OL system, parties choose candidates taking into consideration voter gender bias for both candidates and that the mayor selection might entail a cost if the most voted candidate is female. Thus,[IX]

$$\begin{aligned} P^{OL}(F=0) &= P(f_1 < m_2 + \mu + 2\nu \mathbb{1}_{(f_1-m_1-\mu)\beta>\nu}), & \text{(B.3)} \\ P^{OL}(F=2) &= P(f_2 > m_1 + \mu \wedge \beta(f_1 - m_1 - \mu) > \nu) \\ &\quad + P(f_2 > m_1 + \mu + 2\nu \wedge \beta(f_1 - m_1 - \mu) < \nu), & \text{(B.4)} \end{aligned}$$

where $\mathbb{1}_{(f_1-m_1-\mu)\beta>\nu}$ is an indicator for whether the highest ranked female candidate would get sufficiently more votes than the highest ranked male candidate to overcome party bias and become mayor. The probability of one female candidate, $P^{OL}(F = 1)$, is given by $1 - P^{OL}(F = 0) - P^{OL}(F = 2)$. The difference in the expected number of female candidates across electoral systems is given by

$$\begin{aligned} \mathrm{E}[F]^{CL} - E[F]^{OL} &= P^{CL}(F=1) + 2P^{CL}(F=2) - \left[P^{OL}(F=1) + 2P^{OL}(F=2)\right] \\ &= \left[P^{OL}(F=0) - P^{CL}(F=0)\right] + \left[P^{CL}(F=2) - P^{OL}(F=2)\right]. \end{aligned}$$

The probability that a party chooses a female candidate for mayor in CL is given by equation (11) in the main text, repeated here:

$$P^{CL}(g(\text{mayor}(j)) = f) = P(f_1 > m_1 + \mu + \nu), \quad \text{(B.5)}$$

while the probability that a party has a female candidate potentially selected for mayor in OL is given by

$$P^{OL}(g(\text{mayor}(j)) = f) = P(\beta(f_1 - m_1 - \mu) > 2\nu) + P(f_2 > m_1 + \mu + 2\nu \wedge \beta(f_1 - m_1 - \mu) < 2\nu). \quad \text{(B.6)}$$

Proof of Proposition 1

From the comparison of (B.1) and (B.2) with (B.3) and (B.4), it follows that, if $\mu > 0$,

[IX] The following expressions come from the comparison of objective function (7) for the three possible cases, choosing both male candidates, both female, or a male and a female. Taking into account that each party chooses candidates without observing the other party's choices, and that the probability of winning the election is given by equation (6), these options have the following values for parties:

$$\begin{aligned} &1/2\,(m_1 + m_2)\,, \\ &1/2\,(f_1 + f_2 - 2\mu) - \nu, \\ &1/2\,(f_1 + m_1 - \mu) - \nu \mathbb{1}_{(f_1-m_1-\mu)\beta>\nu}, \end{aligned}$$

where the indicator $\mathbb{1}_{(f_1-m_1-\mu)\beta>\nu}$ shows that when the party wins the election, and the female candidate gets more votes than the male candidate, she has to overcome party bias by securing a sufficient vote advantage to become mayor and in that case the party pays a utility cost, or receives a benefit if $\nu < 0$. To facilitate the presentation of the analytical results we proceed under the assumption that $\nu > 0$. In section 4.3, we show that model estimations indicate that party bias is indeed positive.

$\nu = 0$, and $p = 1$, then

$$P^{CL}(F = 2) = P(m_1 < \min[f_2, f_1 - \mu]) \;\; > \;\; P(m_1 < f_2 - \mu) = P^{OL}(F = 2),$$
$$P^{CL}(F = 0) = P(f_1 < m_2) \;\; < \;\; P(f_1 < m_2 + \mu) = P^{OL}(F = 0),$$

and hence, $\mathrm{E}[F]^{CL} - E[F]^{OL} > 0$. That is, in the presence of voter bias but no party bias nor supply differences, the CL system leads to more female candidates than the OL system.

To see the effect of voter bias on the share of female mayors, we compare (B.5) with (B.6)

$$P^{CL}(g(\text{mayor}(j)) = f) = P(f_1 > m_1 + \mu) = P^{OL}(g(\text{mayor}(j)) = f).$$

Thus, if there is voter bias but no party bias, then the probability that a female candidate is top-listed in CL is the *same* as the probability that a female candidate is ex post selected for mayor in OL. The share of female mayors across electoral systems will depend on the probability of wining an election when a female candidate would eventually be mayor. This is given by (by symmetry, we can consider party A, and we denote by "A>B" the event that party A wins the election)

$$\begin{aligned} & P^{CL}(g(\text{mayor}(A)) = f \wedge A > B) = P^{CL}(A > B|g(\text{mayor}(A)) = f)P^{CL}(g(\text{mayor}(A)) = f) \\ = & \left[\frac{1}{2}P^{CL}(g(\text{mayor}(B)) = f) + P^{CL}(A > B|g(\text{mayor}(A)) = f \wedge g(\text{mayor}(B)) = m) \right. \\ & \left. P^{CL}(g(\text{mayor}(B)) = m)\right] P^{CL}(g(\text{mayor}(A)) = f), \end{aligned}$$

where the term in square brakets in the second and third lines is the conditional probability $P^{CL}(A > B|g(\text{mayor}(A)) = f)$ written as the sum of the probabilities under the complementary events that party B fields either a female or male candidate for mayor. In the former case the probability that party A wins is naturally 1/2, while in the latter it is given by $P^{CL}(A > B|g(\text{mayor}(A)) = f \wedge g(\text{mayor}(B)) = m))$.

Now we evaluate the same probability for OL, i.e., the probability that party A has a female candidate potentially selected for mayor, and that it wins the election:

$$\begin{aligned} & P^{OL}(g(\text{mayor}(A)) = f \wedge A > B) = P^{OL}(A > B|g(\text{mayor}(A)) = f)P^{OL}(g(\text{mayor}(A)) = f) \\ = & \left[\frac{1}{2}P^{OL}(g(\text{mayor}(B)) = f) + P^{OL}(A > B|g(\text{mayor}(A)) = f \wedge g(\text{mayor}(B)) = m) \right. \\ & \left. P^{OL}(g(\text{mayor}(B)) = m)\right] P^{OL}(g(\text{mayor}(A)) = f). \end{aligned}$$

As shown above, $P^{CL}(g(\text{mayor}(A)) = f) = P^{OL}(g(\text{mayor}(A)) = f)$. Thus, the only difference in the share of female mayors across systems is due to the term that reflects the probability of winning the election when fielding a female candidate for the mayor position and the other party fields a male candidate. A comparison of (9) and (10) reveals that having a female candidate for mayor will have a larger negative effect on the probability to win an election for parties in CL than in OL. Thus, the share of female mayors must be higher in OL.

Proof of Proposition 2

From the comparison of (B.1) and (B.2) with (B.3) and (B.4), it follows that, if $\nu > 0$, $\mu = 0$, and $p = 1$, then

$$P^{CL}(F=0) = P(f_1 < m_2) < P(f_1 < m_2 + 2\nu \mathbb{1}_{(f_1 - m_1 - \mu)\beta > \nu}) = P^{OL}(F=0).$$

Since $P^{CL}(F=2)$ may be larger or smaller than $P^{OL}(F=2)$, it is not possible to determine a priori if the share of female candidates will be larger in CL or OL. But, if $\nu << E[f_1] - E[f_2]$, such that $P(m_1 < \min[f_2, f_1 - \nu]) \approx P(m_1 < f_2)$.[X] then

$$P^{CL}(F=2) \approx P(m_1 < f_2) > \frac{P(f_2 > m_1 + \nu) + P(f_2 > m_1 + 2\nu)}{2} \approx P^{OL}(F=2),$$

and the share of female candidates is higher in CL. The other polar case for which we can derive a result is that of ν high enough, $\nu >> E[f_1] - E[f_2]$, such that $P(m_1 < \min[f_2, f_1 - \nu]) \approx P(m_1 < f_1 - \nu)$

$$P^{CL}(F=2) \approx P(m_1 < f_1 - \nu) > P(m_1 < f_2 - 2\nu) \approx P^{OL}(F=2),$$

and there will also be more female candidates in the CL system.

Regarding the share of female mayors, if there is no voter bias the probability of winning the election will not be affected by candidates' gender. Equations (B.5) and (B.6) reduce to

$$\begin{aligned} P^{CL}(g(\text{mayor}(j)) = f) &= P(f_1 > m_1 + \nu), \\ P^{OL}(g(\text{mayor}(j)) = f) &= P(f_1 > m_1 + 2\nu/\beta) + P(f_2 > m_1 + 2\nu \wedge f_1 < m_1 + 2\nu/\beta), \\ &= P(f_1 > m_1 + 2\nu/\beta) + P(f_1 < m_1 + 2\nu/\beta \mid f_2 > m_1 + 2\nu)P(f_2 > m_1 + 2\nu) \end{aligned}$$

Thus, if there is party bias, an increase in β reduces $m_1 + 2\nu/\beta$, increasing the first term of $P^{OL}(g(\text{mayor}(j))$ and reducing the second one. But since the second term is conditioned on an event that is unaffected by the change in β, the first effect dominates such that an increase in β increases $P^{OL}(g(\text{mayor}(j))$.[XI] In the limit, when $\beta \to 0$,

$$P^{OL}(g(\text{mayor}(j)) = P(f_2 > m_1 + 2\nu) < P(f_1 > m_1 + \nu) = P^{CL}(g(\text{mayor}(j)) = f),$$

[X] One could consider $\nu \in (0, \bar{\nu})$ with $\bar{\nu}$ such that $P(m_1 < f_2) - P(m_1 < \min[f_2, f_1 - \bar{\nu}]) \equiv P(f_1 < m_2 + 2\bar{\nu}\mathbb{1}_{(f_1 - m_1 - \mu)\beta > \bar{\nu}}) - P(f_1 < m_2)$. Since this condition depends on properties of the distribution function (in particular there is no guarantee that $P(f_1 < m_2 + 2\nu\mathbb{1}_{(f_1 - m_1 - \mu)\beta > \nu})$ is increasing in ν for all $\nu > 0$), we prefer to state the condition as holding for $\nu << E[f_1] - E[f_2]$ such that $P(m_1 < \min[f_2, f_1 - \nu]) \approx P(m_1 < f_2)$.

[XI] For non-empty sets Ω and Q, $\Omega \subset \Omega'$, $P(\Omega') - P(\Omega) > P(\Omega' \mid Q) - P(\Omega \mid Q)$.

and there are more female mayors under CL. When $\beta = 2$ we have

$$P^{OL}(g(\text{mayor}(j)) > P(f_1 > m_1 + \nu) = P^{CL}(g(\text{mayor}(j)) = f).$$

Thus, there exists a $\bar{\beta}$, $0 < \bar{\beta} < 2$, such that, for $\beta > \bar{\beta}$, there is a higher share of female mayors in OL. This is so because votes reflect candidates' competence, and almost all female winners will be selected as mayor when the norm is strong.

Proposition 3.

If there is no voter nor party bias, $\mu = \nu = 0$, but there is differential supply, $p < 1$, the share of female candidates, councilors, and mayors in OL will reflect the lower supply. Thus, all three shares should be $\frac{1}{2}$ in CL, but only $p\frac{1}{2} + (1-p)\frac{1}{3} = \frac{2+p}{6} < \frac{1}{2}$ in OL.

C Additional Empirical Evidence

Evidence of Norm in OL Mayor Selection

Here we show that the councilor that obtained the most votes in the general election is substantially more likely to be appointed mayor than the runner-up, even when the two councilors almost tied in votes. Importantly, this also implies that who is going to be the mayor cannot have been (completely) decided ex-ante as, if that were the case, the votes obtained in the general election could not affect the probability of being appointed mayor.

Intuitively, we want to compare the two most voted councilors in the list of the party that appointed the mayor, and estimate whether the one with more votes is more likely to become the mayor. For example, consider an election in which one party has three councilors and another party has two—hence, the decision of whom to appoint mayor corresponds in practice to the councilors of the party with three councilors. The general-election votes for the councilors of this party were 50, 49, and 35. We want to compare the probability that the councilors with 50 and 49 votes are appointed mayor. Given that obtaining one more vote is essentially random, the two councilors with 50 and 49 votes should be, on average, equal in any other characteristic (education, quality, gender, etc.). Hence, if the councilor with 50 votes is more likely to become mayor, this identifies a norm that "the most voted councilor has to become mayor".

We use a RD design to estimate the effects, following closely the empirical strategy of Fujiwara and Sanz (2020). We define the running variable as follows:

$$x_{cmt} = \begin{cases} v_{mt} & \text{if } c \text{ is the most voted} \\ -v_{mt} & \text{if } c \text{ is second most voted,} \end{cases} \tag{C.1}$$

where c refers to a councilor of the party of the mayor, and v_{mt} is the difference in general-election votes between the first and second most voted councilors of the party that appointed the mayor in period t.

Therefore, for each election, we have two observations, one for the most voted councilor of the party of the mayor, and another for the second most voted councilor. If $x_{cmt} > 0$, then councilor c has the most votes (*First*), and it has the second most votes otherwise. Let y_{cmt} be the outcome, that is, becoming the mayor. The effect of having most votes is given by $\lim_{x_{cmt}\downarrow 0} \mathrm{E}[y_{cmt}|x_{cmt}] - \lim_{x_{cmt}\uparrow 0} \mathrm{E}[y_{cmt}|x_{cmt}]$, which can be estimated with a RD design:

$$y_{cmt} = \theta_0 + \theta_1 First + f(x_{cmt}) + \epsilon_{cmt}. \tag{C.2}$$

The identification assumption is that barely being the first or second most voted councilor does not correlate with any other factor that affects whether that councilor is appointed mayor. Intuitively, we are comparing two councilors of the same party, one of which obtained just one more vote than the other. As long as the number of votes that candidates are going to obtain cannot be precisely controlled, obtaining one more or less vote should be as good as random and the identification assumption is likely to hold. In particular, the two most voted councilors of the mayor's party should be equal in any characteristics.[XII] Note that, by design, all covariates that do not vary within a municipality-year are balanced, and that the standard errors are not affected by the double-counting of elections, as they are clustered by municipality.

The results from estimating equation (C.2) are displayed graphically in figure A7. It reveals that, when the two most voted councilors in the majority list almost tie in votes, is substantially more likely to be appointed mayor. Using the CCT bandwidth, we obtain a difference of 12.2 p.p., significant at the 1% level.

Evidence of Gender Differences in OL Mayor Selection

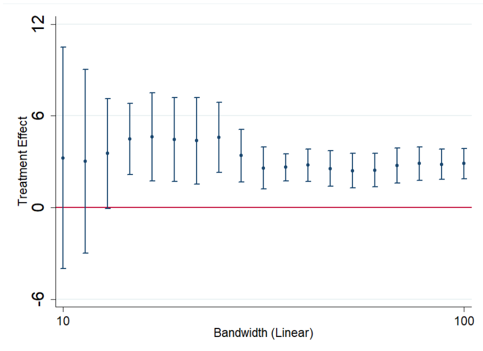
As a fourth moment to match in the model estimation, we focus on gender differences in the mayor selection in OL. As can be seen graphically in Figure A7, we observe that female councilors are less likely to be appointed mayors than male councilors, even when we condition on the share of general-election votes obtained. To derive the moment condition, we focus on cases where the top two councilors are of different genders. In the data, we observe that, when the first is male and the second is female, the first is appointed mayor 83.1% of times. In the other case, when the first is female and the second is male, the first is appointed mayor 56.1% of times. Hence, in this case, the probability that the norm is violated is 27.0 p.p. higher. In

[XII]One issue that can affect the votes obtained by candidates in the OL system is their position within the party-list, as there is evidence that voters tend to vote more for candidates that appear higher in the list (e.g., Esteve-Volart and Bagues (2012) show this happens in elections to the Spanish Senate). We cannot observe the positions of candidates within party-lists but this should also be balanced near the threshold and not drive the results. The logic is the same as for any predetermined characteristic. If obtaining one more or fewer votes is essentially random, the candidate that obtained one more votes than the other should be, on average, equally likely to be the candidate placed at the top of the list.

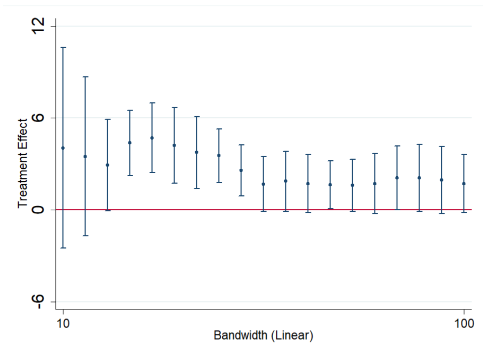
our model, the norm is, by assumption, never violated when the first is male and the second is female. For the case when the first is female and the second is male, we target the gender difference observed in the data, i.e., that the man be appointed mayor 27.0% of times. Thus, when simulating the model, if candidates are of different gender and the female candidate receives more votes than the male one, we choose parameters, and in particular β, such that the male councilor would be the mayor ($\beta(f_1 - m_1 - \mu) < \nu$) with probability 27.0%.

D Appendix Figures

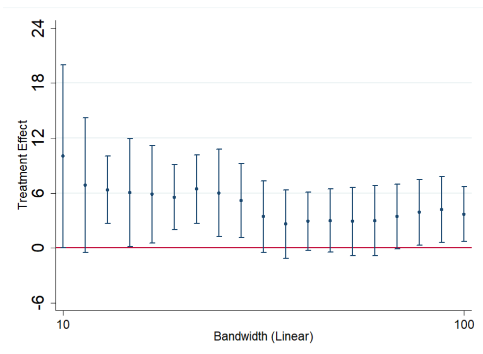
Figure A1: Effect on the Percent of Female Candidates, Councilors, and Mayors—Robustness to Bandwidth Choice



(a) Percent of female candidates



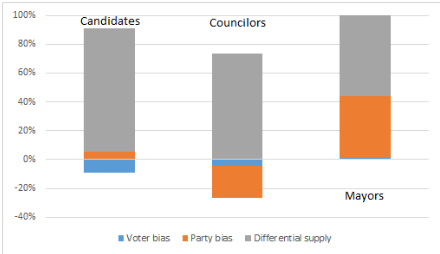
(b) Percent of female councilors



(c) Percent of female mayors

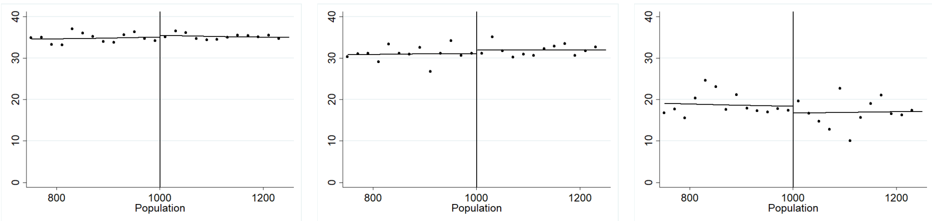
Circles represent the estimated treatment effect, using different bandwidth choices (x-axis), from $Outcome_{mt} = \alpha + \beta CL_{mt} + f(Pop_{mt} - 250) + u_{mt}$. Lines represent the 95% confidence interval (standard errors clustered by municipality and election period).

Figure A2: Share of the Results Explained by Voter Bias, Party Bias, and Differential Supply



Shaded areas represent the explanatory power of voter bias (μ), party bias (ν), and differential supply (p) for the difference in the share of female candidates, councilors, and mayors between the CL and the OL systems. Negative values indicate that the factor is reducing the observed difference.

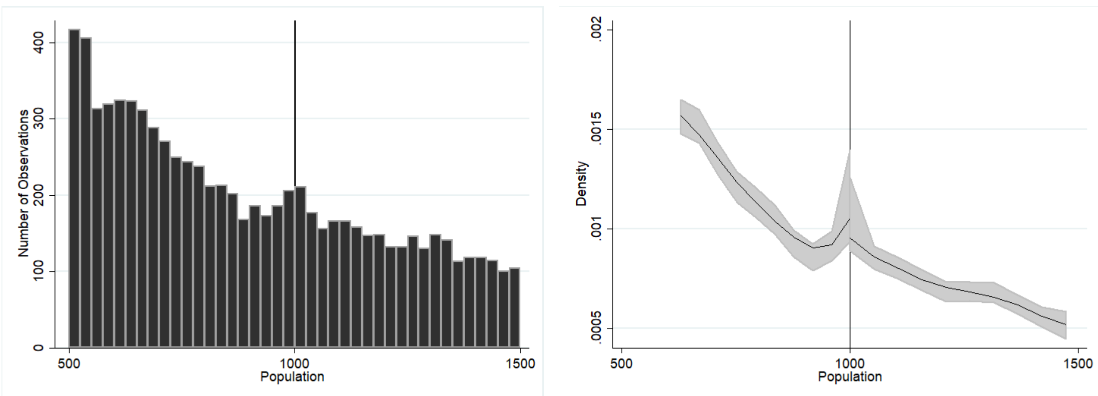
Figure A3: The Effect of Council Size: 1,000-Inhabitant Threshold



(a) Percent of female candidates (b) Percent of female councilors (c) Percent of female mayors

The unit of observation is a municipality-election. Circles represent the local averages of the variables. Averages are calculated within 25 inhabitant-wide bins of population (x-axis). Continuous lines are a linear fit over the original (unbinned) data.

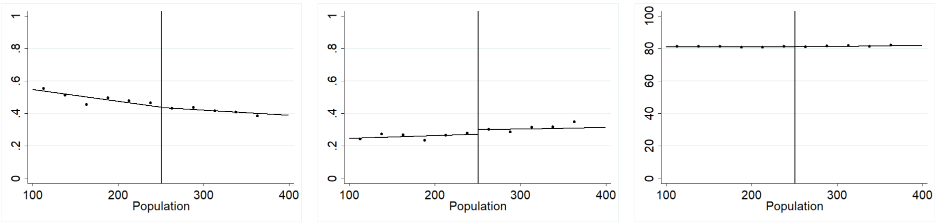
Figure A4: 1,000-Inhabitant Threshold: Test of Manipulation of the Running Variable



(a) Histogram (b) Test of manipulation

Figure (a) shows the histogram of population sizes. The unit of observation is a municipality-election. Bins are 50-inhabitant wide. Figure (b) shows the manipulation test by Cattaneo, Jansson, and Ma (2020): p-value = 0.55.

Figure A5: Effect of the Electoral System on the Party of the Mayor and Turnout

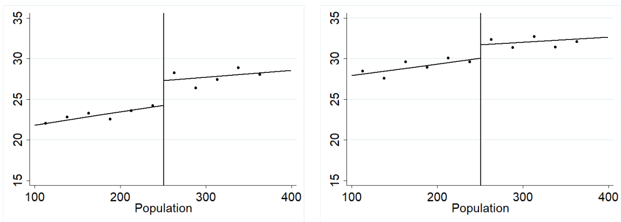


(a) PP Mayor (b) PSOE Mayor (c) Turnout

The unit of observation is a municipality-election. Circles represent the local averages of the variables. Averages are calculated within 25 inhabitant-wide bins of population (x-axis). Continuous lines are a linear fit over the original (unbinned) data.

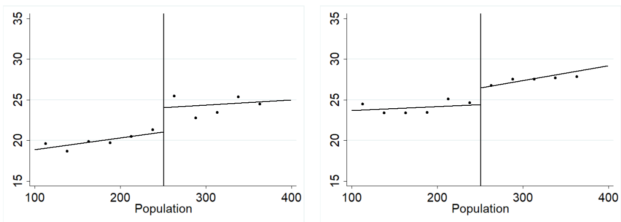
Figure A6: Effect on the Percent of Female Candidates, Councilors, and Mayors, by Party

Percent of female candidates



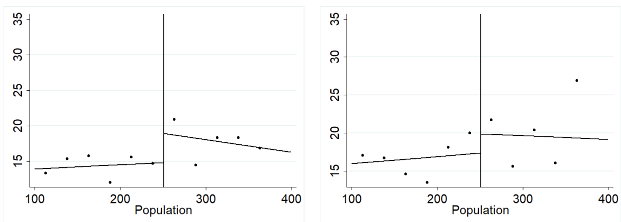
(a) PP (b) PSOE

Percent of female councilors



(c) PP (d) PSOE

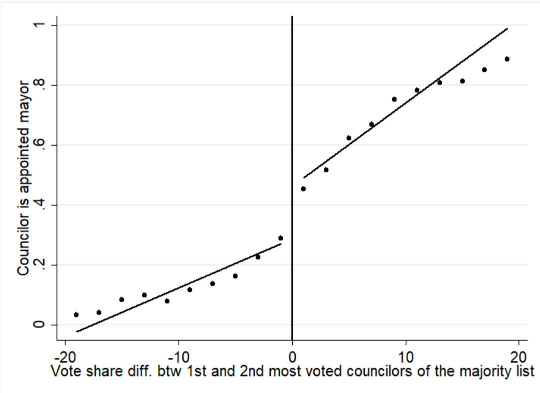
Share of female mayors



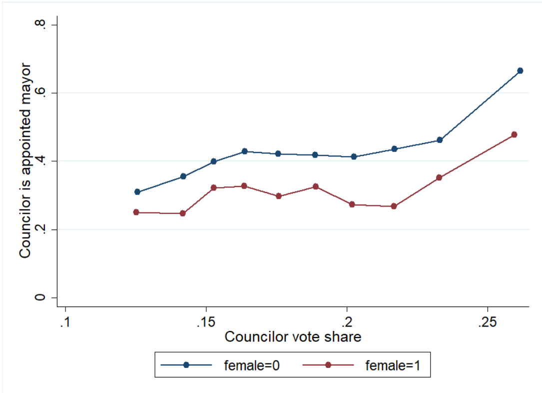
(e) PP (f) PSOE

The unit of observation is a municipality-election. Circles represent the local averages of the variables. Averages are calculated within 25 inhabitant-wide bins of population (x-axis). Continuous lines are a linear fit over the original (unbinned) data.

Figure A7: Additional Empirical Evidence



(a) Norm in OL Mayor Selection



(b) Gender Differences in OL Mayor Selection

Figure (a) represents the probability of being appointed mayor for the two most voted candidates of the majority party, as a function of the vote share difference between them. Observations to the right (left) of the threshold are for the most (second most) voted candidate. Circles represent the local averages of the variables. Averages are calculated within 2 p.p.-wide bins of the vote share difference of the top two councilors of the mayor's party (x-axis). Continuous lines are a linear fit over the original (unbinned) data. Figure (b) represents the probability of being appointed mayor as a function of of the vote share obtained in the general election, separately for males and females.

E Appendix Tables

Table A1: Effect on the Percent of Female Candidates, Councilors, and Mayors: Robustness

Panel A: Percent of Female Candidates

	(1)	(2)	(3)	(4)
CL	4.056***	4.703***	4.703***	0.375***
	(1.192)	(1.480)	(1.480)	(0.103)
Constant	25.78	25.68	25.68	2.861
Observations	1674	2813	2813	2414
Sample	100-400	100-1000	100-615	100-400
Bw Size	23	41	41	34
Outcome	Levels	Levels	Levels	Logs

Panel B: Percent of Female Councilors

	(1)	(2)	(3)	(4)
CL	4.801***	4.194***	3.841***	0.537***
	(1.145)	(1.257)	(1.293)	(0.135)
Constant	21.34	21.81	22.14	2.249
Observations	1886	2414	2552	2490
Sample	100-400	100-1000	100-615	100-400
Bw Size	26	34	36	35
Outcome	Levels	Levels	Levels	Logs

Panel C: Percent of Female Mayors

	(1)	(2)	(3)	(4)
CL	7.096***	6.413***	6.376***	0.290***
	(2.385)	(1.894)	(1.956)	(0.107)
Constant	15.72	15.67	15.85	0.756
Observations	2958	2755	2809	3027
Sample	100-400	100-1000	100-615	100-400
Bw Size	43	39	40	43
Outcome	Levels	Levels	Levels	Logs

Results from estimating $Outcome_{mt} = \alpha + \beta CL_{mt} + f(Pop_{mt} - 250) + u_{mt}$. Each column reports a separate local linear regression estimate with the CCT bandwidth. Separate polynomials are fitted on each side of the threshold. The Sample row indicates the initial window used in the analysis, i.e., the sample used to calculate the CCT bandwidth. Standard errors are clustered by municipality and election period.

Table A2: Calibration of Model Repetitions (M)

	(1)	(2)	(3)	(4)
$ShFemCandidates$	0.217	0.160	0.135	0.159
$ShFemCouncilors$	0.270	0.196	0.165	0.194
$ShFemMayors$	0.580	0.413	0.340	0.387
M	1	2	3	Data

Standard deviation of the specified variables in the model (for different values of M) and in the data. See text for details.

Table A3: 1,000-Inhabitant Threshold: Covariate Smoothness around the Threshold

Variable	(1) Mean	(2) Bandwidth	(3) Results
Average Age (years)	47.37	124	-0.314
		[N = 1778]	(0.361)
Foreigners (%)	6.09	97	-0.277
		[N = 1433]	(0.660)
EU Foreigners (%)	51.10	120	-1.983
		[N = 1712]	(3.829)
Ideology (%)	1.85	157	2.218*
		[N = 2254]	(1.293)
N Turnout (%)	77.72	116	0.288
		[N = 1677]	(0.402)
Female Unemployment (%)	6.37	119	0.680**
		[N = 1360]	(0.313)
Male Unemployment (%)	5.17	100	0.602
		[N = 1176]	(0.372)
Female Hiring (%)	2.16	83	0.0866
		[N = 981]	(0.142)
Male Hiring (%)	3.29	96	0.178
		[N = 1116]	(0.142)
Female Population (%)	48.42	153	-0.0383
		[N = 2204]	(0.179)
$\mathbb{1}_{year=2003}$	0.21	152	-0.00641
		[N = 2204]	(0.0138)
$\mathbb{1}_{year=2007}$	0.20	146	0.0216
		[N = 2115]	(0.0180)
$\mathbb{1}_{year=2011}$	0.20	127	0.00619
		[N = 1842]	(0.0134)
$\mathbb{1}_{year=2015}$	0.20	95	0.00502
		[N = 1405]	(0.00751)
$\mathbb{1}_{year=2019}$	0.19	140	-0.0553
		[N = 2032]	(0.0396)

Column (1) shows the mean of the variables within the bandwidth. Column (2) shows the Calonico, Cattaneo, and Titiunik (2014) bandwidth values and number of observations for a placebo test that estimates the effect of CL on the corresponding variable. Column (3) shows the results for the placebo tests: each column is a separate local linear regression with a uniform kernel. Standard errors, clustered by municipality and election period, are in parentheses.

Table A4: The Effect of Council Size: 1,000-Inhabitant Threshold

Panel A: Percent of Female Candidates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$\mathbb{1}_{Pop_{mt}>1,000}$	1.233*	0.973	-0.623	0.174	2.201*	1.528	0.409
	(0.672)	(1.039)	(0.460)	(0.751)	(1.213)	(1.138)	p-v = 0.575
Constant	34.79						
Observations	1607	2021	8071	8071	1607	2380	1057
Bw Size	143	143	500	500	143	187	71
Bw Method	CCT	CCT	All	All	CCT	CCT	Local
Polynomial	1	2	1	2	1	1	randomization
Kernel	Uniform	Uniform	Uniform	Uniform	Uniform	Triangular	
S.e.	Clustered	Clustered	Clustered	Clustered	CCT Rob.	Clustered	

Panel B: Percent of Female Councilors

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$\mathbb{1}_{Pop_{mt}>1,000}$	0.924	0.480	-0.345	0.275	1.231	1.251	0.323
	(1.363)	(1.436)	(0.712)	(0.867)	(1.514)	(1.490)	p-v = 0.741
Constant	31.18						
Observations	2217	2193	8071	8071	2217	2854	1057
Bw Size	146	146	500	500	146	181	71
Bw Method	CCT	CCT	All	All	CCT	CCT	Local
Polynomial	1	2	1	2	1	1	randomization
Kernel	Uniform	Uniform	Uniform	Uniform	Uniform	Triangular	
S.e.	Clustered	Clustered	Clustered	Clustered	CCT Rob.	Clustered	

Panel C: Percent of Female Mayors

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$\mathbb{1}_{Pop_{mt}>1,000}$	1.140	1.718	-3.099	-1.576	1.343	2.489	-1.204
	(0.792)	(2.045)	(2.102)	(1.875)	(4.083)	(4.126)	p-v = 0.597
Constant	17.55						
Observations	1663	2371	8055	8055	1663	2040	1054
Bw Size	114	114	500	500	114	146	71
Bw Method	CCT	CCT	All	All	CCT	CCT	Local
Polynomial	1	2	1	2	1	1	randomization
Kernel	Uniform	Uniform	Uniform	Uniform	Uniform	Triangular	
S.e.	Clustered	Clustered	Clustered	Clustered	CCT Rob.	Clustered	

Results from estimating $Outcome_{mt} = \alpha + \beta \mathbb{1}_{Pop_{mt}>1,000} + f(Pop_{mt} - 1,000) + u_{mt}$. Each column reports a separate local polynomial regression estimate with the specified bandwidth, polynomial order, and standard errors. Separate polynomials are fitted on each side of the threshold. The last column shows the results from Cattaneo, Frandsen, and Titiunik (2015)'s procedure. Clustered standard errors are clustered by municipality and election period. CCT Rob. standard errors refers to bias-corrected estimates, robust standard errors, as proposed by Calonico, Cattaneo, and Titiunik (2014).

Table A5: Effect of the Electoral System on the Party of the Mayor and on Turnout

Panel A: PP Mayor

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
CL	-0.0212	-0.0201	-0.00225	-0.0521**	-0.0288	-0.0234	-0.035
	(0.0345)	(0.0474)	(0.0214)	(0.0235)	(0.0450)	(0.0435)	p-v = 0.109
Constant	0.445						
Observations	2544	3650	11585	11585	2544	3449	1821
Bw Size	36	52	150	150	36	49	26
Bw Method	CCT	CCT	All	All	CCT	CCT	Local
Polynomial	1	2	1	2	1	1	randomization
Kernel	Uniform	Uniform	Uniform	Uniform	Uniform	Triangular	
S.e.	Clustered	Clustered	Clustered	Clustered	CCT Rob.	Clustered	

Panel B: PSOE Mayor

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
CL	0.0276	0.0240	0.0288*	0.0169	0.0277	0.0273	0.028
	(0.0175)	(0.0382)	(0.0171)	(0.0208)	(0.0368)	(0.0361)	p-v = 0.184
Constant	0.279						
Observations	3228	3228	11585	11585	3228	4173	1821
Bw Size	47	47	150	150	47	60	26
Bw Method	CCT	CCT	All	All	CCT	CCT	Local
Polynomial	1	2	1	2	1	1	randomization
Kernel	Uniform	Uniform	Uniform	Uniform	Uniform	Triangular	
S.e.	Clustered	Clustered	Clustered	Clustered	CCT Rob.	Clustered	

Panel C: Turnout

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
CL	-0.787	-0.927	0.203	-0.0943	-0.789	-0.966	-0.163
	(0.751)	(1.094)	(0.360)	(0.434)	(0.821)	(0.791)	p-v = 0.184
Constant	81.79						
Observations	2352	2884	11613	11613	2352	3100	1826
Bw Size	34	41	150	150	34	44	26
Bw Method	CCT	CCT	All	All	CCT	CCT	Local
Polynomial	1	2	1	2	1	1	randomization
Kernel	Uniform	Uniform	Uniform	Uniform	Uniform	Triangular	
S.e.	Clustered	Clustered	Clustered	Clustered	CCT Rob.	Clustered	

Results from estimating $Outcome_{mt} = \alpha + \beta CL_{mt} + f(Pop_{mt} - 250) + u_{mt}$. Each column reports a separate local polynomial regression estimate with the specified bandwidth, polynomial order, and standard errors. Separate polynomials are fitted on each side of the threshold. The last column shows the results from Cattaneo, Frandsen, and Titiunik (2015)'s procedure. Clustered standard errors are clustered by municipality and election period. CCT Rob. standard errors refers to bias-corrected estimates, robust standard errors, as proposed by Calonico, Cattaneo, and Titiunik (2014).

Table A6: Effect of the Electoral System on the Share of Female Candidates, Councilors, and Mayors, by Party

	(1) Candidates	(2) Candidates	(3) Councilors	(4) Councilors	(5) Mayors	(6) Mayors
CL	3.830**	3.869*	4.823**	5.144*	10.09*	1.783
	(1.733)	(2.198)	(2.026)	(2.788)	(5.341)	(5.517)
Constant	25.24	28.09	22.19	21.99	13.90	21.59
Observations	2996	2034	2349	1605	908	935
Party	PP	PSOE	PP	PSOE	PP	PSOE
p-value: test of equal coefficients	0.99		0.93		0.27	

Results from estimating $Outcome_{mt} = \alpha + \beta CL_{mt} + f(Pop_{mt} - 250) + u_{mt}$. The sample is restricted to PP (columns (1), (3), and (5)) or PSOE (columns (2), (4), and (6)) observations. Each column reports a separate local linear regression estimated with the bandwidth from Calonico, Cattaneo, and Titiunik (2014), a uniform kernel, and standard errors cluster by municipality and election period. Separate polynomials are fitted on each side of the threshold.

Dear Maria,

Thank you very much for your hard work editing our paper “Women’s Representation in Politics: The Effect of Electoral Systems”. We believe that the paper is much stronger after the review process, and are very happy that you think it is a nice contribution for the Journal of Public Economics.

We are attaching a new version of the manuscript addressing the two comments suggested by the referee:

Page 13 - I believe “observational” should probably be removed from the following sentence: “We show that, as the standard deviation of the observational error in voters’ observation of competence increases...” We have removed this word.

Subindix p - Perhaps the subindex p in Yp (Page 13) could be changed to avoid confusion with probability p. We have changed the subindex to “q”.

Please do not hesitate to let us know if you need any additional information to continue with the publication process.

We look forward to meeting you in the future.

Thank you,

Martín Gonzalez-Eiras and Carlos Sanz