Do Women Mayors Enhance Patent Innovation?

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Motivation

Women as political leaders

- Closing the (still-present) gender gap in political leadership.
  - Female parliamentary representation: 2% to 25% from 1970 to 2017
  - Female mayors: 2% to 18% from 1970 to 2005.
  - U.S. House of Representatives: 2.8% to 23.4% from 1971 to 2019.
- Effect on women leaders on policy outcomes
  - Women mayors: no effect on spending, employment or crime rates – (Ferreira & Gyourko, 2014)
  - Female local leaders: ↑ public investments (clean water, educ. attainment) in India (Chattopadhyay & Duflo, 2004; Clots-Figueras, 2012)
  - Women in state legislatures: ↑ spending on education and health issues (Besley & Case, 2003)

What about innovation?

- Women leaders $\rightarrow$ long-run policy view $\rightarrow$ more local innovation?
- Women leaders $\rightarrow$ more female inventors?
  - Bell, Chetty, Jaravel, Petkova & Van Reenen (*QJE*, 2018): "women are much more likely to patent in a specific technology class if female workers in their childhood CZ were especially likely to patent in that class"

Data and merging

Mayoral elections data

- 1970-2016 city, state, month/year election, name, party, votes of winner and runner-up (Ferreira & Gyourko, 2011; Kessner, 2016).

Gender of candidates and patentees

- Match first names with U.S. Census common names list
- Manual match ambiguous names (Ferreira & Gyourko, 2014)
- New gender data on patentees from USPTO.

Match to patent data on address information

- USPTO Public PAIR – inventor or assignee address.

Empirical specification – Validity

- Endogeneity: Female mayorships are not randomly assigned to US cities!
  - They happen for a reason. (e.g. more progressive cities also more innovative)

  → Whether or not a female candidate leads a given city is determined by local developments that are unobserved by the researcher.

- Identification: Regression Discontinuity (RD) Design

  → Narrowly decided races provide quasi-random variation in mayoral winners, because which race wins is likely to be determined by pure change or idiosyncratic factors (Lee, 2008).

- Sample constraint: male/female election pairings.

  → 1,237 out of 5,000 total elections.

Outcome variable of interest

- Amount of local innovation
  - # of patents, # of patent applications.
  - Differentiate by type of innovation.
- Gender of inventor
  - # of female inventors, avg. # female inventors per patent application.
  - Order of inventors listed on patent.
- Mechanism?
  - Invention categories/first-time inventors or assignees.

RD: short-run effects

$$Innovation_{c,t+1} = \beta_0 + \theta_1 female_{c,t} + P(\beta, vote\_margin_{c,t}) + \gamma X_{c,t} + \epsilon_{c,t},$$

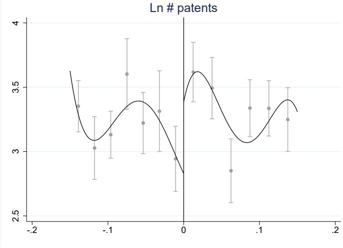
$$\forall \; margin_c \in (\text{cutoff} - h, \text{cutoff} + h).$$

- $Innovation_{c,t+1}$: in city c at time t – various patent counts.
- $female_{c,t}$: 1 if female candidate won election in city c at time t, 0 if female candidate lost the race.
- $vote\_margin_{c,t}$: votes received by female candidate/total votes
- $X_{c,t}$ predetermined control variables (e.g., log(population), median HH income, home ownership rate, poverty rate.

Bandwidth selection *h*

- MSE-optimal algorithm by Calonico et al. (2014).

RD plots


Ln # patents
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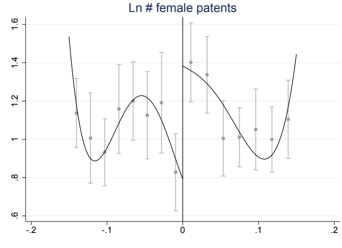
3.5
3
2.5
-.2
-.1
0
.1
.2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1.4
1.2
1
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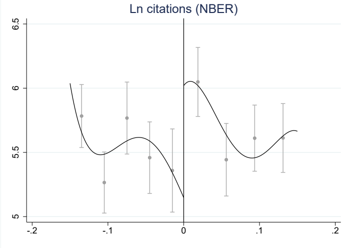
.6
-.2
-.1
0
.1
.2


Ln citations (NBER)
6.5
6
5.5
5
-.2
-.1
0
.1
.2

RD effects - Baseline results I

Table 2: The Effect of Female Mayorships on Innovation: RD Estimates with Controls

	# Patents		# Patents (scaled)		Ln # patents		Citations	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Female Win	41.563***	3.863***	0.058***	0.006***	0.548***	0.534***	1274.179**	0.814***
	(9.28)	(1.03)	(0.01)	(0.00)	(0.06)	(0.08)	(612.74)	(0.11)
Obs.	3,800	3,800	3,800	3,800	3,800	3,800	3,800	3,800
Eff. Obs.	726	763	651	581	1,319	763	1,323	1,141
Bandwidth	0.07	0.07	0.06	0.06	0.13	0.07	0.13	0.11
Polynomial Order	1	1	1	1	1	1	1	1
Covariates	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table presents regression discontinuity treatment effects based on polynomial regressions using the rdrobust command in Stata. The assignment variable is the female vote margin as defined as the difference between the vote share of the female candidate and the vote share of the male competitor. The bandwidth is calculated by the mean-squared-error (MSE) bandwidth selector. The polynomial order describes the functional form of the assignment variable. The dependent variables in column 1 is the total number of issued patents for each year in the first mayoral term for all inventors; in column 2, this count is limited to just female inventors. Columns 5-6 have the same outcomes as columns 1-2, except the counts are logged. The outcomes in columns 3-4 are patent outcomes of the first two columns scaled by city population size as of the election year (interpolated if missing). Columns 7-8 show the number of citations and log citations, respectively, for all issued patents, as calculated in the National Bureau of Economic Research dataset. Standard errors are in parentheses. "Robust" is the robust nearest neighbor variance estimator clustered at the city level. All treatment effects are estimated based on the effective observations; this refers to observations within the optimal bandwidth when using robust standard errors. The covariates are all measured in the election-year and consist of: log(population), homeownership rate, log(employed persons), log(persons in poverty).

***p < .01, **p < .05, *p < .1.

RD effects - Baseline results II

Table 4: The Effect of Female Mayoral Incumbency on Innovation: RD Estimates with Controls

	# Patents		# Patents (scaled)		Ln # patents		Citations	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Female Win	66.454***	6.161***	0.019***	0.006***	0.081	0.395***	1871.482***	-0.017
	(16.25)	(1.60)	(0.01)	(0.00)	(0.11)	(0.12)	(690.23)	(0.20)
Obs.	1,686	1,686	1,686	1,686	1,686	1,686	1,686	1,686
Eff. Obs.	383	471	343	244	455	507	383	723
Bandwidth	0.13	0.16	0.11	0.08	0.15	0.17	0.13	0.22
Polynomial Order	1	1	1	1	1	1	1	1
Covariates	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table presents regression discontinuity treatment effects based on polynomial regressions using the rdrobust command in Stata. The assignment variable is the female vote margin as defined as the difference between the vote share of the female candidate and the vote share of the male competitor. The bandwidth is calculated by the mean-squared-error (MSE) bandwidth selector. The polynomial order describes the functional form of the assignment variable. The dependent variables in column 1 is the total number of issued patents for each year in the first mayoral term for all inventors; in column 2, this count is limited to just female inventors. Columns 5-6 have the same outcomes as columns 1-2, except the counts are logged. The outcomes in columns 3-4 are patent outcomes of the first two columns scaled by city population size as of the election year (interpolated if missing) . The last two columns show the number of citations for all issued patents, as calculated by the National Bureau of Economic Research. Standard errors are in parentheses. "Robust" is the robust nearest neighbor variance estimator clustered at the city level. All treatment effects are estimated based on the effective observations; this refers to observations within the optimal bandwidth when using robust standard errors. The covariates are all measured in the election-year and consist of: log(population), homeownership rate, log(employed persons), log(persons in poverty) and Treasury rates. ***p < .01, **p < .05, *p < .1.

Validity and Robustness

- Validity
  - **McCrary (2008) test**: p-value of 0.26 failing to reject the null hypothesis of no difference in the density of treated and control observations at the cutoff. ▸ Figure
  - **Balanced covariate checks**: no discontinuity of the control variables at the cutoff. ▸ Figure

- Robustness
  - **Alternative specifications**: robust to quadratic or cubic polynomials and controlling for party affiliation.
  - **Location**: robust to assignee location.
  - **Bandwidth and polynomial order sensitivity**: insensitive to different bandwidth choices. ▸ Figure ▸ Benchmark

Conclusion

- This paper finds that women mayors lead to higher innovation activity.
- Long-term effects:
  - Long-tenured women mayors also outperform male long-tenured mayors in terms of local innovation activity.
- Channel
  - To be done.

Thank you for your attention!

Validity: Covariate checks

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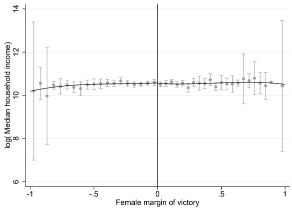

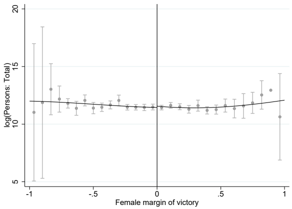

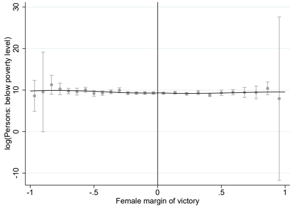

Validity I: Manipulation/validity test

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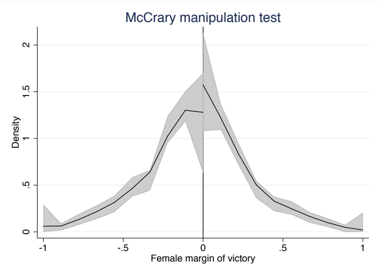

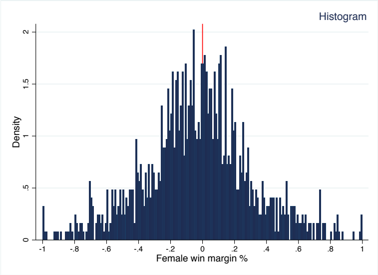

Notes: This graph shows the distribution of the assignment variable for the interracial elections. The assignment variable is the vote share of the black candidate with the cut-off being 50%. Subgraph (a) displays the histrogram of the black vote share. Subgraph (b) reports a local polynomial density plot of the black vote share with 95% confidence intervals to show whether there is a discontinuity at the winner threshold. Vertical lines in both subgraphs denote the 50% cut-off. RD Manipulation Test using local polynomial density estimation delivers a p-value of 0.39 failing to reject the null hypothesis of no difference in the density of treated and control observations at the cutoff.

RD Specifications published in Top Journals

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Main Specification	Number of Papers	1999-2010	2011-2017
Local constant	11	8	3
Local linear	45	9	36
Local quadratic	6	1	5
Local cubic	5	4	1
Local quartic	2	2	0
Local 7th-order	1	1	0
Local 8th-order	1	0	1
Local (but did not mention)	5	0	5
Total local	76	25	51
Global linear	4	1	3
Global quadratic	4	0	4
Global cubic	11	5	6
Global quartic	4	2	2
Global 5th-order	1	0	1
Global 8th-order	1	0	1
Global (but did not mention)	1	0	1
Total global	26	8	18
Did not mention preferred specification	8	2	6
Total	110	35	75

Table: Pei, Card, Lee and Weber (2018) surveyed empirical RD papers published between 1999 and 2017 in the following leading journals: Amercican Economic Review, American Economic Journals, Econometrica, Journal of Political Economy, Journal of Business and Economic Statistics, Quarterly Journal of Economics, Review of Economic Studies, and Review of Economics and Statistics in our survey.